MDS™ ORBIT MCR

Multiservice Connect Router

MDS™ ORBIT ECR

Edge Connect Router

MDS Orbit MCR/ECR Technical Manual, Rev. Q
July 2026

Including Updates through Firmware Revision 9.10.0+

GE VERNOVA

Technical Manual

View instructional videos: MDS Orbit MCR Learning and Development YouTube Channel

Quick-Start instructions for this product are contained in publication 05-6709A01.

Visit our website for downloadable copies of all documentation.

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Copyright and Trademark

RF Regulatory Information

RF Safety Notice (English and French)

RF Exposure

Concentrated energy from a directional antenna may pose a health hazard to humans. Do not allow people to come closer to the antenna than the distances listed in the table below when the transmitter is operating. More information on RF exposure can be found online at the following website: www.fcc.gov/oet/info/documents/bulletins

l'exposition aux RF

Concentré d'énergie à partir d'une antenne directionnelle peut poser un risque pour la santé humaine. Ne pas permettre aux gens de se rapprocher de l'antenne que les distances indiquées dans le tableau ci-dessous lorsque l'émetteur est en marche. Plus d'informations sur l'exposition aux RF peut être trouvé en ligne à l'adresse suivante: www.fcc.gov/oet/info/documents/bulletins

Professional installation required. Antennas must not be co-located. All transmission antennas must be at least 20 cm apart to comply with FCC co-location rules.

Orbit Device vs. Minimum RF Safety Distance

Radio Module Equipped	Minimum Safety Distance from Antenna
Cell	33 cm
NX915	23 cm
LN100/LN200	164 cm - *using 5 dBi antenna* 292 cm - *using 10 dBi antenna* 617 cm - *using 16 dBi antenna*
LN400/LN700	143 cm - *using 5 dBi antenna* 254 cm - *using 10 dBi antenna* 507 cm - *using 16 dBi antenna*
LN900	108 cm - *using 5 dBi antenna* 192 cm - *using 10 dBi antenna* 382 cm - *using 16 dBi antenna*
Other models	Consult factory prior to operation.

NOTE THE ORBIT MCR/ECR DOES NOT SUPPORT VOICE COMMUNICATIONS

FCC Class A Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Modifications: Any modifications made to this device that are not approved by GE Vernova MDS LLC may void the authority granted to the user by the FCC to operate this equipment.

Industry Canada Notice

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Operational Safety Notices

The MDS Orbit may not be used in an environment where radio frequency equipment is prohibited or restricted in its use. This typically includes aircrafts, airports, hospitals, and other sensitive electronic areas.

Do not operate RF devices in an environment that may be susceptible to radio interference resulting in danger, specifically:

- **Areas where prohibited by law -** Follow any special rules and regulations and obey all signs and notices. Do not use the Orbit when you suspect that it may cause interference or danger.
- **Near Medical and life support equipment -** Do not use the Orbit in any area where medical equipment, or life support equipment may be located, or near any equipment that may be susceptible to any form of radio interference.
- **All cables and conductors making connections to the units need to be rated at 85 °C or higher.**
- **Use Copper Conductors Only**
- **Use 18 AWG wire**

Regulatory Limitations

Some product options including hardware and software configuration settings may be restricted based on applicable region-specific regulatory constraints. Shielded Cat 6 cables or higher are required for use. Professional installation required.

FCC IDs of Installed Transmitters

As of the printing date, the following identifiers are assigned to the modules listed below. For the latest, official listings of all agency approvals, please contact your factory representative.

Config. Id – Radio Desc.	FCC ID	IC ID
E4V - 4G/3G CELL Modem	PKRNVWE362	3229B:E362
3G1 - 3G CELL Modem	RI7HE910	5131A-HE910
E4S,E42 - 4G/3G CELL Modem	n/a	n/a
4G1,4G2,4G3,4G4,4G5 - 4G/3G CELL Modem	N7NMC7355	2417C-MC7355
4GP - 4G/3G CELL Modem	N7NMC7354B	n/a
4Gy – 4G/3G CELL	N7NMC7455 E5MDS-4GY	2417C-MC7455
4Gb – 4G/3G CELL	N7NEM75S	2417C-EM75S
4Ga – 4G/3G CELL	N7NEM75	2417C-EM75
4Gd – 4G/3G/2G CELL	XMR201903EG25G	10224A-201903EG25G
4Gc – 4G/3G CELL	RI7LE910CXWWX	5131A-LE910CXWWX
4Gg, 4Gf CELL Modem	n/a	n/a
W51 – Standard WIFI Module	M4Y-ZCN722MV1	3195A-ZCN722MV1
W52 – Enhanced WIFI Module	2AG87NM-DB-3N 2AG87NM-DB-3N-R2	n/a 21411-NMDB3R2
W53 – Standard WIFI Module	E5MDS-AC720M	n/a
NX915 Module	E5MDS-NX915	101D-NX915
LN100 Module	E5MDS-LN100	101D-LN100
LN200 Module	E5MDS-LN200	101D-LN200
LN400 Module	E5MDS-LN400	101D-LN400
LN700 Module	E5MDS-LN700	n/a
LN900 Module	E5MDS-LN900 E5MDS-LN900-1	101D-LN900
LW700 Module	E5MDS-LW700	n/a

Country-Specific Installation Data

Refer to APPENDIX J – Country Specific Information at the back of this manual for important notices regarding installation in specific countries.

Servicing Precautions

No user-serviceable parts are contained inside this equipment. Opening of the unit by unauthorized personnel voids the warranty. All servicing must be performed by an authorized repair facility.

When servicing energized equipment, be sure to wear appropriate Personal Protective Equipment (PPE). During internal service, situations could arise where objects accidentally contact or short circuit components and the appropriate PPE would alleviate or decrease the severity of potential injury. When servicing equipment, all workplace regulations and other applicable standards for live electrical work should be followed to ensure personal safety.

Manual Revision and Accuracy

This manual was updated to cover a range of firmware releases. Accordingly, some screens and features may differ from the actual unit you are working with. While every reasonable effort has been made to ensure the accuracy of this publication, product improvements may also result in minor differences between the manual and the product shipped to you. If you have additional questions or need an exact specification for a product, please contact us by visting our website.

Environmental Information

The manufacture of this equipment has required the extraction and use of natural resources. Improper disposal may contaminate the environment and present a health risk due to hazardous substances contained within. To avoid dissemination of these substances into our environment, and to limit the demand on natural resources, we encourage you to use the appropriate recycling systems for disposal. These systems will reuse or recycle most of the materials found in this equipment in a sound way. Please contact GE Vernova or your supplier for more information on the proper disposal of this equipment.

Battery Disposal—This product may contain a battery. Batteries must be disposed of properly and may not be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. Batteries are marked with a symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point. For more information see:
www.weeerohsinfo.com.

Cyber Security Policy

As part of GE Vernova’s commitment to product safety, quality and reliability and to reduce risk exposure for GE Vernova and our customers, the “GE Vernova Product Cyber Security Standard” (the Policy) outlines the requirements that GE Vernova Business Units must meet. The Policy, requires each GE Business Unit to implement reasonable, industry-specific measures designed to protect all GE Vernova products and services, including all relevant components and services sourced from third parties, from cyber security threats throughout their supported life cycle.

Product Test Data Sheets

Test Data Sheets showing the original factory test results for this unit are available upon request from the product line Quality Leader. Contact the factory using the information at the back of this manual. Serial numbers must be provided for each product where a Test Data Sheet is required.

Safety Regulatory Information – (region-specific)

CE Mark

This product, using either "Standard WIFI", "Enhanced WiFi", "4G LTE", "LN100 radio module", or "LN400 radio module" with a CE mark, indicates compliance with ETSI RE directive (RED).

This product, using "BPL Interface" with a CE mark, indicates compliance with EMC Directive 2014/30/EU and Low Voltage Directive LVD 2014/35/EU.

To confirm if a specific model complies, ensure that the CE mark is present on the product serial number label.

CE General Safety - IEC/CSA/EN62368-1 (applicable for CE marked units)

This product meets CE and General Safety requirements subject to the following constraints:

- Power supply unit will be provided by the end users and installed indoor only. It shall be a certified SELV (Safety Extra Low Voltage) LPS (Limited Power Source) output rated 11-55Vdc, 100W max.
- To reduce the risk of electric shock, this equipment must be installed or serviced by trained personnel in a restricted access location as defined by EN62368-1.
- Power (11-55Vdc)

UL - CSA/us Notice (NOT applicable to CE marked units)

This product is approved for use in Class 1, Division 2, Groups A, B, C & D Hazardous Locations. Such locations are defined in Article 500 of the National Fire Protection Association (NFPA) publication NFPA 70, otherwise known as the National Electrical Code. The transceiver has been recognized for use in these hazardous locations by the Canadian Standards Association (CSA) which also issues the US mark of approval (CSA/US). The CSA Certification is in accordance with CSA STD C22.2 No. 213-M1987.

CSA Conditions of Approval: The transceiver is not acceptable as a stand-alone unit for use in the hazardous locations described above. It must either be mounted within another piece of equipment which is certified for hazardous locations, or installed within guidelines, or conditions of approval, as set forth by the approving agencies. These conditions of approval are as follows: The transceiver must be mounted within a separate enclosure which is suitable for the intended application. The antennas are not intended to be installed and mounted in a Class 1, Division 2 hazardous location. The antenna feedline, DC power cable and interface cable must be routed through conduit in accordance with the National Electrical Code. Installation, operation and maintenance of the transceiver should be in accordance with the transceiver's installation manual, and the National Electrical Code. **Tampering or replacement with non-factory components may adversely affect the safe use of the transceiver in hazardous locations and may void the approval.** A power connector with screw-type retaining screws as supplied by GE Vernova MDS must be used.

Use of this product in a manner not specified by GE Vernova MDS may cause impairments to protection.

NOTE This equipment is not suitable for use in locations where children are likely to be present

Hot Surface Warning

Integrated heatsink surface may be hot while in operation. Do not handle in high ambient environments.

Product Country Certification Information – (Non-NA/EU)

Selected Country Certification Information

Australia

Brazil

Homologation Number varies based on the model and model options chosen.

Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados.

Este dispositivo está em conformidade com as diretrizes de exposição à radiofreqüência quando posicionado a pelo menos 20 centímetro de distância do corpo. Para maiores informações, consulte o site da ANATEL – www.anatel.gov.br

Japan

R 003-140073

T D140039003

Mexico

- IFT Homologation Number varies based on the model and model options chosen.

La operación de este equipo está sujeta a las siguientes dos condiciones:

1. es posible que este equipo o dispositivo no cause interferencia perjudicial y

2. este equipo o dispositivo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada.

New Zealand

Z1300

Philippines

Conformity Number: ESD-GEC-1402584

NTC

South Africa

ICASA

TA-2014/755

APPROVED

UAE

- Registered number = ER0133084/14
- Dealer number = DA0132013/14
-

ECR Selected Country Certification Information

- (consult factory)

1.0 Product Overview and Applications

1.1 Introduction

This manual describes the MDS™ Orbit Multiservice Connect Router (MCR) (Figure 1-1), and the MDS™ Orbit Edge Connected Router (ECR) (Figure 1-2) . The unit is a highly secure, industrial grade, wireless communication product for broad-based applications, including control center monitoring, well site pad operations and video surveillance. It serves the need for localized WiFi communications with a cellular back-up or backhaul option, while providing the extended temperature range and industrial-grade packaging inherent to GE Vernova MDS products. These features allow the best use of communication options at each installation site.

Figure 1-1. MCR-4G Unit
(Standard 2E1S configuration shown)

Figure 1-2. ECR-900 Unit

With a common hardware architecture and user interface, the MCR and ECR offers flexibility in network design and application, with simplified training, maintenance and deployment costs. GE Vernova MDS provides an array of communication products with multiple interface options and a variety of enclosures to give customers the choice and flexibility to design their communications network to meet geographic and industry specific challenges. Information on other products can be found by visiting our website.

There is a series of instructional videos for configuration and setup of the MDS Orbit product on YouTube™. These are available free of charge at: http://tinyurl.com/pey2ull

1.1.1 Product Variations

The MDS Orbit MCR is factory configured with various Network Interface Cards (NICs), based on order selection.

The label on the bottom of the unit identifies the radio model as MDS MCR. It includes the device serial number and agency/regulatory identifications, including IDs for applicable embedded modules. See “Agency/Regulatory Approvals” on Page 504 for more information.

Orbit MCR devices with specific network interfaces may be referred to with the common names below:

- MCR-4G — Name for the product when configured with 4G/LTE
- MCR-900 — Name for the product when configured with unlicensed 900 MHz (FHSS and DTS).
- MCR-LN — Name for the product when configured with licensed narrowband QAM radios.

The MDS™ Orbit ECR is factory configured with various Network Interface Cards (NICs), based on order selection.

The label on the bottom of the unit identifies the radio model as MDS ECR. It includes the device serial number and agency/regulatory identifications, including IDs for applicable embedded modules. See “Agency/Regulatory Approvals” on Page 504 for more information.

Orbit ECR devices with specific network interfaces may be referred to with the common names below:

- ECR-4G — Name for the product when configured with 4G/LTE
- ECR-900 — Name for the product when configured with unlicensed 900 MHz (FHSS and DTS).
- ECR-LN — Name for the product when configured with licensed narrowband QAM radios.

Depending on NIC configuration other marketing names may sometimes be used.

- MDS Orbit PowerNet refers to Orbit devices equipped with a wireline/power line communication interface.

Select MDS Orbit models can be ordered with an Edge Compute interface for advanced applications. Consult your Sales Represenative for more detail.

1.1.2 About This Manual

This manual is intended for systems engineers, network administrators and others responsible for planning, commissioning, using and troubleshooting the wireless system. Installation steps are *not* included in this publication. For installation instructions, refer to the companion *Orbit MCR Setup Guide*, part no. 05-6709A01 or *Orbit ECR Setup Guide*, part no. 05-6709A02. Note that Profession installation is required. Electronic copies of all user documentation are available free of charge on our website.

INSTALLATION & SETUP GUIDES

The MDS Orbit MCR Setup Guide, part no. 05-6709A01 and Orbit ECR Setup Guide, part no. 05-6709A02 contain installation instructions, as well as basic startup information for these products. 05-6709A03 provides a customized guide for MDS Orbit MCR/ECR ETSI configurations..

All user manuals and updates are available online.

Software Command Notations

The product is designed for software control via a connected PC. As such, there are no external controls or adjustments present. To show the names of software commands, keyboard entries, or other information displayed on a PC screen, a bolded font is used throughout the manual. In the case of tabular data displayed on a PC screen, a variation on this font is used to maintain proper layout. See examples that follow.

Bolded font example (used in text for software commands and keyboard entries)

Bolded font example (used to show tables displayed on a PC screen)

In the Device Management section of this manual (Page 43), there are a number of command strings where information is presented by the unit and a reply is required from the user. In such cases, information from the unit is shown in a non-bolded font and the user response is shown in bold. For example:

(none) login: **admin**

Further, in some cases, command lines will be shown with non-bolded, *italicized* text contained within the string. Such text indicates the need for user-supplied variable parameters, such as the name of an item. For example:

% set interfaces interface *myBridge* **type bridge**

In the above example, you would enter the specific name of your bridge to complete the entry.

NOTE The LAN port should be assigned IP addresses only if it is a routed interface (that is, not in a bridge).

NOTE The software commands and responses shown in this manual were obtained from a unit operating in a lab environment. The information displayed may differ from field service conditions.

2.0 Product Description

The Orbit MCR and ECR are rugged networking routers providing comprehensive solutions for IP/Ethernet, SFP, serial and machine-to-machine wireless communication.

2.1 Key Features

Orbit units include the following key features:

- **Security**—The unit uses industry-leading security features to protect data while maintaining compatibility with deployed infrastructures. Features include FIPS 140-2 certified mode, AAA user access with passwords and lockout protection, VPN (IPSec), signed firmware, secure booting, integrity management and more.

NOTE The Orbit device is designed for high security environments. As such, management of the device does not support Telnet, but instead implements the more secure SSH protocol.

- **Small Form Factor**—The unit is housed in a rugged enclosure suited for operation in harsh industrial environments. It requires only protection from direct exposure to the weather and may be easily mounted inside a NEMA enclosure for outdoor applications when required.
- **Network Interfaces**—Several network interfaces are present to provide connectivity for a variety of equipment and applications. Ethernet, SFP, serial and WiFi interfaces provide local connections while a cellular interface provides access to public carrier networks.
- **User Interface**—Multiple user interfaces are provided for configuration and monitoring of the unit. These include local serial console, web, SSH and USB.

NOTE For units certified and installed in hazardous locations, use only the serial, Ethernet, or SFP connections on the unit's front panel. Do *not* use the USB port in hazardous locations.

- **Network Management System**— Orbit is supported by MDS PulseNET, a Network Management System (NMS), providing monitoring of small- and large-scale deployment of all MDS devices.
- **Tamper Detection**—The unit contains a 3-axis magnetometer that can be used to detect changes to the unit's physical environment after installation and generate notification of the change if it exceeds configurable thresholds. See "Tamper Detection" on Page 248.

2.2 Interface Types

- ECR units are provide external interfaces 1 Ethernet, 1 Serial and 1 USB.
- MCR units are offered with a varietry of external interface offerings; 2 Ethernet/1 Serial (2E1S), 2 Serial/1 Ethernet (2S1E), 4 Ethernet/2 Serial (4E2S), 6 Ethernet/1 USB-serial, 2 Ethernet/2 Serial/1 SFP socket.
- The MCR with 2E1S and 2S1E each support up to 2 Network Interface Cards. Other configurations only support one. Most information applies equally to all configurations.

2.3 Network Interface Cards (NICs)

2.3.1 Cell Modules

Orbit supports a variety of 4G LTE/3G modules for use in the United States and internationally. The device supports routing of TCP/UDP/IP data to/from the Cellular WAN network interface from/to any of the other network interfaces using the IPsec VPN or network address and port translation (NAPT) feature, and from/to a serial port using the terminal server service. The configuration of these use cases is specified in respective sections on VPN, Firewall and NAT and Terminal Service.

The cellular modems support main (primary) and secondary antenna (for receive diversity and MIMO). The primary antenna must be installed for cell modem to register with the cellular network. It is strongly recommended that a secondary antenna be installed for achieving a robust cellular link.

Cellular technology continues to evolve rapidly. Current shipping Orbit units support modules equipped for dual SIM operation. Current versions of Orbit firmware support all previous models, but not all are documented in this manual. Please see older revisions of the Orbit MCR/ECR Technical Manual for information on older modules.

2.3.1.1 4G LTE-A Cat-6, DC-HSPA+, Dual SIM (North America) – 4Gy

This 4G modem supports following technologies:

- LTE FDD Bands: 1, 2, 3, 4, 5, 7, 12, 13, 20, 25, 26, 29, 30
- LTE TDD Bands: 41
- UMTS/DC-HSPA+ Bands: 1, 2, 3, 4, 5, 8

NOTE LTE Band 8 supports Anterix™ / US 900MHz Private Broadband (39MHz duplex)

Orbit equipped with this modem is PTCRB and GCF certified for operation on 4G/3G networks in North America and EU. It is also certified for operation on Verizon, AT&T, Bell, TELUS networks.

2.3.1.1 4G LTE Cat-4, DC-HSPA+, Dual SIM (North America) – 4Gc

This 4G modem supports following technologies:

- LTE FDD Bands: 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 19, 20, 26, 28
- UMTS/DC-HSPA+ Bands: 1, 2, 4, 5, 8, 19
- GSM/GPRS/EDGE Bands: 850/900/1800/1900MHz

NOTE LTE Band 8 supports Anterix™ / US 900MHz Private Broadband (39MHz duplex)

Orbit equipped with this modem is PTCRB certified for operation on 4G/3G/2G networks in North America. It is also certified for operation on Verizon and AT&T networks.

2.3.1.2 4G LTE-A Pro Cat-12, DC-HSPA+, Dual SIM (Brazil/Australia) – 4Ga

This 4G modem supports following technologies:

- LTE FDD Bands: 1, 2, 3, 4, 5, 7, 8, 9, 12, 13, 18, 19, 20, 26, 28, 29, 30, 32, 66
- LTE TDD Bands: 41, 42, 43, 46, 48
- UMTS/DC-HSPA+ Bands: 1, 2, 4, 5, 6, 8, 9, 19

Orbit equipped with this modem is certified for use in Brazil (ANATEL) and Australia (ACMA).

2.3.1.3 4G LTE-A Pro Cat-12, DC-HSPA+, Dual SIM (FirstNet B14, CBRS) – 4Gb

This 4G modem supports following technologies:

- LTE FDD Bands: 1, 2, 3, 4, 5, 7, 8, 9, 12, 13, 14, 18, 19, 20, 26, 29, 30, 32, 66
- LTE TDD Bands: 41, 42, 43, 46, 48 (CBRS)
- UMTS/DC-HSPA+ Bands: 1, 2, 4, 5, 6, 8, 9, 19

Orbit equipped with this modem is PTCRB certified for operation on Verizon, AT&T. It is also certified as FirstNet Ready™ with support for B14.

NOTE FirstNet Ready™ Orbits need to be special ordered to ensure they come with required factory default configuration.

2.3.1.4 4G LTE Cat-4, DC-HSPA+, Dual SIM (EMEA/LATAM) – 4Gd

This 4G modem supports following technologies:

- LTE FDD Bands: 1, 2, 3, 4, 5, 7, 8, 12, 13, 18, 19, 20, 25, 26, 28
- LTE TDD Bands: 38, 39, 40, 41
- UMTS/DC-HSPA+ : 1, 2, 4, 5, 6, 8, 19
- GSM/GPRS/EDGE Bands: 850/900/1800/1900MHz

Orbit equipped with this modem is GCF certified for operation on 4G/3G/2G networks in EU and LATAM.

2.3.1.5 4G Private LTE Cat-4, Dual SIM (EMEA/LATAM) – 4Gg/4Gf

These modems are intended for Private LTE deployments in the 410MHz & 450MHz bands, respectively.

The 4Gg modem supports following technologies:

- LTE FDD Bands: B3, B20, B87

The 4Gf modem supports the following technologies:

- LTE FDD Bands: B3, B7, B20, B31, B72

NOTE The 4Gf modem has a maximum recommended operating temperature of +65C

Orbit units equipped with 4Gg or 4Gf modules are intended for CE applications only.

2.3.2 External Interfaces

Orbit supports integration with select third-party devices.

2.3.2.1 FirstNet-enabled HPUE Cellular Modem

In this configuration the Orbit will present a fully integrated “Cell-HPUE” Interface, with configuration and display identical to that of a standard internal Cell Module (NIC card).

Key Characteristics:

- Works with AirgainConnect® AC-HPUE and Assured Wireless AW-12 modems
- Provides a Band 14 enabled, 3GPP Power Class 1 solution
- Standard cell configuration, status, statistics and alarm/event conditions are supported
- HPUE modem connects to Orbit’s mini-USB socket using mini-USB OTG host adapter/cable.

NOTE Use of the mini-USB in this configuration precludes use of the USB as a COM port

2.3.3 WiFi Modules

Orbit supports following types of WiFi modems:

- Standard WiFi operates on 2.4GHz ISM band and supports both access point, station/bridge modes and is limited to a maximum of 7 connected stations in AP mode. Standard WiFi is a special compact NIC and can be added as a secondary media to any model.
- Enhanced WiFi operates on either 2.4GHz or 5GHz ISM bands. It implements 2x2 MIMO operation for robust communication and supports an AP-Station mode for range extension. Enhanced WiFi allows up to 32 connected stations. Enhanced WiFi occupies a full NIC media slot and can only be used with another NIC media type in versions of the Orbit that offer 2 NIC slots.

2.3.4 900 MHz Unlicensed

900 MHz unlicensed operation is provided by the NX915 module. The NX915 provides long-distance communications with data rates ranging from 125 kbps to 1.25 Mbps, suitable to interface both Ethernet and Serial controllers such as PLCs, RTUs and SCADA systems. The NX915 NIC utilizes a combination of FHSS (Frequency Hopping Spread Spectrum), DTS (Digital Transmission System) and hybrid FHSS/DTS technologies to provide dependable wireless communications.

Key Benefits

- Multiple data rates to meet application range and link budget: 125 kbps, 250 kbps, 500 kbps, 1000 kbps, 1250 kbps
- Up to 60 miles LOS (Line of Sight)
- Single unit AP, Remote, or Store and Forward
- Low latency and robust proprietary Media Access Control specifically designed for 900 MHz communications
- High Reliability
  - Error detection and re-transmit on error for Unicast traffic
  - Repeat support for Multicast/Broadcast traffic
  - Interference avoidance will not carelessly send data if a particular frequency cannot support communications because of interference. Communications deferred until frequency becomes available or network moves to a new frequency
- Ability to skip frequency zones, useful for persistent interferes or co-located networks
- Fragmentation support to minimize on-air time in noisy environments
- Ad-hoc network discovery with multiple synchronization methods
- Fast mode for minimizing synchronization times
- Auto mode for discovering network modulation and optimal paths based on statistical analysis of the network
- Store and Forward
  - Supports up to 8-hops SAF level depth.
  - Supports multiple SAFs on any level.
  - Automatically adjusts Media Access scheme for SAF network to support simultaneous communications at alternating levels and minimize latency, using dynamic fragmentation.
  - Supports dynamic and static paths providing flexibility in designing the wireless network.

- Quality of Service (QoS)
  - Priority Queues
  - Source/Destination port and addresses
  - Protocol (UDP, TCP, etc.)

2.3.5 Licensed Narrowband

Licensed Narrowband operation is provided by the LN series NIC modules. Licensed Narrowband modules provide robust long-distance communication in channel bandwidth sizes of 12.5KHz, 25KHz and 50KHz using QAM and FSK technology.

LN modules provide suitable options to interface both Ethernet and Serial controllers such as PLCs, RTUs and SCADA systems. For QAM operation, depending on bandwidth, raw data rates range from 20kbps to 240kbps.

Key Benefits

- Bi-Directional Adaptive QAM Modulation (QPSK, 16QAM, 64QAM)
- Backward Compatible supporting substitution for Legacy remotes including x710A/C/M and SD (using equivalent X710 modems, operating in both transparent-serial and packet-with-mac modes)
- Up to 50 miles LOS (Line of Sight)
- Single unit AP or Remote
- Store and Forward – selectable based on operatin mode
- Low latency and robust proprietary Media Access Control specifically designed narrowband communications
- High Reliability
  - Error detection and re-transmit on error for Unicast traffic
  - Multiple Forward Error Correction (FEC) modes including adaptive FEC
- Quality of Service (QoS)
  - Priority Queues
  - Source/Destination port and addresses
  - Protocol (UDP, TCP, etc.)

2.3.5.1 Licensed Narrowband 3-Port Interface

Select Orbit MCR models allow Licensed Narrowband transceivers to be paired with Licensed Receive-Only modules providing advanced filtering options.

Units equipped with Receive-Only modules can operate in three different software-selectable antenna configurations.

- 1-Port ‘Classic’ Single TX-RX
- 2-Port ‘Split TX-RX’ Duplexer Ready
- 3-Port ‘Enhanced RX’ Single TX-RX with external filter on receive path

NOTE For best performance and system redundancy GE Vernova MDS recommends the Orbit Master Station for AP/base station sites.

Key Benefits of Advanced Filtering

- No insertion loss on the TX path – full output power is maintained
- Seamless duplexer integration
- RX-Only filtering for simplex
- RX-Only filtering for split-frequency
- Smaller external filter options than traditional duplexers

2.3.6 Licensed Wideband

Licensed Wideband operation is provided by the LW7 modules. Orbit's Licensed Wideband uses OFDM (orthogonal frequency-division multiplexing) technology to provide higher data rates than traditional narrowband radios, while still offering very robust long-distance communication.

LW7 can act as a higher capacity interface for Ethernet and Serial controllers such as PLCs, RTUs and SCADA systems or act as a backhaul for lower capacity systems. The LW7 operates in channel sizes of 195 KHz, 315 KHz, and 570 KHz offering gross date rates from 100 kbps to 1.6 Mbps.

Key Benefits

- Simple configuration
- Auto discovery allows remotes to learn network modulation and channel plan
- Over 20 miles LOS (Line of Sight)
- Bi-Directional Adaptive Modulation
- Single unit AP, Remote, or Store-and-Forward
- Low latency and robust proprietary Media Access Control
- High Reliability
  - Error detection and re-transmit on error for Unicast traffic
  - OFDM modulation with adaptive Forward Error Correction
- Quality of Service (QoS)
  - Priority Queues
  - Source/Destination port and addresses
  - Protocol (UDP, TCP, etc.)

2.3.7 BPL Interface

Broadband over Power Lines (BPL) is provided by the PL1 NIC module.

Broadband over Power Lines (BPL) is a a form of Power Line Communication (PLC) technology. By utilizing existing power lines for data transmission, BPL can expand broadband availability in areas where traditional connectivity options may be limited

Orbit implements a BPL NIC based on Nessum WIRE technology rooted in two international standards: IEEE 1901:2020 and ITU G.9905. In addition to power lines it can be used for other lines such twisted pair and coaxial cable.

Key Benefits

- Simple configuration
- Single unit Master or Terminal
- Auto discovery – self forming network
- Max Data rate 42 Mbps
- Long haul capability
  - Flexible Wavelet Channels
  - Tx Power (adjustable) up to -35 dBm/Hz
  - Sensitivity < -130 dBm/Hz
- Dual signal I/O for:
  - Resilient schemes
  - By-pass of signal obstacles
  - Media diversity
- Security
  - MAC address-based “allow” list authentication

2.3.7.1 Connection for BPL

Figure 2-1. ECR with BPL front panel view

Orbit with BPL implements a 6-pin 5.08MM pitch terminal block connector. For connecting copper pairs, the 6-pin BPL connector is generally suitable. The user shall wire A+ and A- to the associated coupler for Channel A and if the cable is shielded with ground wire, attach it to the ground on the outermost right pin. Similar connection is used for Channel B to connect to a second line.

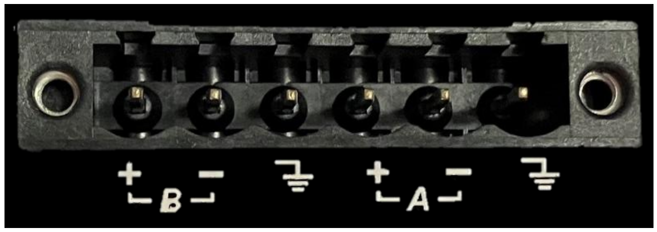

Figure 2-2. BPL 6-pin terminal block connector

NOTE For phase-to-phase coupling, the polarity becomes significant. Typically the user would connect the "+" lead to phase 1 and the "-" lead to phase 2.

For applications attaching a coupler to a BNC connector, GE VERNOVA cable accessories are available.

Table 2-1. Special Accessories for BPL

Item	Description	Part Number
6-pin connector	External mating part: CONN, TERMINAL BLOCK, 5.08mm, 6-PIN, PLUG, TOP LOAD, BLACK	73-1194A89 or Weidmüller 1948280000
BNC cable (single)	Cable 5.5", 6-pin BPL to Single Channel BNC	03-7288A01
BNC cable (dual)	Cable 5.5", 6-pin BPL to 2 Channel BNC	03-7288A02

2.3.7.2 Sample Configuration

Multiple BPL configurations are possible. The example below is a typical application for capacitive coupling connecting to different lines on the A and B side. The connection from the Orbit is via BNC coaxial connection to the coupler.

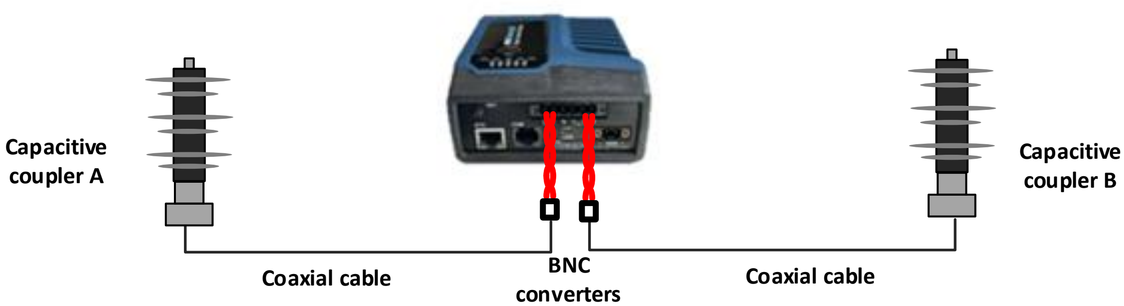

Figure 2-3. BPL example for capacitive coupling

2.4 Typical Applications

The unit provides flexibility in network communications and may be used in a wide variety of applications. In one common scenario, it provides cellular connectivity to locally-connected devices that are located on a local/internal/private LAN or WiFi network. The unit acts as an Access Point on the WiFi interface to provide connectivity to WiFi clients. Figure 2-4 shows an example network in which the unit provides connectivity to multiple end devices. The end devices are connected via Ethernet, serial and WiFi links.

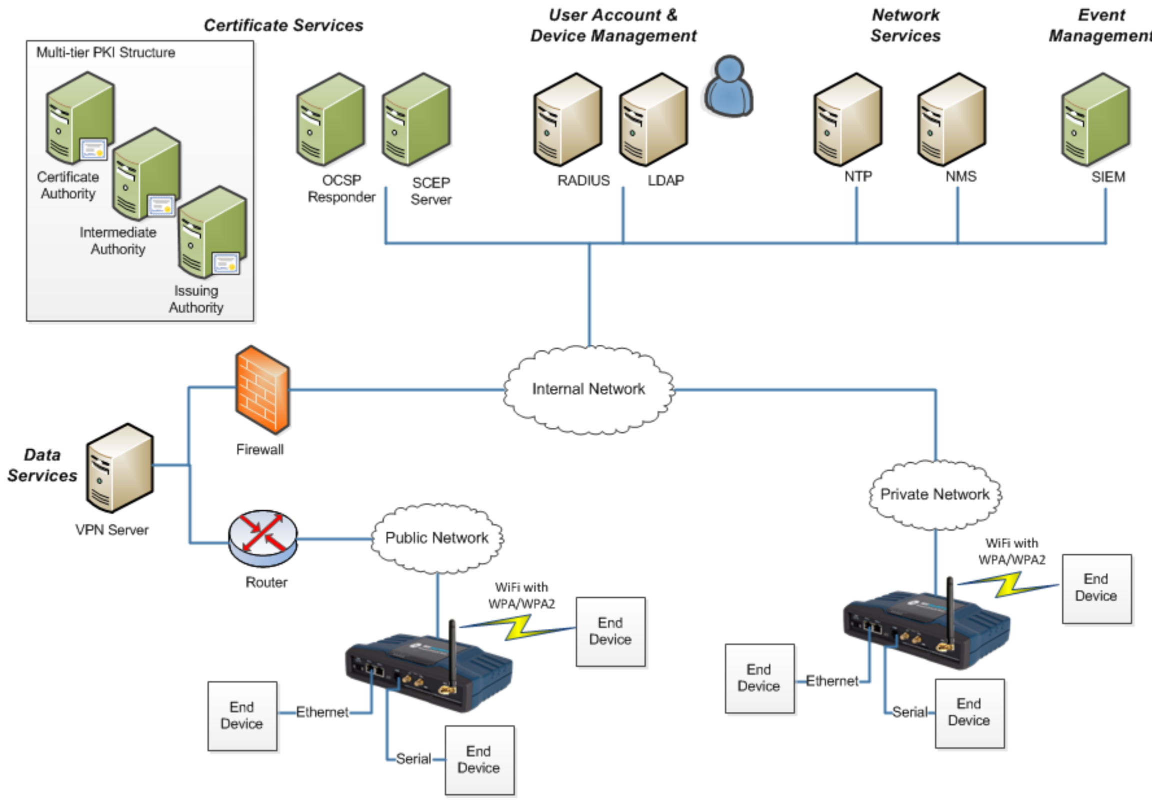

Figure 2-4. Typical Orbit Application

2.5 MCR and ECR Connectors and Indicators

Figure 2-5 shows the unit's front panel connectors and indicators. These items are referenced in the text that follows. The unit's LED Indicator Panel is described in Table 2-6.

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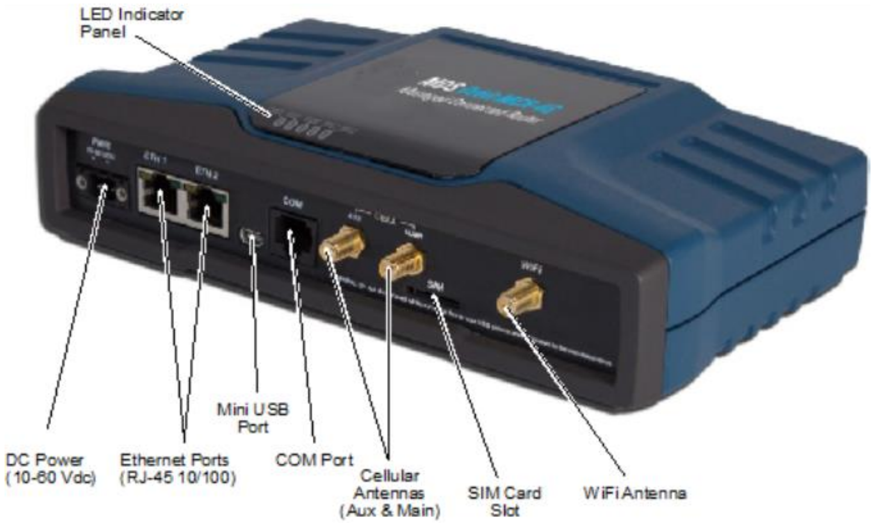


Figure 2-5. MCR Connectors and Indicators (Sample configuration with Cell, WiFi, two Ethernet and one Serial port)

Figure 2-6 shows the unit's front panel connectors and indicators. These items are referenced in the text that follows. The unit's LED Indicator Panel is described in Table 2-6.

Figure 2-6. ECR Connectors and Indicators (Sample configuration with Cell, WiFi, Ethernet and Serial port)

PWR—Two-conductor DC input connection (for 11-55 VDC)

- The DC power connector (Figure 2-7) is keyed and can only be inserted one way.
- Use Copper Conductors Only
- Use 18 AWG wire
- Tighten wire clamps to 5 lb-in. (0.6 Nm)

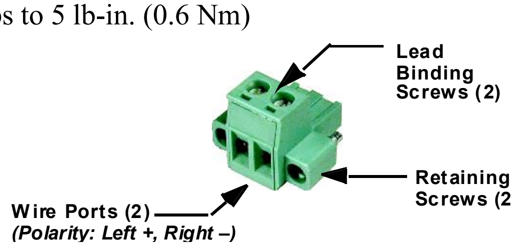


Figure 2-7. DC Power Connector (P/N 73-1194A53)

NOTE Standard Orbit models are designed for use in negative ground DC power systems only. Only use the power supply provided by the manufacturer for the product or a certified LPS power supply rated for nominal power 11-55 VDC, 4.5 A maximum must be used. Otherwise, safety of the product may be impaired. In case of doubt, please consult the local authorized suppliers.

For Standard Orbit models the input voltage to the unit must be well filtered and within the nominal range of 11-55 VDC.

PWR—Select Orbit models have a three-conductor DC input connection that supports +/-48 VDC (. It implements a power supply, supporting both positive and negative ground DC power systems. The positive ground is often found in telecommunication applications.

NOTE Orbit models with the 3-conductor input support nominal power of 48 VDC with maximum range -38.4V to -57.6V and +38.4V to +57.6V. Available options may be limited compared to standard Orbit models.

Figure 2-8. Connector configuration for 3-conductor models

For a positive ground system, the chassis ground (center) is connected to the positive power input (right). Follow the same guidance as Standard Orbit models to use Copper Conductors, 18 AWG wire, and tightening wire clamps to 5lb-in. (0.6 Nm)

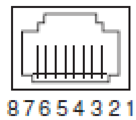
Figure 2-9. Mating connector for 3-conductor Power Connector (P/N 73-1194A22)

NOTE The mating connector shown here is upside down with respect to the Orbit connector and labels. Use caution when wiring for your intended application.

The maximum rated power consumption of the device is 15 watts, but actual power may be much less, depending on configuration. The power supply must be capable of supplying the expected maximum power for the installation. Polarity must match the diagram above, but reverse polarity protection is provided. For expected power requirements in common configurations, see “Technical Specifications on Page 502.

ETH*n*— Ethernet connection ports. These ports support both device management and payload data transport. Depending on ordered options, the unit may have one to six Ethernet ports. This is a standard RJ-45 jack and features MDIX auto-sensing capability, allowing straight-through or crossover cables to be used.

Connecting to the unit via SSH supports device management and provides the same user interface available using the unit’s COM1 serial port. Various options are available for passing Ethernet data, allowing system administrators to optimize the configuration for maximum efficiency, based on the system's operating characteristics.



(As viewed from the outside the unit)

Table 2-2. ETH1/2 Pin Details

Pin	Function	Pin	Function
1	Transmit Data (TX) High	5	Unused
2	Transmit Data (TX) Low	6	Receive Data (RX) Low
3	Receive Data (RX) High	7	Unused
4	Unused	8	Unused

SFP— The SFP port on Orbit is a socket that accepts standard small-pluggable-form-factor transceiver modules. These are typically used for Fiber connections but can support copper connections as well. SFP ports behave similar to ethernet and support both device management and payload data transport. Digital Diagnostic Monitoring (DDM) is supported for standard interfaces. Contact your sales representative for information on available SFP module offerings.

USB Port—This port allows for connection of a laptop or PC. The port provides a local console for management of the device. A standard host-to-mini device USB 2.0 cable may be used.

COM1/COM2 Port—This connector serves as the serial interface port for both console management and payload data. Depending on ordered options, the unit may have one or two COM ports. By default, the port is enabled for local console control. The COM port serves as the primary interface for connecting the unit to an external DTE serial device supporting RS-232 or RS-485. If necessary, an adapter may be used to convert the unit's RJ-45 serial jack to a DB-9F type (MDS 73-2434A25).

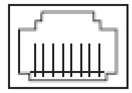
NOTE Not all PCs include a serial port. If one is not available, the unit's USB port may be used to access the device management interface. Alternatively, a PC's USB port may be used with a USB-to-Serial adapter and appropriate driver software. These devices are available from several manufacturers. A video covering USB driver installation may be accessed from the following link: http://tinyurl.com/pey2ull

The COM port supports a serial data rate of 1200-230400 bps (115200 default, asynchronous only). The unit is hardwired as a DCE device. Supported data formats for the COM port are:

8N1 - 8 char bits, no parity, 1 stop bit *(Default setting)*
8N2 - 8 char bits, no parity, 2 stop bits
8O1 - 8 char bits, odd parity, 1 stop bit
8O2 - 8 char bits, odd parity, 2 stop bits
8E1 - 8 char bits, even parity, 1 stop bit
8E2 - 8 char bits, even parity, 2 stop bits
7N1 - 7 char bits, no parity, 1 stop bit
7N2 - 7 char bits, no parity, 2 stop bits
7O1 - 7 char bits, odd parity, 1 stop bit
7O2 - 7 char bits, odd parity, 2 stop bits
7E1 - 7 char bits, even parity, 1 stop bit
7E2 - 7 char bits, even parity, 2 stop bits.

The tables on the following page provide pin descriptions for the COM1 data port in RS-232 mode and RS-485 modes, respectively.

NOTE The COM2 port, if present, is restricted to RS-232 mode; it cannot be used for RS-485.



(As viewed from the outside the unit)

Table 2-3. COM1/2 Port Pin Details (RS-232)

Pin Number	Input / Output	Pin Description
1	OUT	COM1 only: ALARM Output (refer to “Alarms” on Page 209)
2	OUT	DCD (Data Carrier Detect)
3	Reserved	--
4	Ground	Connects to ground (negative supply potential) on chassis
5	OUT	RXD (Received Data)—Supplies received data to the connected device
6	IN	TXD (Transmitted Data)—Accepts TX data from the connected device
7	OUT	CTS (Clear to Send)
8	IN	RTS (Request to Send)

NOTE The COM1 ALARM output uses RS232 levels (+5/-5VDC)

Table 2-4. COM1 Port Pin Details (RS-485)

Pin Number	Input/Output	Pin Description
1	OUT	ALARM Output (refer to “Alarms” on Page 209)
2	OUT	DCD (Data Carrier Detect)
3	Reserved	--
4	Ground	Connects to ground (negative supply potential) on chassis
5	OUT	TXD+/TXB (Transmitted Data +)—Non-inverting driver output. Supplies received payload data to the connected device.
6	IN	RXD+/RXB (Received Data +) — Non-inverting receiver input. Accepts payload data from the connected device.
7	OUT	TXD-/TXA (Transmitted Data -)—Inverting driver output. Supplies received payload data to the connected device.
8	IN	RXD-/RXA (Received Data -) — Inverting receiver input. Accepts payload data from the connected device.

COM1 Port notes and wiring arrangements (for RS-485)

- The COM1 port supports 4-wire and 2-wire RS-485 mode as follows:
  - RXD+ / RXB and RXD– / RXA are data sent *into* the unit

- RXD+ / RXB is positive with respect to RXD– / RXA when the line input is a "0"
- TXD+ / TXB and TXD– / TXA are data sent *out* by the unit
- TXD+ / TXB is positive with respect to the TXD– / TXA when the line output is a "0"

•2-wire RS-485 mode connections:

- Connect pins 5&6 (TXD+/RXD+) together and connect to (TXD+/RXD+) tied together on connected device
- Connect pins 7&8 (RXD-/TXD-) together and connect to (TXD-/RXD-) tied together on connected device

•4-wire RS-485 mode connections:

- Connect pin 5 (TXD+) to RXD+ of connected device
- Connect pin 6 (RXD+) to TXD+ of connected device
- Connect pin 7 (TXD-) to RXD- of connected device
- Connect pin 8 (RXD-) to TXD- of connected device

Figure 2-10 illustrates the 2-wire and 4-wire connections described above.

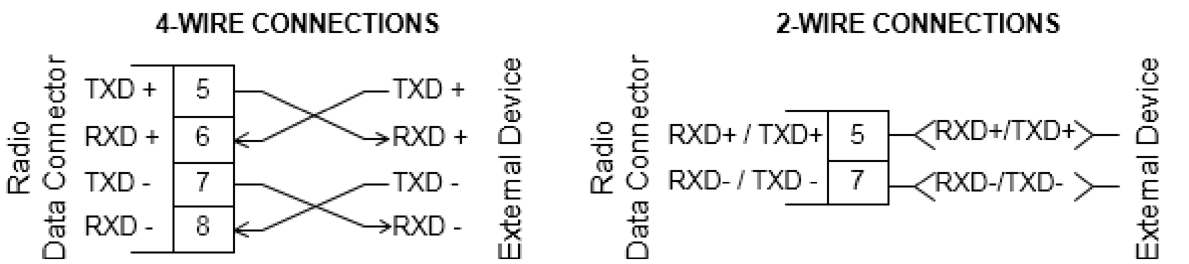
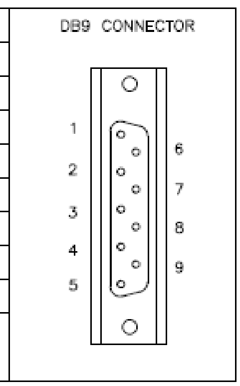


Figure 2-10. EIA-485 4-Wire/2-Wire Connections

NOTE MDS part number 73-2434A25 provides a custom RJ45 to DB9 Adapter for use with the Orbit and other MDS products. The chart below provides details for connections made using this adapter.

WIRING CHART

RJ-45 PIN	FUNCTION	DB9 PIN
1	DSR	6
2	DCD	1
3	DTR	4
4	GND	5
5	RXD	2
6	TXD	3
7	CTS	8
8	RTS	7



LED Status Indicators—The LEDs on the unit provide visual indications of the status of the device as shown in the following chart:

Figure 2-11. LED Status Indicators

Table 2-5. Description of LED Status Indicators

LED Name	LED State	Description
PWR (DC Power)	Off Solid Green Fast Blink/Red (1x/sec.)	No power to unit Unit is powered, no problems detected Alarm indication
ETH (Ethernet)	Off Solid Green Blinking Green	No Ethernet link to network Ethernet link present Ethernet traffic in/out
COM (Serial Comm. Port)	Off Blinking Green	No serial connection, or idle Serial traffic in/out
NIC1	Off Green	Interface disabled Interface enabled/working
NIC2	Off Green	Interface disabled Interface enabled/working

NOTE In addition to the LEDs above, the Ethernet connector has two embedded LEDs. A yellow indicates a link at 100 Mbps operation. A flashing green indicates Ethernet data traffic.

Depending on the interfaces ordered, the NIC1 and NIC2 slot can be populated with a Cellular modem, a WiFi interface, LnRadio interface, or an NxRadio interface. LED associations for NIC1 and NIC2 follow the physical left-to-right order of the physical connector positions as labeled on the faceplate.

See detail described in Table 2-6 and Table 2-7 below, based on the product configuration ordered.

Table 2-6. MCR NIC LED Descriptions

Product Configuration	NIC1	NIC2
MCR-4G + WiFi	Cellular	WiFi
MCR-4G Only	Cellular	Off
MCR-WiFi only	Off	WiFi
MCR-900 + 4G	Cellular	900 ISM (NxRadio)
MCR-900 + WiFi	WiFi	900 ISM (NxRadio)
MCR-900 Only	Off	900 ISM (NxRadio)
MCR-LN + WiFi	WiFi	Lic. Narrowband (LnRadio)
MCR-LN Only	Off	Lic. Narrowband (LnRadio)

Table 2-7. ECR NIC LED Descriptions

Product Configuration	NIC1	NIC2
ECR-4G + WiFi	WiFi	Cellular
ECR-4G Only	Off	Cellular
ECR-WiFi only	WiFi	Off
ECR-900 + WiFi	WiFi	900 ISM (NxRadio)
ECR-900 Only	Off	900 ISM (NxRadio)
ECR-LN + WiFi	WiFi	Lic. Narrowband (LnRadio)
ECR-LN Only	Off	Lic. Narrowband (LnRadio)
ECR-BPL Only	Off	BPL Interface (PL1)

2.6 Protective Earthing: Grounding Considerations

To minimize the chance of injury to personnel or damage to the unit and its connected equipment, a safety ground (NEC Class 2 compliant) is recommended, which bonds the chassis, antenna system(s), power supply and connected data equipment to a *single-point* ground, keeping all ground leads as short as possible.

Normally, the unit is adequately grounded if mounted with the flat brackets to a well-grounded metal surface. If the unit is not mounted to a grounded surface, it is recommended that a 18AWG green/yellow safety ground wire be attached to the screw provided on the bottom corner of the enclosure, in the recessed flat area. Alternatively, a safety ground wire may be attached to one of the mounting bracket screws.

The use of a lightning protector is recommended where the antenna cable enters the building; Bond the protector to the tower ground, if possible. All grounds and cabling must comply with applicable codes and regulations. One source for lightning protection products may be found online at http://www.protectiongroup.com/PolyPhaser.

2.7 Mounting Options

The unit may be mounted with flat mounting brackets *or* an optional 35 mm DIN rail attachment. Figure 2-12 shows the mounting dimensions for a unit equipped with flat mounting brackets.

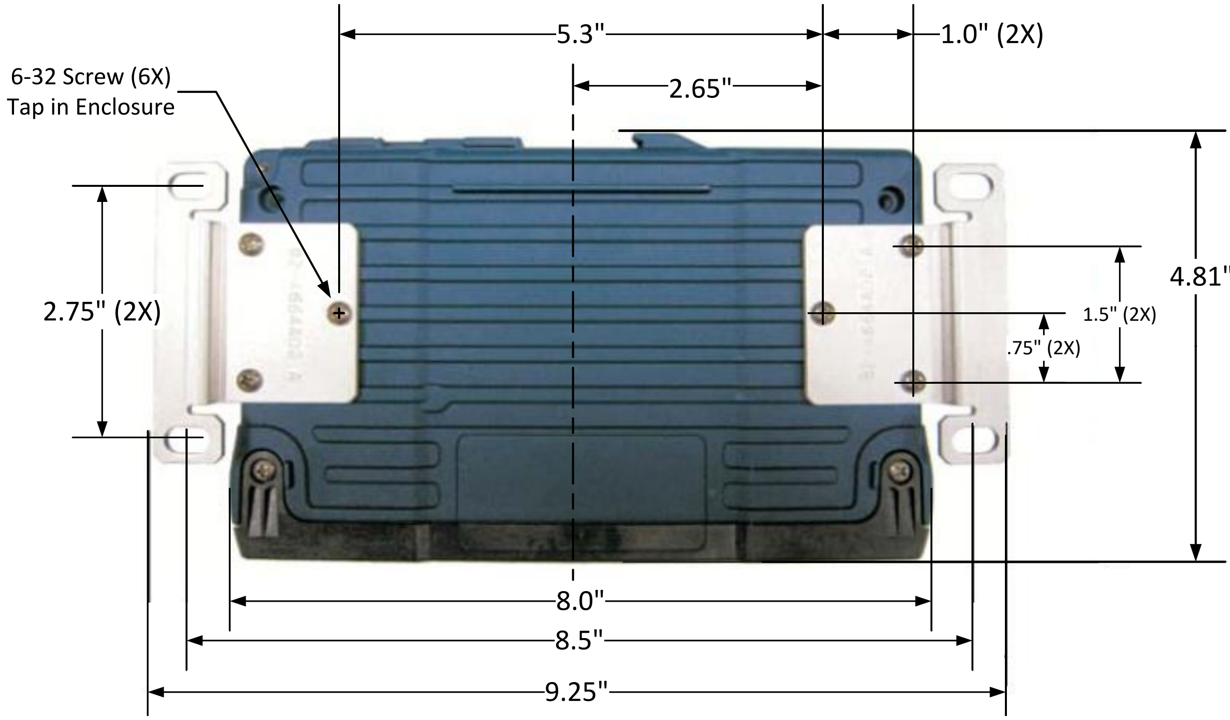


Figure 2-12. MCR Flat Mounting Bracket Dimensions

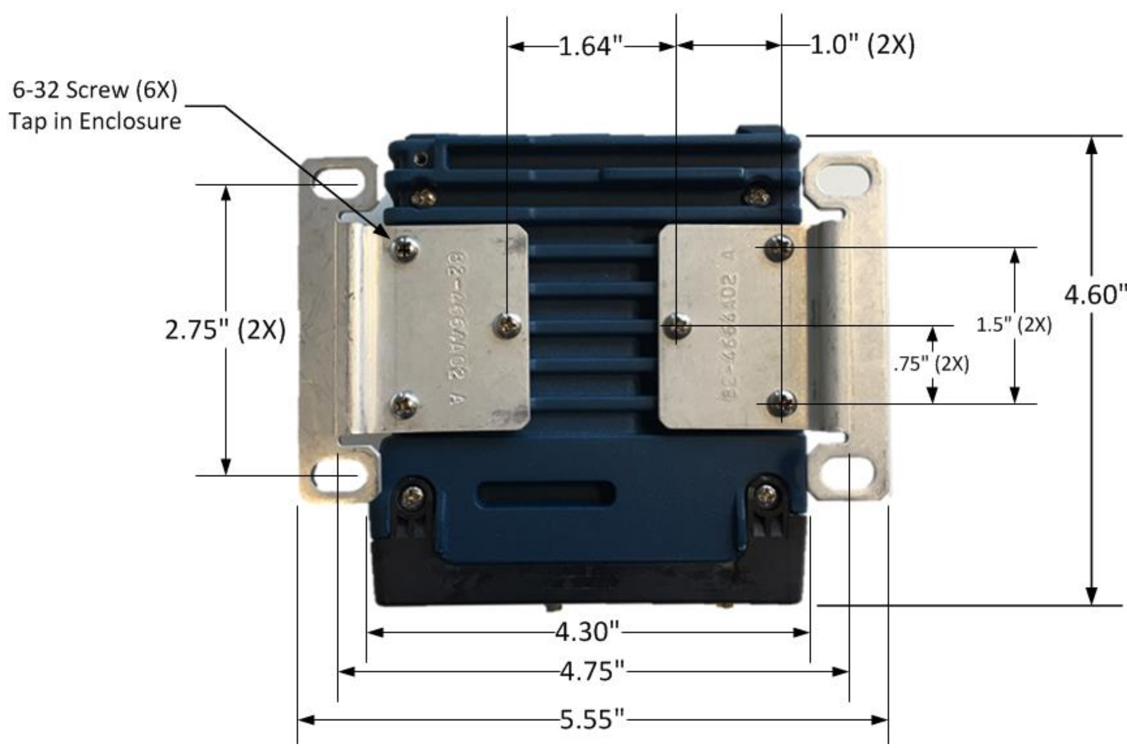


Figure 2-13. ECR Flat Mounting Bracket Dimensions

NOTE To prevent moisture from entering the unit, do not mount the case with the cable connectors pointing up. Also, dress all cables to prevent moisture from running along the cables and into the unit.

2.7.1 Optional DIN Rail Mounting

If ordered with the DIN rail mounting option, the unit is supplied with a DIN rail clip attached to the case. The integrated bracket on the unit's case (for both MCR and ECR) allows for quick installation and removal from a vertical DIN mounting rail as shown in Figure 2-14.

Figure 2-14. DIN Rail Attachment and Removal
(Pull down tab to release from rail)

NOTE A special *horizontal* MCR DIN rail mounting kit is also available to support use of MCR in space-constrained enclosures.

2.8 Antenna Planning and Installation

Consideration must be taken to select appropriate antennas for optimal RF performance. This section reviews the key factors involved in selecting and installing antennas for the Orbit MCR and ECR. Only approved antennas may be used on the unit's RF output connectors. These antennas are listed in each applicable section for each RF type. The use of non-approved antennas may result in a violation of FCC rules and subject the user to FCC enforcement action. Note that with any installation, there needs to be a minimum 20 cm spacing between all transmit antennas to avoid co-location difficulties.

Cell Antennas (Aux and Main)—These SMA coaxial connectors are for attachment of cellular antennas. The MAIN connection is for basic cellular transmission/reception and the AUX connector is for attachment of a receive-only antenna which provides MIMO receive operation (diversity) with standard Cell modules, improving signal quality in many installations. In general, both antennas should always be used for cellular operation. The MDS part number for this antenna type is 97-2485A04.

Figure 2-15. Directly-Connected Cellular Antenna (Typical Style)
(MDS Part No. 97-2485A04)

WiFi Antenna—Antenna connection for 2.4 GHz WiFi service. The connector appears similar to the cellular connectors discussed above but is a *Reverse-SMA* type. It contains a pin that matches with an SMA-F connector. The MDS part number for this antenna is 97-4278A34.

To connect an external WiFi antenna, 97-4278A48, a Reverse SMA to N-Female cable and antenna mount is required. These are not sold from GE Vernova MDS but are available from many retailers.

900 MHz ISM Antennas —Antenna connection is a TNC connector. Multiple options are available for this unlicensed operation.

NOTE For 900MHz ISM operation (NX915 NIC) professional installation is required.

NOTE For Australia and New Zealand, the maximum EIRP must be limited to 30 dBm. If (**`(antenna gain - feed line loss) + power output setting`**) > 30), then the power output of the NX915 must be reduced.

NOTE For regions governed by FCC/IC compliance the maximum EIRP must be limited to 36 dBm. If (**`(antenna gain - feed line loss) + power output setting)`** >36), then the power output of the NX915 must be reduced.

Table 2-8. Special Accessories for 900MHz ISM

Item	Description	Part Number
Bandpass Filter	Antenna system filter that helps eliminate interference from nearby paging transmitters.	20-2822A02

Licensed Narrowband Antennas —Antenna connection is a TNC connector. Multiple options are available based on radio type and site-specific licensing rules.

Antenna Type and Orientation (Cell & Wi-Fi)

It is important to use antennas designed to operate in the applicable cellular coverage bands with a Return Loss of 10 dB or better. Placement of the antennas also plays a key role in the coverage of the system. While the antennas can be placed directly on the face of the unit in some short-range installations, the best performance is obtained when mounting antennas remotely using low loss coaxial cable. Antennas mounted in close proximity to each other can couple signals between them and desensitize the RF module.

When placing the indoor SMA style “paddle” antennas on the face of the unit, position them with a 90-degree angle of separation to improve the isolation. A “V” or an “L” configuration is a common approach to use with the Main channel typically mounted for vertical polarization. The multipath nature of Cellular systems means that polarization for indoor use is not normally a critical factor. Isolation between the antennas is more important.

Indoor use case:

This scenario employs direct mounting of an LTE paddle antenna (MDS PN: 97-2485A04) on the Main and Aux Cell channels and cabled mounting of the Wi-Fi antenna (MDS PN: 97-4278A34) using a magnetic mount (MDS PN: 97-4278A78). This configuration offers easy mobility for evaluation purposes or indoor applications with good cellular signal coverage (see Figure 2-16).

Figure 2-16. Direct Mounting of Cell Antenna; Cabled WiFi Antenna
Minimum 8-inch (20.32 cm) separation between cell and WiFi antennas

This arrangement employs cabled mounting of the LTE paddle antennas (MDS 97-2485A04) on the Main and AUX Cell channels and cabled mounting of the Wi-Fi antenna (MDS 97-4278A34) using a magnetic mount (MDS 97-4278A78). The Wi-Fi antenna may also be directly attached to the unit, if desired. This configuration works well for indoor installations in equipment closets, or for more permanent applications.

Outdoor use case:

External enclosures—If the system is going to be installed in a weathertight enclosure and mounted outside in the elements, cabled use of external LTE antennas (MDS PN: 97-2485A05) on the Main and AUX Cell ports, with cabled use of the External Wi-Fi antenna (MDS PN: 97-4278A48) is a good solution. This configuration requires a suitable metallic ground plane for the Cellular antennas (8" diameter disc minimum for the 97-2485A05 series) or a suitable counterpoise for frequencies as low as 698 MHz Metal enclosures work well for ground plane requirements, when ground contact inside the box is not impeded by painted surfaces.

Do *not* use internally mounted antennas inside of metal enclosures.

Other antenna configurations can be easily customized for applications not listed here. Consult your factory representative for installation matters.

Antenna Installation Guidance (Licensed Narrowband)

Antennas:

LN transceivers may be used with a number of different antennas. The exact style and gain factor depend on regulatory constraints and the physical size/layout of your system. Connection is made to the radio via a TNC coaxial connector. A directional Yagi (Figure 2-17) or corner reflector antenna is generally used at remote sites to minimize interference to and from other users. Antennas of this type are available from several manufacturers, including GE Vernova MDS. Contact your sales representative for details.

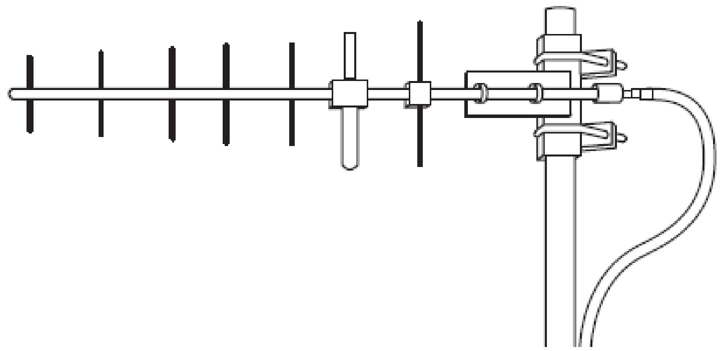


Figure 2-17. Typical Yagi Antenna (mounted to mast)

Feedlines:

Selection of an antenna feedline is very important. Poor quality cable should be avoided as it will result in power losses that may reduce the range and reliability of the radio system. The tables which follow show the approximate losses that will occur when using various lengths and types of coaxial cable. Regardless of the type used, the cable should be kept as short as possible to minimize signal loss.

Table 2-9. Signal Loss in Coaxial Cables (at 100/200 MHz)†

Cable Type	10 Feet (3 Meters)	50 Feet (15 Meters)	100 Feet (30.5 Meters)	200 Feet (61 Meters)
RG-8A/U	0.32 dB	1.6 dB	3.2 dB	16 dB
½ inch HELIAX	0.10 dB	0.49 dB	0.98 dB	4.9 dB
7/8 inch HELIAX	0.05 dB	0.27 dB	0.54 dB	2.7 dB
1-1/4 inch HELIAX	0.04 dB	0.20 dB	0.40 dB	2.0 dB
1-5/8 inch HELIAX	0.03 dB	0.17 dB	0.33 dB	1.65 dB

† Table values based on 200MHz; actual cable loss slightly lower at 150-174MHz

Table 2-10. Signal Loss in Coaxial Cables (at 400 MHz)

Cable Type	10 Feet (3 Meters)	50 Feet (15 Meters)	100 Feet (30.5 Meters)	200 Feet (61 Meters)
RG-8A/U	0.51 dB	2.53 dB	5.07 dB	10.14 dB
½ inch HELIAX	0.12 dB	0.76 dB	1.51 dB	3.02 dB
7/8 inch HELIAX	0.08 dB	0.42 dB	0.83 dB	1.66 dB
1-1/4 inch HELIAX	0.06 dB	0.31 dB	0.62 dB	1.24 dB
1-5/8 inch HELIAX	0.05 dB	0.26 dB	0.52 dB	1.04 dB

Table 2-11. Signal Loss in Coaxial Cables (at 700 MHz)

Cable Type	10 Feet (3 Meters)	50 Feet (15 Meters)	100 Feet (30.5 Meters)	200 Feet (61 Meters)
½ inch HELIAX	0.20 dB	0.98 dB	1.96 dB	3.91 dB
7/8 inch HELIAX	0.11 dB	0.55 dB	1.10 dB	2.19 dB
1-1/4 inch HELIAX	0.08 dB	0.39 dB	0.78 dB	1.57 dB

Table 2-12. Signal Loss in Coaxial Cables (at 900 MHz)

Cable Type	10 Feet (3 Meters)	50 Feet (15 Meters)	100 Feet (30.5 Meters)	500 Feet (152 Meters)
RG-214	0.76 dB	3.80 dB	7.60 dB	Unacceptable Loss
LMR-400	0.39 dB	1.95 dB	3.90 dB	Unacceptable Loss
1/2 inch HELIAX	0.23 dB	1.15 dB	2.29 dB	11.45 dB
7/8 inch HELIAX	0.13 dB	0.64 dB	1.28 dB	6.40 dB
1-1/4 inch HELIAX	0.10 dB	0.48 dB	0.95 dB	4.75 dB
1-5/8 inch HELIAX	0.08 dB	0.40 dB	0.80 dB	4.00 dB

Accessories and Spares

The table below lists common accessories and spare items for use with the Orbit. GE Vernova also offers an *Accessories Selection Guide* listing an array of additional items that may be used with the product. Contact your factory representative or visit our website to obtain a copy of the guide.

Table 2-13. Accessories & Ancillary Items

Item	Description	Part Number
DC Power Plug, 2-pin, polarized	Mates with power connector on the unit's case. Screw terminals are provided for wires, threaded locking screws to prevent accidental disconnect.	73-1194A53 or Phoenix Contact 1961986 or 1786831
Setup Guide (for installation instructions)	Describes the installation and setup of the unit. It is a companion to this Technical Manual. PDF copy available free on the website.	05-6709A01
Flat Mounting Bracket Kit	Brackets that attach to the bottom of the unit, used for mounting to a flat mounting surface.	03-4123A14
COM Port Adapter	Converts the unit's RJ-45 serial jack to a DB-9F type.	73-2434A25
Ethernet Surge Suppressor	Surge suppressor for protection of the Ethernet port against lightning.	29-4018A01
Mini USB 2.0 Cable, 3 ft	USB Type A (M) to mini-USB Type B (M) cable to provide console access through the radio's mini USB connector.	97-6694A05
MCR vertical DIN Rail Mounting Kit	Hardware for DIN Rail Mounting	03-4125A06
ECR vertical DIN Rail Mounting Kit	Hardware for DIN Rail Mounting	03-4125A07
MCR horizontal DIN Rail Mounting Kit	Hardware for DIN Rail Mounting	03-7226A03

3.0 Device Management

This section describes the steps for connecting a PC, logging in and setting unit parameters. The focus here is on the local serial console interface, but other methods of connection are available and offer similar capabilities. The key differences are with initial access and appearance of data.

Orbit offers several interfaces to allow device configuration and monitoring of status and performance. These include local serial console, USB, NETCONF, HTTPS and Secure Shell (SSH) for local and remote access via the WAN and LAN networks. The serial console, USB and SSH services offer a command line interface (CLI). There are three user accounts/roles for management access: admin, tech and oper. User accounts can be centrally managed with a RADIUS or TACACS+ server. RADIUS and TACACS+ accounts can be mapped to one of the three user accounts/roles (See “User Management and Access Controls” on Page 226).

NOTE The Orbit device is designed for high security environments. As such, management of the device does not support Telnet, but instead implements the more secure SSH protocol.

Configuring and managing the Orbit is done by changing configuration data via the Web User Interface (UI) or from the Command Line Interface (CLI). Either way requires two steps. The first step is to use a user interface to add, remove, or alter a piece of configuration data. The second step is to use the user interface to *commit* the change. Multiple changes can be made prior to committing them. This two-step process allows users to make multiple changes to the configuration and apply them in a bulk commit. Additionally, the device can validate the bulk commit and reject it if there is an error.

The *Device Man*ager is a built-in software tool that works with your PC’s browser to provide an intuitive, web-style presentation of all unit information, settings, and diagnostics. Web management uses the unit’s Ethernet RJ-45 connector.

NOTE For security, web access can be enabled/disabled via the CLI using the command: **`% set services web http(s) enabled true/false`**

To connect to the unit and manage it via the Device Manager, you will need the following:

- A PC with a web browser program installed.
- An Ethernet cable connected between the PC and the Orbit as shown in PC Connection for Web Management.
- The unit’s IP address. Check with your Network Administrator, or determine the address via a command line interface connection. The default address for a factory supplied unit is 192.168.1.1.
- The user name and password for the unit. Check with your Network Administrator, or, if a username and password have not been set, use the factory defaults of admin for both entries. (For security, a new password may be required immediately before allowing any other actions. If the default of “admin” is used it should be changed as soon as possible after login.)

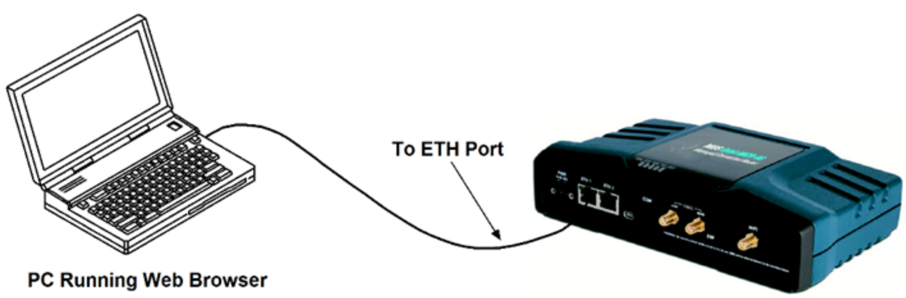


Figure 3-1. PC Connection for Web Management

Use of a modern browser is highly recommended.

Table 3-1. Browser Support

Browser Type	Version
Microsoft ™ Internet Explorer	10.x or newer
Mozilla Firefox	39.0 or newer
Apple Safari (Mac OS X only)	10.0 or newer
Google Chrome	26.x or newer

Logging On

1. Connect the unit to a PC via an Ethernet connection.
2. Configure your PC network settings to an IP address on the same subnet as the unit. The default subnet mask is 255.255.255.0.

NOTE For IP addressing the Orbit uses a routing prefix expressed in CIDR notation instead of the specifying a subnet mask. The CIDR notation is the first address of a network, followed by a slash character (/), and ending with the bit-length (max 32) of the prefix. A subnet mask is expressed in dot-decimal notation. For example, 192.168.1.0/24 is equivalent to specifying 192.168.1.0 with a subnet mask of 255.255.255.0.

3. Enter the unit's IP address in a web browser window, just as you would enter a website address. When the login screen appears (Figure 3-2. Login Screen), enter the User Name and Password for the unit. The default entries for a new unit are *typically* both admin. Click OK.

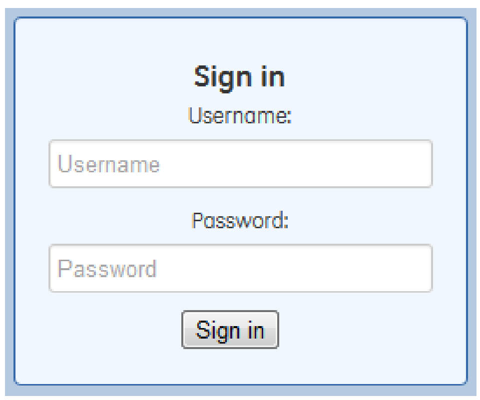
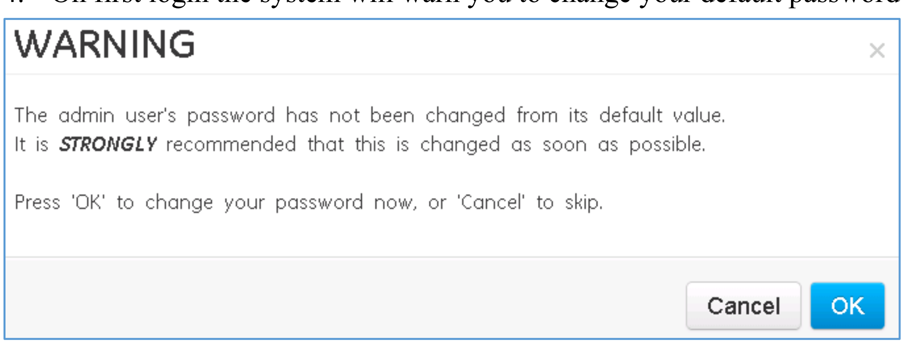


Figure 3-2. Login Screen

NOTE Depending on device configuration you may be required to immediately change the admin password on first use prior to any other activity. If not the system will provide a warning as shown below.

4. On first login the system will warn you to change your default password as shown below



Organization of the Device Manager

The header of every webpage on the Device Manager provides navigational aids and important information about the state of the system.

Starting at the top left (underneath the GE logo) icons are presented for *notifications*, *alarm state*, and *radio connectivity*, respectively. The *alarm state,* represented by the alarm clock icon, goes red when an alarm is active. *Radio connectivity*, represented by the tower icon, mirrors the state of the NIC LED for the primary radio. Clicking on an icon brings up the corresponding information associated with that icon.

Continuing right, the pull-down menu allows the choice of **Basic** or **Advanced** web operating mode. By default, Orbit units equipped with a proprietary licensed (LN) or unlicensed (NX) radio automatically select the Basic mode.

On the top right, an Orbit photo icon displays the general type of device. The current running firmware version is shown directly below the icon. Clicking on the firmware version brings the user to the firmware update page.

In both Basic and Advanced modes a navigational panel appears on the left; detail appears immediately to the right.

Advanced mode presents the device as fully featured industrial router with layer 2/3 functionality. Advanced mode uses an accordion style presentation to allow the user to expand and collapse subsets of the configuration based on the current area of focus.

Basic mode strives for a radio-centric view and appears more like a layer-2 switch (supporting bridging and VLAN operation). The navigation pane is typically simplified to 5 items (Radio, Serial, Security, Logging, and System) with Radio appearing first. If WiFi is present it will appear as an additional navigation pane element. Simple and intuitive menus allow configuration of basic firewall rules and operating functionality. Basic mode presents all content as fully exploded and scrollable to more quickly get to the most commonly used items.

The Device Manager allows switching between Basic to Advanced mode so that configuration of most items can use the simpler menu, while still providing access to full functionality for more complex items. If the user creates a more complex configuration in Advance mode, transitioning to Basic mode may generate an informational warning that a complex configuration is in use and some items will not be visible.

The majority of this manual uses Advanced mode for configuration examples. Users are encouraged to explore the intuitive nature of the Basic mode for faster configuration of less complex systems.

Getting an Overview of Unit Settings (Advanced mode)

To get a top-level view of the key settings and operating parameters for the unit, click the Logo in the upper left hand side of the screen and a summary screen will be displayed. When finished, log out of the Device Manager by clicking Logout in the upper right hand side of the screen.

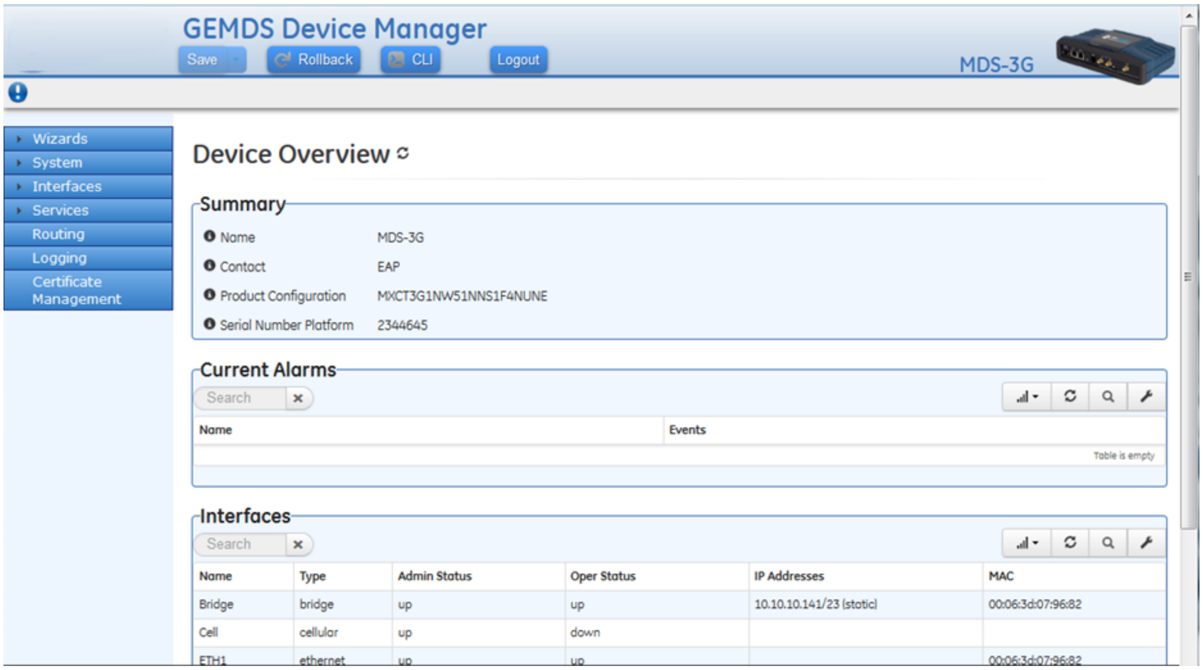


Figure 3-3. Device Manager, Overview Screen

For initial configuration, the Setup Wizard will appear and provide guidance in typical setups. This will be disabled after initial setup is completed but may be re-run at any time from the **Wizards** page.

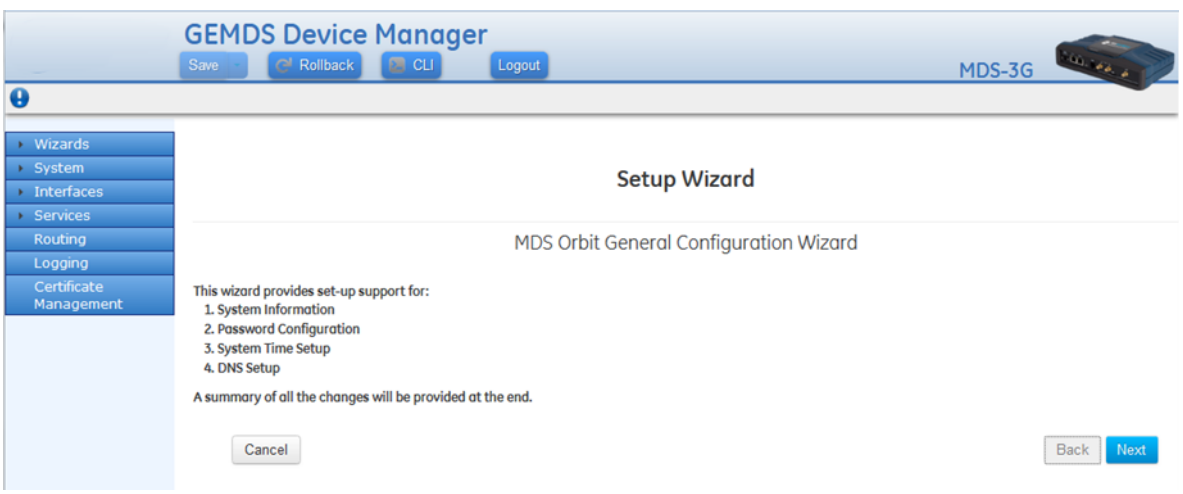
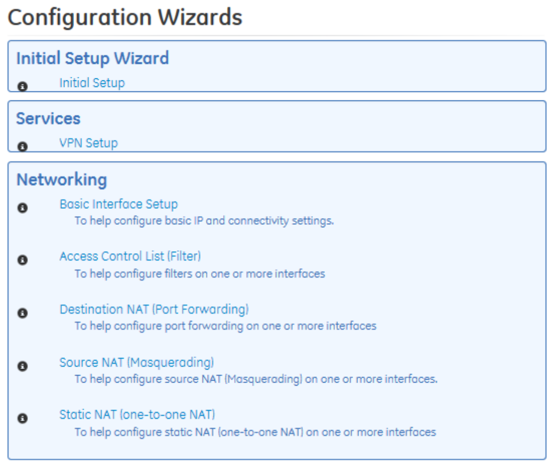


Figure 3-4. Initial Setup Wizard Starting Page

In addition to the Setup Wizard other Configuration Wizards are available to assist Services and Networking. The Basic Interface Setup wizard can be particularly helpful for initial device configuration.



From the Web UI changes made on the screens are not saved or implemented until via the save button or commit command. The **Save** button in the banner on the top left of every page. Normally this is not highlighted and blue in color as shown below:

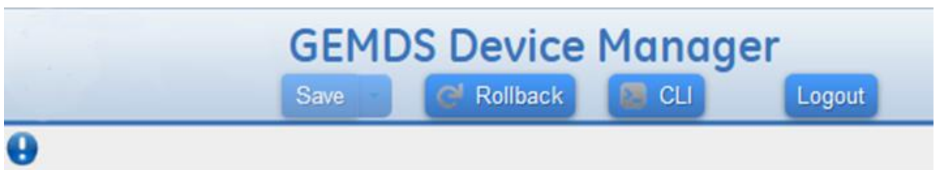


Figure 3-5. Save Button—No changes to commit

When there are changes to commit, the button is highlighted and colored green. Options available are: View, Validate and Cancel. Clicking the button defaults to Validate and saves the changes.

Figure 3-6. Save Button—Changes to commit

From the CLI, all changes are made and committed using by using the commit command and enter.

% commit

3.1 Initial Settings Overview

3.1.1 Setting Basic Parameters—First Steps

There are three tasks that should be performed after initial startup and connection to a PC, as follows:

1. Create One-Time Programmable passwords for device recovery in the event a password is lost.
2. Change the login passwords.
3. Evaluate the default factory configuration and set it to the user's required security level.

3.1.2 One-Time "Recovery" Passwords

The MDS Orbit platform employs extensive security measures to prevent unauthorized access. As such, there are no hidden manufacturer passwords or other "back doors" found in less secure products. If a password is lost, there is no way to access the unit, except by using a one-time password (OTP) for recovery. This must be established by the user beforehand. Without a one-time password, the unit will not be accessible, and the hardware will need to be returned to the factory to be re-imaged to defaults. ***Technical Support will not be able to assist you if a password is lost, so creating a one-time password is strongly encouraged. A device with a lost password***

Refer to instructional video:

https://youtu.be/UU1WpXBMl0k

Associated QR Code:

One-Time Passwords: How They Work

One-time recovery passwords put control directly and exclusively in the user's hands. They are similar to spare keys for a lock. If you make a spare key and put it away safely, you can take it out to quickly gain entry when your primary key is lost. If you don't make a spare, you are always at risk of locking yourself out.

A one-time recovery password is different from the one used to log into the unit on a routine basis. It is *only* for use when the primary password is lost or forgotten. When a one-time password is used to log in, that password is *automatically revoked* from the list of passwords created. You may create up to five one-time passwords at one time and more can be created if some get used. A password cannot be used again for log in to the unit, hence the name "one-time" password.

NOTE One-time passwords are only displayed at the time of creation. The password must be saved and archived at that time. There is no way to view this password again.

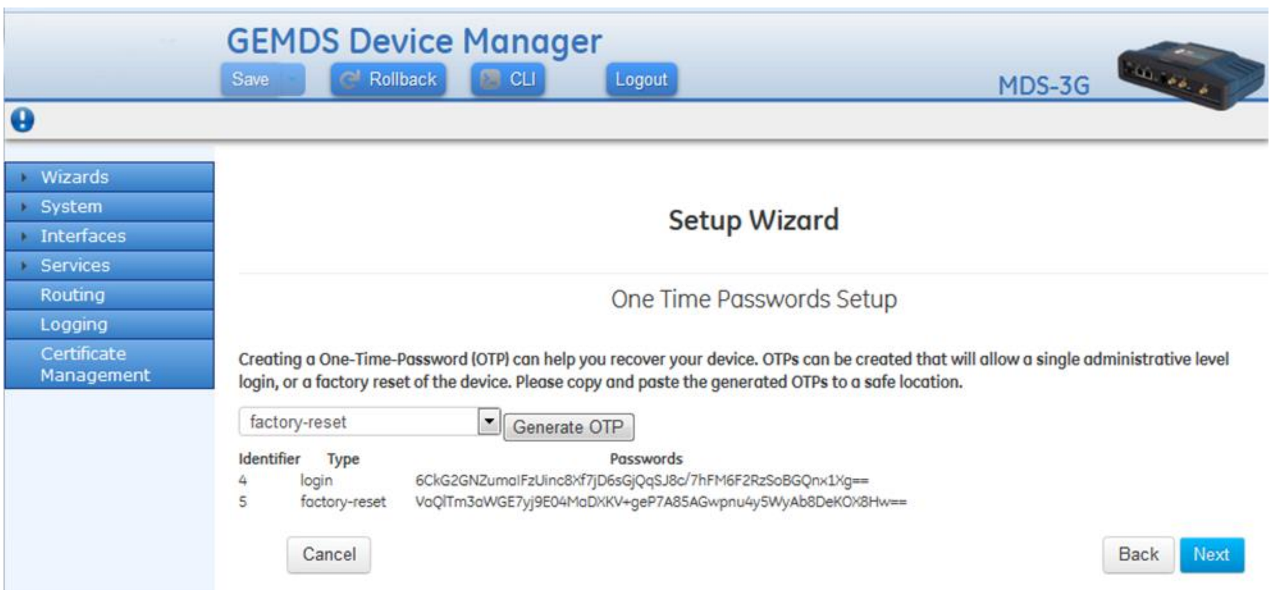


Figure 3-7. One-Time Password Add in Setup Wizard

Logging in With a One-Time Password

To use the one-time password for log-in, proceed as follows:

1. At the username prompt, enter the word "recovery".
2. At the password prompt, paste in the one-time-password saved earlier on your PC. Using a one-time-password forces the unit to perform the function which was previously defined when the password was created:

- **factory-reset** — The unit resets its entire configuration to factory defaults
- **login** — The unit allows logging in with admin privileges

Special case: If someone has disabled console access on the COM port, the login prompt will still be present on that console, but only one-time passwords will be accepted. This is done to provide a way to recover the unit in the case where the COM1 port has been disabled and the unit cannot be accessed via TCP (for example; SSH).

Deleting a One-Time Password

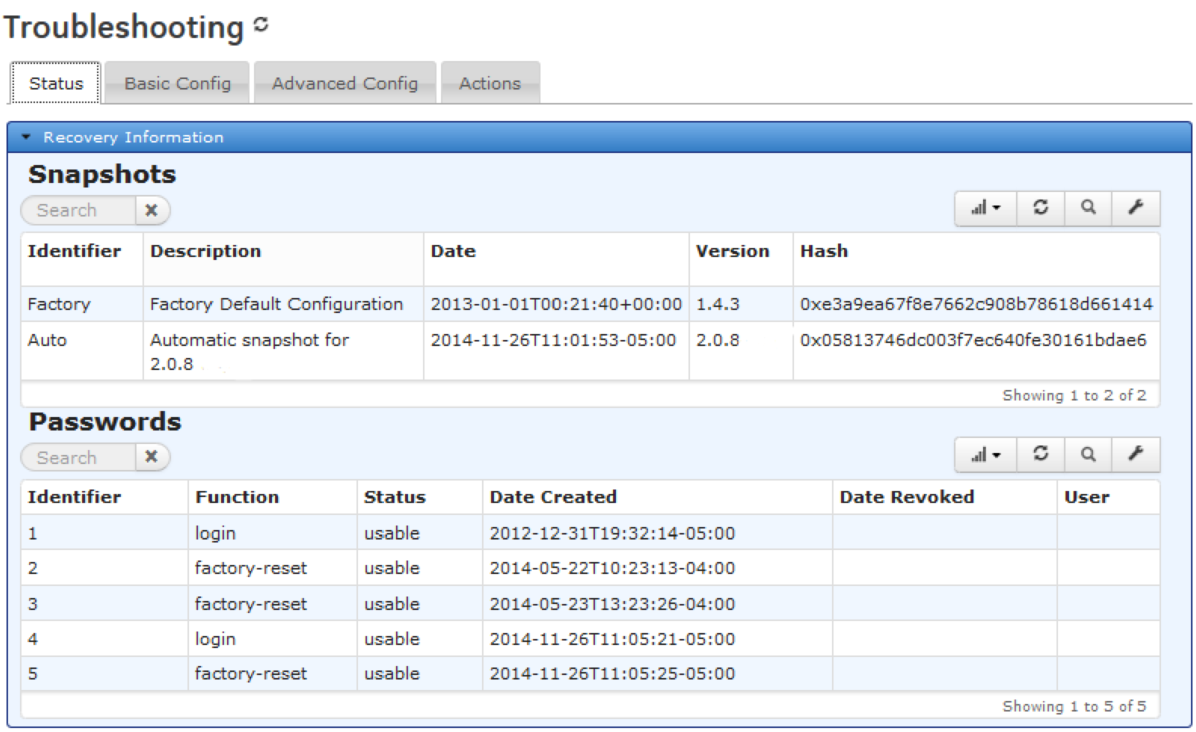
As noted earlier, a one-time password is automatically revoked when it is used for log-in. A revoked password may be replaced, but it must first be removed from the list, so a new one can be generated. Any of the five stored passwords may be removed on demand. As long as there is a free slot, an additional password can be created, up to the maximum number of five. Logs are generated when the user creates, deletes or logs in with a one-time-password.

Managing One-Time Passwords

One-Time passwords can be created as part of the Initial Setup Wizard, as shown in the example below.

To view currently configured One-Time Passwords, navigate to

Troubleshooting ---> Status / Recovery Information / Passwords



Identifier	Description	Date	Version	Hash
Factory	Factory Default Configuration	2013-01-01T00:21:40+00:00	1.4.3	0xe3a9ea67f8e7662c908b78618d661414
Auto	Automatic snapshot for 2.0.8	2014-11-26T11:01:53-05:00	2.0.8	0x05813746dc003f7ec640fe30161bdae6

Identifier	Function	Status	Date Created	Date Revoked	User
1	login	usable	2012-12-31T19:32:14-05:00		
2	factory-reset	usable	2014-05-22T10:23:13-04:00		
3	factory-reset	usable	2014-05-23T13:23:26-04:00		
4	login	usable	2014-11-26T11:05:21-05:00		
5	factory-reset	usable	2014-11-26T11:05:25-05:00		

Figure 3-8. One-Time Password Display Screen

To edit or delete (revoke) a One-Time Password, navigate to:

Troubleshooting ---> Actions / One Time Passwords

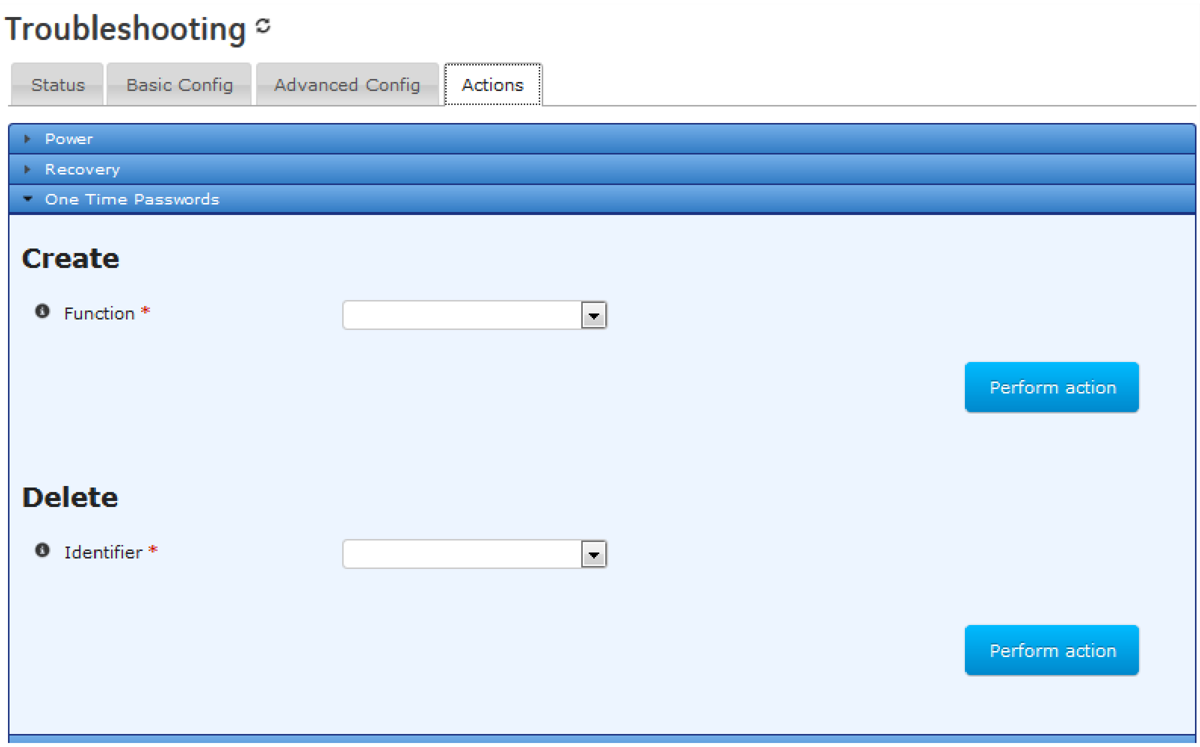


Figure 3-9. One Time Passwords Management Screen

Up to 5 passwords may be added. They may also be deleted. Remember to replace a used password which is automatically revoked. It must be deleted if there are no more password slots available.

3.1.3 Change Default Passwords

For security purposes it is highly advised to change the default passwords for all user roles. This is accomplished on the “Change Password” Screen shown below located at:

User Authentication ---> Actions / Change Passwords

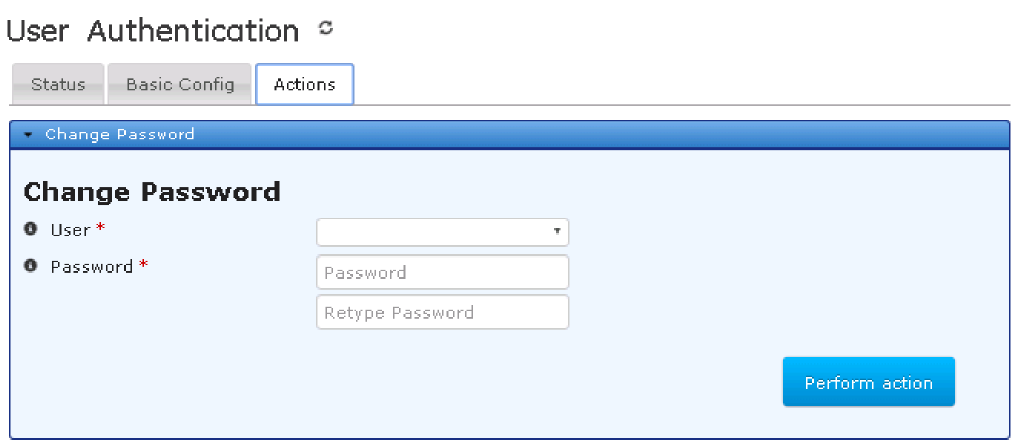


Figure 3-10. Change User Password Screen

This feature is also a part of the Initial Setup Wizard, as shown in the Figure below.

Figure 3-11. User Password Initial Setup Wizard Change Screen

The selected password(s) must follow the rules established on the "Password Options" screen located under the ***Basic Config*** tab of the ***User Authentication*** section. These rules may be modified to conform to the local security requirements.

3.1.4 Security Review

The Orbit provides strong cyber security capabilities that may be customized to meet enterprise security policy requirements. By default, the Orbit is configured with a light level of security. There are many features and parameters that should be considered and adjusted according to the security policy. Some of the areas to consider are:

1. User Authentication
   - Update factory default passwords.
   - Secure login access into Orbit with local, RADIUS, or TACACS+ based user authentication.
2. Device Management
   - Secure access to Orbit for device management by enabling/disabling HTTP/HTTPS/SSH and Remote Management
   - It is recommended that HTTP be disabled.
   - It is recommended that SNMPv1/v2c be disabled and SNMPv3 be enabled
   - It is recommended to replace the HTTPS self-signed certificates with certificates trusted by your enterprise security policy.
   - It is recommended to change the Remote Management shared-secret.
3. Static Routing - Limit local broadcast and multicast traffic from being shared with specified interfaces.
4. Packet Filtering – Prevent ingress/egress of unwanted traffic by configuring firewall/NAT.
5. Secure end-to-end network links using IPsec VPN with pre-shared-key or certificate based setup.

6. Cellular Security – Utilize IPSec VPN to secure end-to-end cellular link over public cellular networks.
7. WiFi Security – Secure Wi-Fi link with pre-shared key or EAP-TLS/RADIUS using certificates.
8. NX915 Security – Secure 900MHz link pre-shared key or EAP-TLS/RADIUS using certificates.
9. LN Security – Secure Licensed Narrowband link pre-shared key or EAP-TLS/RADIUS using certificates.
10. Event Logging – Securely send event logs to central SYSLOG server by configuring SYSLOG over TLS.
11. PKI/Certificate Management – Generate/upload private keys/certifications for use in certificate based security setup.
12. Tamper Detection – Enable tamper detection to detect unauthorized device enclosure removal and physical movement from authorized install site.
13. RADIUS server connection – Ensure operation within a trusted network segment. This can be established by setting up an IPSEC tunnel.

3.2 Preconfigured Settings

The MDS product factory configuration establishes typical settings based on the types of modules ordered.

The intent is to provide as much out-of-box functionality as possible. For example, in WiFi/Cell configurations, the unit is configured as a WiFi hotspot.

- The Orbit is highly configurable to meet field requirements, but comes preconfigured as follows:
  - The COM and USB ports are enabled for local console operation.
  - When applicable, interfaces are preconfigured as members of a bridge.
  - A DHCP server is enabled for WiFi clients and the Ethernet LAN ports.
- Units are configured with a set of pre-defined defaults set by the factory.
  - Default Ethernet IP address **192.168.1.1**
  - Firewall/NAT/DNS proxy enabled
  - DHCP server enabled

Other defaults

- WiFi (hotspot):
  - Set as Access Point (AP)
  - SSID = GEMDS_<SERNUM> SERNUM refers to the unit's serial number, printed on a chassis sticker.
  - The Ethernet ports are bridged with the WiFi AP.
  - SSID broadcast enabled
  - Security = WPA2-PSK, CCMP with passphrase: **GEMDS_ORBIT**
- Cellular modem:
  - 4G Cellular interface is enabled by default since network can enable connectivity on default APN.
  - 3G Cellular interface is disabled by default since it requires carrier specific APN to be configured.

- ISM Unlicensed 900 MHz radio (NX915):
  - Radio Mode set to **Remote**
  - Modem Mode 500kbps
  - Power at 30 dBm
- Licensed Narrowband radio (LN100/LN200/LN400/LN700/LN900):
  - Radio Mode set to **Remote**
  - Adaptive Modulation enabled
  - FEC set to disabled
  - Power at 40 dBm
- Licensed Wide radio (LW700):
  - Radio Mode set to **Remote**
  - AP is set to channel 1, bandwidth 315KHz
  - Remote is set to AutoDiscover
  - Power at 30 dBm

These configuration settings allow a connection to a PC to the unit via WiFi or the LAN port and access to the Internet via cellular, if equipped and supported by a suitable service plan.

3.3 Specific Application Examples Using Device Manager

The following examples illustrate the set of steps to configure the Orbit for specific scenarios. The “Step” column is the high level concept, the “Manual Section” provides a link to the manual section that can explain in more detail and the “Comment...” column provides additional information or specific settings pertinent to the example. More examples can be found in **05-6909A01** ***Orbit MCR Cookbook*** available on the GE Vernova website.

Initial Setup Example

During the initial configuration of a device the following checklist in Table 3-2 should be consulted to commission the unit for operation.

Table 3-2. Checklist for Initial Setup/Configuration

Step	Applicable Manual Section	Comment / Additional Information
Establish connection to the device (SSH/ Serial/ USB/ Web)	Initial Settings Overview Specific Application Examples Using Device Manager Application Example #4	With serial/USB/SSH interfaces the "Command Line Interface" (CLI) is provided.
Create One-Time Programmable passwords for device recovery in the event a password is lost	One-Time “Recovery” Passwords	This is extremely important for recovering a unit if an admin password is lost. Note - this is part of the Initial Setup Wizard
Change the login passwords/configure users	Change Default Passwords	For security purposes it is highly recommended that password for all user type

Step	Applicable Manual Section	Comment / Additional Information
		be changed from their defaults. Note - this is part of the Initial Setup Wizard
Review factory default configuration	Preconfigured Settings	
Disable DHCP if using Static IP Addresses for WiFi and Ethernet port(s)	3.8.15 - DHCP Service	
Set Date /Time or NTP Server	3.7.1 - Date, Time and NTP	Note - this is part of the Initial Setup Wizard
Set Geographic Location (if desired)	3.7.2- Geographical-location	Note - this is part of the Initial Setup Wizard
Configure WiFi (if present)	3.5.3 - WiFi	
Configure Cell interface (if present)	3.5.2 - Cell 10.0 - APPENDIX E – Obtaining Provisioned 4G/LTE Service (Verizon)	A guide to setting up cellular service in the listed Appendix
Configuring for 900MHz operation (if present)	3.5.4 - Unlicensed 900 MHz ISM (NX915)	NX915 is the hardware module that provides the 900 MHz operations. It is factory configured based on country codes for legal operations.
Configuring for Licensed Narrowband operation (if present)	3.5.5 - Licensed Narrowband (LN)	LNxxx hardware modules provide operation in various narrowband global frequencies. User configuration is required to match conditions of license.

Application Example #1

In the figure below, the Orbit is functioning as a WiFi Access Point to provide connectivity between a set of laptops and a handheld device. The Orbit is also acting as a DHCP server for the laptops and handheld device.

Figure 3-12. Example 1: Unit Providing Laptop and Handheld Device Connectivity

By default, the unit is configured in this basic configuration. Refer to Preconfigured Settings for accessing the unit using the default setting for the Ethernet ports, WiFi and the bridge.

The following chart lists the required steps to configure the Orbit for this specific scenario. Note that for each step the linked manual section is provided as well as detailed information for use in recreating the example.

Step	Applicable Manual Section	Comment / Additional Information
Configure WiFi	3.5.3 - WiFi	Enable unit as Access Point Set SSID *mysid*
Configure network	3.8.5 - Bridging	Add *ETH1* and *WiFi* to the bridge
Set the Bridge IP address	3.8.5 - Bridging	Set ipv4 address *192.168.1.21* Set prefix-length *24*
Configure DHCP Server	3.8.15 - DHCP Service	Set v4subnet *192.168.1.0/24* Set domain-name *gemds* Set range-start *192.168.1.10* Set range-end *192.168.1.19* Set router *192.168.1.1* Set broadcast-address *192.168.1.255*

Application Example #2

In the figure below, there are two Orbit devices, one acting as a WiFi Access Point, the other as a WiFi Station. Together, they provide a wireless bridge between the laptop and the SCADA device.

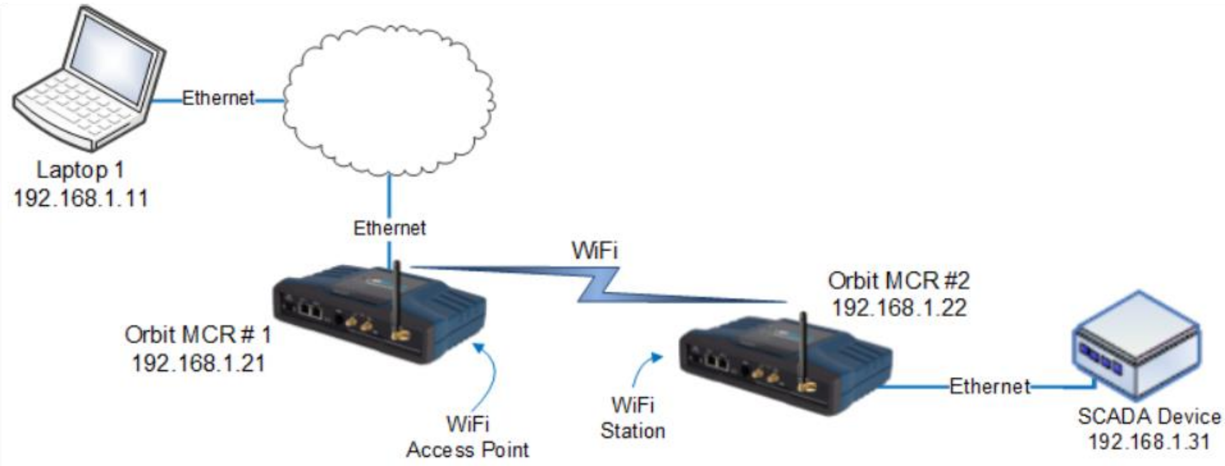


Figure 3-13. Example 2: Units Providing Wireless Bridge Between Laptop & SCADA Device

Step	Applicable Manual Section	Comment / Additional Information
Orbit MCR #1: Configure WiFi as an Access Point	3.5.3 - WiFi	Enable Access Point mode Create SSID of *myssid*
Orbit MCR #1: Configure to bridge traffic from ETH1 and WiFi	3.8.5 - Bridging	Add *ETH1* and *WiFi* to the bridge
Orbit MCR #1: Set bridge IP address	3.8.5 - Bridging	Set to *192.168.1.21* prefix-length *24*
Orbit MCR #1: Enable DHCP Server on bridge	3.8.15 - DHCP Service	Set v4subnet *192.168.1.0/24* Set domain-name: *gemds* Set range-start: *192.168.1.10* Set range-end:*192.168.1.19* Set router: *192.168.1.1* Set broadcast-address: *192.168.1.255*
Orbit MCR #2: Configure WiFi as a Station connecting to Orbit MCR #1	3.5.3 - WiFi	Enable Station mode Connect to AP SSID of *myssid*
Orbit MCR #2: Configure to bridge traffic from ETH1 and WiFi	3.8.5 - Bridging	Add *ETH1* and *WiFi* to the bridge
Orbit MCR #2: Set bridge IP address	3.8.5 - Bridging	Set to *192.168.1.22* prefix-length *24*

Application Example #3

The figure below shows the Orbit MCR #2 device acting as a terminal server to provide connectivity to the serial-based SCADA device via UDP.

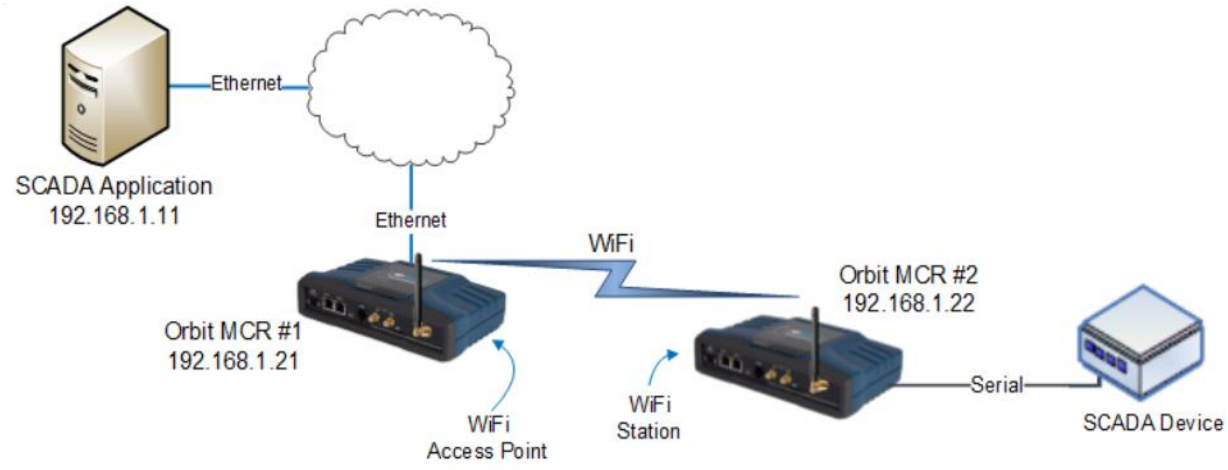


Figure 3-14. Example 3: Unit Providing Connectivity to Serial-Based SCADA Device via UDP

NOTE The configuration for Orbit MCR #1 in Example 3: Unit Providing Connectivity to Serial-Based SCADA Device via UDP is identical to the configuration shown in the previous example (Example #2).

Step	Applicable Manual Section	Comment / Additional Information
Orbit MCR #1: Configure WiFi as an Access Point	3.5.3 - WiFi	Enable Access Point mode Create SSID of *myssid*
Orbit MCR #1: Configure to bridge traffic from ETH1 and WiFi	3.8.5 - Bridging	Add *ETH1* and *WiFi* to the bridge
Orbit MCR #1: Set bridge IP address	3.8.5 - Bridging	Set to *192.168.1.21* prefix-length *24*
Orbit MCR #1: Enable DHCP Server on bridge	3.8.15 - DHCP Service	Set v4subnet *192.168.1.0/24* Set domain-name *gemds* Set range-start *192.168.1.10* Set range-end *192.168.1.19* Set router *192.168.1.1* Set broadcast-address *192.168.1.255*
Orbit MCR #2: Configure WiFi as a Station connecting to Orbit MCR #1	3.5.3 - WiFi	Enable Station mode connect to AP SSID of *myssid*
Orbit MCR #2: Configure to bridge traffic from ETH1 and WiFi	3.8.5 - Bridging	Add *ETH1* and *WiFi* to the bridge
Orbit MCR #2: Set bridge IP address	3.8.5 - Bridging	Set to *192.168.1.22* prefix-length *24*
Set up Terminal Server COM1	3.8.16 - Terminal Service	Set mode *udp* port *30000* remote addr: *192.168.1.11* port *30001*

Application Example #4

In Figure 3-15, an Orbit provides internet access for a laptop that is accessing a public web page.

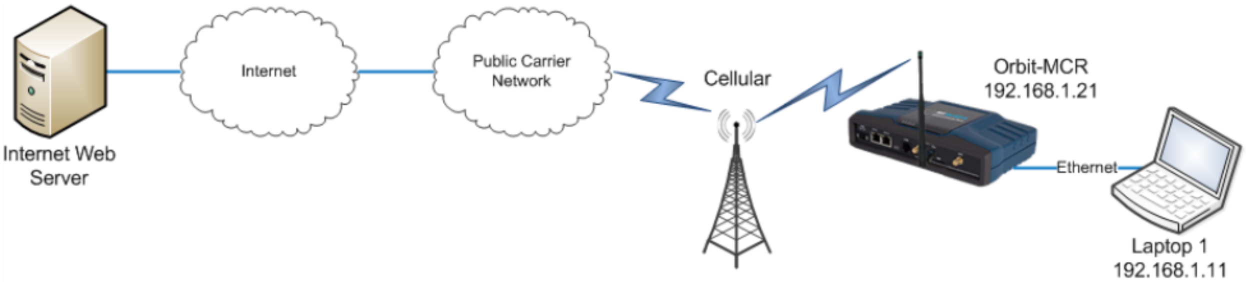


Figure 3-15. Example 4: Unit Providing Internet Access for Laptop

SIM Type: In this scenario, the Orbit has a SIM card installed that simply provides Internet access.

Step	Applicable Manual Section	Comment / Additional Information
Configure ETH1 to be in Bridge	3.8.5 - Bridging	Add *ETH1* to the bridge.
Configure Bridge for an IP address	3.8.5 - Bridging	Set address to *192.168.1.1* prefix length *24*
Enable the firewall for local address space	3.8.9 - Access Control List (Packet Filtering / Firewall)	Enable firewall
Configure the incoming out of network address to accept only ICMP	3.8.9 - Access Control List (Packet Filtering / Firewall)	Set Rule *1* protocol *ICMP*, Action *accept*
Configure the incoming out of network address to drop all other traffic (IN_UNTRUSTED)	3.8.9 - Access Control List (Packet Filtering / Firewall)	Set Rule *10* protocol *all*, Action *drop*
Configure the outgoing destination to allow local network (OUT_UNTRUSTED)	3.8.9 - Access Control List (Packet Filtering / Firewall)	Set Rule *1* src Address: *LOCAL-NETS* Add Interface address; *true* Action *accept*
Configure the outgoing destination to drop other network destined packets (OUT_UNTRUSTED)	3.8.9 - Access Control List (Packet Filtering / Firewall)	Set Rule 10 protocol *all* Action *drop*
Enable Firewall NAT to masquerade	3.8.9 - Access Control List (Packet Filtering / Firewall)	rule-set: *MASQ*
Enable Firewall NAT rule	3.8.10 - Source NAT (Masquerading)	Set Rule *1* source-nat : *interface*
Enable Cell interface	3.5.2 - Cell	
Apply Firewall IN_UNTRUSTED and OUT_UNTRUSTED filters to Cell interface	3.8.9 - Access Control List (Packet Filtering / Firewall)	Set Cell input filter to *IN_UNTRUSTED* Set Cell output filer to *OUT_UNTRUSTED*
Set NAT on Cell interface to masquerade	3.8.10 - Source NAT (Masquerading)	Set cell NAT source to *MASQ*

Application Example #5

In Figure 3-16, Orbits with LN radios provide connection from a serial polling host to a serial RTU controlling a pipeline.

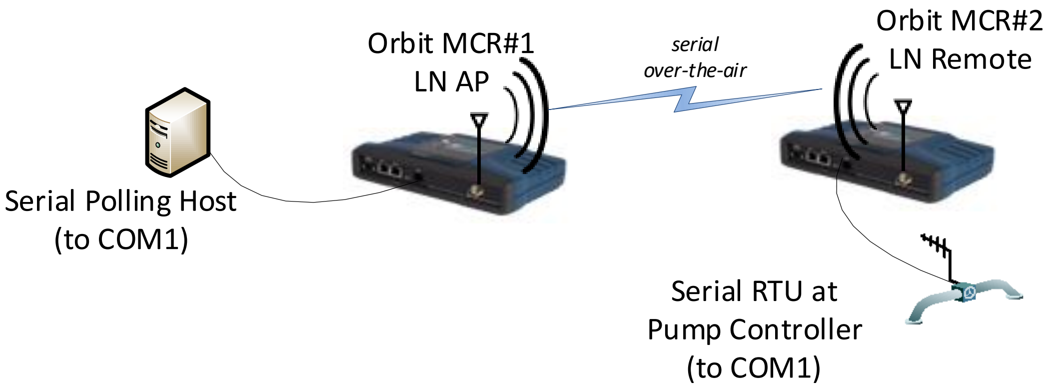


Figure 3-16. Example 5: Orbit LN using serial Pass-Through

Step	Applicable Manual Section	Comment / Additional Information
Configure Orbit MCR #1 with a Virtual Radio Channel	3.5.5.1 - Simplified Serial Operation in QAM modes	Create vrcX which automatically creates virtual serial port vrcX-serial
Create a Pass-Through instance	3.8.5 - Pass-Through Settings	Pass-Through instance between vrcX-serial and COM1
Set COM1 settings as needed	3.5.1 - Serial Interface	Baud, etc.
Configure Orbit MCR #2 with a Virtual Radio Channel	3.5.5.1 - Simplified Serial Operation in QAM modes	Create vrcY which automatically creates virtual serial port vrcY-serial
Create a Pass-Through instance	3.8.5 - Pass-Through Settings	Pass-Through instance between vrcY-serial and COM1
Set COM1 settings as needed	3.5.1 - Serial Interface	Baud, etc.

3.4 Using the Command Line Interface (CLI)

3.4.1 Differences between Serial and SSH

Serial and SSH both present identical management capabilities, but the method of access is different for each. Serial involves an RS-232 serial connection from a PC to the unit's COM port. SSH uses an Ethernet PC connection to the unit's ETH port. Maximum recommended cable length for a serial connection is 50 feet (15 meters). SSH can be connected to the unit from any network point that has connectivity with the PC, including remotely over the Internet, or using other networks.

The focus of these instructions is on *Serial* access, but SSH may also be used by following these additional points, which replace Steps 1-3 below:

- Connect to the unit with a PC that is in the same IP network as the Orbit. Launch an SSH client program and connect to the unit using its programmed IP address.
- The default IP address for the unit is 192.168.1.1. If you do not know the current IP address of the unit, follow the serial configuration instructions below, where you can determine the address and continue configuration, or check with your network administrator.

3.4.2 Establishing Communication—Serial Interface

Follow these steps to configure the unit for its first use with serial console interface:

1. Connect a PC to the unit's COM port as shown in Figure 3-17. Maximum recommended cable length is 50 ft/15 m.

NOTE Not all PCs include a serial port. If one is not available, the Orbit's USB port can be used to access the device management console by using a Mini-USB cable between the device and a PC. The PC needs to install the device driver.

NOTE If the COM port has been configured for terminal server operation, pressing +++ switches it to console (management) mode. Serial console mode is required for the following steps.

Launch a terminal communications program, such as HyperTerminal or PuTTY, with the following communication parameters: 115200 bps (default speed), 8 bits, no parity, one stop bit (8N1) and flow control disabled. Incorrect parameter settings are a frequent cause of connection difficulties. Double check to be sure they are correct.

An adapter may be used to convert the unit's RJ-45 serial jack to a DB-9F type (MDS part no. 73-2434A25). If no serial port exists on the PC, a Mini-USB cable may be connected between the Orbit's USB device port and the PC.

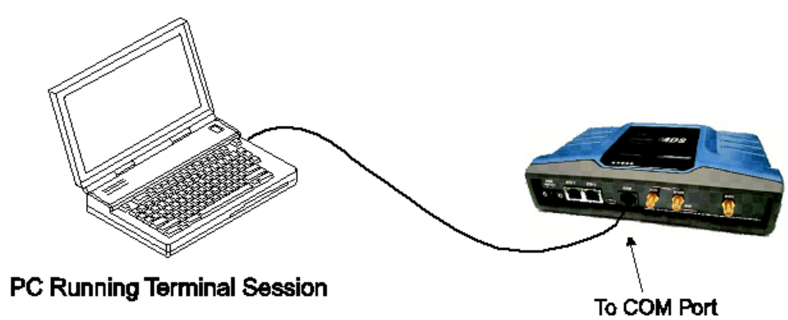


Figure 3-17. PC Connection for Programming/Management

2. Press the ENTER key to receive the Login: prompt. This indicates that the unit is ready to receive commands.
3. At the Login: prompt, enter admin (lower case) and press ENTER .

4. If no password has been previously set, enter the default password (admin) and press ENTER ; otherwise, enter the saved password at the Password: prompt.

NOTE Depending on device configuration you may be required to immediately change the admin password on first use prior to any other activity. If not, then before placing the unit in final service, it is recommended that the default password be changed to ensure that only authorized users have access.

5. After successful login, the command prompt appears where you may configure and manage a number of unit settings.

3.4.3 Using the CLI

This section describes how to use the CLI by using an example: changing the name of the unit.

Step 1: Login to the device using the serial console and use the default username admin and the appropriate password.

```
(none) login: admin
Password:
Welcome to the CLI
admin connected from 127.0.0.1 using console on (none)
```

Step 2: Instruct the device to enter configuration mode by typing configure and pressing the enter key:

```
> configure
Entering configuration mode private
```

Step 3: Change the device name by typing in the following, followed by enter: set system name Device539

```
% set system name Device539
```

Step 4: Verify the change looks correct by reading the data back, using the following, followed by the enter key: show system name

```
% show system name
name Device539;
```

Step 5: Commit the change by typing in the following, followed by the enter key: commit

```
% commit
Commit complete.
```

Step 6: Exit the configuration mode by typing the following, followed by the enter key: exit

```
% exit
```

Step 7: Exit the login session by typing the following, followed by the enter key: exit

```
> exit
Device539 login:
```

Tab Completion Feature

Tab-completion is a powerful feature that presents CLI users with assistance while typing. Depending on the text that was already entered, tab-completion will display different possible completions. When the tab key is pressed, and no text has been entered, the CLI shows all possible commands that can be typed.

Creating a One-Time Password

To create a one-time recovery password, proceed as follows:

- Upon successful log-in, enter the following command:

> request system recovery one-time-passwords create function <selected function>

NOTE A one-time password is automatically generated and displayed on the screen. Copy this password and save it in the desired location on your PC. There is no way to ever view it again from the command line console, so be sure it is properly saved.

- To create additional one-time passwords (up to a total of five), repeat the step above.

Deleting a One-Time Password

To remove an existing password from the list, proceed as follows:

Enter the command request system recovery one-time-passwords delete identifier X, where X is a number from the currently available one-time passwords. This identifier is not reused. If all five passwords have been created, then ID 1 can be deleted, and the next created password will be at ID 6.

The current list of passwords may be viewed by issuing the command show system recovery one-time-passwords. The following is an example output from that command. On the unit shown, only two passwords have been stored. Password 1 or 2 can be deleted from this list.

```
IDENTIFIER  FUNCTION  STATUS   DATE CREATED               DATE REVOKED  USER
----------------------------------------------------------------------------------------------------------------
1           login     usable   2012-06-19T00:27:24+00:00
2           login     usable   2012-06-19T00:27:25+00:00
```

3.4.4 CLI Quick Reference Table

Table 3-3 provides a summary listing of commonly needed tasks and the appropriate commands to enter. The table can be used as a quick reference before consulting the more detailed information, which follows in this section. Each CLI command is preceded by the symbol > for operational command, or % for a configuration command.

Table 3-3. CLI Quick Reference Table

If you wish to...	Enter this CLI command:
Create a one-time password	**> request system recovery one-time-password create function <user function>**
View all network interface status and statistics	**> show interfaces-state interface**
Create a bridge	**% set interfaces interface** Bridge **type bridge**
Add the ETH1 interface to a bridge	**% set interfaces interface** Bridge **bridge-settings members port** ETH1
Remove the ETH1 interface from a bridge	**% delete interfaces interface** Bridge **bridge-settings members port** ETH1
Set WiFi AP SSID	**% set interfaces interface** Wi-Fi **wifi-config mode access-point ap-config ap myssid**
Enable WiFi WPA2-Personal security	**% set interfaces interface** Wi-Fi **wifi-config mode access-point ap-config ap** myssid **privacy-mode wpa2-personal psk-config psk** mypassphrase **encryption ccmp**
Enable WiFi SSID Broadcasting	**% set interfaces interface** Wi-Fi **wifi-config ap-config ap** myssid **broadcast-ssid true**
View Cell Settings	**> show configuration interfaces interface** Cell **cell-config**
Monitor Cell Status	**> show interfaces-state interface** Cell **cell-status | repeat** 5
View NxRadio Settings	**> show configuration interfaces interface** NxRadio **nx-config**

Table 3-3. CLI Quick Reference Table

If you wish to...	Enter this CLI command:
Monitor NxRadio Status	> **show interfaces-state interface** NxRadio **nx-status | repeat** 5
View WiFi Settings	> **show configuration interfaces interface** Wi-Fi **wifi-config**
Monitor WiFi Status	> **show interfaces-state interface** Wi-Fi **wifi-status | repeat** 5
View the routing table	> **show routing**
View the event log	> **show table logging event-log**
Set the admin user's password	> **request system authentication change-password user** admin **password** admin1234 Or > **change-password user** admin *(prompts for new value)*
Set the device name	**% set system name** "Mydevice"
Set the baud rate on COM1	**% set services serial ports** COM1 **baud-rate** b19200
Download a firmware package from TFTP server at 192.168.1.10	> **request system firmware reprogram-inactive-image filename** orbit-bkrc-7_1_1.mpk **manual-file-server { tftp { address** 192.168.1.10 **} }**
Monitor firmware reprogramming status	> **show system firmware reprogram-status**
Export configuration file to a TFTP server at 192.168.1.10	> **request system configuration-files export filename myConfig.xml manual-file-server { tftp { address** 192.168.1.10 **} }**
Reboot device to firmware inactive image	> **request system power restart inactive**

3.4.5 Specific Examples Using CLI

Example #1

In Figure 3-18, the Orbit is functioning as a WiFi Access Point to provide connectivity between a set of laptops and a handheld device. The Orbit is also acting as a DHCP server for the laptops and handheld device.

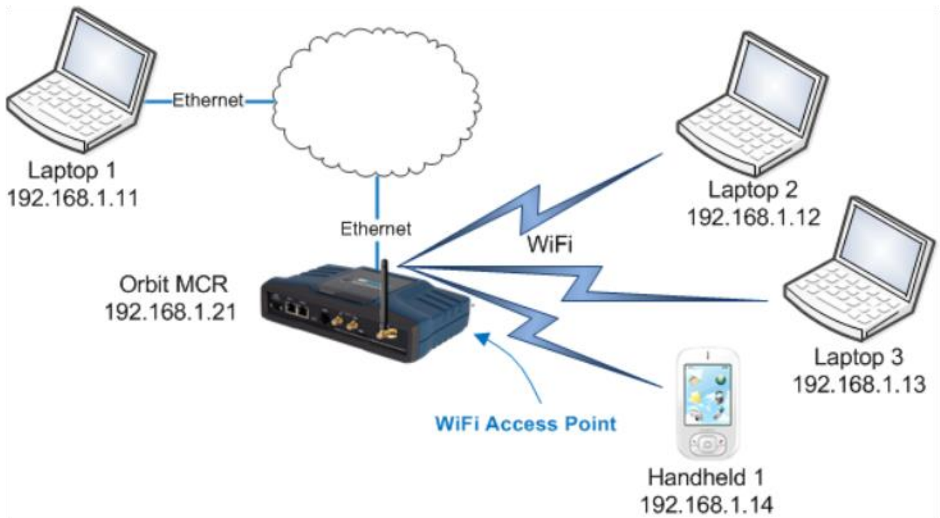


Figure 3-18. Example 1: Unit Providing Laptop and Handheld Device Connectivity

The following commands will configure the Orbit for this scenario.

% set interfaces interface Wi-Fi **type wifi**

% set interfaces interface Wi-Fi **wifi-config mode access-point ap-config ap** myssid **enabled true**

% set interfaces interface Bridge **type bridge**

% set interfaces interface Bridge **bridge-settings members port** ETH1

% set interfaces interface Bridge **bridge-settings members wifi-ap** myssid

% set interfaces interface Bridge **ipv4 address** 192.168.1.21 **prefix-length** 24

% set services dhcp enabled true v4subnet 192.168.1.0/24 **domain-nam**e gemds **range-start** 192.168.1.10 **range-end** 192.168.1.19 **router** 192.168.1.1 **broadcast-address** 192.168.1.255

Example #2

In Figure 3-19, there are two Orbit MCR devices, one acting as a WiFi Access Point, the other as a WiFi Station. Together, the units are providing a wireless bridge between the laptop and the SCADA device.

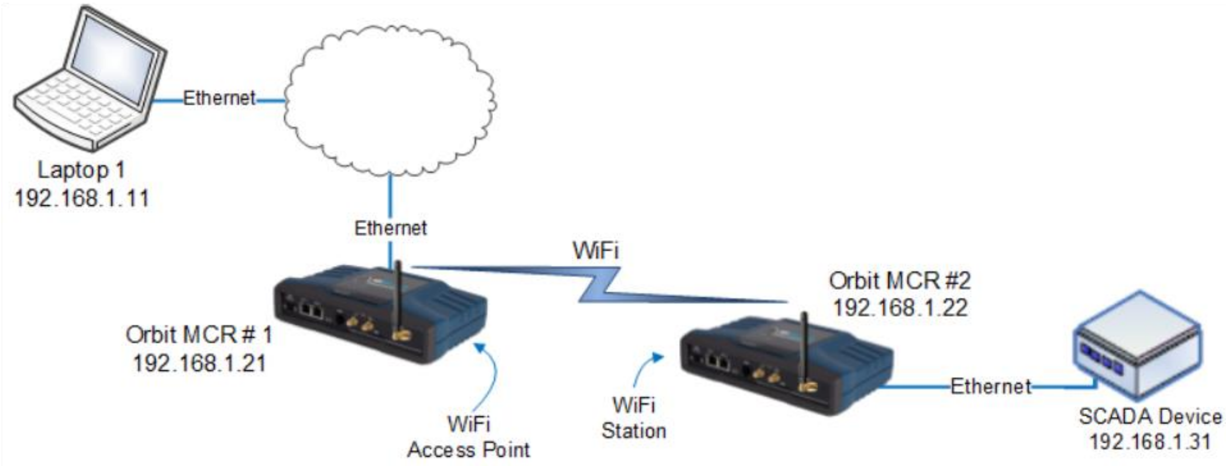


Figure 3-19. Example 2: Units Providing Wireless Bridge Between Laptop & SCADA Device

The following commands will configure the Orbit MCR #1 for this scenario.

% set interfaces interface Wi-Fi **type wifi**

% set interfaces interface Wi-Fi **wifi-config mode access-point ap-config ap** myssid **enabled true**

% set interfaces interface Bridge **bridge-settings members wifi-ap** myssid

% set interfaces interface Bridge **ipv4 address** 192.168.1.21 **prefix-length** 24

% set services dhcp enabled true v4subnet 192.168.1.0/24 **domain-nam**e gemds **range-start** 192.168.1.10 **range-end** 192.168.1.19 **router** 192.168.1.1 **broadcast-address** 192.168.1.255

The following commands will configure the Orbit MCR #2 for this scenario.

% set interfaces interface Wi-Fi **type wifi**

% set interfaces interface Wi-Fi **wifi-config mode access-point ap-config ap** myssid **enabled true**

% set interfaces interface Bridge **type bridge**

% set interfaces interface Bridge **bridge-settings members port** ETH1

% set interfaces interface Bridge **bridge-settings members wifi-station interface** Wi-Fi

% set interfaces interface Bridge **ipv4 address** 192.168.1.22 **prefix-length** 24

Example #3

Figure 3-20 shows the Orbit MCR #2 device acting as a terminal server to provide connectivity to the serial-based SCADA device via UDP.

NOTE The configuration for Orbit MCR #1 in Figure 3-20. Example 3: Unit Providing Connectivity to Serial-Based SCADA Device via UD is identical to the configuration shown in the previous example (Example #2).

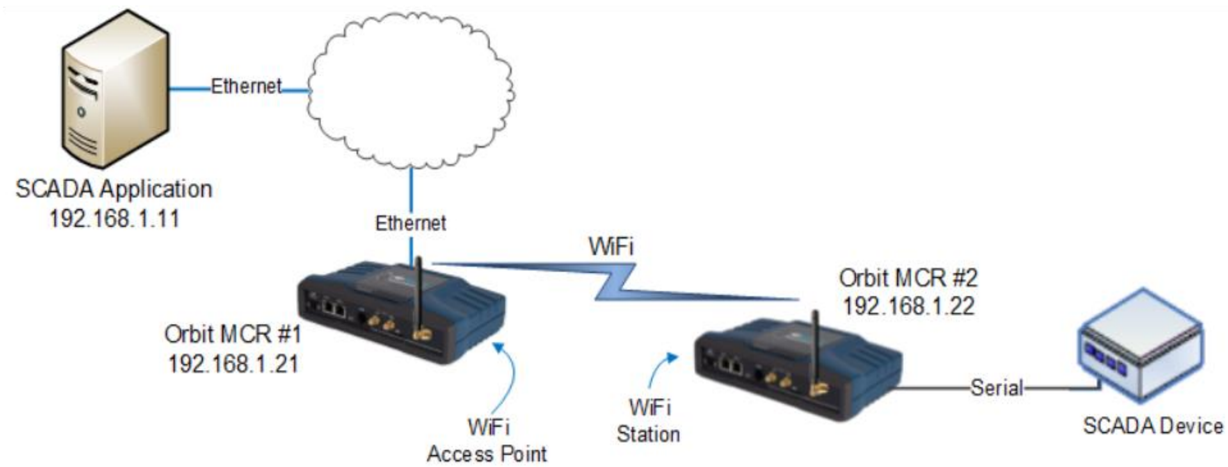


Figure 3-20. Example 3: Unit Providing Connectivity to Serial-Based SCADA Device via UDP

The following commands will configure the Orbit MCR #2 for this scenario.

% set interfaces interface Wi-Fi **type wifi**

% set interfaces interface Wi-Fi **wifi-config mode access-point ap-config ap** myssid **enabled true**

% set interfaces interface Bridge **type bridge**

% set interfaces interface Bridge **bridge-settings members port** ETH1

% set interfaces interface Bridge **bridge-settings members wifi-station interface** Wi-Fi

% set interfaces interface Bridge **ipv4 address** 192.168.1.22 **prefix-length** 24

% set services serial terminal-server server COM1 **mode udp port** 30000 **remote address** 192.168.1.11 **port** 30001

Example #4

In Figure 3-21, an Orbit provides internet access for a laptop that is accessing a public web page.

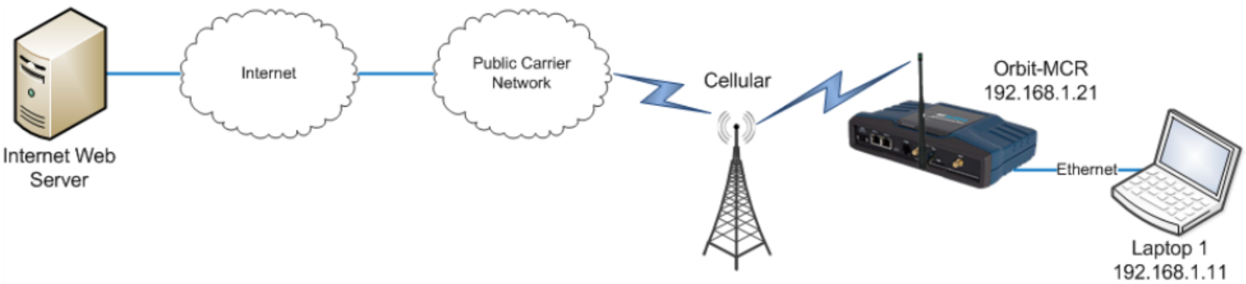


Figure 3-21. Example 4: Unit Providing Internet Access for Laptop

SIM Type: In this scenario, the Orbit has a SIM card installed that simply provides Internet access.

The following commands will configure the Orbit for this scenario.

% set interfaces interface Bridge **type bridge**

% set interfaces interface Bridge **bridge-settings members port** ETH1

% set interfaces interface Bridge **ipv4 address** 192.168.1.1 **prefix-length** 24

% set services firewall enabled true

% set services firewall address-set LOCAL-NETS **addresses** [192.168.1.0/24]

% set services firewall filter IN_UNTRUSTED **rule** 1 **match protocol** icmp

% set services firewall filter IN_UNTRUSTED **rule** 1 **actions action** accept

% set services firewall filter IN_UNTRUSTED **rule** 10 **match protocol** all

% set services firewall filter IN_UNTRUSTED **rule** 10 **actions action** drop

% set services firewall filter OUT_UNTRUSTED **rule** 1 **match src-address address-set** LOCAL-NETS

% set services firewall filter OUT_UNTRUSTED **rule** 1 **match src-address add-interface-address true**

% set services firewall filter OUT_UNTRUSTED **rule** 1 **actions action** accept

% set services firewall filter OUT_UNTRUSTED **rule** 10 **match protocol** all

% set services firewall filter OUT_UNTRUSTED **rule** 10 **actions action** drop

% set services firewall nat source rule-set MASQ

% set services firewall nat source rule-set MASQ **rule** 1 **source-nat** interface

% set interfaces interface Cell **type cell enabled true**

% set interfaces interface Cell **filter input** IN_UNTRUSTED

% set interfaces interface Cell **filter output** OUT_UNTRUSTED

% set interfaces interface Cell **nat source** MASQ

The following sections describe key operational features of the Orbit and list configuration options for them. Each major heading begins at the top of a new page. For this reason, large areas of white space exist at the end of some sections. This is done to provide a clear delineation between major sections.

NOTE The LAN port should be assigned IP addresses only if it is a routed interface (that is, *not* in a bridge).

NOTE The commands that follow in this section vary depending on the Orbit options ordered.

3.5 Interface Configuration

3.5.1 Serial Interface

Understanding

Orbit supports COM ports (RJ45) that can be used for either console access (the CLI) or payload data. Depending on ordered options, the unit may have multiple COM ports. COM ports serves as the primary interface for connecting the unit to an external DTE serial device supporting RS-232 or RS-485. By default, a COM ports are enabled for local console control, using 115200 bps with 8N1 format.

A mini-USB-to-USB cable may also be used to connect to a Computer in case no physical serial device exists. If a mini-USB connection is used, the computer must contain the appropriate device driver. A driver for serial operation can be found on GE Vernova website.

Orbit considers the COM ports and the USB as members of a broader interface category called “serial ports”. In Orbit, serial ports include any user addressable interfaces that pass serial bytes. Depending on configuration, serial ports may also include virtual ports that provide access to the serial data stream of internal Orbit interfaces. This is useful, for example, to allow the Orbit to access the over-the-air serial data stream of legacy licensed narrowband MDS radios.

Serial ports in Orbit can be used in one of three ways:

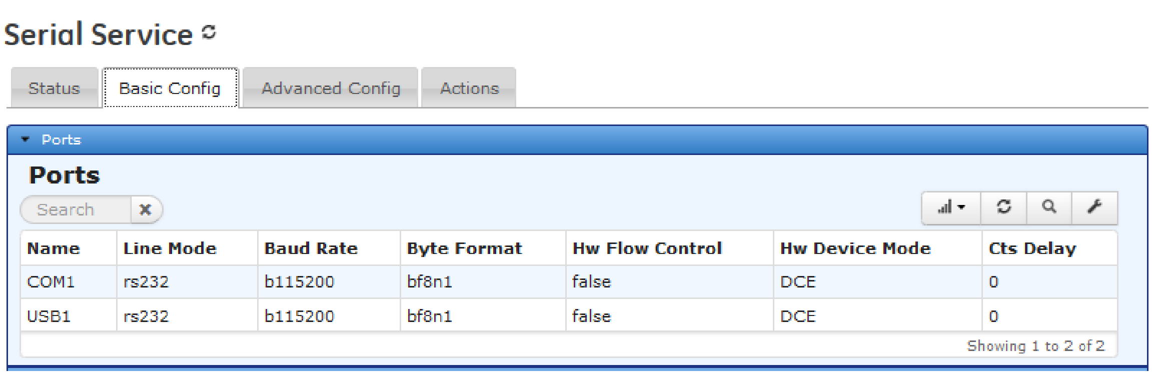
1. Console / Command Line access – the CLI for administering the unit
2. Terminal Server – conversion between serial and IP
3. Serial Pass-Through – direct connection between serial interfaces

When configured for sending serial data Orbit also provides the ability to enable a virtual RTU simulator that will allow any COM port to respond with fixed messages based on polls sent by custom MDS polling software.

Configuring

The screens below shows examples for how to configure the COM1 and USB serial ports:

Navigate to: ***Serial ---> Basic Config / Ports***



Click on **COM1** to get:

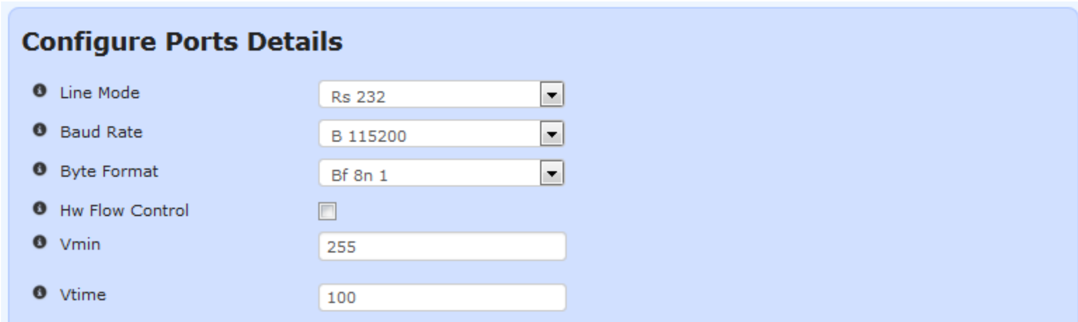
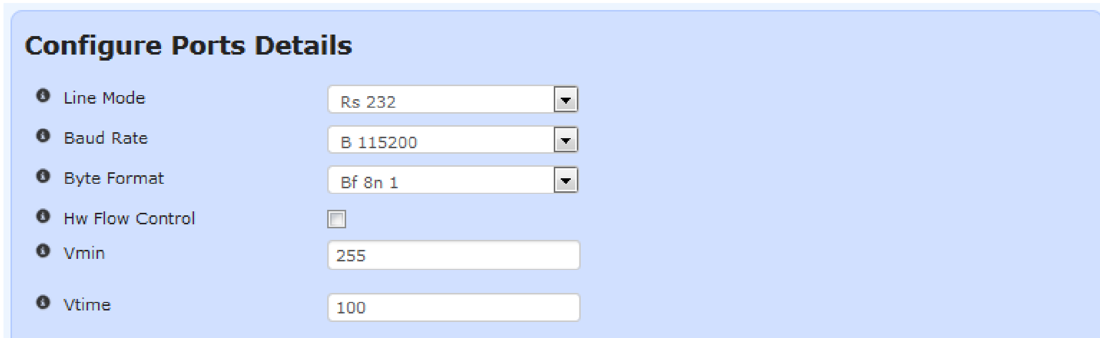


Figure 3-22. COM1 Configuration Screen

- **Line Mode** - Selection of the operation line mode of the serial port. Choices are:
  - RS232 (DEFAULT)
  - RS485 - 2 Wire
  - RS485 - 4 Wire
- **Baud Rate** - The serial port baud rate in bps. Choices are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 (DEFAULT), 230400.
- **Byte Format** - The data byte format in bits, parity and stop bits: Choices are:
  - 7N1 - 7 char bits, no parity, 1 stop bit
  - 7E1 - 7 char bits, even parity, 1 stop bit
  - 7O1 - 7 char bits, odd parity, 1 stop bit
  - 7N2 - 7 char bits, no parity, 2 stop bits
  - 7E2 - 7 char bits, even parity, 2 stop bits
  - 7O2 - 7 char bits, odd parity, 2 stop bits
  - 8N1 - 8 char bits, no parity, 1 stop bit (DEFAULT)
  - 8E1 - 8 char bits, even parity, 1 stop bit
  - 8O1 - 8 char bits, odd parity, 1 stop bit
  - 8N2 - 8 char bits, no parity, 2 stop bits
  - 8E2 - 8 char bits, even parity, 2 stop bits
  - 8O2 - 8 char bits, odd parity, 2 stop bits
- **Hw Flow Control** - Hardware flow control enable/disable (DEFAULT) using RTS/CTS lines
- **Vmin** - Receive Buffer Size - The minimum number of data bytes that will be buffered by the serial port before handling of the data to be processed by the terminal server. (255 = DEFAULT).
- **Vtime** - Receive Inter-Byte Timeout - The amount of time between bytes of data on the serial port in milliseconds, that indicate the end of a serial message ready to be processed by the terminal server. (10 = DEFAULT)

Click on the USB1 to get:



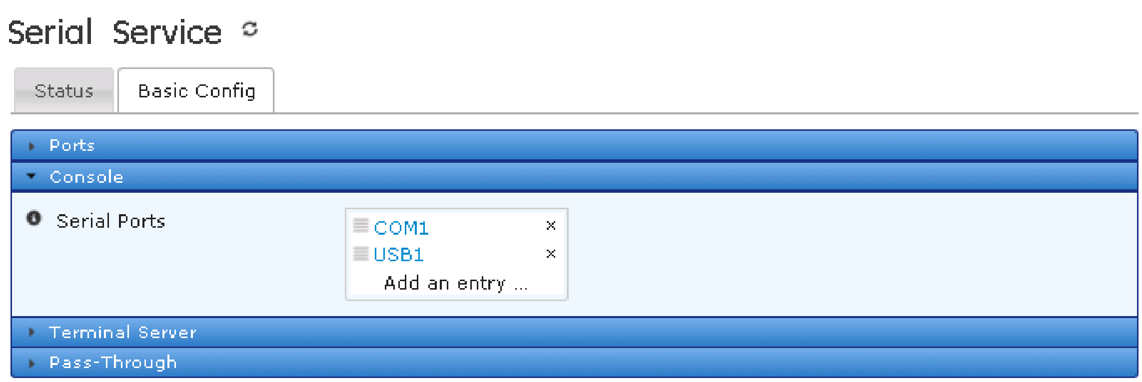
NOTE For serial ports other than physical COM ports, the only useful attributes are Vmin and Vtime. Other settings like line mode, baud rate, and flow control are ignored.

- **Vmin** - Receive Buffer Size - The minimum number of data bytes that will be buffered by the serial port before handling of the data to be processed by the terminal server. (255 = DEFAULT).
- **Vtime** - Receive Inter-Byte Timeout - The amount of time between bytes of data on the serial port in milliseconds that indicates the end of a serial message ready to be processed by the terminal server. (10 = DEFAULT)

Console Settings

Any physical serial port can be set up as a console port by adding the port under the Console tab.

Navigate to: ***Serial ---> Basic Config / Console***



From the CLI, this sequence shows how to add console access to the COM1 and COM2 serial ports and set the COM2 baud rate to 19200 bps:

% set services serial console serial-ports [COM1 COM2]
% set services serial ports COM2 **baud-rate** b19200
% commit

Terminal Server Settings

When configuring a serial port that will be used as a terminal server the VMIN and VTIME settings need additional explanation. As described above VMIN is a number describing bytes that are received from the interface, while VTIME is a delay value in milliseconds. These parameters act together to control serial data collection and transmission as described below:

- VMIN == 0; VTIME == 0: The terminal server will continuously read to see if a byte if data is available and process each byte.

NOTE While this is a valid mode in most cases this causes a high processing load on the device that may impact performance of other operations of the device.

- VMIN > 0; VTIME == 0: The terminal server waits to process data until at least VMIN bytes of serial data are received.
- VMIN == 0; VTIME > 0: If serial data is received, the terminal server will continuously read the number of bytes available until VTIME has elapsed then process the data.
- VMIN > 0; VTIME > 0: Once an initial byte of input becomes available the terminal server waits until the MIN bytes have been read, or when the inter-byte timeout expires. The timer is restarted after each further byte is received and because the timer is started only after the initial byte is received, at least one byte will be read.

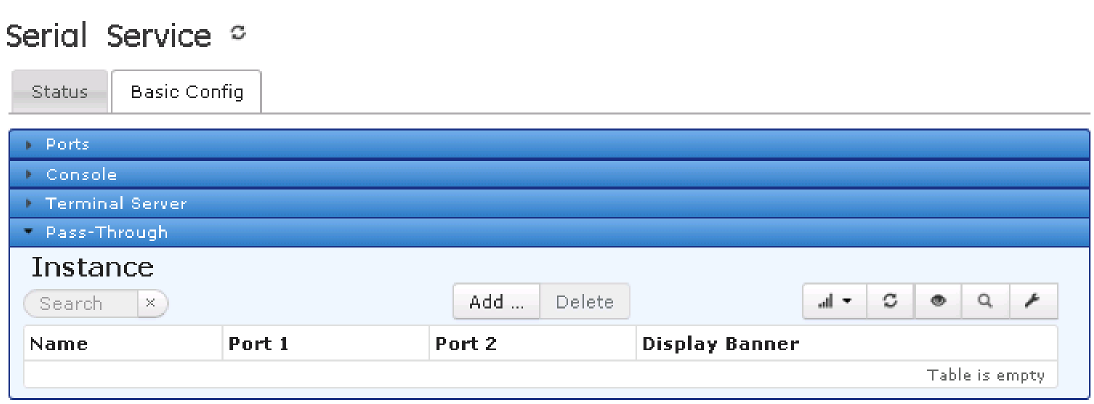
For more information on Terminal Server configuration see 3.8.15.

Pass-Through Settings

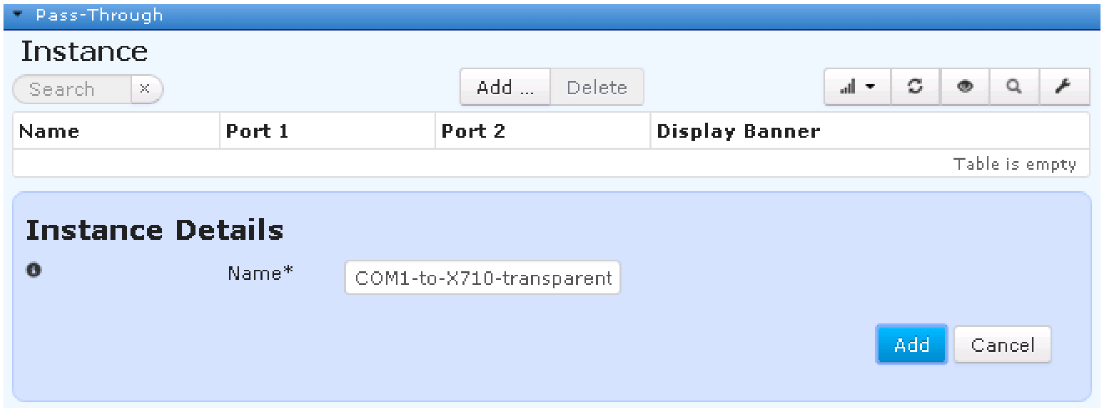
Orbit offers Serial Pass-Through operation as a low-overhead means to transport serial data. Unlike Terminal Server operation, there is no need to convert the serial data to IP.

A Pass-Through Instance defines the connection between the two serial ports.

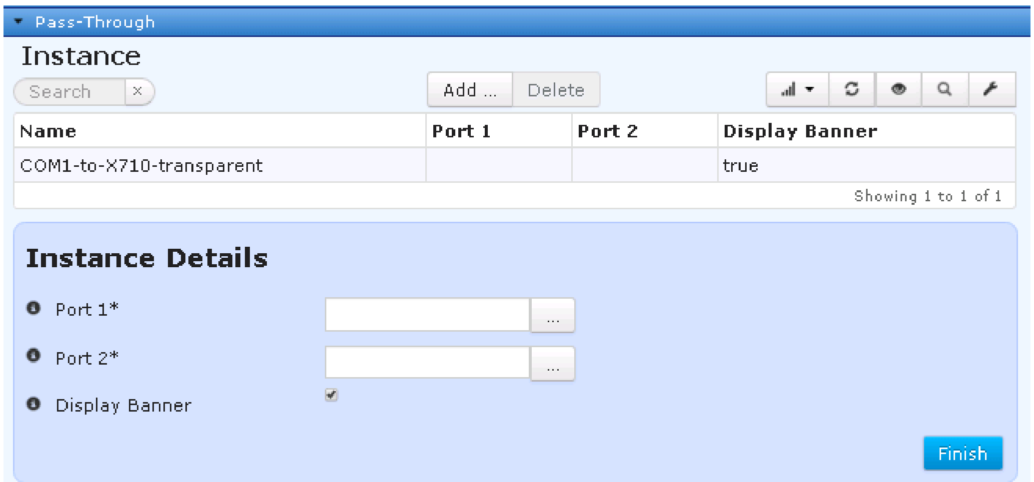
Navigate to: ***Serial ---> Basic Config / Pass-Through***



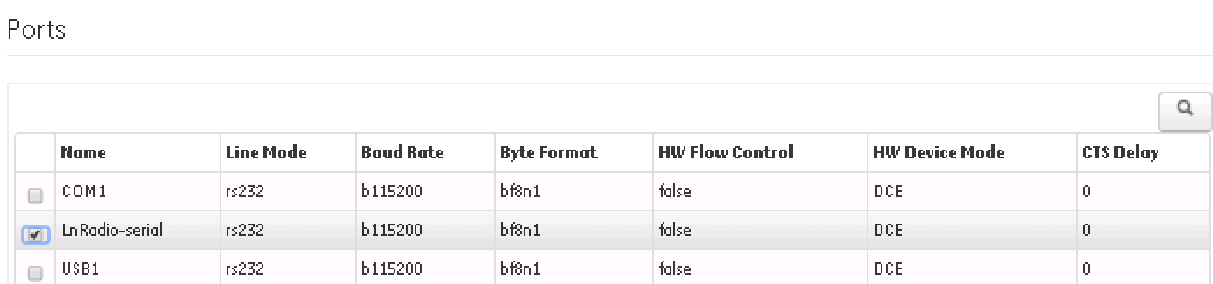
The example below defines a Pass-Through Instance to connect COM1 to an Orbit LN operating in transparent-serial mode (backward compatible to x710). First the instance is named as shown:



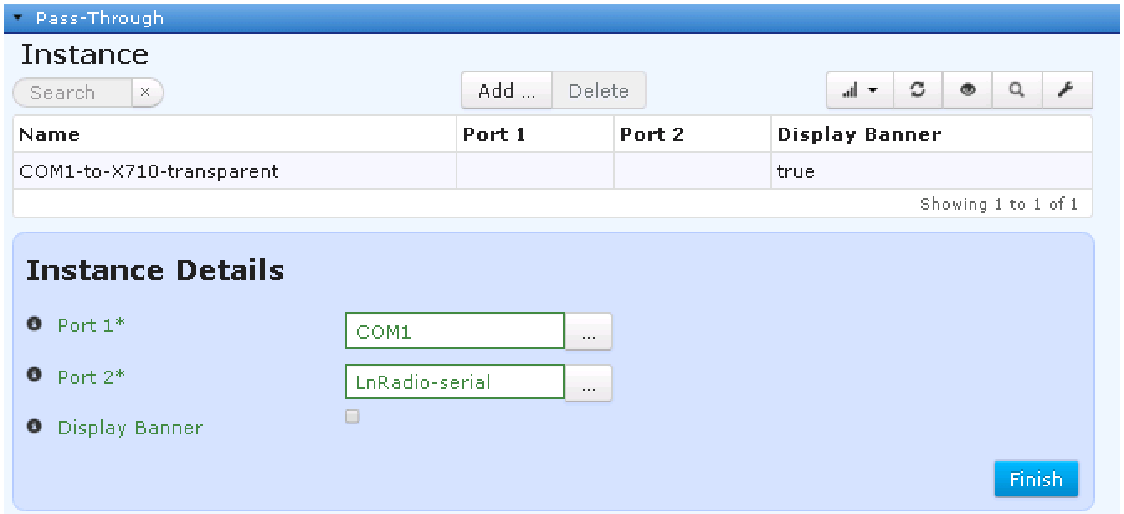
Next the connection is specified between the ports, labeled Port 1 and Port 2.



Clicking the "…" button provides the serial port choices. In this example, COM1 is the physical serial port; LnRadio-serial is the virtual serial port created automatically when an Orbit LN interface is configured for "transparent-serial" operation.



The last image below shows the final configuration prior to selecting the "Finish" button.



Note that the "Display Banner" check-box at the bottom applies to ports that also function as Console ports. It indicates whether or not an informational message is displayed on startup describing that the port is going into data mode and not available for console use.

Embedded RTU Simulator Operation

Orbit provides a way to enable a virtual RTU simulator on any COM port. When a device is polled using custom MDS polling software (included with MDS Field Network Manager), the Orbit will respond to polls as if an actual connected serial device was attached. This provides a convenient way to test connectivity in a deployed network without requiring actual customer payload data to be sent.

The embedded RTU can be configured as follows.

- **RTU Simulator** – A checked box indicates the RTU simulator is configured and active (unchecked = DEFAULT).
- **Address** – The address of the RTU to simulate.
  - 0..80 standard (0 = DEFAULT)
  - 81..414 reserved – do not use
- **Simulate Delay** – A checked box indicates the orbit will simulate a connected device by using response timing representing the timing on a physical serial port.

Serial Hardware Flow Control

Hardware Flow Control: When operating in CTSKEY mode, all serial ports in the data path are required to be set to the same baud rate, and that VMIN and VTIME remain at the defaults for serial data packets less than or equal to 255 bytes. For serial packets over 255 bytes it is recommended that a cts-delay time of at least 90ms be used to account for the VTIME delay of the over-the-air sending unit.

Hardware Flow Control Modes:

1. DCE
   - CTS follows RTS after a programmable **CTS delay**.
   - If the unit's input buffer approaches a full condition it can deassert CTS regardless of state of RTS.
2. CTSKEY
   - Based on legacy MDS devices including TransNET and SD, the device will act similar to a DTE but will provide signaling on the CTS line instead of the RTS line.
   - When the first character of a transmission is ready to be sent to the serial port, the unit shall assert CTS and delay for **CTS delay** time expiration before outputting the first character.
   - After the last character of a transmission is output from the serial port, the unit shall keep CTS asserted until the expiration of **CTS hold** time.
3. CTSKEYPLUS
   - The unit shall support flow control (Throttling) on the RTS pin. The device is expected to be wired via null modem to an external DCE device. The CTS line of the external DCE device drives the RTS line of the unit.

Outlined Configuration: Orbit: Hardware Flow Control

1. Configure Serial Port under test for Hardware Flow Control
   - Configure Hw Flow Control to true
   - Configure Hw Device Mode: DCE, CTSKEY, CTSKEYPLUS
   - Configure any remaining parameters, Cts Delay, Cts Hold, VMIN, VTIME
2. Save/Commit Configuration

Step by step Web based Walkthrough:

1. On the left hand side of the Web GUI, click *Services*.
2. Click *Serial* from the Services drop down.
3. Click the Serial Port *Name* on the ***Basic Config*** tab to configure Hardware Flow Control.

NOTE **Cts Hold** -The CTS hold parameter is applicable only when h/w device mode = CTSKEY or CTSKEYPLUS. This parameter specifies the time (in milliseconds) to hold CTS up after data is transmitted.

▾ Ports

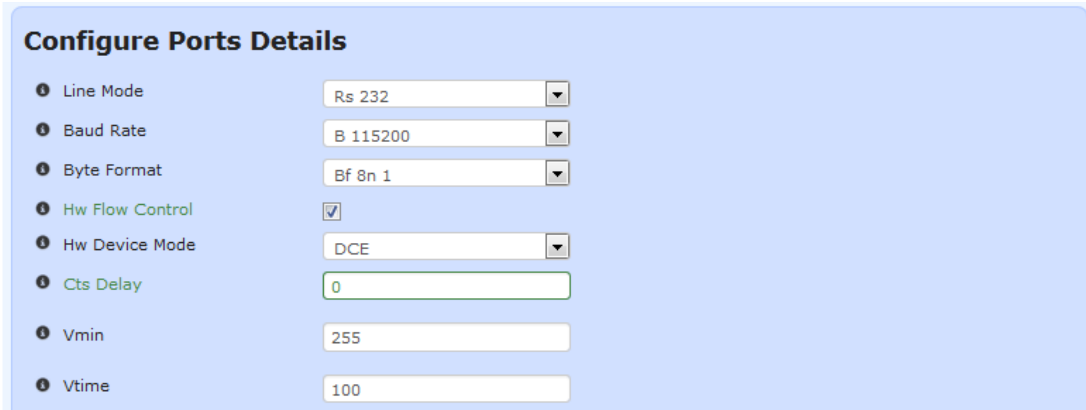
Ports

Search

Name	Line Mode	Baud Rate	Byte Format	Hw Flow Control	Hw Device Mode	Cts Delay
COM1	rs232	b115200	bf8n1	false	DCE	0
USB1	rs232	b115200	bf8n1	false	DCE	0

Showing 1 to 2 of 2

1. To enable Hardware Flow Control, click the *Hw Flow Control* checkbox.
2. Adjust the new parameters to fit the system, *Hw Device Mode, Cts Delay, Cts Hold*.



3. This is also where VMIN and VTIME can be adjusted.
4. Save the Configuration.

CLI Configuration Commands

Change *ITALICS* to fit the system

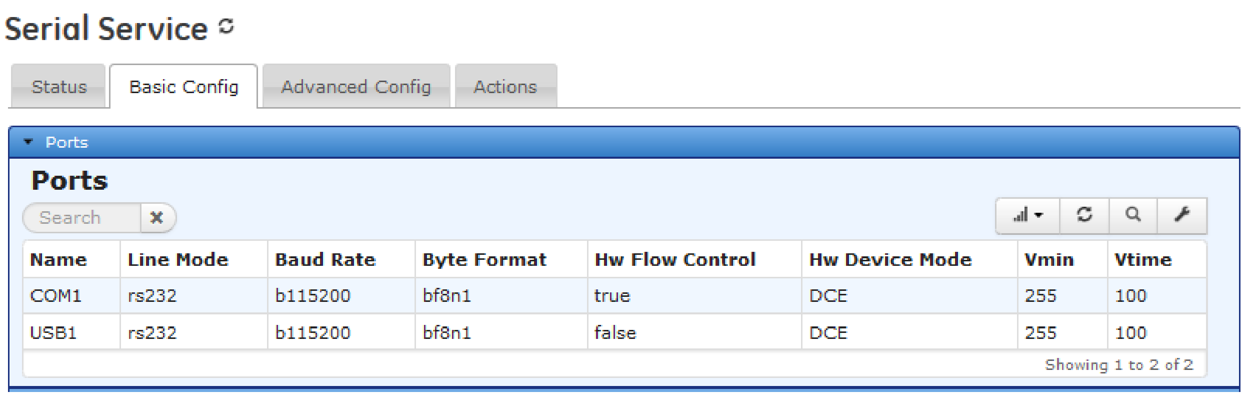
Configure the following as an example:

% set services serial ports COM1 **hw-flow-control true hw-device-mode** CTSKEY **cts-delay** 90 **cts-hold** 40
% commit

Monitoring

From the Web UI, the Serial Ports screen shows the settings:

Navigate to: ***Serial ---> Basic Config / Ports***



NOTE Vmin and Vtime are not displayed by default. To modify the view, click the button and add them to the view.

From the CLI in operational mode, follow the example below to view the state and statistics:

> show configuration services serial | details
ports COM1 {

line-mode	**rs232;**
baud-rate	**b115200;**
byte-format	**bf8n1;**
hw-flow-control	**false;**
vmin	**255;**
vtime	**10;**

```
}

ports COM2 {
        line-mode               rs232;
        baud-rate               b19200;
        byte-format             bf8n1;
        hw-flow-control         false;
        vmin                    255;
        vtime                   10;
}

console {
        serial-ports [ COM1 COM2 ];
}
```

3.5.2 Cell

3.5.2.1 Understanding

The Orbit product family is available with 4G LTE/3G UMTS cellular modem options for various regions around the world.

NOTE GE Vernova is continually certifying the product for different countries and carriers, please contact sales or technical support to inquire about the current certification status for particular country/carrier.

Orbit supports routing of TCP/UDP/IP data from the Cellular WAN network interface to any of the other network interfaces (including WiFi or LAN) using the IPsec VPN or network address and port translation (NAPT) feature and to the COM1 (or COM2) serial port using the terminal server service. The configuration of these use cases is specified in the respective sections on VPN, Firewall and NAT and Terminal Service.

The cellular modem inside the unit supports main (primary) and secondary antenna (for receive diversity). The primary antenna must be installed for the cell modem to register with the cellular network. It is strongly recommended that a secondary antenna be installed for achieving a robust cellular link. There should be no physical obstructions around the antennas. The main and diversity antennas must have at least 27 dB of isolation from each other to ensure optimal operation of the cellular modem. For Antenna Installation assistance, see "Antenna Planning and Installation" on Page 36 or contact your local MDS product representative. See the below table for approved Antenna Types.

Table 3-4. Approved Cell Antenna Types

Application	Location	Frequency Range	Gain	Antenna Description	MDS Part Number
3G/4G Cellular	Indoor	698-2700MHz CELL BANDS	2 dBi	Direct Connect, - SMA Paddle antenna	97-2485A04
3G/4G Cellular	Outdoor	698-2700MHz CELL BANDS	4.5 dBi	External Mount, Omni Ant. with N-Female connector - no cable Note: requires a metal Ground Plane	97-2485A05
3G/4G Cellular	Outdoor	698-2700MHz CELL BANDS	1 dBi	External Mount, Dipole Omni with N-Female connector - no cable	97-2485A06

Application	Location	Frequency Range	Gain	Antenna Description	MDS Part Number
3G/4G Cellular	Outdoor	694-960MHz 1.7-2.2GHz 2.2-2.7GHz 3.3-3.8GHz CELL BANDS	3 dBi 3.5 dBi 3.5 dBi 4 dBi (by band)	External Mount, 2x2 MIMO OMNI with 2xSMA plugs	97-3194A51

Table 3-5 describes the Orbit's LED behavior when using the cellular interface.

Table 3-5. Cell Interface LED Descriptions

LED - NIC1	State	Description
Cell Interface	Off Solid green	No cellular connection Cell connection

SIM Port(s) - These ports accept a mini SIM card (2FF type) for cell operation. The unit's cellular interface will not function without at least one valid SIM card installed. Users are responsible for obtaining provisioned SIM cards for the appropriate service plan from their cellular provider. Information on determining the cell module's IMSI/IMEI (typically required for provisioning) is provided on Page 91 of this manual.

Effective February 2019, standard Orbit 4G LTE offerings now provide two SIM ports labeled SIM-A and SIM-B. SIM port locations vary based on the specific Orbit model configuration. The figures below show proper alignment of the SIM card for both orientations.

<u>CAUTION</u>: Do not insert the SIM card when the unit is powered on.

Card Insertion: SIM cards only insert one way; do not force it. Each SIM should be inserted with the printed label and the cut-off corner matching the orientation described in the figures below. A small instrument, such as a flathead screwdriver, may be helpful to *gently* push the SIM all the way in until it locks.

Orbit MCR offerings with 2 Serial + 1 Ethernet port or 1 Serial + 2 Ethernet ports, have SIM-A and SIM-B horizontally aligned with a small vertical separation. Note that the printed label for SIM A faces up with the cut-off corner on the left side; the printed labeled for SIM B faces down with the cut-off corner on the right side.

Figure 3-23. Steps for Inserting SIM Cards on MCR with horizontal alignment

Orbit ECR and Orbit MCR with 2 Serial + 4 Ethernet ports have SIM-A and SIM-B diagonal to each other. The SIM card orientation is opposite the case above. The printed label for SIM A faces down with the cut-off corner on the right side; the printed labeled for SIM B faces up with the cut-off corner on the left side.

Figure 3-24. Steps for Inserting SIM Cards on ECR and MCR with diagonal alignment

Orbit MCR with Dual Cell modem options have three SIM slots, with SIM-A and SIM-B connected to cellular modem in NIC slot 1 and SIM-C slot connected to cellular modem in NIC slot2. Cellular modem can use either SIM-A or SIM-B slot (configurable under connection-profile setting as detailed in later sections).

3.5.2.2 Configuring

A **Connection Profile** must be configured for the unit to establish a data connection with the cellular network. A connection profile allows the user to configure various parameters related to the cellular connection. One or more connection profiles can be configured on the unit. The order of the connection profiles can be chosen by the user. The unit will use the first connection profile to establish connection with the cellular network. If connection profile switching (described later) is enabled, then the unit will switch to second profile in the list if it is unable to establish a connection using the first profile after a configurable, specified timeout.

An Orbit equipped with a 4G LTE modem is shipped out of the factory with the cellular interface enabled and a connection profile (named **PROFILE-1**).

In the UI, start on the following page: ***Interfaces / Cell ---> Basic Config / Cellular***

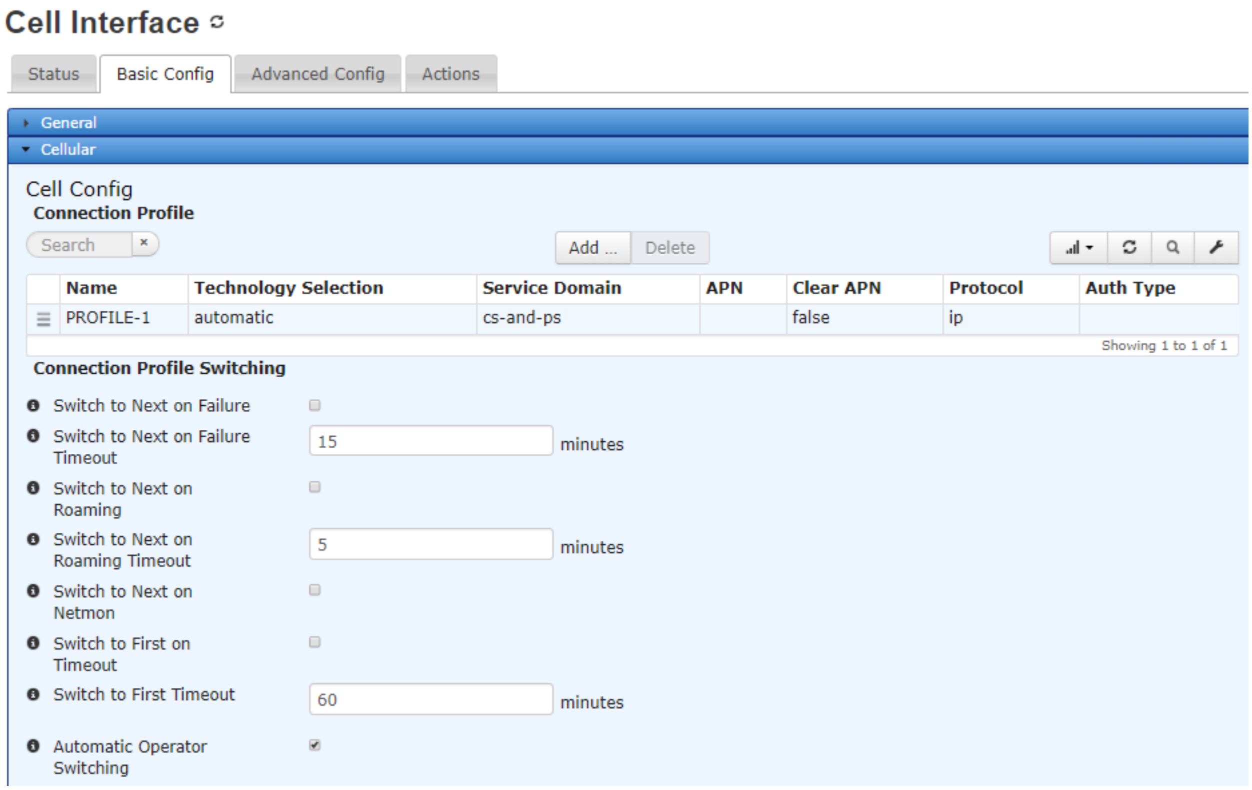


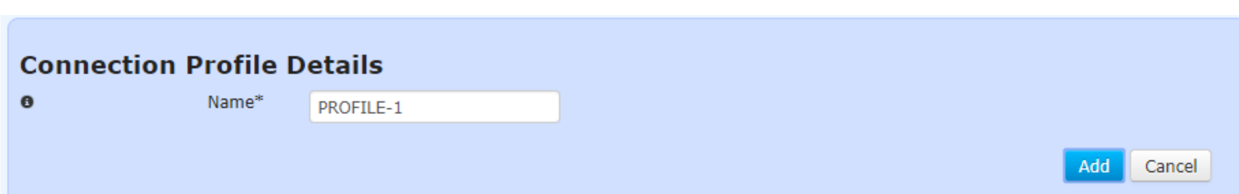
Figure 3-25. Connection and Connection Profile Switching UI Screen

The cellular configuration is configured by creating a “Connection Profile” to describe the connection and consists of four major groups of information:

- **Network Configuration** - contains various parameters related to how the modem registers with the cellular network.
- **Bearer Configuration** - parameters related to data connection with the cellular network.
- **Keep Alive** - Keep alive configuration for sending ICMP Echo messages to a remote host/server periodically to keep the connection alive (i.e. prevent any network initiated disconnect due to no data activity). This functionality can also to detect and recover connectivity by resetting the modem.
- **Service Recovery** – Parameters related to built-in connectivity recovery configuration.

If multiple cellular providers are supported, the “Connection Profile Switching” choices may need to be configured.

The following is an example UI screen to create a connection profile named ***PROFILE-1*** by clicking on the **ADD** button and naming the profile as such.



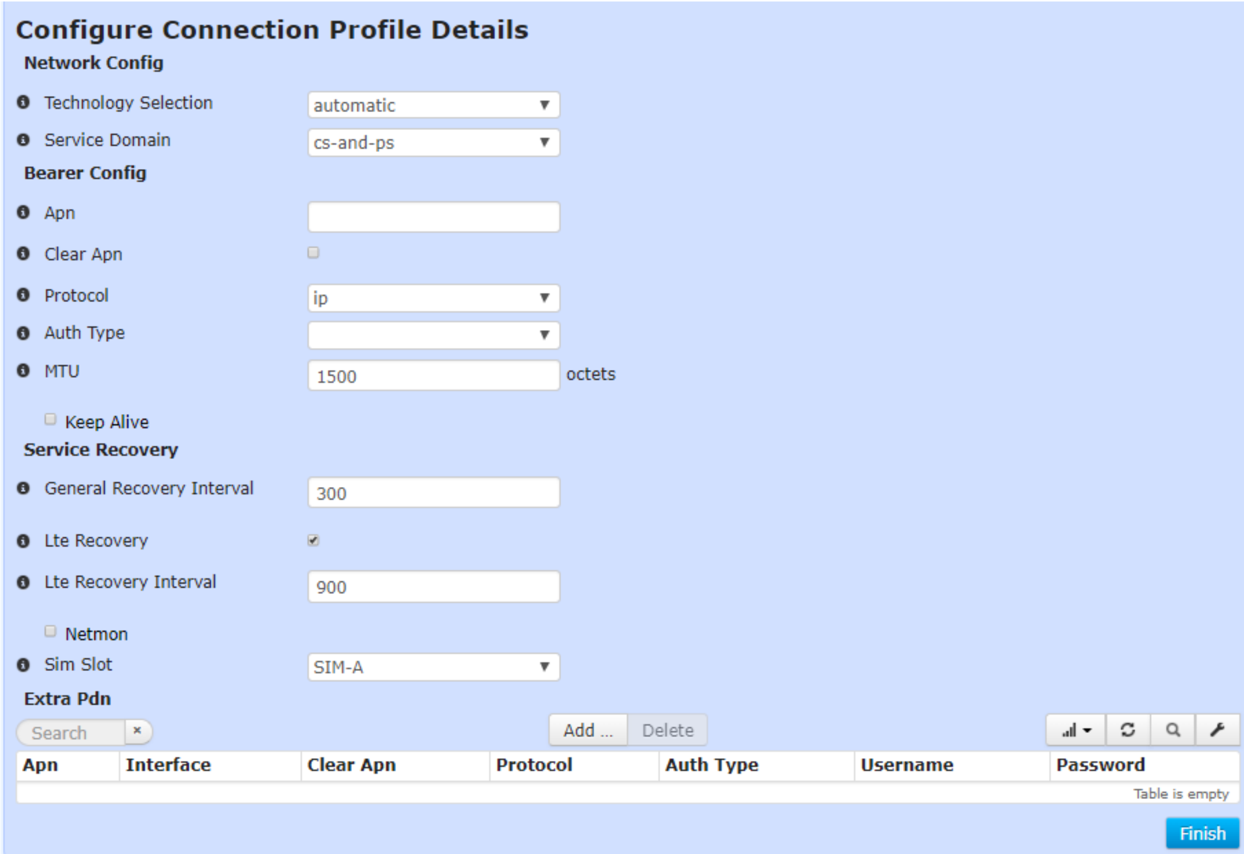


Figure 3-26. Example Connection Profile

Each **Connection Profile** contains following information to be selected. The choices are described below:

- **Network Configuration** - contains various parameters related to how the modem registers with the cellular network.
  - **Technology-selection** - The user can configure the modem to automatically select the network technology to connect to (automatic) or force it to register only on:
    - Automatic (DEFAULT)
    - 2G GSM (geran),
    - 3G UMTS (utran),
    - 4G LTE (e-utran),
    - 2G CDMA(cdma-1xrtt)
    - 3G CDMA EV-DO (cdma-evdo).
  - **Service Domain** - Network Service Domain - choices are:
    - Circuit Switched (CS) and Packet Switched (PS)
    - Packet Switched (PS) Only

If cellular network does not support CS then configure as PS Only. Consult your service provider for this information. Typically, this field is left as default.

- **Bearer Configuration** - parameters related to data connection with the cellular network.
  - **Apn** - Once the unit has registered to the cellular network, it sets up the IP data connection with a specific Packet Data Network (PDN) identified by the Access Point Name (APN). APN is a string identifier. If a private network (PN) account has been set up with Verizon wireless, a SIM card will be issued from that account. When the modem is powered up with such a SIM, the default APN on the modem is automatically updated to the one that identifies the user's private network.

This procedure is called OTA APN update. This procedure might not always succeed and hence, may require the user to manually update the APN on the Orbit.

The following example shows how to update the APN to, ***MYAPN.GW6.VZWENTP***, manually, via the CLI:

% set interfaces interface Cell **cell-config connection-profile** PROFILE-1 **bearer-config apn** MYAPN.GW6.VZWENTP

% commit

Older Orbits equipped with a 3G GSM modem shipped out of factory with cellular interface disabled. The following example shows how to create a connection profile to allow it to connect to, for example, AT&T's 3G GSM network with an APN entitled "Broadband":

% set interfaces interface Cell **cell-config connection-profile** PROFILE-1 **bearer-config apn** Broadband

% set interfaces interface Cell **enable true**

% commit

NOTE In Orbit MCR/ECR firmware version 7.6.5 and above, if the APN field is empty and the modem is not running Verizon carrier image, the APN is cleared from the modem. This ensures that modem sends LTE attach without any APN, which enables the network to setup the default bearer on default APN associated with the SIM card.

- **Clear APN** – This field should be selected to remove APN from the modem. When modem does not provide APN during LTE attach, the network can activate the default bearer on APN associated with the SIM card. This is often desirable as it obviates the need to configure APN explicitly. However, this is dependent on network policy as some LTE networks may require configuration of APN on the device.

NOTE In Orbit MCR/ECR firmware version 7.6.5 and above, clear-apn field does NOT have any effect and has been obsoleted. To achieve the same effect, delete APN from the bearer config as explained in the earlier note.

- **Protocol** - This parameter specifies the Packet Data Protocol (PDP) type. DEFAULT - “IP”.
- **Auth-type, Username, Password** - These parameters should be set if the cellular network provider requires a username and a password along with authentication protocol (PAP, CHAP or PAP/CHAP) to be specified. The user does not need to configure the Orbit with 4G LTE modem with these parameters. The user may need to configure Orbit with 3G GSM modem parameters, depending on the cellular network.

NOTE In FIPS mode, use of PAP/CHAP with user/password authentication is disabled

---

- **Mtu** - Maximum Transmission Unit in bytes - leave at the default value of 1500, unless directed by technical support to change.

NOTE This MTU parameter applies only to 3G1 modem type that uses PPP to connect to the network. For all other modem types, MTU configuration under IPv4 settings is used.

- **Keep Alive** - The keep-alive feature allows the cellular modem to maintain connection in situations where no traffic is passed over the cellular link for long periods of time or when the traffic is traversing through a NAT middle box in the network and where the mobile terminated traffic can be sent only if the NAT entries exist for corresponding mobile originated traffic. The keep-alive mechanism sends an ICMP echo message to the configured address/name at the configured interval. This feature should be used only if an application is passing data very infrequently over a cellular connection (i.e., if data is passed at a rate of less than once per hour).
- **Address** - This parameter specifies the address or DNS name of the destination host to which keep-alive messages should be sent

- **Interval** - This parameter specifies the time interval (in minutes) between keep-alive messages
- **Recovery on Timeout** - This parameter enables the connectivity recovery mechanism to reset the cellular modem if no response to the keep-alive messages are received up to max-num-retries attempts. DEFAULT - ***true*** if the keep-alive feature is configured
- **Max Num Retries** - This parameter specifies the number of keep-alive messages that are sent before modem recovery is attempted. DEFAULT - ***15*** - configurable only when recovery-on-timeout is enabled.
- **Service Recovery** - The service recovery configuration contains various parameters related to connectivity recovery features. The service recovery mechanism is meant as a watchdog mechanism for the cellular connection, where the cellular modem is reset under following conditions:
  - The unit is unable to get connected to the network.
  - The unit is unable to register specifically for the LTE service.
- **General Recovery Interval -** This parameter specifies the time interval after which the cellular modem is reset if the modem-state does transition into 'connected' state. DEFAULT - **300 sec** (5 min).
- **Lte Recovery** – For an Orbit equipped with an LTE modem, this parameter enables LTE service recovery. The LTE service recovery mechanism resets the cellular modem if it is stuck in 3G service-state (EV-DO or UMTS) for more than the lte-recovery-interval. This is enabled by default. This parameter affects only units with LTE capable modem.
- **Lte Recovery Interval** - For an Orbit with an LTE modem, this parameter specifies the time interval (in sec) after which, the cellular modem is reset if the modem-state does not transition to 'LTE' service-state. DEFAULT - ***900 sec*** (15 min).

```
% set interfaces interface Cell cell-config service-recovery lte-recovery false
% commit
```

NOTE The **Lte Recovery** mechanism should be disabled if the unit is deployed in areas that either lack or have poor LTE coverage. Otherwise, the cellular modem and hence the cellular data connection will be unnecessarily reset every **'lte-recovery-interval'** seconds.

- **Netmon** – The connection profile can be associated with one or more NETMON service operations. This enables following functionality: a.) Use of NETMON operation status to trigger modem reset for connectivity recovery. This is an alternative to using keep alive feature for connectivity recovery. b.) Use of NETMON operation status to trigger connection profile switching. Please see section on DUAL SIM for further information.
  - **Init Delay** – After cellular modem starts (or restarts after a reset), the NETMON status is checked after this initial delay. This is necessary to give the NETMON operation enough time to change status to UP (true) after modem has been reset. Otherwise, the action associated with NETMON operation status being down like modem reset or connection profile switch could be executed prematurely.
  - **Operation** – This is a list of NETMON operations that can be associated with this profile. The action will be taken when the status of ALL the operations is DOWN (false).
- **sim-slot** - This parameter specifies the SIM slot that should be used to read the SIM card. Orbit units equipped with cell modems may have one or two SIM slots: SIM-A and SIM-B. DEFAULT - SIM-A. The slots are located on the outside of the case, on the front panel. If multiple slots are provided, the upper slot will be labeled SIM-B and the lower slot will be labeled SIM-A.

NOTE The **sim-slot** option will not be visible on older Orbit devices.

The **Connection Profile Switching** feature allows a user to enable switching between one or more connection profiles automatically. This feature can be used to implement **SIM switching** functionality, where the user obtains and configures a unit with two SIM cards, each from a different cellular provider. This can help increase the reliability of the connection by allowing the unit to switch to a different SIM card if data connection with the other SIM card fails for any reason (for example, due to reduced signal strength etc).

For example, the UI screen for a **Connection Profile Switching** is shown below:

Interfaces / Cell ---> Basic Config / Cellular

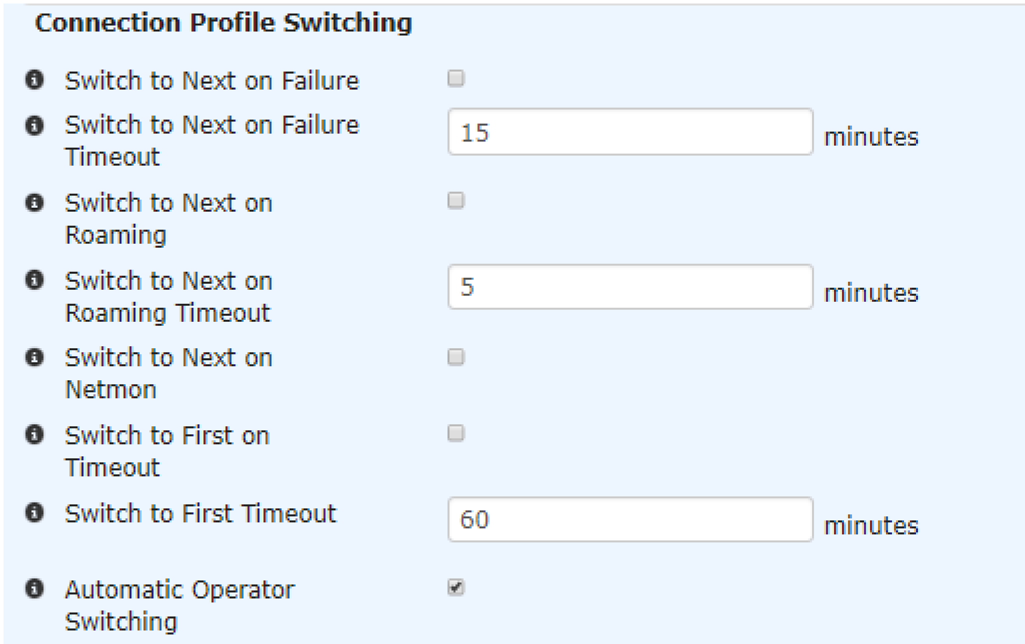


Figure 3-27. Connection Profile Switching Example

Following mechanisms/criteria are supported for connection profile switching

- **Switch to next on failure** - Cell connection manager attempts to establish data connection with first profile in the list. If the connection is unsuccessful for up to switch-to-next-on-failure-timeout (configurable in mins), it attempts to establishes connection with second profile in the list. If the connection is unsuccessful for up to **switch-to-next-on-failure-timeout** (in minutes, configurable), it circles back to the first profile and so on. DEFAULT - ***FALSE*** (disabled).
- **Switching to next on roaming**- Cell connection manager is always monitoring the roaming status of the cellular modem. When it detects that modem is roaming (i.e. not at home network) for up to **switch-to-next-on-roaming-timeout** (in minutes, configurable), it attempts to establish connection with next profile in the list and so on. DEFAULT - ***FALSE*** (disabled).
- **Switch to next on NETMON**: Cell connection manager can be configured to switch to next profile in the list based on the status of a NETMON operation. NETMON is a generic network monitor service in Orbit that supports various types of monitor operations. This provides a mechanism to switch connection profile (and hence SIM slot) using ICMP ping or BGP neighbor state etc. DEFAULT - ***FALSE*** (disabled).
- **Switch to first on timeout** - Cell connection manager can be configured to go back to the first profile in the list even if it has a successful data connection with second profile after a **switch-to-first-timeout** (in minutes, configurable). DEFAULT - ***FALSE*** (disabled).
- **Automatic Operator Switching** – This enables automatic switching of modem image to be compatible to the currently used SIM card. DEFAULT - ***TRUE*** (enabled).

NOTE The automatic operator switching feature is applicable only to Orbit devices with 4Gy cellular modem.

The **"SIM switching"** is achieved by configuring two connection profiles with first profile in the list referencing the primary slot (SIM-A) and second profile referencing secondary slot (SIM-B) and enabling connection profile switching.

Following example shows a sample configuration for SIM switching based on failure to establish connection, where SIM card from carrier A is inserted in SIM-A and the SIM card from carrier B is inserted in SIM-B.

- Configure a profile for carrier A to use SIM-A:

set interfaces interface Cell **cell-config connection-profile** CARRIER-A **bearer-config apn** carrierA.apn
set interfaces interface Cell **cell-config connection-profile** CARRIER-A **sim-slot** SIM-A

- Configure a profile for carrier B to use SIM-B:

set interfaces interface Cell **cell-config connection-profile** CARRIER-B **bearer-config apn** carrierB.apn
set interfaces interface Cell **cell-config connection-profile** CARRIER-B **sim-slot** SIM-B

- Enable connection profile switching on connection failure

set interfaces interface Cell **cell-config switch-to-next-on-failure** true

- Commit configuration

commit

Following example shows a sample configuration for SIM switching based on NETMON icmp operation status:

- Configure NETMON operation to ping a remote host (8.8.8.8) that should be reachable through either carrier network.

set services netmon operation PROBE-1 **enabled true**

set services netmon operation PROBE-1 **type icmp-echo-monitor**

set services netmon operation PROBE-1 **icmp-echo-monitor dst-host 8.8.8.8**

set services netmon operation PROBE-1 **icmp-echo-monitor interval 5**

set services netmon operation PROBE-1 **icmp-echo-monitor timeout 2000**

set services netmon operation PROBE-1 **icmp-echo-monitor successive-loss-threshold 12**

set services netmon operation PROBE-1 **icmp-echo-monitor successive-gain-threshold 6**

- Configure CARRIER-A profile with carrierA.apn, SIM-A and NETMON PROBE-1.

set interfaces interface Cell **cell-config connection-profile** CARRIER-A **bearer-config apn** carrierA.apn

set interfaces interface Cell **cell-config connection-profile** CARRIER-A **service-recovery netmon initial-delay 180**

set interfaces interface Cell **cell-config connection-profile** CARRIER-A **service-recovery netmon operation [** PROBE-1 **]**

set interfaces interface Cell **cell-config connection-profile** CARRIER-A **sim-slot** SIM-A

- Configure CARRIER_B profile with carrierB.apn, SIM-B and NETMON PROBE-1.

set interfaces interface Cell **cell-config connection-profile** CARRIER-B **bearer-config apn** carrierB.apn

set interfaces interface Cell **cell-config connection-profile** CARRIER-B **service-recovery netmon initial-delay 180**

set interfaces interface Cell **cell-config connection-profile** CARRIER-B **service-recovery netmon operation [** PROBE-1 **]**

set interfaces interface Cell **cell-config connection-profile** CARRIER-B **sim-slot** SIM-B

- Configure connection profile switching based on NETMON operation status.

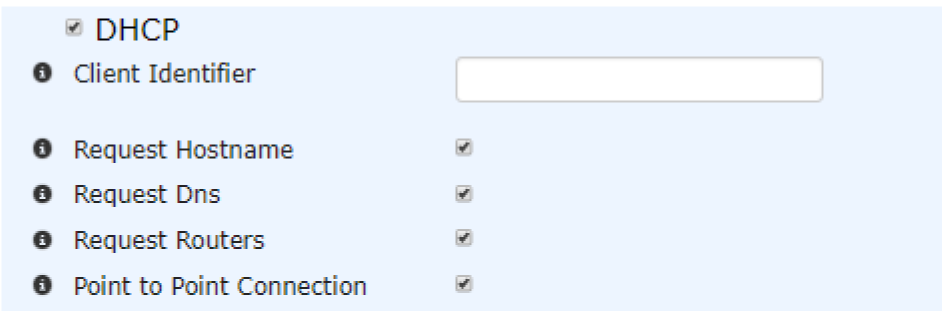
set interfaces interface Cell **cell-config connection-profile-switching switch-to-next-on-netmon true**

- Commit configuration

commit

Interfaces / Cell ---> Basic Config / IPv4

Following describes the IPv4 configuration relevant to the Cell interface:



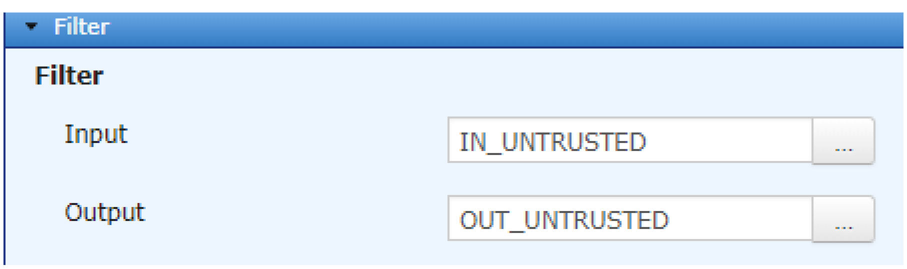
The Orbit cell interface uses DHCP to retrieve IPv4 address (assigned by the network) from the modem.

- **Request DNS** – If enabled, the DNS servers provided by the network are used by the system.
- **Request Routers -** If enabled, default route is added automatically over the Cell interface.
- **Point-to-Point Connection** – If enabled, the IP address assigned by the network is added to the Cell interface with /32 prefix. This should almost always be selected.

NOTE If multiple interfaces on orbit are configured to obtain addresses using DHCP, only one of the interfaces should enable request-dns and request-routers parameters.

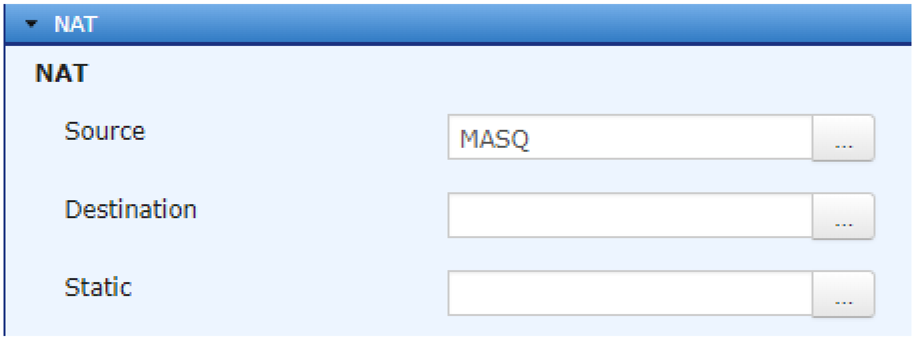
Interfaces / Cell ---> Basic Config / Filter

Following describes the firewall filters applied to the Cell interface:



Interfaces / Cell ---> Basic Config / NAT

Following describes the firewall NAT rule-sets applied to the Cell interface:



NOTE The cellular provider network can disconnect the cellular connection if any packets get routed from LAN to Cellular interface without undergoing masquerading (Source Network Address Translation (NAT) before exiting the cellular interface. Therefore, always configure masquerading on the cellular interface. See “Source NAT (Masquerading)” on Page 303 for more information on NAT configuration.

A cellular interface named ‘Cell-HPUE” will be be automatically created upon first detection of the HPUE external modem connected to the mini-USB connector on the Orbit. The cellular configuration can be performed on this interface just like any other internal cellular interface as described in earlier sections.

In the dual cellular modem Orbit MCR, the cellular interface in NIC SLOT-1 is named ‘Cell’ and the cellular interface in NIC SLOT-2 is named ‘Cell2’. The cellular configuration can be performed on these interfaces as described in earlier sections.

The default factory configuration (relevant snippet listed below) on the dual cellular modem Orbit MCR, configures the ‘Cell’ interface as the preferred default path:

Following is the lower preference fallback route over ‘Cell2’. When ‘Cell’ is up, default route with preference=254 (i.e. higher preference than below) is added over ‘Cell’.

```
set routing static-routes ipv4 route 1 dest-prefix 0.0.0.0/0
set routing static-routes ipv4 route 1 outgoing-interface Cell2
set routing static-routes ipv4 route 1 preference 255
```

Following disables automatic default route addition for Cell2

```
set interfaces interface Cell2 ipv4 dhcp request-routers false
```

3.5.2.3 Monitoring

From the Web UI, status of the cell module can be reviewed on the page:

Interfaces / Cell ---> Status / General

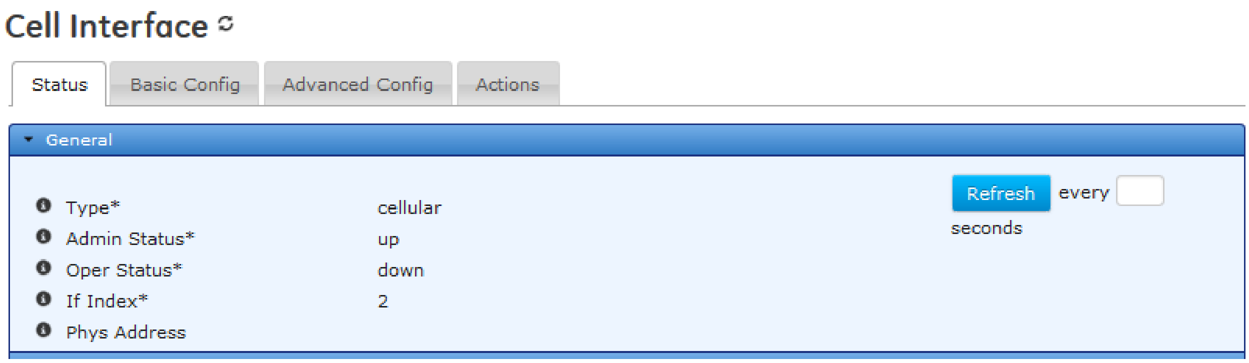


Figure 3-28. Cell Interface Status Screen

- **Type** - The type of the interface
- **Admin Status** - The desired state of the interface.
- **Oper Status** - The current operational state of the interface.
- **If Index** - The if Index value for the if Entry represented by this interface. Valid values: 1—2147483647
- **Phys Address** - The interface's address at its protocol sub-layer. For example, for an 802.x interface, this object normally contains a MAC address.

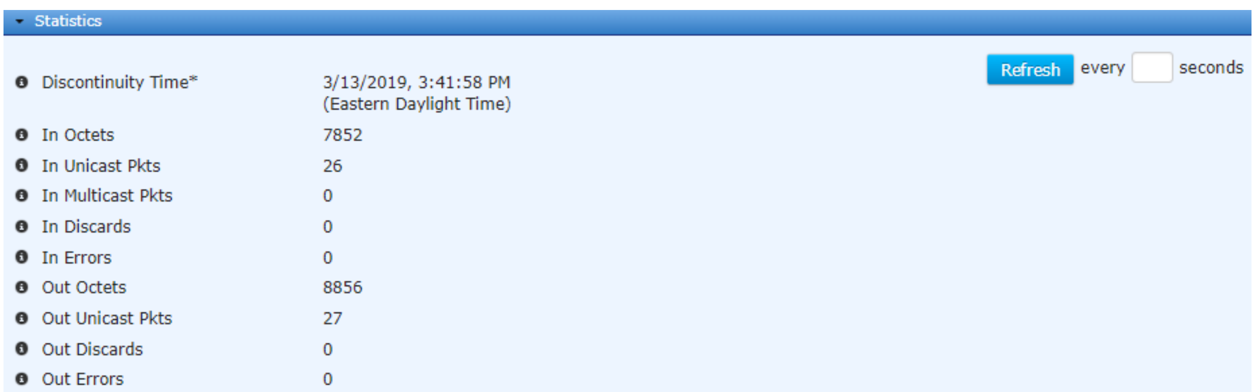


Figure 3-29. Cell Interface Statistics Screen

- **Discontinuity Time** - The time on the most recent occasion at which any one or more of this interface's counters suffered a discontinuity or interruption of service.
- **In Octets** - The total number of octets received on the interface, including framing characters.
- **In Unicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
- **In Broadcast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a broadcast address at this sub-layer.
- **In Multicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer.
- **In Discards** - The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
- **In Errors** - For packet-oriented interfaces, the number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
- **In Unknown Protos** - For packet-oriented interfaces, the number of packets received via the interface which were discarded because of an unknown or unsupported protocol.

- **Out Octets** - The total number of octets transmitted out of the interface, including framing characters.
- **Out Unicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Broadcast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Multicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent.
- **Out Discards** - The number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted.
- **Out Errors** - For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors.

When provisioning the cell module for network service, the cellular provider typically requires the International Mobile Subscriber Identity code (IMSI) or International Mobile Station Equipment Identity code (IMEI) to be provided. The Cell Status page contains this information.

Navigate ***to Interfaces / Cell ---> Status / Cellular***

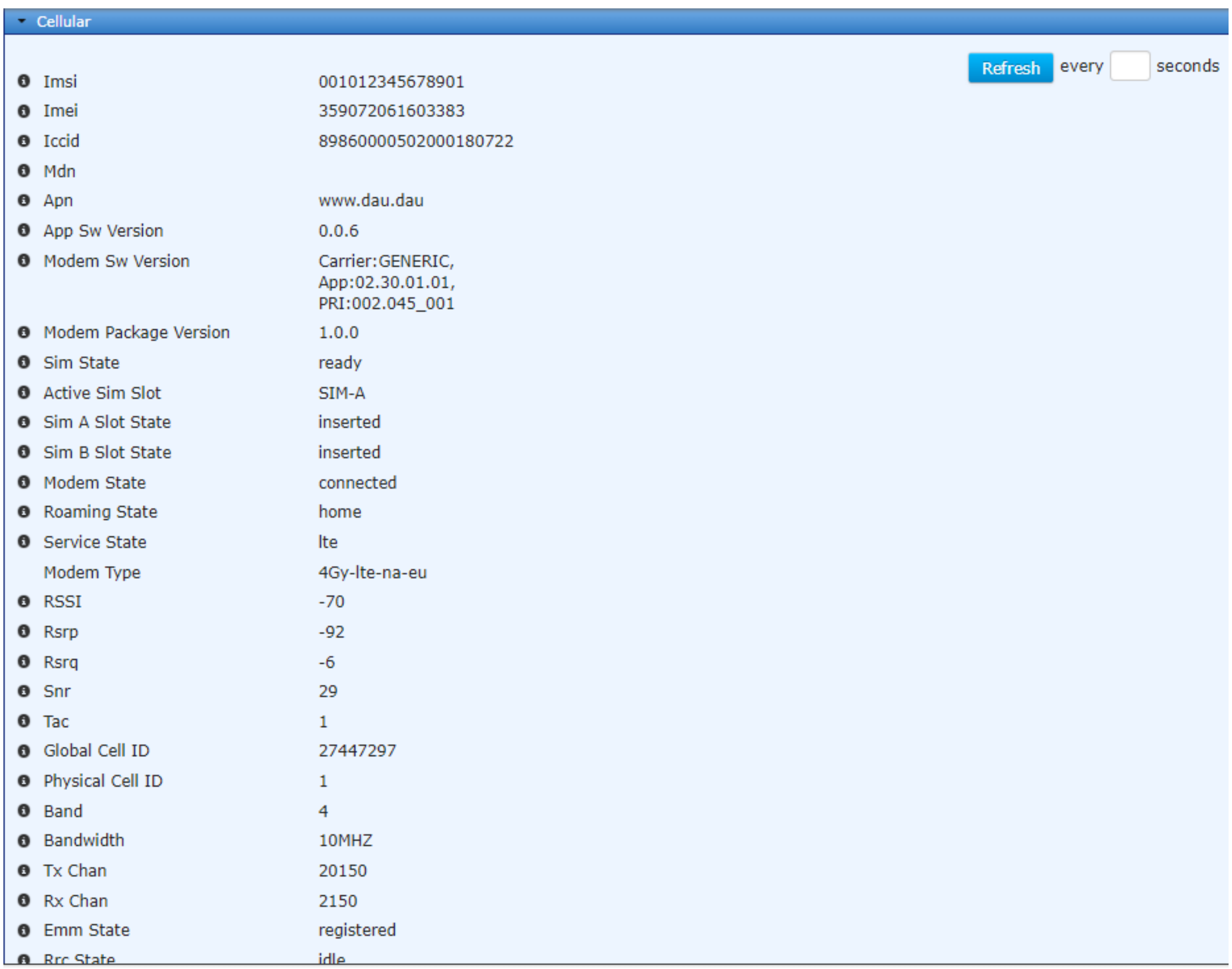


Figure 3-30. Cell Operational Status Screen

- **Imsi** - International mobile subscriber identity
- **Imei** - International mobile equipment identity
- **Iccid** - Unique serial number of the SIM card
- **Mdn** - Mobile directory number.
- **Apn** - Access Point Name
- **App Sw Version** - Application software version.
- **Modem Sw Version** - Modem software version
- **Sim State** - SIM state of currently active SIM - (Inserted, Not Inserted)
- **Active Sim Slot** –SIM slot currently being used by the modem (SIM-A or SIM-B).
- **Sim A Slot State** – State of SIM-A slot (Inserted, Not Inserted)
- **Sim B Slot State** – State of SIM-B slot (Inserted, Not Inserted)
- **Modem State** - Device state of the cellular modem
- **Roaming State** - Roaming state of the cellular modem
- **Service State** - Service state of the cellular modem
- **Modem Type -** This parameter identifies the type of modem inside the unit.
- **Rssi** - Received signal strength indicator (dBm) of cellular modem.
- **Rsrp** – Reference signal received power (dBm). (LTE Only)
- **Rsrq** – Reference signal received quality (dB). (LTE Only)
- **Snr** – Signal to interference-plus-noise ratio (dB). (LTE Only)
- **Tac** – Tracking area code. (LTE Only)
- **Global Cell Id** - (LTE Only)
- **Physical Cell Id** - (LTE Only)
- **Band** – Frequency band (LTE only)
- **Bandwidth** – System bandwidth. (LTE only)
- **Tx Chan** – Transmit Channel Number. (LTE only)
- **Rx Chan** – Receive Channel Number. (LTE only)
- **Emm State** – EPC mobility management state (LTE only)
- **Rrc State –** Radio Resource Control state (LTE only)

NOTE Certain fields are displayed only for dual SIM devices.

Monitoring via the CLI

Ensure the CLI is in Operational mode.

Check cell status

The example on the following page shows cell status of a unit with 3G GSM modem operating on AT&T network:

```
> show interfaces-state interface Cell cell-status
  cell-status imsi 310410635138718
  cell-status imei 351579050793072
  cell-status iccid 89014103276351387185
  cell-status mdn  15857544129
```

```
cell-status apn  ccspbsc210.acfes.org
cell-status app-sw-version 0.0.5
cell-status modem-sw-version 12.00.024
cell-status sim-state ready
cell-status modem-state connected
cell-status roaming-state home
cell-status service-state hsdpa
cell-status rssi -71
```

The example below shows cell status of a unit with 4G LTE modem operating on Test network:

```
> show interfaces-state interface Cell cell-status
  cell-status imsi      001012345678901
  cell-status imei      359072061603383
  cell-status iccid     89860000502000180722
  cell-status mdn       ""
  cell-status apn       www.dau.dau
  cell-status app-sw-version 0.0.6
  cell-status modem-sw-version "Carrier:GENERIC, App:02.30.01.01, PRI:002.045_001"
  cell-status modem-package-version 1.0.0
  cell-status sim-state ready
  cell-status active-sim-slot SIM-A
  cell-status sim-a-slot-state inserted
  cell-status sim-b-slot-state inserted
  cell-status modem-state connected
  cell-status roaming-state home
  cell-status service-state lte
  cell-status modem-type 4Gy-lte-na-eu
  cell-status rssi      -70
  cell-status rsrp      -92
  cell-status rsrq      -6
  cell-status snr       29
  cell-status tac       1
  cell-status global-cell-id 27447297
  cell-status physical-cell-id 1
  cell-status band      4
  cell-status bandwidth 10MHZ
  cell-status tx-chan   20150
  cell-status rx-chan   2150
  cell-status emm-state registered
  cell-status rrc-state idle
```

NOTE Cell status items may vary based on interface type. For example **bandwith**, **emm-state**, and **rrc-state** are not available for 4GC and 4GH cell media type.

Check Cell Statistics

```
> show interfaces-state interface Cell statistics
  statistics discontinuity-time 2013-01-01T02:16:01+00:00
  statistics in-octets 1218
  statistics in-unicast-pkts 18
  statistics in-multicast-pkts 0
  statistics in-discards 0
  statistics in-errors 0
```

```
statistics out-octets 774
statistics out-unicast-pkts 14
statistics out-discards 0
statistics out-errors 0
```

Check Cell IP Address

```
> show interfaces-state interface Cell ipv4
  ipv4 forwarding true
  ipv4 mtu   1500
                                PREFIX
  IP                             LENGTH      ORIGIN
  -------------------------------------------------------------------------------------------------
  166.130.200.173        32               static
```

Determining the Cell Module's IMSI/IMEI

When provisioning the cell module for network service, the cellular provider typically requires the International Mobile Subscriber Identity code (IMSI) or International Mobile Station Equipment Identity code (IMEI) to be provided. These codes can be determined by entering the following command:

> show interfaces-state interface Cell **cell-status**

where *Cell* is the configured name for the cellular device. Cell is the factory default name, but it may have been changed by a previous user.

When the previous command is entered, a number of items are returned as shown in the example below. The first two items (highlighted blue) show the IMSI and IMEI codes. These are unique for each unit.

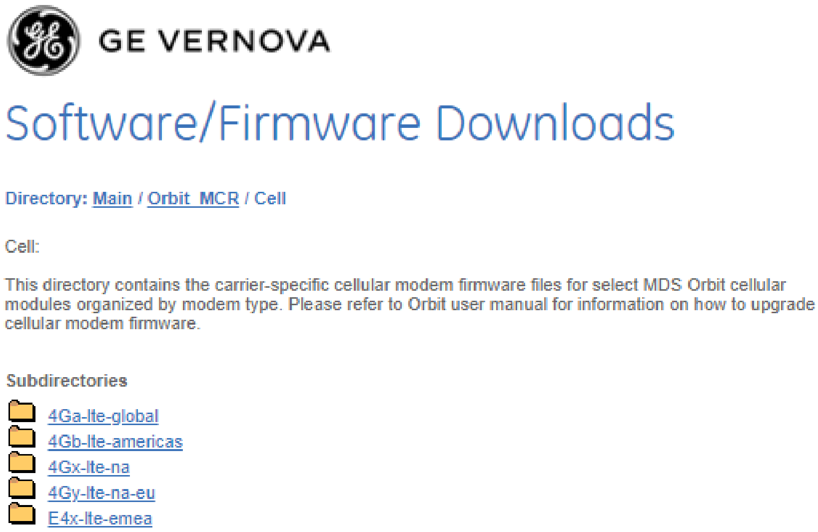
```
> show interfaces-state interface Cell cell-status
cell-status imsi      001012345678901
cell-status imei      359072061603383
...
```

3.5.2.4 Modem Reprogramming

The cell modem has its own set of firmware supplied by the wireless carrier. Occasionally new versions of this firmware become available. The user has the option to upgrade the cell modem firmware if they wish to do so.

The cell modem firmware files are posted at following location under modem specific folder:

http://www.gegridsolutions.com/communications/mds/software.asp?directory=Orbit_MCR/Cell



NOTE Effective in 2019, each for 4Gx-lte-na modem's cell firmware MPK files listed above are available in TWO different configurations, matching the security level of signed firmware in the Orbit device. For Orbit units running code 7.x and higher, use the corresponding cell MPK with the -SHA256 suffix. For Orbit units running code early than 7.x, use the corresponding cell MPK with a -SHA1 suffix.

To start reprogramming the cell modem firmware, navigate to the **Reprogram Cellular Modem** section**.** The following example shows how to upload a cell modem firmware image file through the web browser and reprogram the cell modem with that image file.

Navigate to ***Interfaces / Cell ---> Actions / Reprogram***

Click on the **Begin Reprogramming** button once the file source is configured.

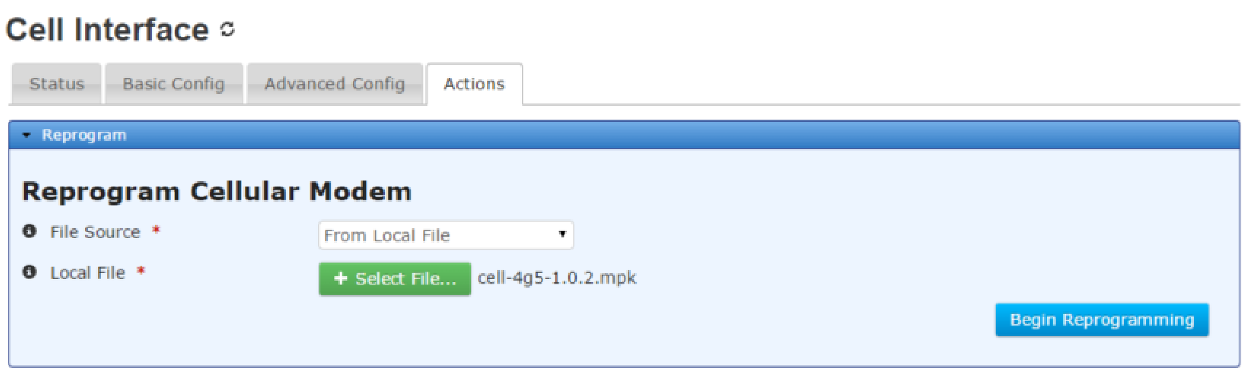


Figure 3-31. Reprogram Cellular Modem

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, and SFTP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, and From SFTP Server. Local file uploads are only available through the web UI and not through the CLI
- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server

- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device download a cell modem firmware image (named cell-4g5-1.0.2.mpk) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start reprogramming the cell modem firmware from the CLI, enter the following command to download the firmware image from the TFTP server:

> **> request interfaces interface** Cell **firmware reprogram filename** cell-4g5-1.0.2.mpk **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring - Reprogram

Once the reprogramming is begun, the process may be cancelled by clicking the **Cancel Reprogramming** button. The current status of the reprogramming process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to reprogram (in other words, if the state is "inactive").

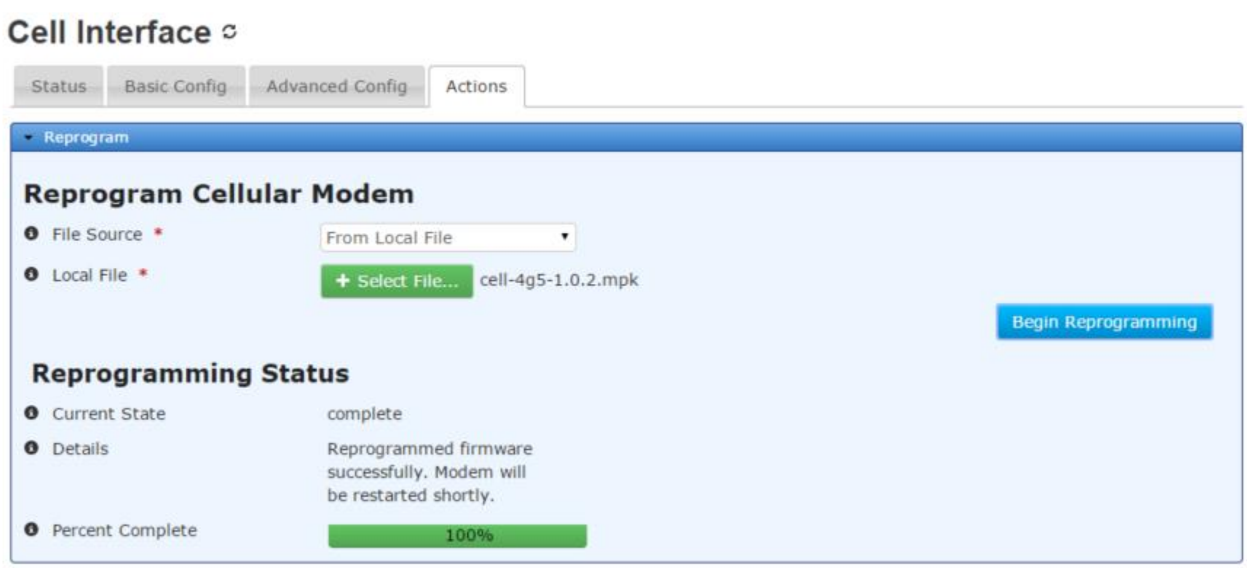


Figure 3-32. Reprogram Cellular Modem Monitoring

The reprogramming status contains the following items:

- **Current State** – The status of the reprogramming task:
  - inactive
  - transfering
  - processing
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Processing cellular modem firmware image*"

- **Size** – The total number of bytes in the image (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the reprogramming process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system firmware reprogram-status
  system firmware reprogram-status state complete
  system firmware reprogram-status detailed-message "Reprogrammed firmware
  successfully. Modem will be restarted shortly."
  system firmware reprogram-status size 34849644
  system firmware reprogram-status bytes-transferred 34849644
  system firmware reprogram-status percent-complete 100
```

3.5.3 WiFi

3.5.3.1 Understanding

The Orbit can be ordered with following WiFi module options that have FCC/CE modular approval:

- Standard – IEEE 802.11b/g/n 2.4Ghz 1x1 SISO
- Enhanced– IEEE 802.11a/b/g/n 2.4/5Ghz 2x2 MIMO

The content specified in following sections is applicable to both of the above options unless specifically indicated otherwise. The specifications for the WiFi module options are covered in "WiFi Specifications" on Page 504.

The tables below contain the list of MDS approved antennas for standard WiFi.

Table 3-6. Approved Antenna Types for Standard WiFi

Application	Location	Frequency Range	Gain	Antenna Description	MDS Part Number
WiFi	Indoor	2.4/5GHz	3.0 dBi	Direct Connect, RP SMA, Dipole Whip	97-4278A93
WiFi accessory	Indoor	--	--	Magnetic Mount, 5 ft./1.52 m Cable, RP SMA Plug use with above	97-4278A78
WiFi	Outdoor	2.4-2.5 GHz	2 dBi	External Mount, Omni Ant. with N-Male connector - no cable	97-4278A48
WiFi	Outdoor	2.4-2.5 GHz	7.85 dBd (10dBi)	Enclosed Yagi Ant. with 18" coax to N-Female connector	97-4278A01
WiFi	Outdoor	2.4-2.5 GHz	10.85 dBd (13dBi)	Panel Ant. Linear, Vertical/Horizontal with N-Female connector - no cable	97-4278A16

Table 3-7. Approved Antenna Types for Enhanced WiFi

Application	Location	Frequency Range	Gain	Antenna Description	MDS Part Number
WiFi*	Indoor/ Outdoor	2.4/5GHz	3.0 dBi	2x2 MIMO, Dual Band, RP SMA, 3ft. cables	97-4278A94

Application	Location	Frequency Range	Gain	Antenna Description	MDS Part Number
WiFi	Indoor	2.4/5GHz	3.0 dBi	Direct Connect, RP SMA, Dipole Whip	97-4278A93

*Preferred for most installations.

The standard WiFi module can be configured to operate as an Access Point (AP) or Station (Client) and the enhanced WiFi module can be configured to operate as an Access Point (AP), Station or Access Point+Station (to extend coverage).

Following WiFi security modes are supported:

- **WPA2/WPA Personal** – This uses pre-shared keys (passphrases) configured on the AP and client devices.
- **WPA2/WPA Enterprise** – This supports EAP-TLS based authentication of client devices (configured with certificates/keys) via RADIUS.

The following WiFi encryption modes are supported:

1. None (should be used only to test connectivity)
2. CCMP/AES Encryption – This mode should be used if all client devices support WPA2/CCMP.
3. CCMP/AES Encryption + TKIP Encryption – This mode should be used if there is mix of both legacy client devices that only support WPA/TKIP and newer devices that support WPA2/CCMP.In this mode, stations must select only TKIP or AES/CCMP + TKIP. Stations cannot specify only AES/CCMP.

NOTE In FIPS mode, only CCMP/AES encryption is allowed. TKIP is not permitted.

The table below shows the valid combinations of Station Encryption settings that will work for a given AP Encryption setting.

Table 3-8: WPA Enterprise Combinations

AP Encryption	Station Encryption Choices
AES/CCMP	AES/CCMP
AES/CCMP + TKIP	TKIP AES/CCMP + TKIP

The default SSID is based on the unit's serial number and takes the form of: **GEMDS_<SERNUM>** (the serial number is printed on the chassis sticker). The default password for WiFi operation is **GEMDS_ORBIT**.

The table below describes the Orbit MCR's LED behavior when using the WiFi interface. The LED for the NIC varies, depending on the configuration of the device. When equipped with 900 MHz support, WiFi information is in NIC 1; otherwise, it is in NIC 2.

Table 3-9. WiFi Interface LED Descriptions

LED - NIC1 or NIC2	State	Description
WiFi Interface	Off	Interface disabled
Access Point Mode	Solid Green Solid Red	Operating as AP and at least one client connection Operating as an AP and no client connection
Station Mode	Solid Red Solid Green	No connection to AP Wi-Fi connection established to AP.
Access Point + Station Mode	Solid Red Solid Green	No connection to AP Wi-Fi connection established to AP.

3.5.3.2 Configuring

Configuring the WiFi begins with the following UI:

Navigate to: ***Interfaces / Wi-Fi ---> Basic Config / Wi-Fi / Wifi Config***

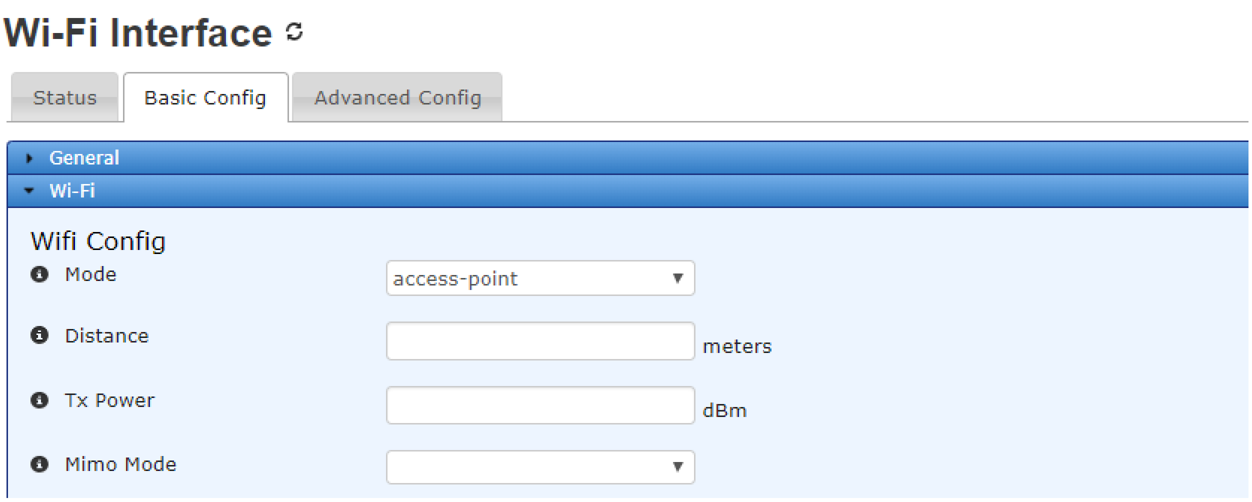


Figure 3-33. WiFi Mode /Power Configuration Screen

- **Mode** - WiFi Mode
  - Station - makes connection to a WiFi AP
  - Access Point – provides WiFi connections to multiple clients.
  - Access-Point-Station-makes connection to an AP as well as provides WiFi connection to downstream clients for range extension.
- **Distance –** The link distance. This should be specified for distances greater than 450m to adjust 802.11 ACK timeout to prevent unnecessary retransmissions.
- **Tx Power** - The transmission power of the WiFi interface – Valid Values are 0 to 20 (dBm) for standard WiFi; 0 to 26dBm for enhanced WiFi (2.4Ghz operation mode) and 0 to 23dBm (5Ghz operation mode), DEFAULT - 16 dBm for standard WiFi; 26dBm (2.4Ghz 2x2 MIMO) and 23dBm (5Ghz 2x2 MIMO) for enhanced WiFi. NOTE: The power is split equally between RF ports CH0 and CH1.
- **Mimo Mode –** Antenna selection for transmission and reception (Enhanced WiFi Only).

- 1x1 – enables SISO operation. If there is only one antenna connection, use this mode and connect the antenna to RF port CH0
- 2x2 – enables MIMO operation. RF ports CH1 and CH0 are both active for TX and RX. This is the preferred mode of operation using 2 antenna ports

3.5.3.2.1 AP Mode

To configure the parameters necessary for Access Point mode, start by using the following section of the web UI:

Navigate to: ***Interfaces / Wi-Fi ---> Basic Config / Wi-Fi***

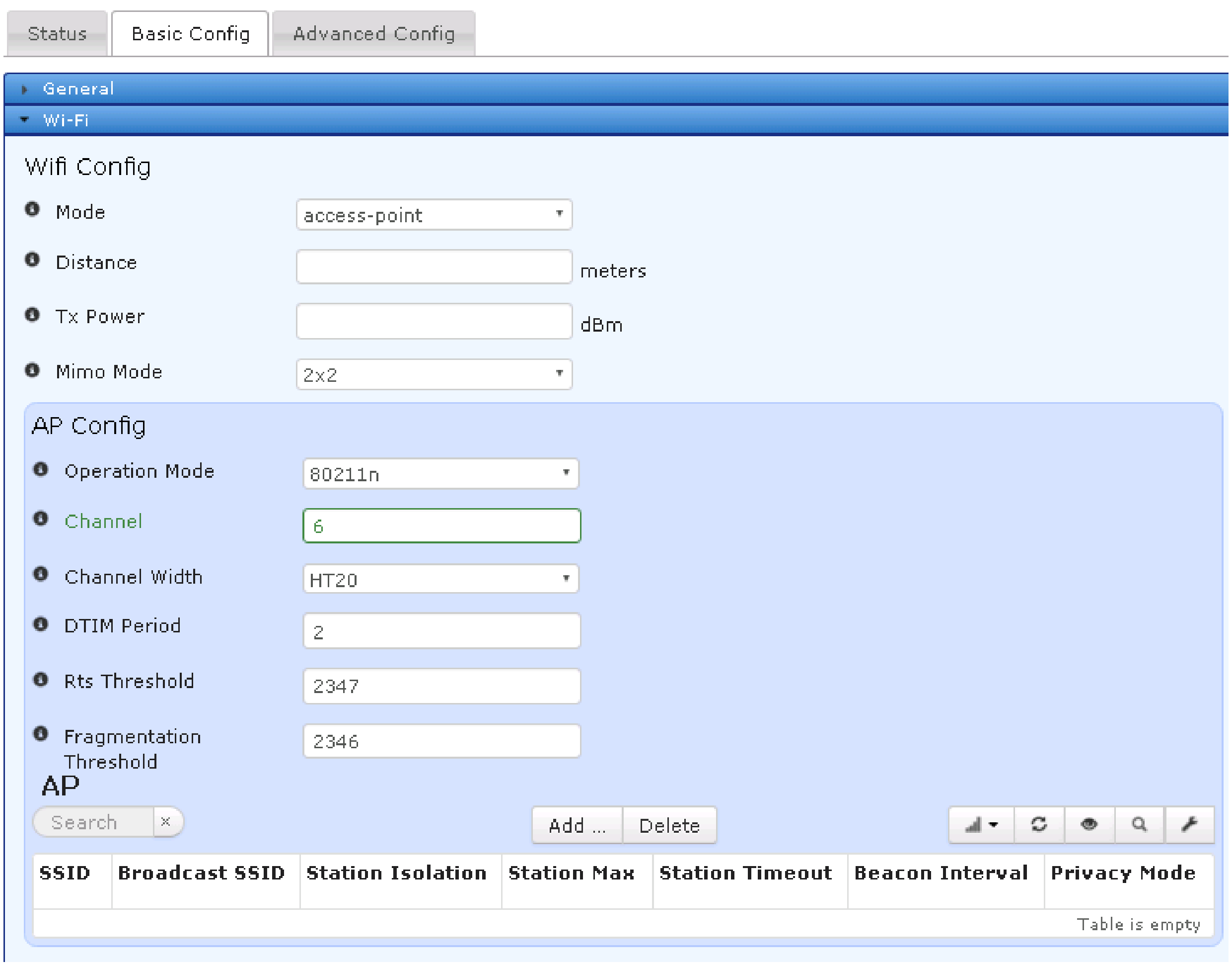


Figure 3-34. WiFi AP SSID Configuration Screen

Each AP Profile contains specific information to be selected (SSID etc). Following parameters are shared by all AP profiles:

- **Channel** – The IEEE 802.11 channel number to operate on:

  Standard WiFi:

  - 2.4Ghz (HT20): 1-11
  - 2.4Ghz (HT40-): 5-11
  - 2.4Ghz (HT40+): 1-7

  DEFAULT - 6.

Enhanced WiFi:

- 2.4Ghz (HT20): 1-11
- 2.4Ghz (HT40-): 5-11
- 2.4Ghz (HT40+): 1-7
- 5Ghz (HT20):36,40,44,48,149,153,157,161,165
- 5Ghz (HT40-): 40,48,153,161
- 5Ghz (HT40+): 36,44,149,157

DEFAULT - 6.

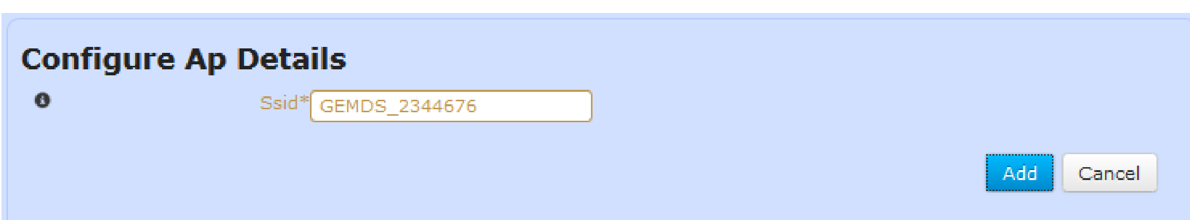
NOTE When channel is set to 0, automatic channel selection is enabled. This is supported only for enhanced WiFi.

- **Channel Width**- Channel bandwidth:
  - HT20 - 20 MHz channels only.
  - HT40+ - Both 20Mhz and 40Mhz channels with secondary channel above primary channel.
  - HT40- - Both 20Mhz and 40Mhz channels with secondary channel below primary channel.
- **Operation Mode** - IEEE 802.11 mode to operate in.
  - 802.11a (5Ghz OFDM) - Enhanced WiFi only
  - 802.11b (2.4Ghz, CCK)
  - 802.11g (2.4Ghz, OFDM)
  - 802.11n (2.4Ghz, OFDM with 802.11n)
  - 802.11an (5Ghz, OFDM with 802.11n) - Enhanced WiFi only

NOTE The following are advanced WiFi network settings and should only be modified with the assistance of a network engineer.

- **Dtim Period** – DTIM (delivery traffic information message) period. The number of beacons between DTIMs. Valid Values: 1-255, DEFAULT - 2.
- **Rts Threshold** – RTS/CTS Threshold. Valid Values 0-2347, DEFAULT - 2347 (disabled).
- **Fragm Threshold** –Fragmentation Threshold. Valid Values 0-2346, DEFAULT - 2346 (disabled).

To add an AP, click on the **ADD** button, or to delete an AP, click on the SSID and then the Delete button. By default, an access point will be configured with the SSID, **GEMDS <SERNUM>** and the WiFi password, **GEMDS-ORBIT**. To edit an AP, click on the SSID of the configured network. In the following example, the SSID is **GEMDS_2344676**.



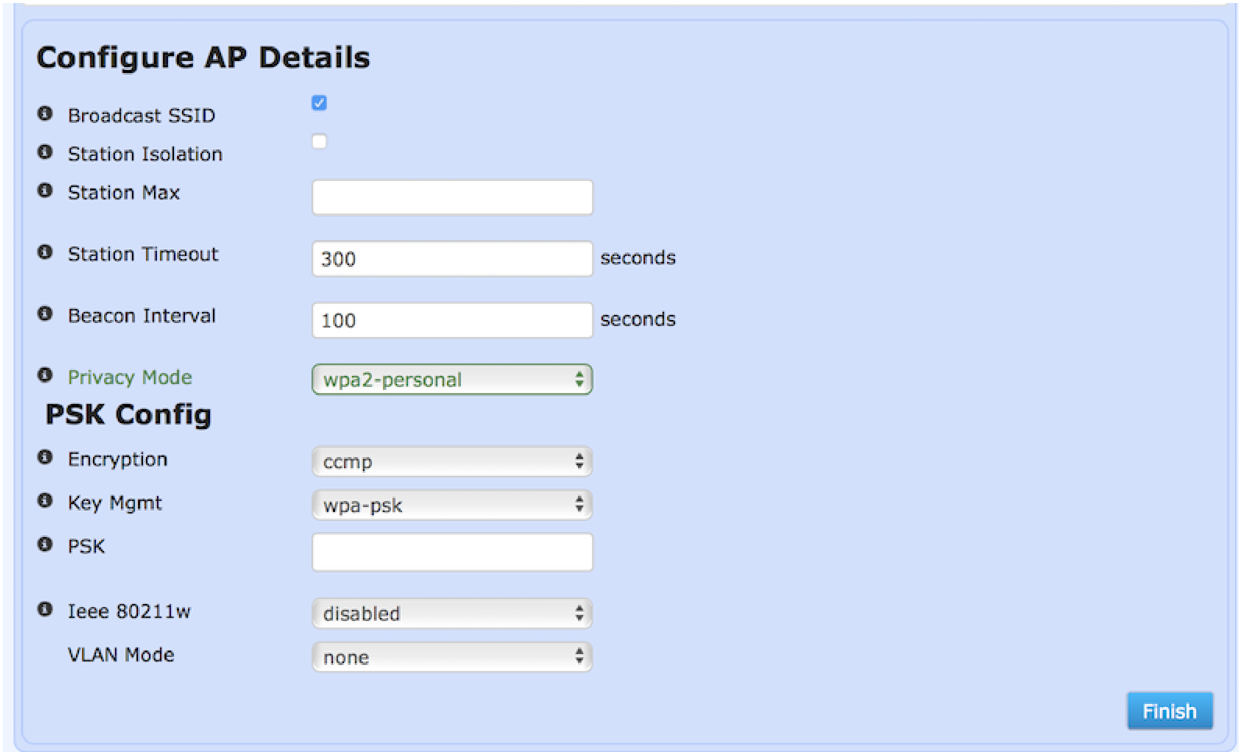


Figure 3-35. WiFi AP Details Configuration Screen

- **Broadcast Ssid** – If checked (true), the SSID will be broadcast.
- **Station Isolation** – If enabled client to client communication is not allowed.

NOTE This only applies to non-bridged clients. For bridged clients, layer-2 firewall rules should be applied to Bridge interface at the AP to prevent inter-client communication.

- **Station Max** – The maximum number of clients that will be allowed to connect to this access point. Valid values: 1-MAX (Standard WiFi: DEFAULT/MAX = 7, Enhanced WiFi: DEFAULT/MAX = 64)
- **Station Timeout** – The number of seconds a station may be inactive before the access point will verify that the station is still within range. Valid values: 1-300 (DEFAULT = 300)
- **Beacon Interval** – The number of seconds between WiFi beacon transmissions. Valid values: 15-65535. (DEFAULT = 100)
- **Privacy Mode** – The privacy mode to use on this interface.
  - None
  - Wpa 2 Personal (DEFAULT)
  - Wpa 2 Enterprise
  - Wpa 2 Personal Mixed
  - Wpa 2 Enterprise Mixed
- **Encryption** – The encryption mode to use
  - Ccmp - AES-based encryption mechanism that is stronger than TKIP for WPA2
  - Tkip - RC4-based stream cipher is used with a 128-bit per-packet key, meaning that it dynamically generates a new key for each packet for WPA.
  - Ccmp Tkip – allows a mixture of WPA and WPA2 client.

NOTE In FIPS mode, only CCMP/AES encryption is allowed. TKIP is not permitted.

- **Key Mgmt** – The type of preshared key to use
    - Wpa Psk
    - Wpa Psk sha 256
- **PSK** – The pre-shared key. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. DEFAULT = <blank>.

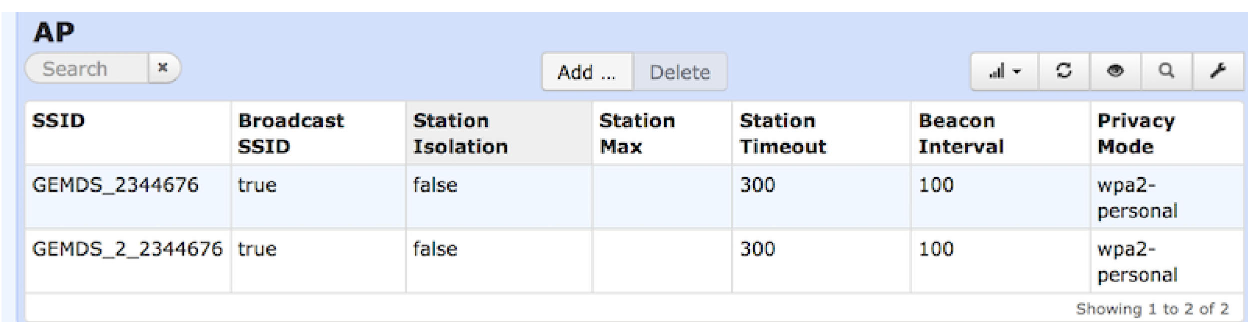
NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **IEEE 80211w** –IEEE 802.11w management frame protection:
    - Disabled – disables this feature.
    - Optional – Enable 802.11w for clients that support it while still allowing non-802.11w clients to join the network.
    - Required – Allow only 80211w clients to join the network.
- **Vlan Mode –** VLAN configuration for the WiFi Interface
    - None
    - Access – An AP/SSID can only be configured as access port on one VLAN.
    - Trunk – Not Applicable.

NOTE Remember to click on **SAVE** when finished.

Dual-SSID Functionality (AP mode only)

The Orbit supports up to two SSIDs to be configured when the Wi-Fi interface is set to an Access Point. The first SSID should be reserved for high throughput data paths. The second SSID is intended to support auxiliary applications such as a dedicated management connection or guest LAN access. The following example demonstrates having a second Wi-Fi AP with the SSID:



SSID	Broadcast SSID	Station Isolation	Station Max	Station Timeout	Beacon Interval	Privacy Mode
GEMDS_2344676	true	false		300	100	wpa2-personal
GEMDS_2_2344676	true	false		300	100	wpa2-personal

Figure 3-36. WiFi AP Configuration

Operational Notes Regarding Dual SSID

- The channel, channel-width, operation mode, tx-power, dtim-period, rts-threshold and fragm-threshold parameters are shared between the two SSIDs.
- The Orbit organizes the SSIDs in alphabetical order. If an SSID of *ssidexample* exists and a second SSID of *examplessid* is created, this will become the first SSID and the SSID *ssidexample* will become the second SSID.

- Each SSID is independent of the other, except for the parameters noted above. Each SSID can be in or out of the bridge/vlan.

Using CLI Commands

Following section describes some examples of AP configuration using CLI commands.

NOTE The CLI needs to be in configuration mode to change settings. Remember to **COMMIT** changes when finished.

2.4Ghz 802.11n w/ WPA2-Personal

The following CLI commands will configure an access point with an SSID of SOMESSID operating in 2.4Ghz 802.11n mode on channel 11 with WPA2-Personal (w/ CCMP encryption):

```
set interfaces interface Wi-Fi type wifi
set interfaces interface Wi-Fi wifi-config mode access-point
set interfaces interface Wi-Fi wifi-config ap-config operation-mode 80211n
set interfaces interface Wi-Fi wifi-config ap-config channel 11
set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID privacy-mode wpa2-personal
set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID psk-config encryption ccmp
set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID psk-config psk test123456
commit
```

5Ghz 802.11n w/ WPA2-Personal (Enhanced WiFi Only)

The following CLI commands will configure an access point with SSID of SOMESSID running in 5Ghz 802.11n mode on channel 36 with WPA2-Personal (w/ CCMP encryption):

```
set interfaces interface Wi-Fi type wifi
set interfaces interface Wi-Fi wifi-config mode access-point
set interfaces interface Wi-Fi wifi-config ap-config operation-mode 80211an
set interfaces interface Wi-Fi wifi-config ap-config channel 36
set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID privacy-mode wpa2-personal
set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID psk-config encryption ccmp
set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID psk-config psk test123456
commit
```

2.4Ghz 802.11n w/ WPA2-Enterprise

The following CLI commands will configure an access point with SSID of SOMESSID running in 2.4Ghz 802.11n mode on channel 11 with WPA2-Enterprise (w/ CCMP encryption) with RADIUS server address of 172.16.23.2.

- Configure RADIUS server

set system mds-radius servers RADIUS-1 address 172.16.23.2

set system mds-radius servers RADIUS-1 shared-secret testing123

- Configure Wi-Fi

set interfaces interface Wi-Fi type wifi

set interfaces interface Wi-Fi wifi-config mode access-point

set interfaces interface Wi-Fi wifi-config ap-config operation-mode 80211n

set interfaces interface Wi-Fi wifi-config ap-config channel 11

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID privacy-mode wpa2-enterprise

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID eap-config encryption ccmp

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID radius-server RADIUS-1

2.4Ghz 802.11n w/ WPA2-Personal, Dual-SSID w/ VLANs

The following CLI commands will configure an access point with SSID of SOMESSID in VLAN 100 and SOMEGUEST in VLAN 200 running in 2.4Ghz 802.11n mode with auto channel selection with WPA2-Personal (w/ CCMP encryption).

- Configure VLAN100

set interfaces interface VLAN100 type vlan

set interfaces interface VLAN100 vlan-config vlan-id 100

set interfaces interface VLAN100 filter input IN_TRUSTED

set interfaces interface VLAN100 filter output OUT_TRUSTED

set interfaces interface VLAN100 ipv4 address 1.1.1.1 prefix-length 24

- Configure VLAN200

set interfaces interface VLAN200 type vlan

set interfaces interface VLAN200 vlan-config vlan-id 200

set interfaces interface VLAN200 filter input IN_TRUSTED

set interfaces interface VLAN200 filter output OUT_TRUSTED

set interfaces interface VLAN200 ipv4 address 2.2.2.2 prefix-length 24

- Configure Wi-Fi

set interfaces interface Wi-Fi type wifi

set interfaces interface Wi-Fi wifi-config mode access-point

set interfaces interface Wi-Fi wifi-config ap-config operation-mode 80211n

set interfaces interface Wi-Fi wifi-config ap-config channel 0

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID privacy-mode wpa2-personal

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID psk-config encryption ccmp

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID psk-config psk test123456

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID vlan-mode access

set interfaces interface Wi-Fi wifi-config ap-config ap SOMESSID vlan VLAN100

set interfaces interface Wi-Fi wifi-config ap-config ap GUESTSSID privacy-mode wpa2-personal

set interfaces interface Wi-Fi wifi-config ap-config ap GUESTSSID psk-config encryption ccmp

set interfaces interface Wi-Fi wifi-config ap-config ap GUESTSSID psk-config psk test123456

set interfaces interface Wi-Fi wifi-config ap-config ap GUESTSSID vlan-mode access

set interfaces interface Wi-Fi wifi-config ap-config ap GUESTSSID vlan VLAN200

commit

3.5.3.2.2 Station Mode

To configure the WiFi interface as a station/client, start at the following:

Navigate to: ***Interfaces / Wi-Fi ---> Basic Config / Wi-Fi***

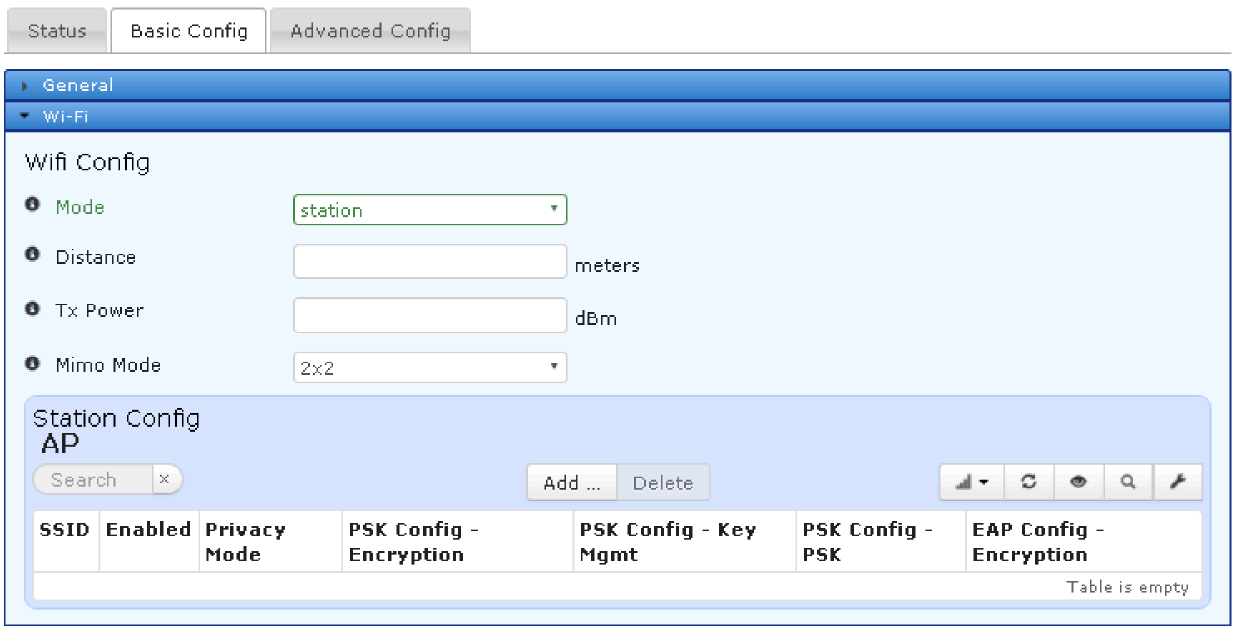
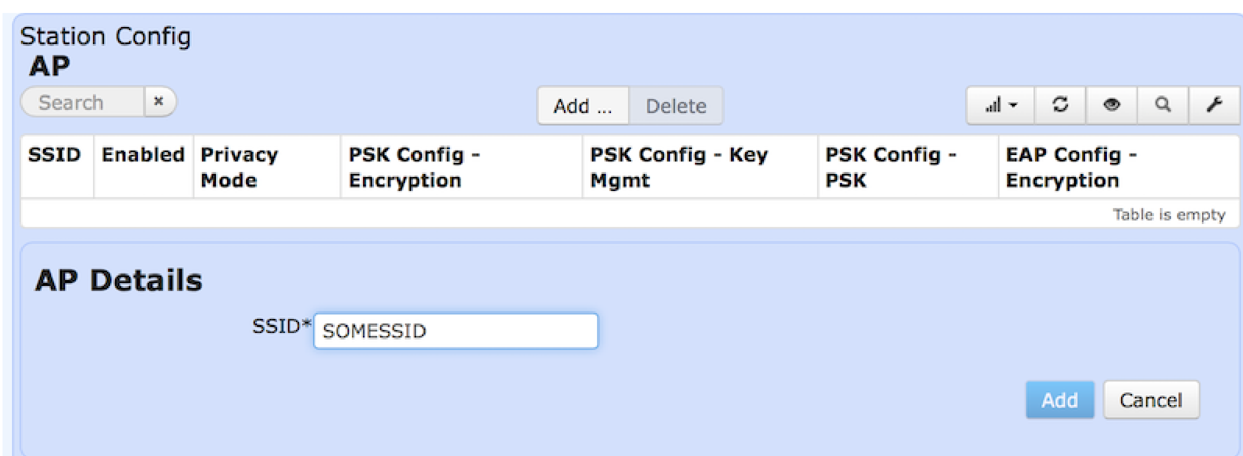


Figure 3-37. WiFi Station Configuration

Select *Station* from the drop down. In *Station Config,* add a new AP by clicking on the *ADD* button. Enter the SSID of the AP to have the station associate to it. Then, click on the *ADD* button to enter additional details about the Wi-Fi AP.

In the following example, the SSID of *SOMESSID* is used.

Navigate to: ***Interfaces / Wi-Fi ---> Basic Config / Wi-Fi***



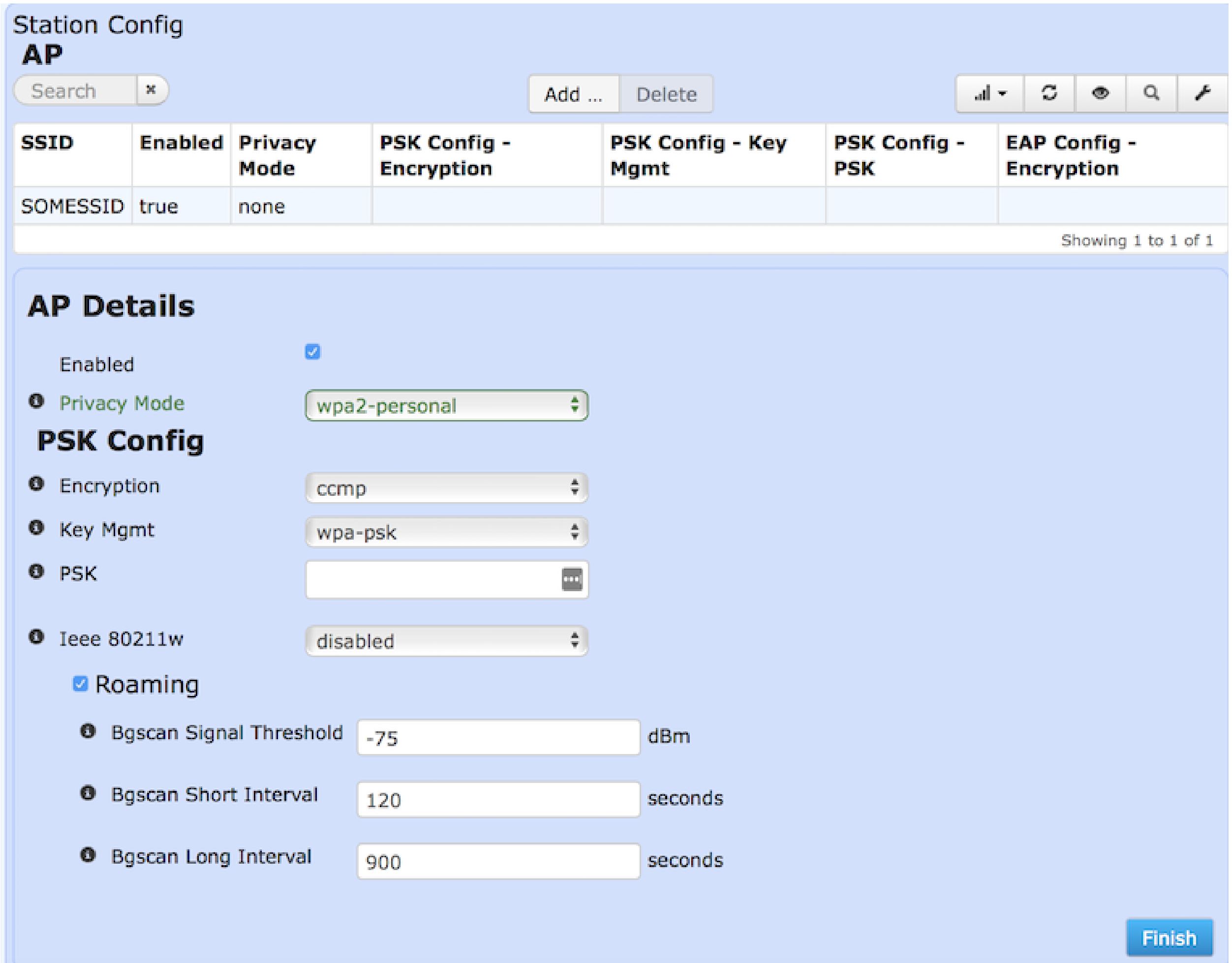


Figure 3-38. WiFi Configuration Settings

- **Enabled** – Check the box to enable the WiFi interface.
- **Privacy Mode** – The privacy mode to use on this interface.
    - None (DEFAULT)
    - Wpa 2 Personal
    - Wpa 2 Enterprise
    - Wpa 2 Personal Mixed
    - Wpa 2 Enterprise Mixed
- **Encryption** – The encryption mode to use
    - Ccmp - AES-based encryption mechanism that is stronger than TKIP for WPA2
    - Tkip - RC4-based stream cipher is used with a 128-bit per-packet key, meaning that it dynamically generates a new key for each packet
    - Ccmp Tkip – allows a mixture of WPA and WPA2 clients

NOTE In FIPS mode, only CCMP/AES encryption is allowed. TKIP is not permitted.

- **Key Mgmt** – The type of preshared key to use
    - Wpa Psk
    - Wpa Psk sha 256

- **PSK** – The pre-shared key. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. DEFAULT = <blank>.

NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **IEEE 80211w** – 802.11w management frame protection:
  - **Disabled** – disables this feature.
  - **Optional** – Activates 802.11w if AP supports it.
  - **Required** – Only connects to the AP if it supports 802.11w.
- **Roaming** – This enables background scanning to detect and connect to APs with stronger signal. Otherwise, the client will remain connected to the AP unless signal becomes very weak. This can be enabled for applications where client is mobile. (DEFAULT = disabled)
  - **Bgscan signal threshold** – background scan signal threshold (DEFAULT = -75dBm)
  - **Bgscan short interval** – background scan is performed every short interval if signal level is below the threshold.
  - **Bgscan long interval** – background scan is performed every long interval if signal level is above the threshold.

NOTE Remember to click on the **Save** button when finished.

Following section describes some examples of STATION/CLIENT configuration using CLI commands.

NOTE The CLI needs to be in configuration mode to change settings. Remember to **COMMIT** changes when finished.

Using CLI Commands

WPA2-Personal

The following CLI commands will configure the Wi-Fi in station/client mode to connect to an access point with an SSID of SOMESSID with WPA2-Personal (w/ CCMP encryption):

```
set interfaces interface Wi-Fi type wifi
set interfaces interface Wi-Fi wifi-config mode station
set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID privacy-mode wpa2-personal
set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID psk-config psk test123456
commit
```

WPA2-Enterprise

The following CLI commands will configure the Wi-Fi in station/client mode to connect to an access point with an SSID of SOMESSID with WPA2-Enterprise (w/ CCMP encryption):

```
set interfaces interface Wi-Fi type wifi
set interfaces interface Wi-Fi wifi-config mode station
set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID privacy-mode wpa2-enterprise
```

set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID eap-config encryption ccmp

set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID pki cert-type rsa

set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID pki cert-id CLIENT-CERT

set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID pki key-id CLIENT-KEY

set interfaces interface Wi-Fi wifi-config station-config ap SOMESSID pki ca-cert-id CA-CERT

commit

NOTE The CLIENT-CERT, CLIENT-KEY and CA-CERT are the identifiers given to the client certificate, client key and CA certificate when loading them into unit either manually or through SCEP. Please refer to section 3.9 Public Key and Certificates.

3.5.3.2.3 Access-Point-Station Mode

The enhanced WiFi can be configured to operate as station/client and AP simultaneously (a.k.a store-n-forward mode) by selecting the mode as "access-point-station". When this mode is selected, both AP and station configuration as described in previous sections is applicable. The unit connects to configured upstream APs as a client and acts AP for other downstream clients. This mode can be used for extending network coverage.

Following should be considered when using this mode for extending network coverage:

- The operation-mode of the AP should be the same as the one for upstream AP.
- The AP channel should be set to 0. With this setting, the AP is started on the same channel as the one on which the client connects to the upstream AP. Therefore, if the upstream AP's channel is changed, the local AP will be automatically restarted on the same channel.
- If more there is more than one device with this mode in the network, the SSID for the AP should be different than the one configured for upstream AP. Otherwise, two devices in this mode can end up connecting to each other instead of connecting to upstream AP. In such a case, the client-only devices can be configured with SSIDs of both upstream and intermediate APs, in order to allow them to connect to either of them based on signal strength.

Using CLI Commands

The following CLI commands will configure the Wi-Fi in station/client mode to connect to an access-point with an SSID of SSID-1 with WPA2-Personal (w/ CCMP encryption) and configure an access-point with SSID of SSID-2 with WPA2-Personal (w/ CCMP encryption).

- Configure mode as AP+station

set interfaces interface Wi-Fi type wifi

set interfaces interface Wi-Fi wifi-config mode access-point-station

- Configure station/client to connect to upstream AP with SSID-1

set interfaces interface Wi-Fi wifi-config station-config ap SSID-1 privacy-mode wpa2-personal

set interfaces interface Wi-Fi wifi-config station-config ap SSID-1 psk-config psk test123456

- Configure AP to provide service on SSID-2

set interfaces interface Wi-Fi wifi-config ap-config channel 0

set interfaces interface Wi-Fi wifi-config ap-config ap SSID-2 privacy-mode wpa2-personal

set interfaces interface Wi-Fi wifi-config ap-config ap SSID-2 psk-config psk test123456

- Add local AP to bridge

set interfaces interface Bridge bridge-settings members wifi-ap SSID-2

- Add local station/client to bridge

set interfaces interface Bridge bridge-settings members wifi-station interface Wi-Fi

commit

3.5.3.3 Monitoring

3.5.3.3.1 General

The following UI screens are read-only. ***Navigate to: Interfaces / Wi-Fi ---> Status / General***

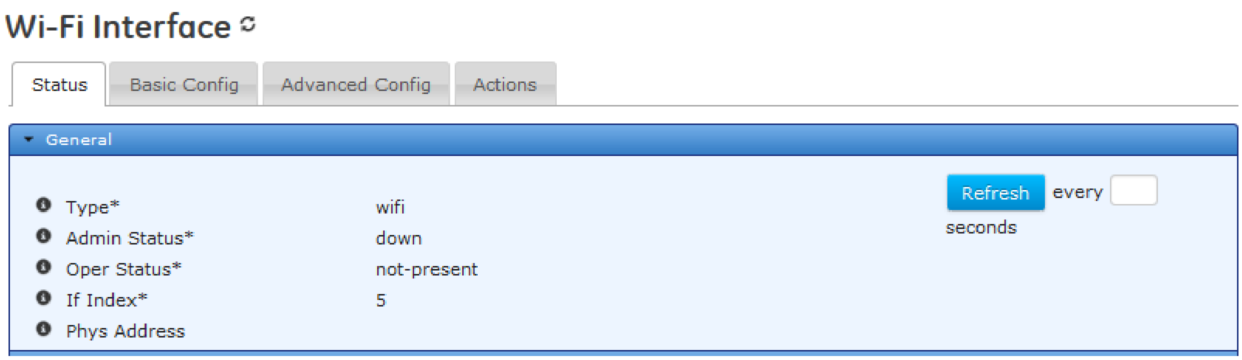


Figure 3-39. WiFi Status Information

- **Type** - The type of the interface
- **Admin Status** - The desired state of the interface. ("Up" - meaning operational)
- **Oper Status** - The current operational state of the interface.

NOTE The following information is useful for are advanced WiFi users for debugging.

- **If Index** - The if Index value for the if Entry represented by this interface. Valid values: 1—2147483647
- **Phys Address**- The interface's address at its protocol sub-layer. For example, for an 802.x interface, this object normally contains a MAC address. The interface's media-specific modules must define the bit and byte ordering and the format of the value of this object. For interfaces that do not have such an address (e.g., a serial line), this node is not present.

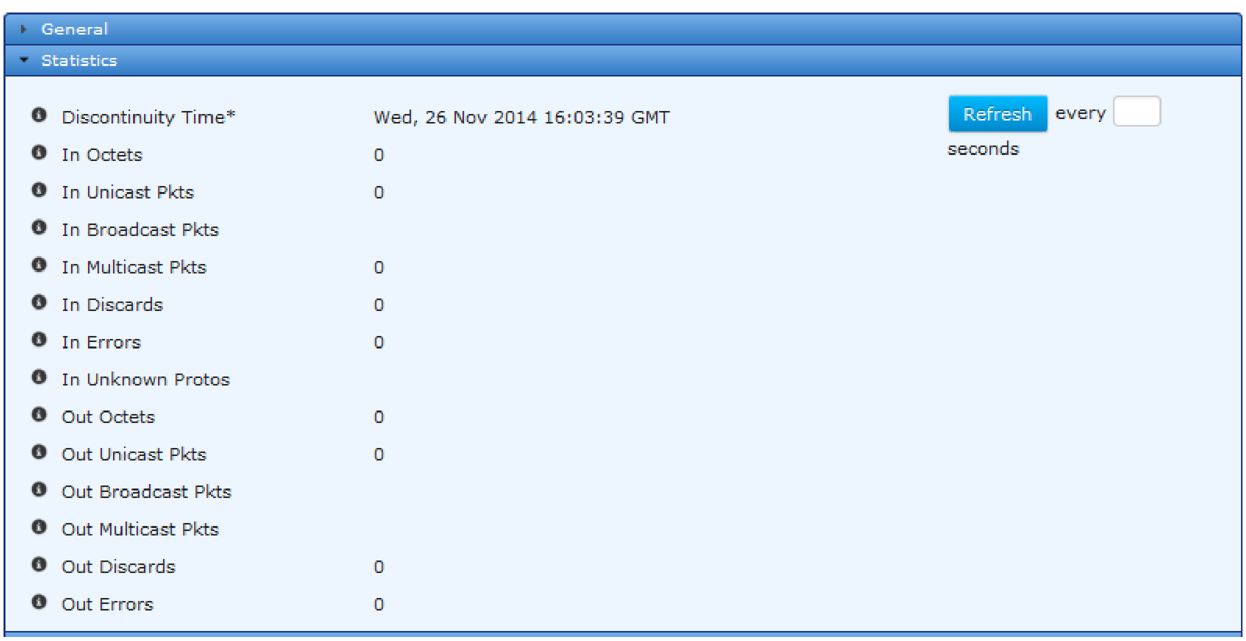


Figure 3-40. WiFi Statistics Information

NOTE The following information is reset on system reboot or power cycle.

- **Discontinuity Time** - The time on the most recent occasion at which one or more of this interface's counters suffered a discontinuity.
- **In Octets** - The total number of octets received on the interface, including framing characters.
- **In Unicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-) layer, which were not addressed to a multicast or broadcast address at this sub-layer.
- **In Broadcast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-) layer, which were addressed to a broadcast address at this sub-layer.
- **In Multicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-) layer, which were addressed to a multicast address at this sub-layer.
- **In Discards** - The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
- **In Errors** - For packet-oriented interfaces, the number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
- **In Unknown Protos** - For packet-oriented interfaces, the number of packets received via the interface which were discarded because of an unknown or unsupported protocol.
- **Out Octets** - The total number of octets transmitted out of the interface, including framing characters.
- **Out Unicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Broadcast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Multicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent.
- **Out Discards** - The number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted.
- **Out Errors** - For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors.

3.5.3.3.2 AP Status

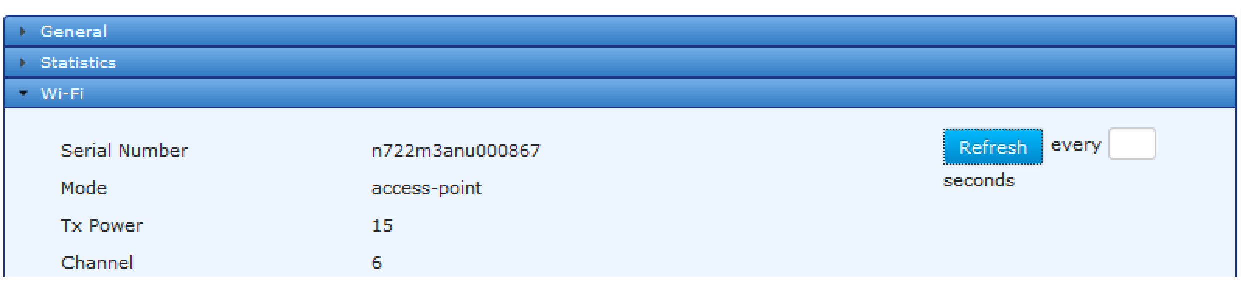


Figure 3-41. WiFi AP Status Information

- **Serial Number** – Internal WiFi module serial number
- **Mode** - WiFi Mode
  - Station - makes connection to a WiFi Access Point
  - Access Point – provides WiFi connections to multiple Stations

- **Tx Power** - The transmission power of the WiFi interface – Valid Values 1-18 (dBm)
- **Channel** – IEEE 802.11 channel number to operate on. Valid values 1-11.
- **Ap Status -** link to information regarding the Ap linked to this station - as shown below

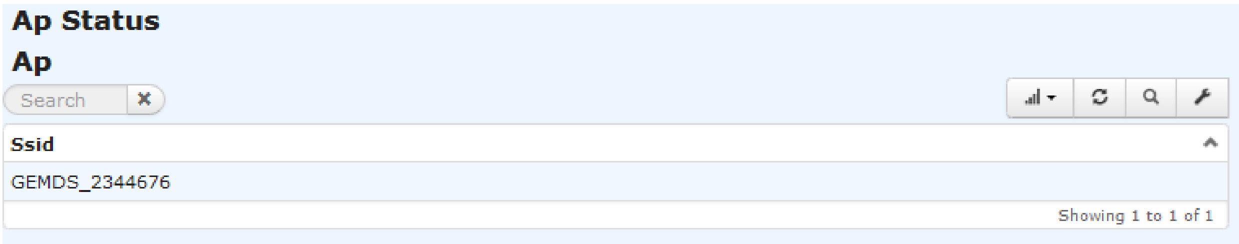


Figure 3-42. WiFi AP Status Information

- **Mac** - Hardware Id of connected device.
- **Rssi** - Received Signal Strength Indication - possible values are: -20 to -90 dBm
- **Authenticated** – indicates the client is valid to connect - True/False
- **Authorized** – indicates the client has valid logon credentials - True/False
- **Inactive –** milliseconds since last packet
- **Rxbytes** – received byte count
- **Rxpackets** – received packet count

3.5.3.3.3 Station Status

Figure 3-43. WiFi Station Statistics Information

- **Ssid** - SSID of access point to which the unit is connected - up to 32 characters.
- **Bssid** – Basic SSID of access point to which the unit is connected - up to 32 characters

- **Rssi** - Received Signal Strength Indication - possible values are: -20 to -90 dBm
- **Authenticated** – indicates the client is valid to connect - True/False
- **Authorized** – indicates the client has valid logon credentials - True/False
- **Inactive –** milliseconds since last packet
- **Rxbytes** – Received byte count
- **Rxpackets** – Received packet count
- **Txbitrate** – Transmit bit rate
- **Txbytes** – Transmitted byte count
- **Txpackets** – Transmitted packet count
- **Txfailed** – Transmit packet failures
- **Txretries** – Transmit packet retries

```
> show interfaces-state interface Wi-Fi wifi-status
  wifi-status serial-number N722M33NU000628
  wifi-status mode Station
  wifi-status tx-power 15
  wifi-status channel 4
  wifi-status station-status ssid somessid
  wifi-status station-status bssid 00:19:70:2c:40:3f
  wifi-status station-status rssi -58
  wifi-status station-status authenticated true
  wifi-status station-status authorized true
  wifi-status station-status inactive 29270
  wifi-status station-status rxbytes 27119
  wifi-status station-status rxpackets 564
  wifi-status station-status txbitrate 54
  wifi-status station-status txbytes 897
  wifi-status station-status txpackets 9
  wifi-status station-status txfailed 0
  wifi-status station-status txretries 0
```

```
> show interfaces-state interface Wi-Fi statistics
  statistics discontinuity-time 2013-09-24T13:12:25-04:00
  statistics in-octets 288
  statistics in-unicast-pkts 2
  statistics in-multicast-pkts 0
  statistics in-discards 0
  statistics in-errors 0
  statistics out-octets 752
  statistics out-unicast-pkts 7
  statistics out-discards 0
  statistics out-errors 0
```

3.5.4 Unlicensed 900 MHz ISM (NX915)

Understanding

The 900 MHz ISM Module (NX915) interface provides operation in the 900 MHz unlicensed ISM band. The module provides long-distance communications with data rates ranging from 125 kbps to 1.25 Mbps, suitable to interface both Ethernet and Serial controllers such as PLCs, RTUs and SCADA systems. The module utilizes a combination of FHSS (Frequency Hopping Spread Spectrum), DTS (Digital Transmission System) and hybrid FHSS/DTS technologies to provide dependable wireless communications.

The MDS NX915 NIC module is a point-to-multipoint, medium speed, long range (>20 miles), spread-spectrum, wireless data transmission product. It operates as a Frequency-Hopping Spread Spectrum (FHSS) or a Digital Transmission System (DTS) in the 902 to 928 MHz license-free ISM band. The NIC can operate as an Access Point, a Remote, or a Store and Forward (SAF) device. It will operate as an intentional radiator in accordance with FCC Rule Part 15.247 under full modular rules per DA 00-1407.

For serial applications, the 900 MHz NX915 NIC is automatically configured with a virtual serial port called "NxRadio-serial". Using the Pass-Through service (see section 3.5.1) "NxRadio-serial" can be connected to a physical COM port allowing serial data to pass over-the-air.

The specifications for the 900 MHz NX915 NIC module:

- Frequency Range: 902 to 928 MHz
- Power Output: 20 dBm to 30 dBm in 1.0 dBm steps (DEFAULT = 30 dBm)
- Output Impedance: 50 Ohms
- Permissible Antennas: See Table 3-11 below
- Antenna Connector: TNC female
- Number of Frequency Channels: Selectable 50 to 81 for FHSS, 1 to 18 for DTS
- Channel Separation: 307.5 kHz minimum
- Modulation Type: 2-Level GFSK / 4-Level GFSK
- Data Rates: 125, 250, 500, 1000, 1000W, 1250 kbps
- Peak Frequency Deviation: 1250 kbps / 4-level GFSK: 550 kHz
- Beacon Interval: 10 to 300 ms (DEFAULT is 150)
- Dwell Time: 10 to 400 ms (DEFAULT is 50)
- FCC Part 15.247 under modular rules per DA00-1407
- FCC ID: E5MDS-NX915
- IC: 101D-NX915
- Six modulation rate / bandwidth combinations; as seen in Table 3-10:

Table 3-10. Modulation and Bandwidth Combinations

	125	**250**	**500**	**1000N***	**1000W***	**1250**
Mode	FHSS	FHSS	DTS	DTS	DTS	DTS
Rate (kbps)	125	250	500	1000	1000	1250
Channels	80	80	27	18	15	13
Modulation	2-GFSK	2-GFSK	2-GFSK	4-GFSK	4-GFSK	4-GFSK
RF Bandwidth	152 kHz (20dB)	300 kHz (20dB)	505 kHz (6 dB)	680 kHz (6 dB)	933 kHz (6 dB)	1320 kHz (6 dB)
Sensitivity 1x10-6	-105 dBm	-103 dBm	-99 dBm	-92 dBm	-95 dBm	-95 dBm

*1000N occupies 250 kHz less spectrum bandwidth than 1000W which is why it has a "narrower bandwidth", this comes with a ~2-3 dBm reduction in sensitivity when compared to 1000W kbps. For clear spectrum, use 1000W, for unknown or busy spectrum it's safer to use the narrow 1000N modem.

Table 3-11. Approved NxRadio Antenna Types

Application	**Location**	**Frequency Range**	**Gain**	**Antenna Description**	**MDS Part Number**
900 MHz (NX915)	Indoor	902-928MHz	2 dBi	Omni Indoor Flex	97-2952A01
900 MHz (NX915)	Indoor	902-928MHz	5 dBi	Omni with 16” N-F Connect and Mount	97-3194A16
900 MHz (NX915)	Outdoor	902-960MHz	10 dBd (12.15 dBi)	Yagi 6 Element, N-Female - no cable	97-3194A14
900 MHz (NX915)	Outdoor	902-960MHz	10 dBd (12.15 dBi)	Yagi 6 Element, N-Female - with 10’ Jumper N-M and Mount	97-3194A14A
900 MHz (NX915)	Outdoor	902-960MHz	10 dBd (12.15 dBi)	Yagi 6 Element, N-Female - with 15’ Jumper N-M and Mount	97-3194A14B
900 MHz (NX915)	Outdoor	902-960MHz	6.4 dBd (8.55 dBi)	Yagi 3 Element N-Female - no cable	97-3194A13
900 MHz (NX915)	Outdoor	902-960MHz	6.4 dBd (8.55 dBi)	Yagi 3 Element N-Female – with 10’ Jumper N-M and Mount	97-3194A13A
900 MHz (NX915)	Outdoor	902-960MHz	6.4 dBd (8 55 dBi)	Yagi 3 Element N-Female – with 15’ Jumper N-M and Mount	97-3194A13B
900 MHz (NX915)	Outdoor	902-960MHz	6.4 dBd (8.55 dBi)	Yagi 3 Element N-Female – with 25’ Jumper N-M and Mount	97-3194A13C
900 MHz (NX915)	Outdoor	902-928MHz	7 dBd (9.15 dBi)	5/8-wavelength Omni Ant. with 16" coax to N-Female connector	97-3194A17

For the 900MHz radio (NX915) – If the installed antenna network does not provide the proper load matching, an alarm is generated by the unit to indicate a VSWR Error condition. This must be corrected in order for the radio to operate properly and to ensure optimal operation.

NOTE The only required steps for basic configuration are programing a network name in all units and establishing one unit as the AP.

Minimal configuration is necessary, but several advanced tuning facilities are provided.

Frequency operating range is restricted by pre-set factory calibration to ensure compliance with applicable country-specific regulatory requirements. Frequency operating range can be further restricted by user input to avoid select portions of the operating band. This is sometimes helpful when attempting to collocate a network with another 900MHz network, such as the MDS iNET or TransNET. For example, the iNET network can be configured to operate in the top half of the band while the Orbit can have its NX915 module configured for the lower half.

By default, the radio ships from the factory with the 500kbps modem selected. Dwell time is set to 50ms and Hop Set A is enabled. For typical configuration (e.g., North America) this provides 27 discrete channels over which to hop.

Hop Sets provide a way of specifying the minimum channel spacing within the band and implicitly define the maximum number of hops. Hop Set A uses 307.5 kHz spacing and provides 80 channels. (Required for Modem selections 125kbps and 250kbps).

Table 3-12. Selected Modem Modes

	Selected Modem Modes					
Hop Set / Channels	125	250	500	1000	1000W	1250
A	80	80	27	18	15	13
B	0	0	27	20	15	12
C	0	0	26	20	16	12
D	0	0	0	20	16	13
E	0	0	0	0	16	13
F	0	0	0	0	0	13

See "APPENDIX F – NX915 Module Frequencies" on Page 552 for a chart listing RF channels/frequencies in each hop set, as they apply to each modem selection.

Other items of interest for tuning configuration include Modem Mode (125kbps, 250kbps, 500kbps, etc.) and dwell time. For remotes, setting modem mode to "auto" allows remotes to automatically follow the configuration of the AP. Setting the remote to use a specific modem trades faster sync times for system flexibility. Dwell time determines how frequently the radio switches channels. Longer dwell times are more efficient for data transport and provide higher throughput; but smaller dwell times provide faster synchronization and are more robust in weak signal environments or in the presence of interferers.

For the advanced user, the module supports configuring more items including:

- **Data Retries** - Number of times to retry unicast data before declaring NACK.
- **Fragment Threshold** - Fragmentation threshold
- **Lna State** - Controls the low noise amplifier
- **Mcast Repeat** - Number of times to repeat downstream broadcast and multicast data.
- **Propagation Delay** - Correction for the propagation delay of the RF signal.
- **Stale Packet Timeout** - If the MAC is unable to transmit a packet in this time, it will drop the packet.

In general, it is recommended that users start with the simplest configuration and then make parameter changes as necessary to meet specific needs.

NOTE Frequency blocking to meet country specific regulatory requirements may be configured for by the factory to disallow operation. These settings can NOT be changed or modified by the user. See the table below:

Table 3-13. Country Limitations Example

Country	Limitation
Brazil	Operate only in the band 902-907 and 915-928 MHz
Australia/Chile	Operate only in the band 915-928 MHz
New Zealand	Operate only in the band 921-928 MHz

Table 3-14. NxRadio Interface LED Descriptions

LED - NIC2	State	Description
NxRadio Interface	Off	Interface disabled
Access Point Mode	Blink Red Solid Red Solid Green	NIC Initialization No Remotes connected Linked with at least 1 Remote
Remote Mode	Blink Red Solid Green	NIC Initialization / Not linked to an Access Point Linked with Access Point

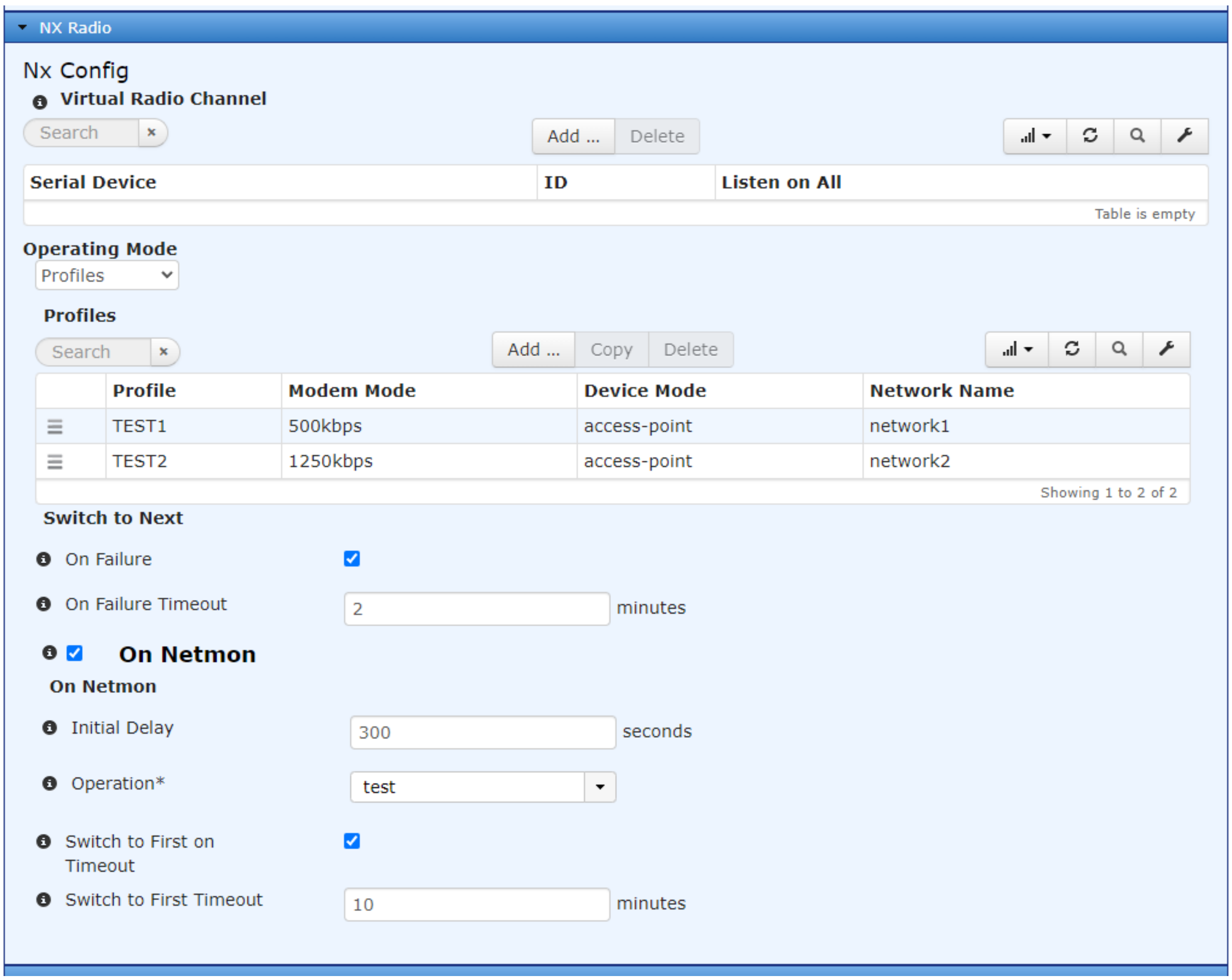
Understanding NX Profiles

NX profiles allow multiple radio configurations to be stored and automatically accessible in a single device. Only one profile is active at a time. The NX starts with the first profile, then upon failover criteria it will automatically advance to the next profile and load a new set of radio configuration choices.

For example, an Orbit unit could be provisioned to search among a set of multiple APs each using a different network name and modem speed. When deployed the Orbit will cycle through the set profiles until it finds the first AP that it can connect to.

As another example, if new radio settings are to be pushed to the network, then the new settings can be added to a different profile in all the remotes before the AP is switched over. This provides a safety net for the whole network to easily be brought back to its former state if there is an error with the new configuration.

Upon changing the *Operating Mode* to Profiles, previous configuration will be removed, and a table will be displayed that can be configured with multiple profiles. Selecting a row of a profile will open a section below the table that will allow the user to configure all of the radio parameters (both basic and advanced).

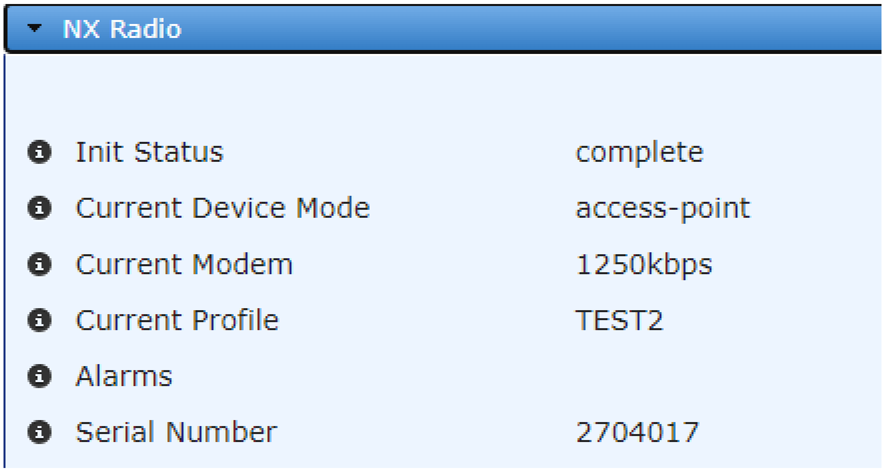


Once profiles are configured, *Switch to Next* settings can be configured to control how the system advances to the next profile. The *On Failure* check box will cause the profile to advance whenever the radio fails to connect to another for the configured time.

If *On Netmon* is selected, the profile will advance based on any configured Netmon trigger.

Profiles behave as a prioritized, ordered list. After successfully connecting on a given profile the radio will maintain that profile, unless connectivity is lost or unless *Switch to First on Timeout* is selected. If *Switch to First on Timeout* is selected the radio will to go back to the first profile after the specified *Switch to First Timeout* duration elapses.

The current active profile can be viewed in the status tab of the web page, or in the CLI under nx-status.



Important Notes and Information Regarding LQI

LQI is dependent on the modulation format and should be used as a relative measurement of the link quality. A low LQI value indicates a better link quality than a high value. Algorithmically, using GFSK modulation, the transceiver calculates the value by measuring the frequency of each "bit" and compares it with the expected frequency based on the channel frequency and the deviation and the measured frequency offset.

- LQI is a metric of the quality of the received signal. It is a dynamic value that is computed only when data is received on the RF interface and should be refreshed accordingly.
- Unlike RSSI which simply measures signal strength, LQI is only a measurement of the "correctness" of this signal. (This means how easily the received signal can be correctly demodulated.)
- In general, the lower the LQI the better the quality.
- LQI should be used as a "relative" measurement. Precision is fairly loose and subject to variation from radio to radio and modulation format.
- For each modem (125,250,500…) LQI means something different because each modulation has varying receive bandwidths which can affect LQI calculations.

The following table can used as a reference to quickly check the LQI reading and determine if it's good or not, and whether you should move to the next modem.

For example: Running Modem 1000 and the LQI reads 9, change to Modem 500. LQI then reads 16, change to Modem 250 and so forth.

Table 3-15. LQI Reference Table

LQI / Modem	125 kbps	250 kbps	500 kbps	1000 kbps	1000W kbps	1250 kbps
Pristine	0 - 8	0 - 16	0 - 8	0 - 4	0 - 1	0 - 1
Usable	9 - 14	17 - 21	9 - 14	5 - 6	2 - 3	2 - 3
Sensitivity (dBm) based on $1x10^{-6}$ @ XXX kbps	-105	-103	-99	-95	-95	-95

Again, the LQI on modem's 1000W and 1250 are usually low. Display of an LQI value indicates a signal is present. Due to the Receiver's wide bandwidth in 1000/1000W/1250 Modems, the dynamic range is lower which typically resolves on a low LQI.

For the remaining modems, "Pristine" means in an absolutely perfect signal environment the best LQI will be less than or equal to the number in the table.

"Usable" means the signal quality is good and the radio should be able to demodulate correctly, however if LQI averages are approaching this limit then errors would be expected. Ideally average LQI should fall somewhere in between the two values shown for each modem.

Lastly, keep in mind this is a "relative" measurement. Please do not make any hard decisions based on this metric. Systems (obviously) are not all the same and optimizing the system may take a little configuring based on Noise Floor/Data Type/Data Volume…

An LQI of 255 is reported (on a given channel/s) during the setup sequence and might also be reported after the remote unit is “associated” with the AP. This does not necessarily imply poor RF conditions; only that no user traffic has been received by the remote from the AP on that specific channel.

As mentioned above since the LQI is a dynamic value that varies upon the environment and is only updated when data is received on the RF interface. It is recommended that to obtain a “good” LQI reading the user enable some traffic to/from the RF interface (where the LQI is being read). Example: If at a remote site, ping the AP and refresh LQI readings at the remote to get most updated LQI reading.

Another note on Modems and distance. The lower the kbps the further the units may be separated (lower the sensitivity). A 125kbps modem can reach out the farthest and the 1250kbps Modem would be the shortest. The Orbit will support up to 8 Hop Store-and-Forward to extend these distances (although Latency must be considered with each additional hop).

Adaptive Data Rate

The adaptive data rate mode allows the uplink traffic to adjust which modem is used on a per remote basis and also works in Store and Forward networks. The mode selection allows the modem to vary over two ranges. It can vary over either 125 kbps to 250 kbps for FHSS operation or 500 kbps to 1250 kbps for DTS operation. When a remote’s RSSI is stronger than the ADR threshold it will attempt to transmit with a faster modem. The downstream traffic is only sent at the lower data rate, either 125 kbps or 500kbps depending on the mode.

The primary use case for this feature is if an AP has some remotes that are close to the AP and could support a higher data rate and some farther away that can only support a lower data rate. This mode allows the close remotes to take advantage of the higher data rate for the uplink, when otherwise the whole network would have had to be run at the lower data rate. This feature will not give the optimal data rates if all remotes can support the higher data rate, because all downlink traffic will be sent at a lower data rate.

Security

Setting the security mode to EAP or PSK will enable device authentication. When enabled, the remotes will authenticate with the AP (PSK) or a backend RADIUS server (EAP) before they are allowed to pass data on the network. The authentication protocol is compliant with IEEE 802.1X. If device authentication is enabled, over the air data encryption can also be enabled. This ensures all over the air traffic is protected. When encryption is enabled, the device must occasionally rotate the encryption keys. This rotation is logged in the event log with event type nx_auth. These events can be suppressed in the event log configuration to prevent them from filling the event log. See section 3.6.2 for instruction on controlling the event log.

Configuring

AP Mode

Basic configuration with defaults

Navigate to: ***Interfaces / NxRadio ---> Basic Config / Nx Radio***

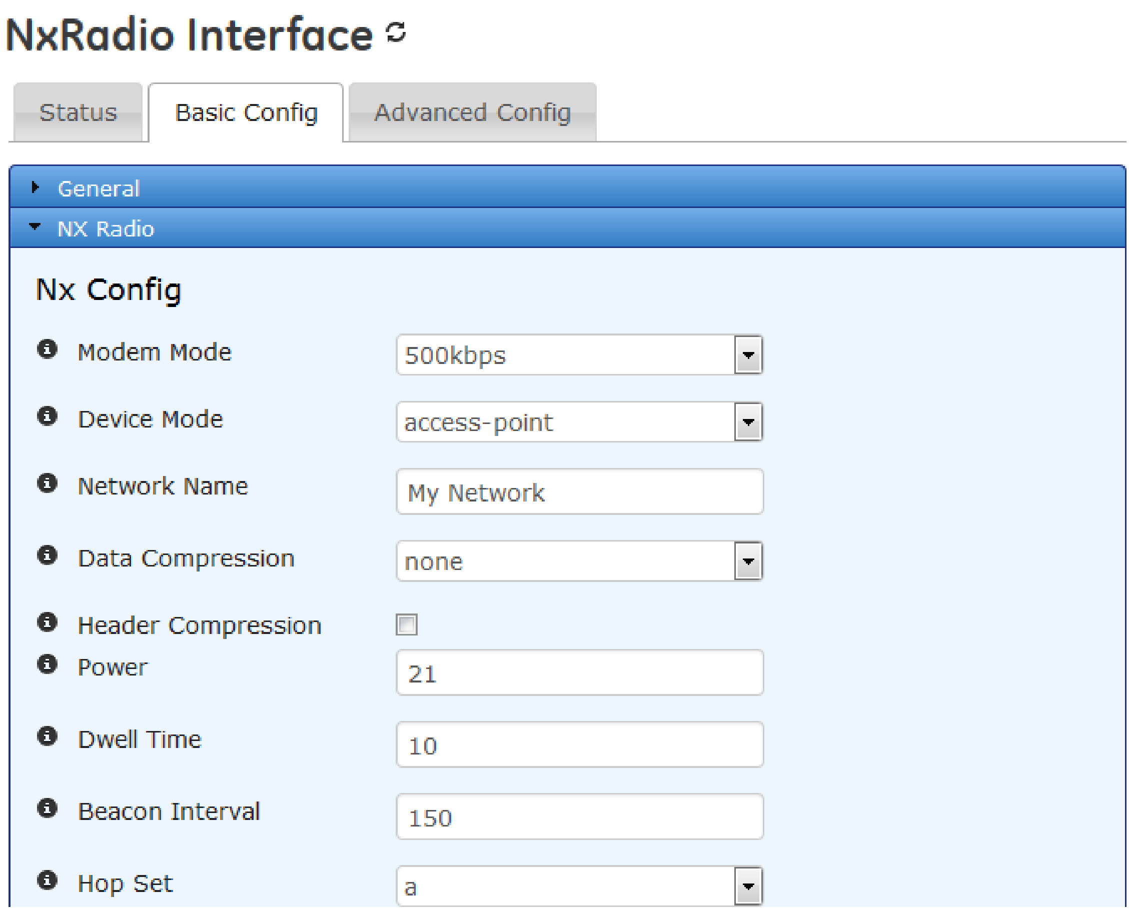


Figure 3-44. ISM 900 (NX) Configuration Settings

- **Modem Mode** - Controls the target throughput of the radio and attached remotes
    - 125kbps - Theoretical throughput of 125 kbps
    - 250kbps - Theoretical throughput of 250 kbps
    - 500kbps - Theoretical throughput of 500 kbps (DEFAULT)
    - 1000kbps - Theoretical throughput of 1000 kbps with narrow bandwidth
    - 1000Wkbps - Theoretical throughput of 1000 kbps with higher sensitivity
    - 1250kbps - Theoretical throughput of 1250 kbps

- **Device Mode** - Sets the role the radio will assume in the network.
  - Remote (DEFAULT)
  - Access Point
  - Store and Forward
- **Network Name** - The name of the network. Used to control what networks is connected to. Valid values: 1 to 31 letters (DEFAULT is mds-nx). The network name string is used to identify the logical network the device as a member of a network. If the network name does not match, the device will log an event, to identify network name collisions.
- **Data Compression** – Over the air compression
  - lzo - Compresses the over the air traffic with the LZO algorithm
  - none - No data compression (DEFAULT)
- **Header Compression –** Disabled by DEFAULT. Enable/disable over the air robust header compression. This feature compresses IP headers to improve system performance and is most useful in applications that rely on IP packets with small payloads, such as terminal server operations or MODBUS polling. This setting must match on each radio (Remote and AP).

NOTE Header Compression and packet concatenation should be disabled when using links with marginal RF performance, due to higher probability of packet errors.

- **Power** - The transmit power of the radio: Valid values: 20 - 30 dBm – DEFAULT is 30dBm
- **Dwell Time** - Time spent on a channel, Valid values: 10 - 400 ms - DEFAULT is 50ms
- **Beacon Interval** - The time interval that the AP will send beacons, the smaller the value the faster remotes will associate, the larger the value less over the air time is taken up by beacons and can be used for data. Valid values: 10 - 400 ms – DEFAULT = 150ms
- **Hop Set** - The hop set of the radio - DEFAULT "A"
  - A – F - refer to APPENDIX J – Country Specific Information
  - Auto - for Remotes - this causes the radio to hunt for an AP, trying different modem modes. This can take a significant amount of time to sync and begin to pass data.

NOTE Remember to click on the Save button when finished.

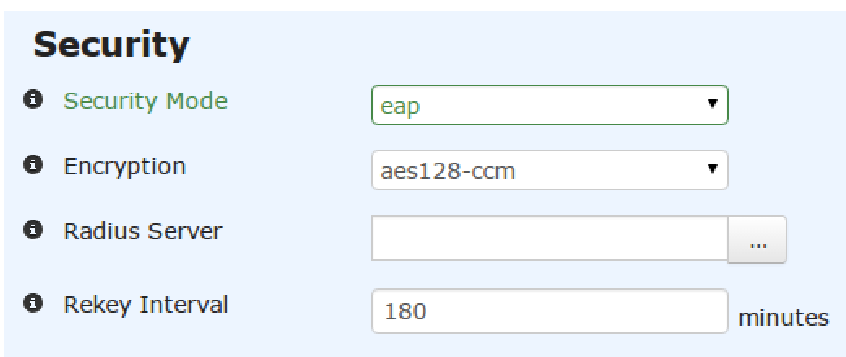


Figure 3-45. ISM 900 (NX) EAP Security Settings

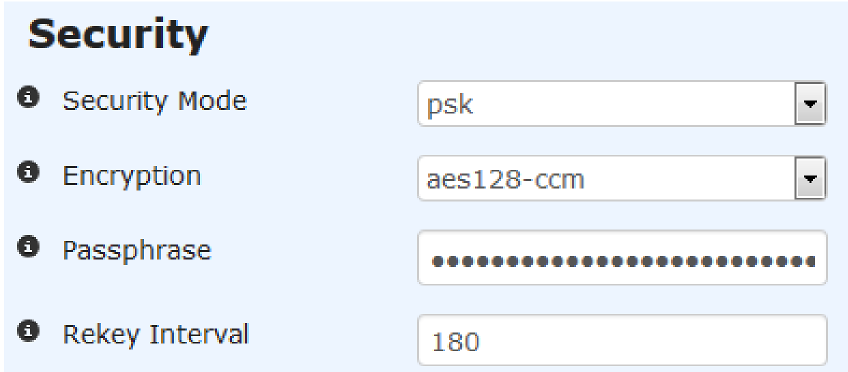


Figure 3-46. ISM 900 (NX) PSK Security Settings

- **Security Mode** - The type of authentication to perform
  - none - Provide no device authentication or data privacy (DEFAULT)
  - psk - Use pre-shared key authentication protocol
  - eap - Use Encapsulated Authentication Protocol - will change the fields displayed and give the user the ability to enter RADIUS info on the AP and certificate info on the remote.
- **Encryption** - The type of encryption to perform
  - none - No data privacy (DEFAULT)
  - aes128-ccm - Protect data with 128-bit AES encryption using CCM mode
  - aes256-ccm - Protect data with 256-bit AES encryption using CCM mode
- **Passphrase** -The key material used in PSK mode. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. (DEFAULT=blank)

NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **Radius Server** – A reference to the RADIUS server configuration configured through the System – RADIUS side menu item (section 3.7.6).
- **Rekey Interval –** The session key for an active secure link changes at a regular basis. You may increase the length of the rekey interval in order to reduce overhead caused by the rekeying communications between radios on a narrowband channel. Valid values:
  - 0 – Rekeying will not be time-based but will instead occur every one million packets.
  - 30-525600 minutes, DEFAULT 180

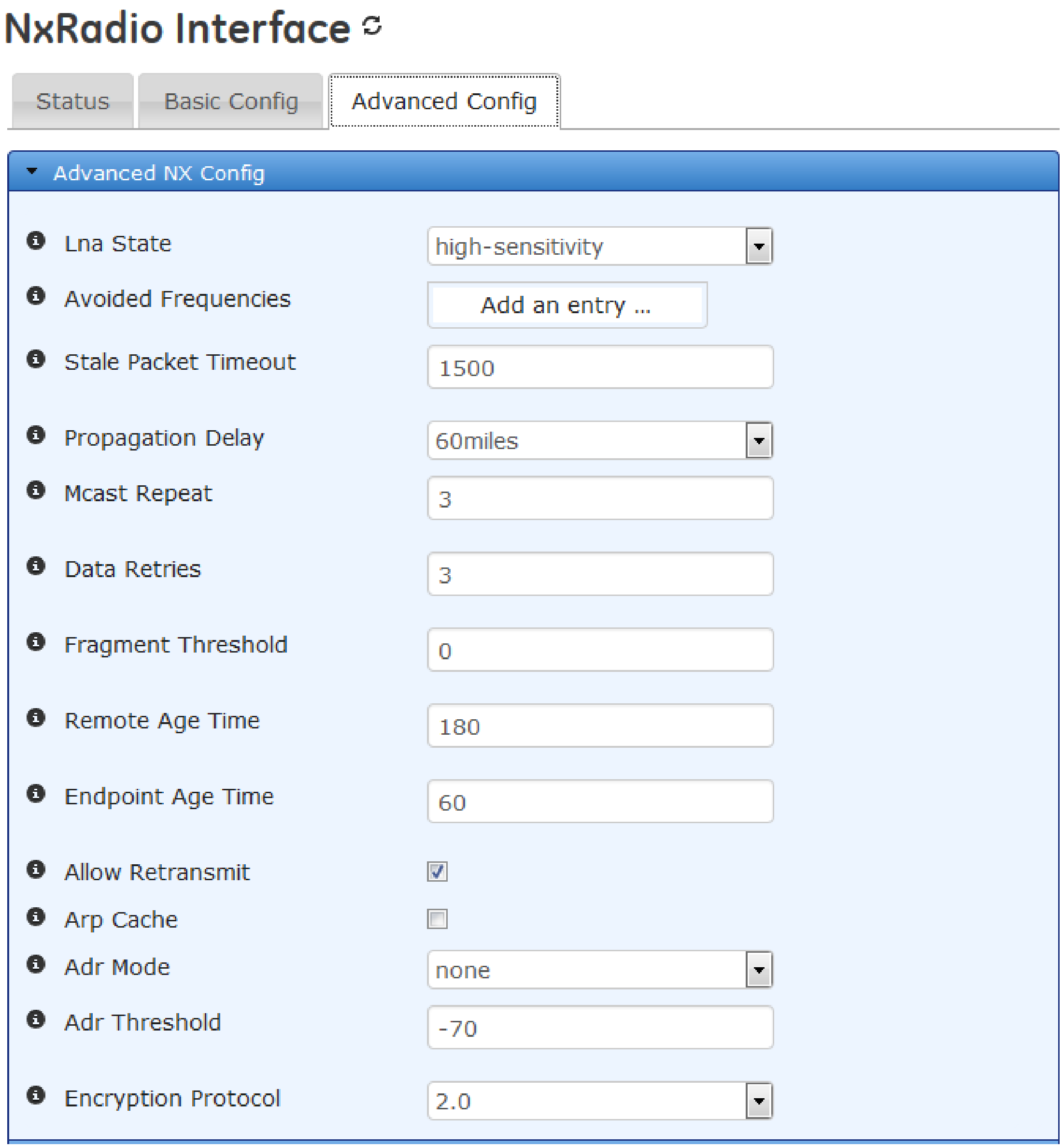


Figure 3-47. ISM 900 (NX) AP Advanced Settings

- **Lna State –** The *High Sensitivity* setting will amplify the incoming signal and increase the chance of detecting weak signals. This is the default mode for the LNA. In a high noise environment, such as at main tower where an AP might be located, it can help to turn the LNA to *High Immunity*, which disables the LNA amplification. This means the radio will not be trying extra to amplify the collocated RF noise. It will be more difficult to detect weak signals, if at all, but enhance the probability to detect the stronger ones.
  - High Sensitivity – set when operating in a low noise environment with minimal radio interference (DEFAULT)
  - High Immunity - set when operating in an environment with radio interference
- **Avoided Frequencies** - Frequencies that are not included in the hop pattern. Decimal MHz in the form of "###", "###.#", "###.##", "###.###", "###.####". A range is required, with the values separated by a hyphen, with or without spaces on either side. For example, "902.2-910" to block 8MHz on the lower portion of the band from 902-910 MHz. To block a single channel, enter a value like "915.615-915.615" . This ensures blocking the specified frequency but depending on hop settings, may block other channels as well.

NOTE The frequency range of each radio channel is dependent on Modem Mode and Hop Set (selected in the Basic Config tab). If any part of a radio channel falls into an avoided frequency range, the entire channel will be avoided. When specifying an avoided frequency range, be aware of any overlaps with known channels to avoid unintended exclusion of a channel.

- **Stale Packet Timeout** - If the MAC is unable to transmit a packet in this time, it will drop the packet. Milliseconds, DEFAULT= 1500, range from 0 to 65535.
- **Propagation Delay** - Correction for the propagation delay of the RF signal. Enumeration of 20, 40, or 60 mile speed-of- light delay. DEFAULT = 40
- **Mcast Repeat** – Multicast repeat number - Number of times to repeat downstream broadcast and multicast data. DEFAULT = 3, range from 0 to 255.
- **Data Retries** - Number of times to retry unicast data before declaring NACK. Valid values: 0—15**,** DEFAULT = 3.
- **Fragment Threshold** - – This parameter controls the NIC's over the air fragmentation. It is transparent to all network traffic and is independent of any IP fragmentation. Any packet larger than the threshold will be broken up into packets up to the threshold size. Valid values: 0, 50—1500 Bytes, 0 is disabled. DEFAULT = 0.
- **Remote Age Time** – Length of time, in seconds, of inactivity of the device before it is disconnected. Valid values: 180-4294967295, DEFAULT = 600
- **Endpoint Age Time**- Length of time in seconds if inactivity on this endpoint before it is removed from the database. DEFAULT = 300. Range of 0 to 4294967295
- **Allow Retransmit** – All traffic from the remotes is sent to the AP. When enabled the AP will retransmit traffic from one remote to another based on the MAC address. It will also resend any remotes broadcast traffic to all other remotes.
- **ARP Cache** – Disabled by DEFAULT. When enabled, the radio will respond to ARP requests intended for other network devices with known addresses. It will not forward the ARP to the intended device. See APPENDIX L – Understanding ARP Cache.
- **ADR Mode** – Adaptive data rate mode controls whether the NIC will attempt to use different modem speeds for different remotes. All downstream traffic uses the lowest rate; only upstream traffic can use the variable rate. ADR setting is automatically learned by remotes, but remotes modem must be set to Auto, or 125 for 125-250kbps, or 500 for 500-1250 kbps operation.
    - 125-250kbps – ADR will attempt to use the FHSS modems (125kbps and 250kbps) when trying to determine the best modem for the remote.
    - 500-1250kbps – ADR will use the DTS modems (500kbps, 1000kbps, 1000W kbps, and 1250 kbps) when attempting to determine the optimal rate.
    - none – ADR is not used and the static modem setting in nx-config is used for the modem. (Default)
- **ADR Threshold** – The threshold is an RSSI threshold. If the received signal is stronger than the threshold the NIC will attempt to use a faster modem. ADR Threshold must be set for each radio (Remotes and AP). This is advantageous in that you can run the majority of the network in ADR mode, but if a particular remote has strong RSSI but difficult channel conditions you can effectively disable ADR on that specific remote by setting the ADR threshold artificially low.
- **Encryption Protocol –** Encryption Protocol 2.0 provides the highest level of over the air encryption security with a strong encryption key but is not compatible with Orbit radios running firmware earlier than 3.1.0. Encryption Protocol 1.0 provides compatibility with older firmware by using the strong key when talking to units with firmware 3.1.0 and later, and a less strong key when talking to units with firmware earlier than 3.1.0. DEFAULT 2.0. For more information, refer to Product Bulletin PB15001_A, *MCR-900 Encryption Issue Resolution,* available on our website.

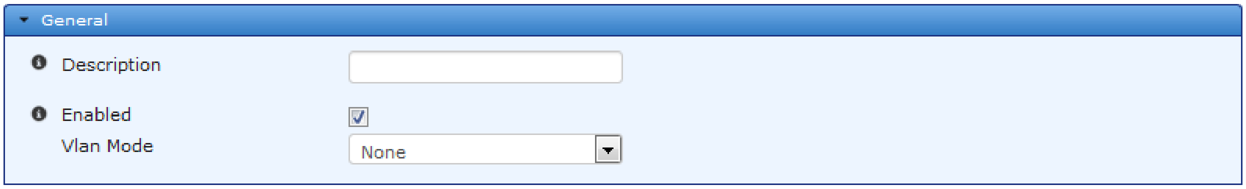


Figure 3-48. ISM 900 (NX) VLAN Setting

- **Description** – User description of the NxRadio.
- **Enabled** – Enable the NxRadio. DEFAULT = ENABLED.
- **Vlan Mode -** VLAN configuration
  - None
  - Access - Only one VLAN can be configured on an access interface; traffic carried for only one VLAN.
  - Trunk - Two or more VLANs configured on a trunk port; several VLANs can be carried simultaneously.

Remote Mode

Basic configuration with defaults

The advanced configuration on an NX915 module operating as a Remote, shares the same configuration for LNA state, stale packets timeout and data retries as an Access Point. Using the default value of 0 (zero) for the NIC and Gateway Identifiers configure the module to automatically obtain a path in the network. This is particularly useful in a network that contains Store-and-Forward devices.

Navigate to: ***Interfaces / NxRadio ---> Basic Config / Nx Radio***

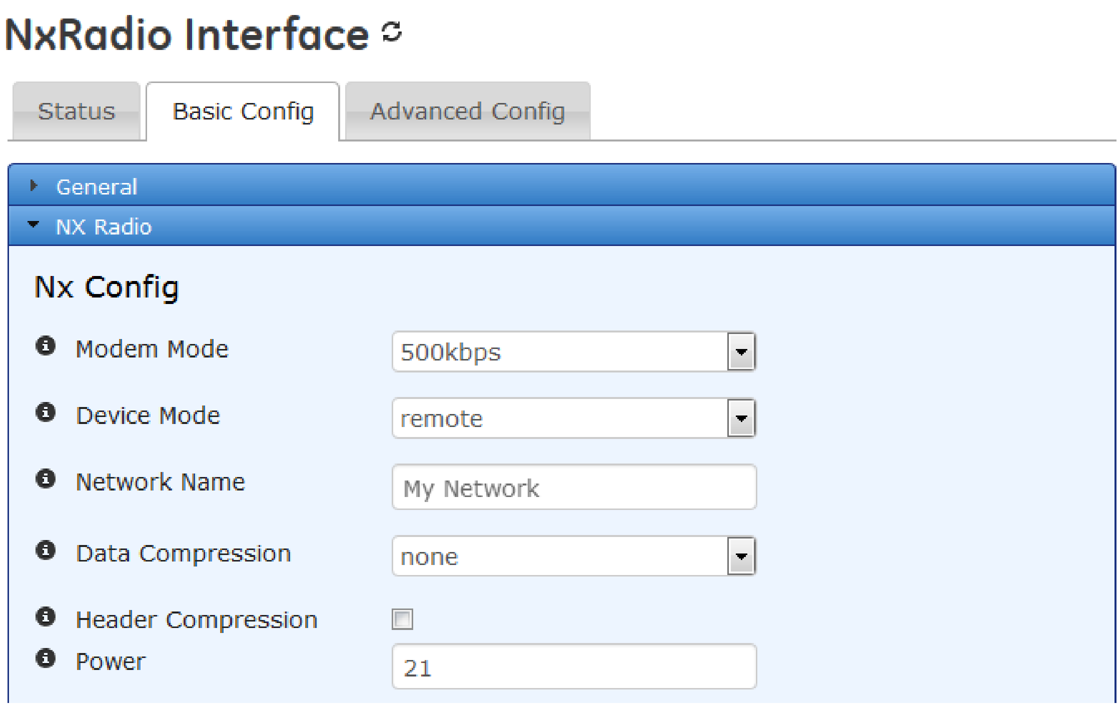


Figure 3-49. ISM 900 (NX) Remote Configuration

- **Modem Mode** - Controls the target throughput of the radio**.**
  - 125kbps - Theoretical throughput of 125 kbps
  - 250kbps - Theoretical throughput of 250 kbps
  - 500kbps - Theoretical throughput of 500 kbps (DEFAULT)

- 1000kbps - Theoretical throughput of 1000 kbps with narrow bandwidth
- 1000Wkbps - Theoretical throughput of 1000 kbps with higher sensitivity
- 1250kbps - Theoretical throughput of 1250 kbps
- Auto - While the AP must pick a fixed modem, in this mode the remote will scan through all modems and find the one with the strongest signal. Each modem scan can take a few minutes which means worst case it could take up to 5 modem changes before finding the correct modem. The unit will continue to scan until it connects with an AP.

- **Device Mode** - Sets the role the radio will assume in the network.
  - Remote (DEFAULT)
  - Access Point
  - Store and Forward
- **Network Name** - The name of the network. Used to control what networks is connected to. Valid values: 1 to 31 letters (DEFAULT = mds-nx). The network name string is used to identify the logical network the device as a member of a network. If the network name does not match, the device will log an event, to identify network name collisions.
- **Data Compression** – Over the air compression
  - lzo - Compresses the over the air traffic with the LZO algorithm
  - none - No data compression (DEFAULT)
- **Header Compression –** Disabled by DEFAULT. Enable/disable over the air robust header compression. This feature compresses IP headers to improve system performance and is most useful in applications that rely on IP packets with small payloads, such as terminal server operations or MODBUS polling. This setting must match on each radio (Remote and AP).

NOTE Header Compression and packet concatenation should be disabled when using links with marginal RF performance, due to higher probability of packet errors.

- **Power** - The transmit power of the radio. Valid values are: 20—30 dBm –DEFAULT =30dBm

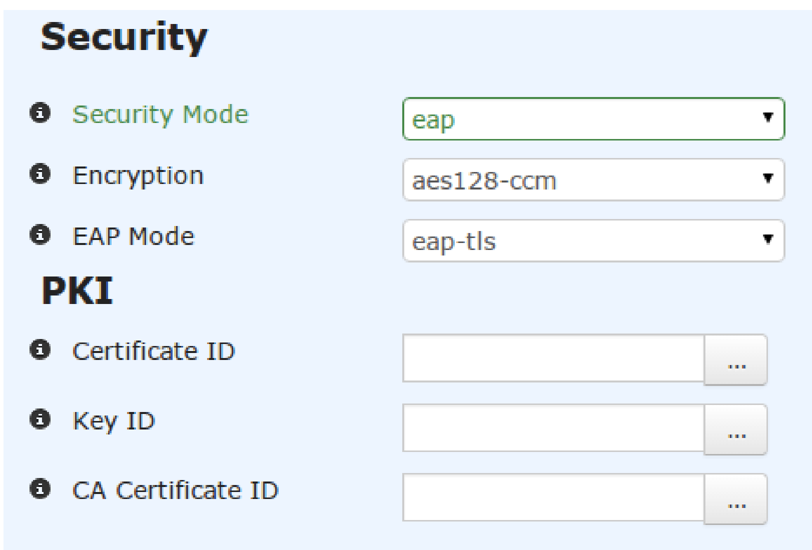


Figure 3-50. ISM 900 (NX) Remote EAP Security Configuration

Figure 3-51. ISM 900 (NX) PSK Remote Security Configuration

- **Security Mode** - The type of authentication to perform
  - none - Provide no device authentication or data privacy
  - psk - Use pre-shared key authentication protocol
  - eap - Use Encapsulated Authentication Protocol
- **Encryption** - The type of encryption to perform
  - none - No data privacy (DEFAULT)
  - aes128-ccm - Protect data with 128-bit AES encryption using CCM mode
  - aes256-ccm - Protect data with 256-bit AES encryption using CCM mode
- **Passphrase** - The key material used in PSK mode. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. (DEFAULT=blank)

NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **Certificate ID, Key ID, CA Certificate ID –** Reference to the remotes certificate material loaded through the Certificate Management side menu (section 3.9).

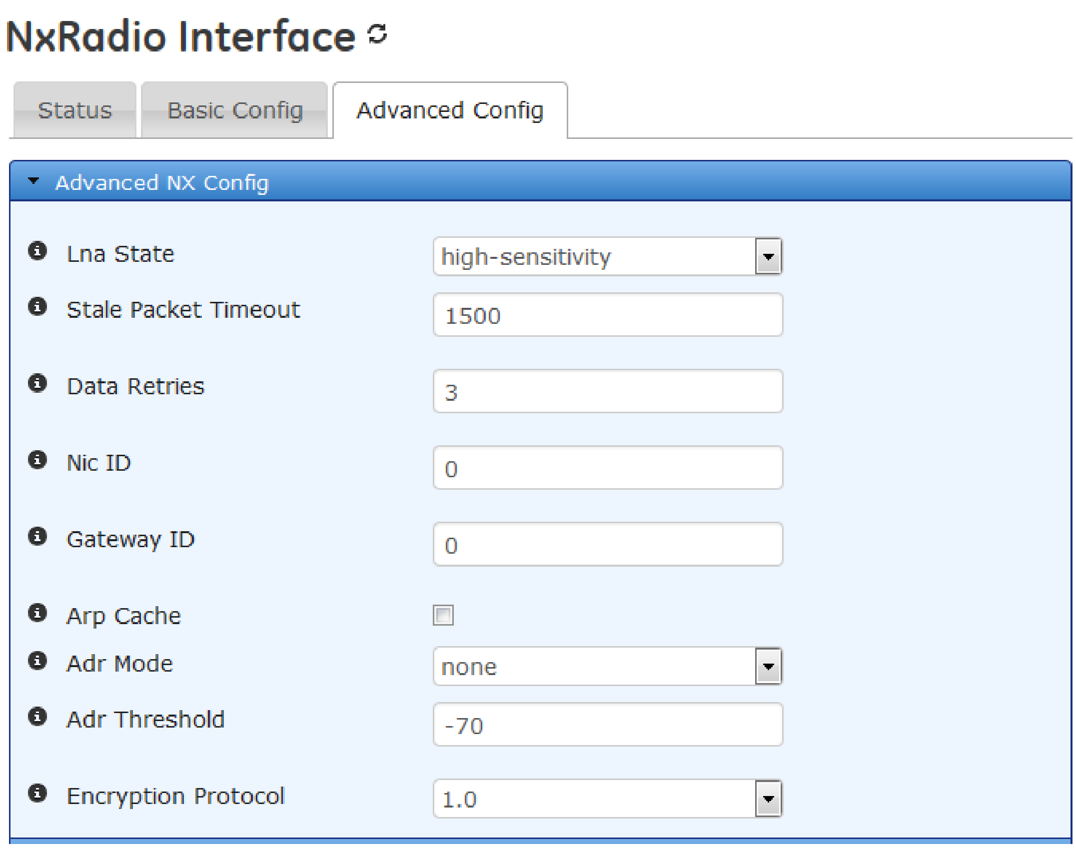


Figure 3-52. ISM 900 (NX) Remote Advanced Configuration

- **Lna State –** Low Noise Amplifier in the *High Sensitivity* setting will amplify the incoming signal and increase the chance of detecting weak signals. This is the default mode for the LNA. In a high noise environment, such as at main tower where an AP might be located, it can help to turn the LNA to *High Immunity,* which disables the LNA amplification. This means the radio will not be trying extra to amplify the collocated RF noise. It will be more difficult to detect weak signals, if at all, but enhance the probability to detect the stronger ones.
  - High Sensitivity – set when operating in a low noise environment with minimal radio interference
  - High Immunity - set when operating in an environment with radio interference
- **Stale Packet Timeout -** If the MAC is unable to transmit a packet in this time, it will drop the packet. Milliseconds, DEFAULT = 1500, range from 0 to 65535.
- **Data Retries -** Number of times to retry unicast data before declaring NACK. Valid values: 0—15**,** DEFAULT = 3.
- **NIC ID – ADVANCED SETTING – TYPICALLY DO NOT CHANGE -** Manual overrides of the NIC identifier: DEFAULT = 0, means auto, not manual. Range of 0 or 400-500
- **Gateway ID - ADVANCED SETTING – TYPICALLY DO NOT CHANGE -** Manual overrides of the NIC's gateway identifier: DEFAULT = 0, means auto, not manual Range of 0 or 65535.
- **ARP Cache** – Disabled by DEFAULT. When enabled, the radio will respond to ARP requests intended for other network devices with known addresses. It will not forward the ARP to the intended device. See APPENDIX L – Understanding ARP Cache
- **ADR Mode –** Adaptive data rate mode controls whether the NIC will attempt to use different modem speeds for different remotes. All downstream traffic uses the lowest rate; only upstream traffic can use the variable rate. ADR setting is automatically learned by remotes, but remotes modem must be set to Auto, or 125 for 125-250kbps, or 500 for 500-1250 kbps operation.
  - 125-250kbps – ADR will attempt to use the FHSS modems (125kbps and 250kbps) when trying to determine the best modem for the remote.
  - 500-1250kbps – ADR will use the DTS modems (500kbps, 1000kbps, 1000W kbps, and 1250 kbps) when attempting to determine the optimal rate.
  - none – ADR is not used and the static modem setting in nx-config is used for the modem.
- **ADR Threshold** – The threshold is an RSSI threshold. If the received signal is stronger than the threshold the NIC will attempt to use a faster modem. ADR Threshold must be set for each radio (Remotes and AP). This is advantageous in that you can run the majority of the network in ADR mode, but if a particular remote has strong RSSI but difficult channel conditions, you can effectively disable ADR on that specific remote by setting the ADR threshold artificially low. DEFAULT = -70, range from -127 to 0.
- **Encryption Protocol –** Encryption Protocol 2.0 provides the highest level of over the air encryption security with a strong encryption key but is not compatible with Orbit radios running firmware earlier than 3.1.0. Encryption Protocol 1.0 provides compatibility with older firmware by using the strong key when talking to units with firmware 3.1.0 and later, and a less strong key when talking to units with firmware earlier than 3.1.0. DEFAULT 2.0. For more information, refer to Product Bulletin PB15001_A, *MCR-900 Encryption Issue Resolution,* available on our website.

Store and Forward Mode

Basic configuration with defaults

The advanced configuration on an NX915 module operating as a Store-and-Forward device, shares the same configuration as a Remote.

Interfaces / NxRadio ---> Basic Config / Nx Radio

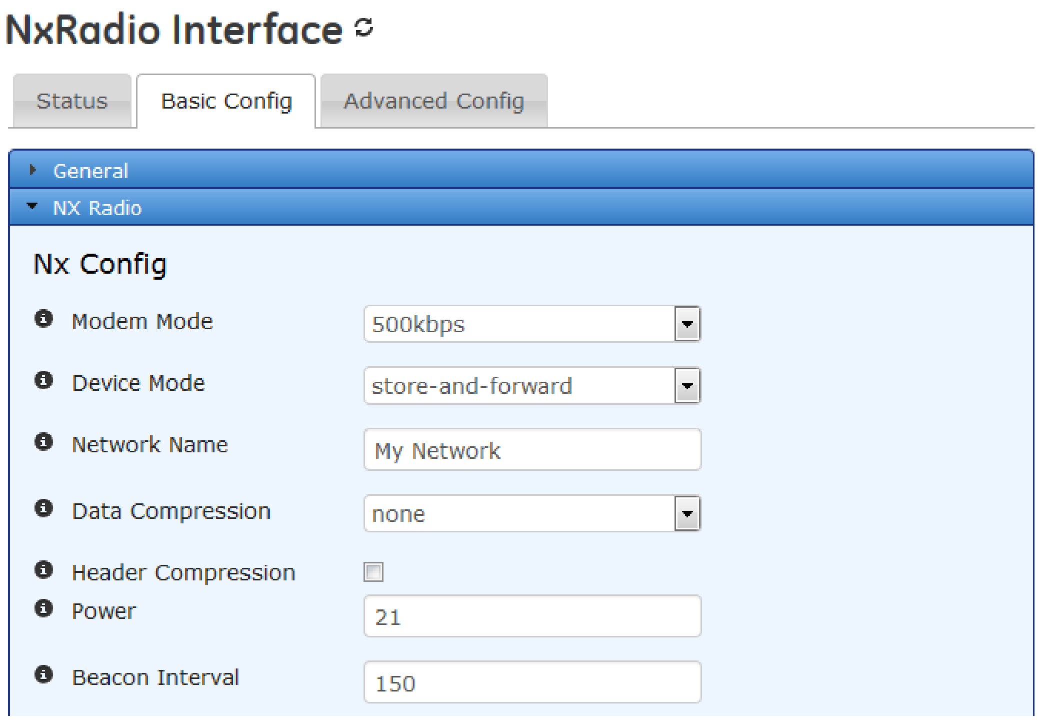


Figure 3-53. ISM 900 (NX) S&F Configuration

- **Modem Mode** - Controls the target throughput of the radio
  - 125kbps - Theoretical throughput of 125 kbps
  - 250kbps - Theoretical throughput of 250 kbps
  - 500kbps - Theoretical throughput of 500 kbps (DEFAULT)
  - 1000kbps - Theoretical throughput of 1000 kbps with narrow bandwidth
  - 1000Wkbps - Theoretical throughput of 1000 kbps with higher sensitivity
  - 1250kbps - Theoretical throughput of 1250 kbps
  - Auto - While the AP must pick a fixed modem, in this mode the remote can walk all modems and find the one with the strongest signal.
- **Device Mode** - Sets the role the radio will assume in the network.
  - Remote (DEFAULT)
  - Access Point
  - Store and Forward
- **Network Name** - The name of the network. Used to control what networks the radio connects to. Valid values: 1 to 31 letters (DEFAULT is mds-nx). The network name string is used to identify the logical network that the device should join. If the network name does not match, the device will log an event to identify network name collisions.
- **Data Compression** – Over the air compression
  - lzo - Compresses the over the air traffic with the LZO algorithm

- none - No data compression (DEFAULT)

- **Header Compression –** Disabled by DEFAULT. Enable/disable over the air robust header compression. This feature compresses IP headers to improve system performance and is most useful in applications that rely on IP packets with small payloads, such as terminal server operations or MODBUS polling. This setting must match on each radio (Remote and AP).

NOTE Header Compression and packet concatenation should be disabled when using links with marginal RF performance, due to higher probability of packet errors.

- **Power** - The transmit power of the radio. Valid values are: 20-30 dBm – (DEFAULT -30dBm)
- **Dwell Time** - Time spent on a channel. Valid values are: 10-400 ms - (DEFAULT - 50ms)
- **Beacon Interval** - Time spent on a channel. Valid values are: 10-400 ms -(DEFAULT - 50ms)

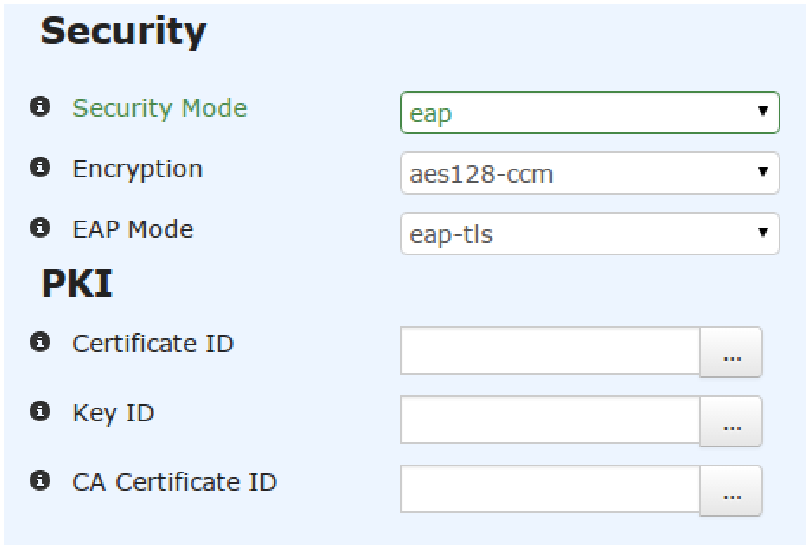


Figure 3-54. ISM 900 (NX) S&F PSK Security Configuration

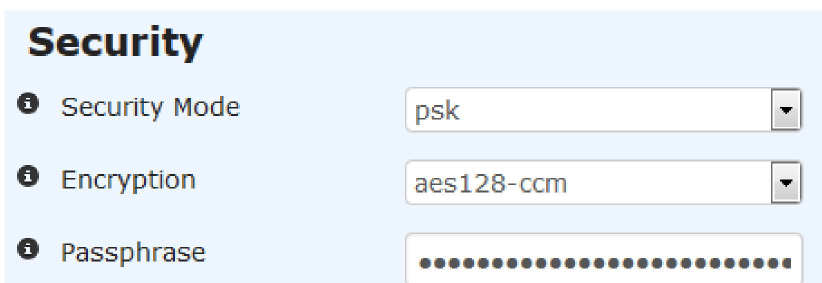


Figure 3-55. ISM 900 (NX) S&F PSK Security Configuration

- **Security Mode** - The type of authentication to perform
  - none - Provide no device authentication or data privacy (DEFAULT)
  - psk - Use pre-shared key authentication protocol
  - eap - Use Encapsulated Authentication Protocol
- **Encryption** - The type of encryption to perform
  - none - No data privacy
  - aes128-ccm - Protect data with 128-bit AES encryption using CCM mode
  - aes256-ccm - Protect data with 256-bit AES encryption using CCM mode
- **Passphrase** - The key material used in PSK mode. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. (DEFAULT=blank)

NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **Certificate ID, Key ID, CA Certificate ID –** Reference to the remotes certificate material loaded through the Certificate Management side menu (section 3.9).

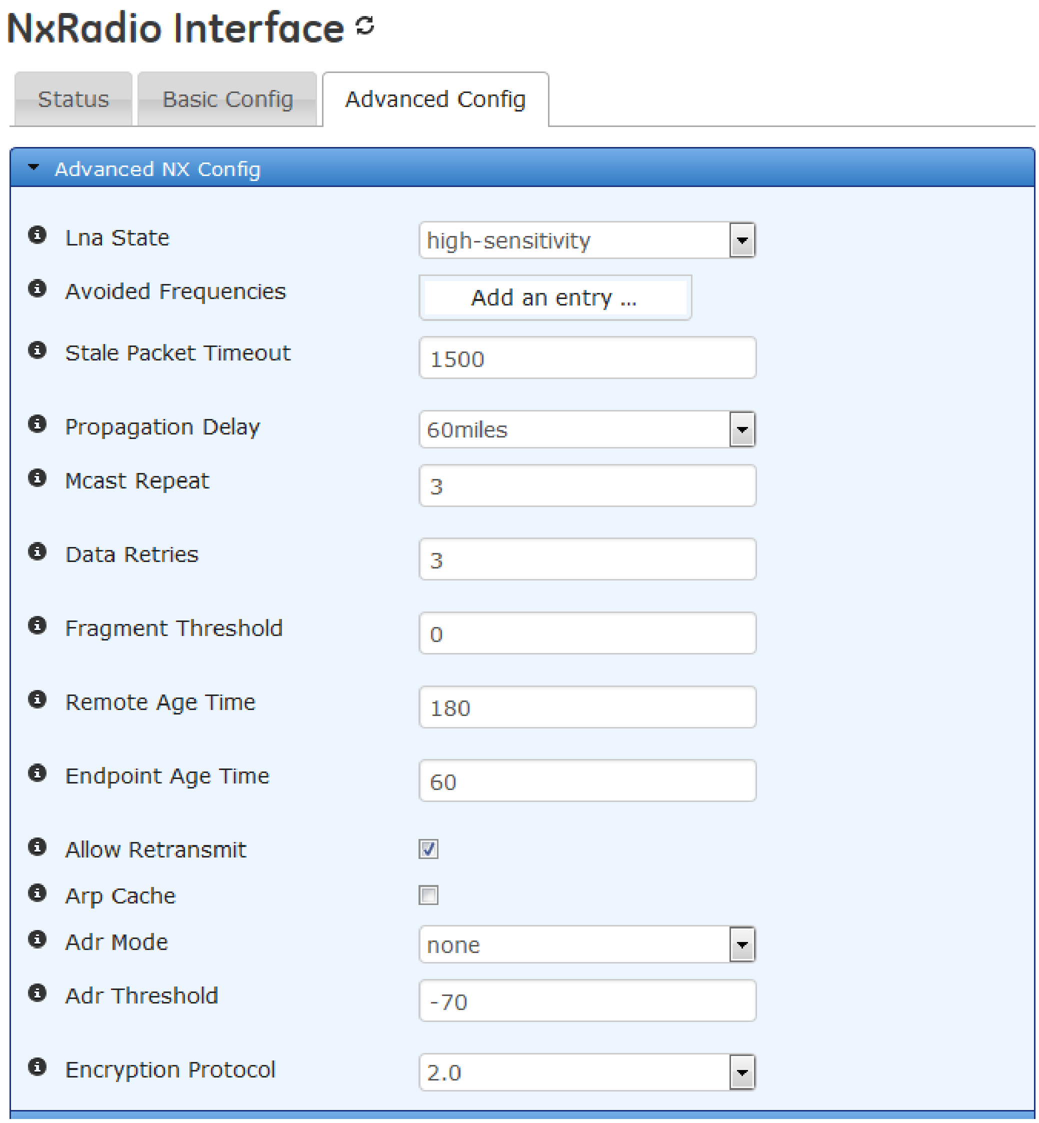


Figure 3-56. ISM 900 (NX) S&F Advanced Configuration

- **Lna State –** The *High Sensitivity* setting will amplify the incoming signal and increase the chance of detecting weak signals. This is the default mode for the LNA. In a high noise environment, such as at main tower where an AP might be located, it can help to turn the LNA to High Immunity, which disables the LNA amplification. This means the radio will not be trying extra to amplify the collocated RF noise. It will be more difficult to detect weak signals, if at all, but enhance the probability to detect the stronger ones.
  - High Sensitivity – set when operating in a low noise environment with minimal radio interference
  - High Immunity - set when operating in with radio interference
- **Stale Packet Timeout** - If the MAC is unable to transmit a packet in this time, it will drop the packet. Milliseconds, DEFAULT = 1500, range from 0 to 65535.

- **Data Retries** - Number of times to retry unicast data before declaring NACK. Valid values: 0—15**,** DEFAULT = 3.
- **NIC ID – ADVANCED SETTING – TYPICALLY DO NOT CHANGE** - Manual overrides of the NIC identifier.
- **Gateway ID - ADVANCED SETTING – TYPICALLY DO NOT CHANGE** - Manual overrides of the NIC's gateway identifier.
- **ARP Cache** – Disabled by DEFAULT. When enabled, the radio will respond to ARP requests intended for other network devices with known addresses. It will not forward the ARP to the intended device. See APPENDIX L – Understanding ARP Cache
- **ADR Mode** – Adaptive data rate mode controls whether the NIC will attempt to use different modem speeds for different remotes. All downstream traffic uses the lowest rate; only upstream traffic can use the variable rate. ADR setting is automatically learned by remotes, but remotes modem must be set to Auto, or 125 for 125-250kbps, or 500 for 500-1250 kbps operation.
  - 125-250kbps – ADR will attempt to use the FHSS modems (125kbps and 250kbps) when trying to determine the best modem for the remote.
  - 500-1250kbps – ADR will use the DTS modems (500kbps, 1000kbps, 1000W kbps, and 1250 kbps) when attempting to determine the optimal rate.
  - none – ADR is not used and the static modem setting in nx-config is used for the modem.
- **ADR Threshold** – The threshold is an RSSI threshold. If the received signal is stronger than the threshold the NIC will attempt to use a faster modem. ADR Threshold must be set for each radio (Remotes and AP). This is advantageous in that you can run the majority of the network in ADR mode, but if a particular remote has strong RSSI but difficult channel conditions, you can effectively disable ADR on that specific remote by setting the ADR threshold artificially low. DEFAULT = -70, range from -127 to 0.
- **Encryption Protocol –** Encryption Protocol 2.0 provides the highest level of over the air encryption security with a strong encryption key but is not compatible with Orbit radios running firmware earlier than 3.1.0. Encryption Protocol 1.0 provides compatibility with older firmware by using the strong key when talking to units with firmware 3.1.0 and later, and a less strong key when talking to units with firmware earlier than 3.1.0. DEFAULT 2.0. For more information, refer to Product Bulletin PB15001_A, *MCR-900 Encryption Issue Resolution,* available on our website.

Monitoring

AP Status Monitoring:

General Interface information: ***Interfaces / NxRadio ---> Status / General***

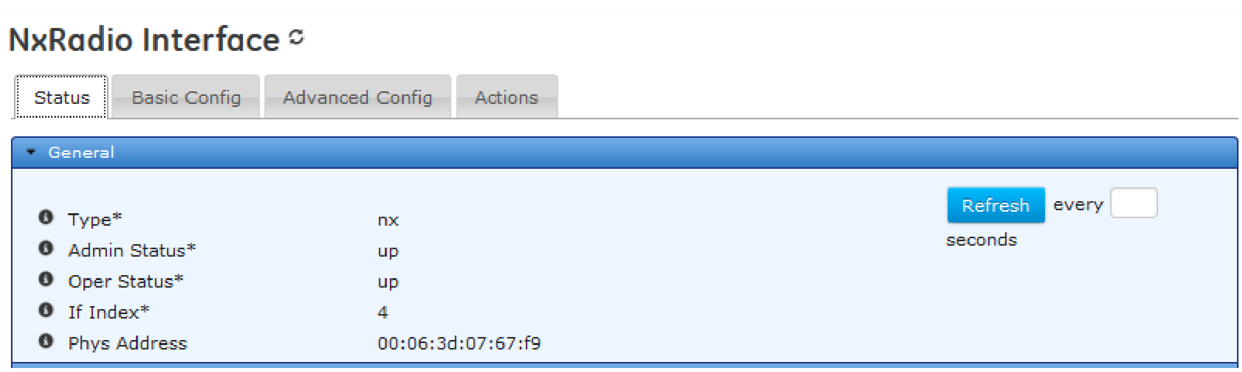


Figure 3-57. ISM 900 (NX) AP Status

- **Type** - The type of the interface
- **Admin Status** - The desired state of the interface.

- **Oper Status** - The current operational state of the interface.
- **If Index** - The ifIndex value for the ifEntry represented by this interface. Valid values are: 1—2147483647
- **Phys Address**- The interface's address at its protocol sub-layer. For example, for an 802.x interface, this object normally contains a MAC address. The interface's media-specific modules must define the bit and byte ordering and the format of the value of this object. For interfaces that do not have such an address (e.g., a serial line), this node is not present.

Statistics - A collection of interface-related statistics objects.

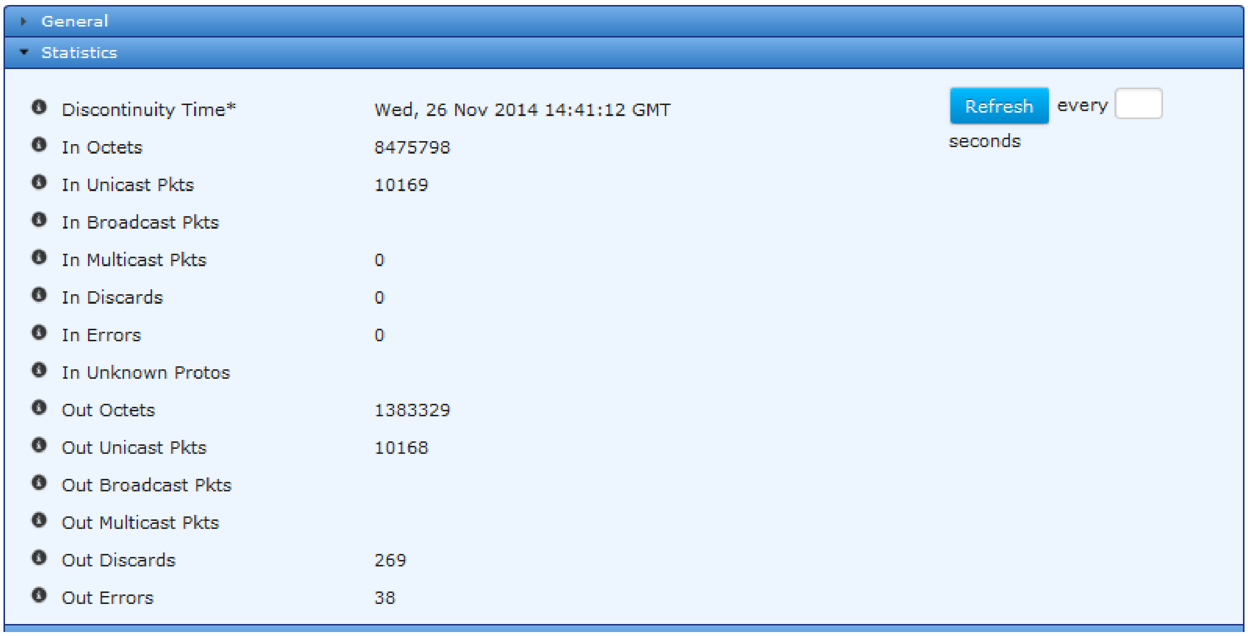


Figure 3-58. ISM 900 (NX) AP Statistics

- **Discontinuity Time** - The time on the most recent occasion at which one or more of this interface's counters suffered a discontinuity.
- **In Octets** - The total number of octets received on the interface, including framing characters.
- **In Unicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
- **In Broadcast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a broadcast address at this sub-layer.
- **In Multicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer.
- **In Discards** - The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
- **In Errors** - For packet-oriented interfaces, the number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
- **In Unknown Protos** - For packet-oriented interfaces, the number of packets received via the interface which were discarded because of an unknown or unsupported protocol.
- **Out Octets** - The total number of octets transmitted out of the interface, including framing characters.

- **Out Unicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Broadcast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Multicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent.
- **Out Discards** - The number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted.
- **Out Errors** - For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors.

NX Status Monitoring:

Interfaces / NxRadio ---> Status / Nx Radio

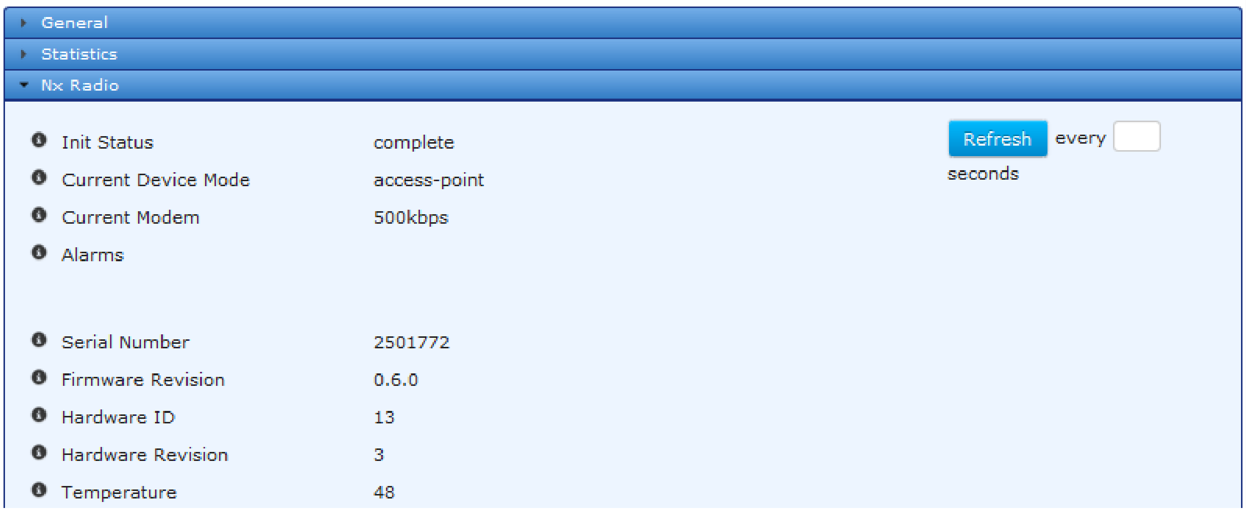


Figure 3-59. ISM 900 (NX) Status

- **Init Status** - State of the NIC Initialization
  - Off - Not operating
  - Initializing - Powering on the NIC
  - Discovering - Determining the NIC address
  - Reprogramming - Programming the NIC firmware
  - Configuring - Configuring the NIC
  - Complete - Initialization complete
- **Current Device Mode** – Read-only display of the active mode the NxRadio is operating.
- **Current Modem -** The current operating modem
  - 125kbps - Theoretical throughput of 125 kbps
  - 250kbps - Theoretical throughput of 250 kbps
  - 500kbps - Theoretical throughput of 500 kbps (DEFAULT)
  - 1000kbps - Theoretical throughput of 1000 kbps with narrow bandwidth
  - 1000Wkbps - Theoretical throughput of 1000 kbps with higher sensitivity
  - 1250kbps - Theoretical throughput of 1250 kbps
- **Alarms** - The current NIC alarms**:**

- frequency-not-programmed
- authorization-fault
- synthesizer-out-of-lock
- a-to-d-fault
- voltage-refrequency-not-programmed
- authorization-fault
- synthesizer-out-of-lock
- a-to-d-fault
- voltage-regulator-fault-detected
- radio-not-calibrated
- dsp-download-fault
- flash-write-failure
- checksum-fault
- receiver-time-out
- transmitter-time-out
- alarm-test
- vswr-fault

NOTE If the antenna system does not provide a proper impedance match an alarm is generated that indicates "VSWR Fault". This is an indication that the ratio of RF power out to power reflected is approaching a 4:1 ratio or higher - ideally this should be 1:1. This should be corrected to achieve optimal radio performance. It may be helpful to use an SWR test device to troubleshoot.

- unit-address-not-programmed
- data-parity-error
- data-framing-error
- configuration-error
- six-v-regulator-output
- dc-input
- rf-output-power
- internal-temp

- **Serial Number** – Serial number of the installed NX radio.
- **Firmware Revision** - NIC Firmware Revision 0 to 32 characters.
- **Hardware ID** - The Hardware ID.
- **Hardware Revision** - The Hardware Revision.
- **Temperature** - The transceiver temperature in degrees C.

Remote's AP Info (Remote and Store-And-Forward Mode ONLY):

Ap Info

Ap Address	00:06:3d:07:67:f9
IP Address	10.10.10.142
Connected Time	585
Avg Rssi	-57
Avg Lqi	5

Figure 3-60. ISM 900 (NX) S&F AP Information

- **Ap Address -** MAC address of access point this device is linked to
- **Ip Address** - IP address of access point this device is linked to.
- **Connected Time -** Time elapsed in seconds since link established. Roll over after 4294967295 seconds
- **Avg Rssi** - Average received signal strength index in dBm and ignores the "quality" or "correctness" of the signal - Refer to Table 3-10. Modulation and Bandwidth Combinations for modem related RSSI information.
- **Avg Lqi** - Average Link Quality Index - This is a unit-less metric representing the quality of the latest signal decoded by the transceiver. Refer to *Important Notes and Information Regarding LQI*

MAC Statistics

Mac Stats

Tx Success	12881
Tx Fail	0
Tx Queue Full	0
Tx No Sync	1
Tx No Assoc	0
Tx Error	0
Tx Retry	0
Rx Success	12799
Sync Check Error	1
Sync Change	16

Figure 3-61. ISM 900 (NX) MAC Statistics

- **Tx Success** - Successful transmissions.
- **Tx Fail -** Failed transmissions, TTL expired or retry count exceeded.
- **Tx Queue Full -** Failed transmissions, MAC queue full.
- **Tx No Sync** - Number of packets dropped because the MAC is not synchronized
- **Tx No Assoc -** Packets dropped because the MAC is not associated
- **Tx Error** - Packets dropped for other reasons. Currently unused.
- **Tx Retry** - Re-transmission count due to previously unsuccessful transmission.
- **Rx Success** - Valid packet received.

- **Sync Check Error** - Lost synchronization.
- **Sync Change** - Synchronization changed or forced drop.

Connections Status

In AP mode the “Connected Remotes” and “Endpoints” information will be displayed in addition to the Active Channel.

NOTE Clicking on the mac address in either connected remotes or endpoints will bring up more stats.

Connected Remotes

Search

Address	IP Address	Time to Live	Link Status	Nic ID	Avg Rssi	Avg Lqi
00:06:3d:07:3e:3a	10.10.10.143	158	associated	1	-71	9

Showing 1 to 1 of 1

Endpoints

Search

Address	IP Address	Time to Live	Remote Address	Device Stats - Tx Packets	Device Stats - Tx Bytes	Device Stats - Rx Packets

Table is empty

Active Channels

Search

Channel	Frequency	Avg Rssi	Avg Lqi
42	915.615000	-128	255
45	916.537500	-128	255
48	917.460000	-128	255
51	918.382500	-71	6
54	919.305000	-128	255
57	920.227500	-128	255
60	921.150000	-71	12
63	922.072500	-128	255
66	922.995000	-128	255
69	923.917500	-128	255

Showing 1 to 10 of 13

|← ← 1 2 → →|

Figure 3-62. ISM 900 (NX) Connection Status

CLI Configuration Examples

AP Mode

On the next page, the example will display how to configure the NX915 module as an access point with the network name of ‘MyNetwork’ and default settings.

% set interfaces interface NxRadio **nx-config device-mode access-point network-name** MyNetwork

% show interfaces interface NxRadio **nx-config | details**

modem-mode	**500kbps;**
device-mode	**access-point;**
network-name	**MyNetwork;**
data-compression	**none;**
header compression	**false;**

```
power                     30;
dwell-time                50;
beacon-interval           150;
hop-set                   a;

security {
   security-mode          none;
   encryption             none;
}
advanced-config {
   lna-state              high-sensitivity;
   stale-packet-timeout   1500;
   propagation-delay      40miles;
   mcast-repeat           3;
   data-retries           3;
   fragment-threshold     0;
   remote-age-time        600;
   endpoint-age-time      300;
   allow-retransmit       true;
   arp-cache              false;
   adr-mode               none;
   adr-threshold          -70;
   encryption-protocol    2.0;
}
```

Security configuration

The default security mode, as shown above, is none.

The following configures the NX915 module to use data compression, pre-shared key authentication with the passphrase 'mypassphrase' and aes128-ccm encryption.

```
% set interfaces interface NxRadio nx-config data-compression lzo security encryption
   aes128-ccm security-mode psk passphrase mypassphrase
% show interfaces interface NxRadio nx-config | details
modem-mode                500kbps;
device-mode               access-point;
network-name              MyNetwork;
data-compression          lzo;
header compression        false;
power                     30;
dwell-time                50;
beacon-interval           150;
hop-set                   a;
security {
   security-mode          psk;
   encryption             aes128-ccm;
   passphrase             mypassphrase;
}
advanced-config {
   lna-state              high-sensitivity;
   stale-packet-timeout   1500;
   propagation-delay      40miles;
   mcast-repeat           3;
   data-retries           3;
```

```
    fragment-threshold          0;
    remote-age-time             600;
    endpoint-age-time           300;
    allow-retransmit            true;
    arp-cache                   false;
    adr-mode                    none;
    adr-threshold               -70;
    encryption-protocol         2.0;
}
```

The following configures the NX915 module to use data compression, EAP authentication and aes128-ccm encryption. The radius server used by the EAP authentication is selected from a list of configured Radius servers.

```
% set interfaces interface NxRadio nx-config data-compression lzo security encryption
  aes128-ccm security-mode eap radius-server RADIUS_SERVER
% show interfaces interface NxRadio nx-config | details
modem-mode                      500kbps;
device-mode                     access-point;
network-name                    MyNetwork;
data-compression                lzo;
header compression              false;
power                           30;
dwell-time                      50;
beacon-interval                 150;
hop-set                         a;
security {
    security-mode               eap;
    encryption                  aes128-ccm;
    radius-server               RADIUS_SERVER;
}
advanced-config {
    lna-state                   high-sensitivity;
    stale-packet-timeout        1500;
    propagation-delay           40miles;
    mcast-repeat                3;
    data-retries                3;
    fragment-threshold          0;
    remote-age-time             600;
    endpoint-age-time           300;
    allow-retransmit            true;
    arp-cache                   false;
    adr-mode                    none;
    adr-threshold               -70;
    encryption-protocol         2.0;
}
```

Other configuration

The following will configure the NX915 module to operate at 20 dBm on hop-set b, with a beacon interval of 25 ms and a dwell time of 75 ms. It also setups several advanced configuration parameters to move the propagation delay to 60 miles, disabled the data retries and multicast/broadcast repeats. It configures the LNA to operate in a high immunity mode, fragments data frames to 50 bytes, set a stale packet timeout to 1250 ms and avoids operating in the band from 915 to 920 MHz.

```
% set interfaces interface NxRadio nx-config power 20 hop-set b beacon-interval 25 dwell-
  time 75 advanced-config propagation-delay 60miles data-retries 0 mcast-repeat 0 lna-state
  high-immunity fragment-threshold 50 stale-packet-timeout 1250 avoided-frequencies 915-
  920
% show interfaces interface NxRadio nx-config | details
  modem-mode               500kbps;
  device-mode              access-point;
  network-name             MyNetwork;
  data-compression         lzo;
  header compression       false;
  power                                20;
  dwell-time               75;
  beacon-interval          25;
  hop-set                              b;
 security {
       security-mode       psk;
       encryption          aes128-ccm;
       passphrase          mypassphrase;
 }
 advanced-config {
   lna-state               high-immunity;
   avoided-frequencies     [ 915-920 ];
   stale-packet-timeout    1250;
   propagation-delay       60miles;
   mcast-repeat            0;
   data-retries            0;
   fragment-threshold      50;
   remote-age-time         600;
   endpoint-age-time       300;
   allow-retransmit        true;
   arp-cache               false;
   adr-mode                none;
   adr-threshold           -70;
   encryption-protocol     2.0;
}
```

Remote Mode

The following will configure the NX915 module as a Remote with the network name of 'MyNetwork' and default settings.

```
% set interfaces interface NxRadio nx-config device-mode remote network-name MyNetwork
% show interfaces interface NxRadio nx-config | details
modem-mode                 500kbps;
device-mode                remote;
network-name               MyNetwork;
data-compression           none;
header-compression         false;
power                      30;
security {
   security-mode           none;
   encryption              none;
}
advanced-config {
```

```
   lna-state                  high-sensitivity;
   stale-packet-timeout       1500;
   data-retries               3;
   nic-id                     0;
   gateway-id                 0;
  arp-cache                   false;
  adr-mode                    none;
  adr-threshold               -70;
  encryption-protocol         2.0;
}
```

Security Configuration

The default security mode, as shown above, is none. The following configures the NX915 module to use data compression, pre-shared key authentication with the passphrase "mypassphrase" and aes128-ccm encryption.

% set interfaces interface NxRadio **nx-config data-compression** lzo **security encryption** aes128-ccm **security-mode psk passphrase** mypassphrase

% show interfaces interface NxRadio **nx-config | details**

```
modem-mode                    500kbps;
device-mode                   remote;
network-name                  MyNetwork;
data-compression              lzo;
header-compression            false;
power                         30;
security {
    security-mode             psk;
    encryption                aes128-ccm;
    passphrase                mypassphrase;
}
advanced-config {
   lna-state                  high-sensitivity;
   stale-packet-timeout       1500;
   data-retries               3;
   nic-id                     0;
   gateway-id                 0;
  arp-cache                   false;
  adr-mode                    none;
  adr-threshold               -70;
  encryption-protocol         2.0;
}
```

The following configures the NX915 module to use data compression, EAP authentication and aes128-ccm encryption. The EAP mode currently supports only EAP-TLS. This requires configuring the appropriate PKI Certificates and Keys to use in the TLS authentication. This information is selected from the PKI configuration.

% set interfaces interface NxRadio **nx-config data-compression** lzo **security encryption** aes128-ccm **security-mode** eap **eap-mode** eap-tls **pki ca-cert-id** CACert **key-id** DevicePrivKey **cert-id** DevicePubCert

% show interfaces interface NxRadio **nx-config | details**

```
modem-mode                    500kbps;
device-mode                   remote;
network-name                  MyNetwork;
```

```
data-compression          lzo;
header-compression        false;
power                     30;
security {
   security-mode          eap;
   encryption             aes128-ccm;
   eap-mode               eap-tls;
   pki {
      cert-id             DevicePubCert;
      key-id              DevicePrivKey;
      ca-cert-id          CACert;
   }
}
advanced-config {
  lna-state               high-sensitivity;
  stale-packet-timeout    1500;
  data-retries            3;
  nic-id                  0;
  gateway-id              0;
  arp-cache               false;
  adr-mode                none;
  adr-threshold           -70;
  encryption-protocol     2.0;
}
```

Other configuration

The advanced configuration on an NX915 module operating as a Remote, shares the same configuration for LNA stat, stale packets timeout and data retries as an Access Point. The NIC and Gateway Identifier are for use in manually configuring link paths a station will use in the network. The default value of 0 for the identifiers configured the module to automatically obtain a path in the network. This is particularly useful in a network that contains Store-and-Forward devices.

Store-and-Forward Mode

Basic configuration with defaults

The following will configure the NX915 module as a Store-and-Forward (SAF) device with the network name of "MyNetwork" and default settings.

```
% set interfaces interface NxRadio nx-config device-mode store-and-forward network-name
   MyNetwork
% show interfaces interface NxRadio nx-config | details
modem-mode                500kbps;
device-mode               store-and-forward;
network-name              MyNetwork;
data-compression          none;
header-compression        false;
power                     30;
security {
   security-mode          none;
   encryption             none;
}
advanced-config {
   lna-state              high-sensitivity;
   stale-packet-timeout   1500;
```

```
    propagation-delay            40miles;
    mcast-repeat                 3;
    data-retries                 3;
    fragment-threshold           0;
    remote-age-time              600;
    endpoint-age-time            300;
    allow-retransmit             true;
    arp-cache                    false;
    adr-mode                     none;
    adr-threshold                -70;
    encryption-protocol          2.0;
}
```

Security configuration

The default security mode, as shown above, is none. The configuration options are the same as an NX915 module operating in remote mode.

Other configuration

The advanced configuration on an NX915 module operating as a Store-and-Forward device, shares the same configuration as a Remote. The NIC and Gateway Identifier are for use in manually configuring link paths a station will use in the network. The default value of 0 for the identifiers configured the NIC module to automatically obtain a path in the network. Manually setting the NIC ID to a specific value, allows you to configure Remotes to use that value as their Gateway ID. Doing so will cause the Remote to only synchronize with this Store-and-Forward device to gain network access.

Monitoring

Ensure the CLI is in operational mode.

Access Point Mode

The following shows status with two remotes connected.

```
> show interfaces-state interface NxRadio nx-status | tab
    nx-status init-status complete
    nx-status current-device-mode access-point
    nx-status current-modem 500kbps
    nx-status alarms    ""
    nx-status serial-number 2652308
    nx-status firmware-revision 0.6.0
    nx-status hardware-id 14
    nx-status hardware-revision 3
    nx-status temperature 46
    nx-status mac-stats tx-success 5903
    nx-status mac-stats tx-fail 1
    nx-status mac-stats tx-queue-full 0
    nx-status mac-stats tx-no-sync 0
    nx-status mac-stats tx-no-assoc 0
    nx-status mac-stats tx-error 0
    nx-status mac-stats tx-retry 1253
nx-status mac-stats rx-success 6940
nx-status mac-stats sync-check-error 0
nx-status mac-stats sync-change 0
                    TIME
                    TO    LINK    NIC AVG  AVG  TX    TX    RX    RX    TX    RX    TX    RX
```

```
ADDRESS            IP ADDRESS     LIVE  STATUS      ID  RSSI  LQI  PACKETS  BYTES   PACKETS  BYTES    ERROR  DROP
-------------------------------------------------------------------------------------------------------------------------------------
00:06:3d:07:3e:3a  10.15.65.184   179   associated  1   -70   7    13       780     435      22933    0      0     0    0
00:06:3d:07:67:f9  10.15.65.182   179   associated  2   -69   9    1597     285716  2431     2444359  0      0     0    0
```

```
                          AVG
CHANNEL  FREQUENCY        RSSI  LQI
-------------------------------------------------------------
0        902.700000       -66   8
3        903.622500       -66   9
6        904.545000       -66   8
9        905.467500       -67   8
12       906.390000       -67   8
15       907.312500       -68   7
18       908.235000       -69   9
21       909.157500       -69   8
24       910.080000       -70   8
27       911.002500       -70   8
30       911.925000       -70   8
33       912.847500       -70   8
36       913.770000       -70   9
39       914.692500       -70   7
42       915.615000       -69   9
45       916.537500       -69   8
48       917.460000       -69   8
51       918.382500       -68   8
54       919.305000       -68   8
57       920.227500       -68   10
60       921.150000       -69   7
63       922.072500       -69   8
66       922.995000       -70   9
69       923.917500       -71   10
72       924.840000       -72   8
75       925.762500       -72   7
78       926.685000       -73   7
```

Remote and Store-and-Forward Mode

The following shows status when connected to a configured Access Point.

```
> show interfaces-state interface NxRadio nx-status
  nx-status link-status associated
  nx-status init-status complete
  nx-status current-device-mode remote
  nx-status current-modem 500kbps
  nx-status alarms    ""
  nx-status serial-number 2501772
  nx-status firmware-revision 0.6.0
  nx-status hardware-id 13
  nx-status hardware-revision 3
  nx-status temperature 49
  nx-status ap-info ap-address 00:06:3d:09:06:01
  nx-status ap-info ip-address 10.15.65.146
  nx-status ap-info connected-time 0
  nx-status ap-info avg-rssi -70
  nx-status ap-info avg-lqi 7
```

```
nx-status mac-stats tx-success 19083
nx-status mac-stats tx-fail 0
nx-status mac-stats tx-queue-full 0
nx-status mac-stats tx-no-sync 1
nx-status mac-stats tx-no-assoc 0
nx-status mac-stats tx-error 0
nx-status mac-stats tx-retry 4330
nx-status mac-stats rx-success 419096
nx-status mac-stats sync-check-error 5
nx-status mac-stats sync-change 21
                              AVG
CHANNEL   FREQUENCY           RSSI  LQI
------------------------------------------------------------------------
0         902.700000          -68   7
3         903.622500          -69   6
6         904.545000          -69   6
9         905.467500          -69   6
12        906.390000          -70   6
15        907.312500          -70   7
18        908.235000          -71   5
21        909.157500          -71   5
24        910.080000          -72   6
27        911.002500          -72   6
30        911.925000          -71   5
33        912.847500          -71   6
36        913.770000          -71   7
39        914.692500          -71   6
42        915.615000          -71   6
45        916.537500          -70   7
48        917.460000          -70   7
51        918.382500          -70   6
54        919.305000          -69   7
57        920.227500          -68   12
60        921.150000          -70   7
63        922.072500          -70   7
66        922.995000          -70   7
69        923.917500          -72   7
72        924.840000          -72   7
75        925.762500          -72   6
78        926.685000          -72   7
```

3.5.5 Licensed Narrowband (LN)

Understanding

Licensed Narrowband Modules are available in various global frequencies.

The term "LN" is used to denote *all* licensed narrowband modules within the Orbit family. Specific identification, such as "LN400," is used when necessary to reference band-specific hardware.

The LN NIC modules are reliable point-to-multipoint, wireless data transmission products. They are suitable to interface both Ethernet and Serial controllers such as PLCs, RTUs and SCADA systems. The modules provide robust long-distance communication in channel bandwidth sizes of 12.5KHz, 25KHz and 50KHz. The modules utilize direct digital modulation, a highly efficient PA, and a direct conversion receiver to provide dependable wireless communications.

LN modules support both a spectrally efficient QAM mode (default) and an FSK mode for backward compatibility with legacy MDS radios.

When operating in QAM modes an LN NIC can operate as an Access Point or Remote. Depending on bandwidth, raw data rates range from 20kbps to 240kbps, offering greater throughput then traditional FSK solutions. An advanced Media Access Control provides advanced interference avoidance, error detection, retransmission, auto repeat, and guaranteed collision free data. 10-Watts of peak power and dynamic FEC extend coverage to up to 50 miles.

When operating in FSK modes an LN NIC supports backward compatibility – i.e., functional substitution of an equivalent x710A/C/M or SD remote. The LN NIC provides operating modes for both transparent-serial and SD-compatible packet-with-mac modes.

For serial applications, all LN operating modes include a virtual serial port called "LnRadio-serial". Using the Pass-Through service (see section 3.5.1) "LnRadio-serial" can be connected to a physical COM port allowing serial data to pass over-the-air.

The specifications for the LN100 NIC module:

- Frequency Range(s): 135-156 MHz, 150-174 MHz
- FCC Part 90 (private land mobile radio services)
- FCC ID: E5MDS-LN100
- IC: 101D-LN100

The specifications for the LN200 NIC module:

- Frequency Range: 216-237 MHz
- FCC Part 90 (private land mobile radio services) and Parts 80, 95F
- FCC ID: E5MDS-LN200
- IC: 101D-LN200

The specifications for the LN400 NIC module:

- Frequency Range(s): 330-406 MHz, 406-470 MHz, 450-520 MHz
- FCC Part 90 (private land mobile radio services)
- FCC ID: E5MDS-LN400
- IC: 101D-LN400

The specifications for the LN700 NIC module:

- Frequency Range: 757-758 and 787-788 MHz
- FCC Part 27
- FCC ID: E5MDS-LN700

The specifications for the LN900 NIC module:

- Frequency Range(s): 800-870 MHz, 896-960 MHz
- FCC Part 90 (private land mobile radio services) & Part 101
- FCC ID: E5MDS-LN900 or E5MDS-LN900-1
- IC: 101D-LN900

The general specifications for all LN NIC modules are:

- Power Output: 20 dBm to 40 dBm peak power in 1.0 dBm steps (DEFAULT = 40 dBm)
- Output Impedance: 50 Ohms
- Antenna Connector: TNC female
- QAM Modulation Type: QPSK, 16QAM, 32QAM, 64QAM
- QAM FEC: Convolutional and Reed Solomon
- QAM Data Rates: 20kbps - 120kbps (or 240kbps depending on module)
- FSK Modulation Types (3FSK): 9600-3FSK, 9600M-3FSK, 19200-3FSK, 19200M-3FSK
- FSK Modulation Types (7FSK): 19200N-7FSK, 19200E-7FSK, 38400N-7FSK, 38400E-7FSK
- FSK Data Rates: 9.6kbps – 38.4kbps

NOTE To meet country specific regulatory requirements, parameter restrictions may be configured by the factory. These settings can NOT be changed or modified by the user. See the table below:

Table 3-16. Country-specific Limitations (Example)

Country	Limitation
USA	Prohibit LN400 25KHz operation using 20ksps (from 406 MHz - 450 MHz; 450 MHz – 470 MHz is allowed)

Minimal configuration is necessary, but several advanced tuning facilities are provided.

Radio Mode is a key configuration parameter because it defines the operating characteristics of the radio.

- **Radio Mode**
  - **standard** - Orbit native mode supporting QAM operation
  - **store-and-forward** - variation of Orbit native mode supporting Store-and-Forward
  - **transparent-serial** – FSK mode supporting x710 backward compatibility
  - **packet-with-mac** – FSK mode supporting SD backward compatibility
  - **advanced** – Newest evolution of QAM operation providing highest performance
  - **advanced-polling** – Newest evolution of QAM operation for use in large scale, primarily polled networks

NOTE For standard QAM operation. the only required steps for basic configuration are: Program transmit and receive frequencies per user licensing; program a network name in all units; establish one unit as the AP

NOTE LN radios are shipped from the factory without set frequencies. The LN radio module will not power on until you enter a valid TX and RX frequency.

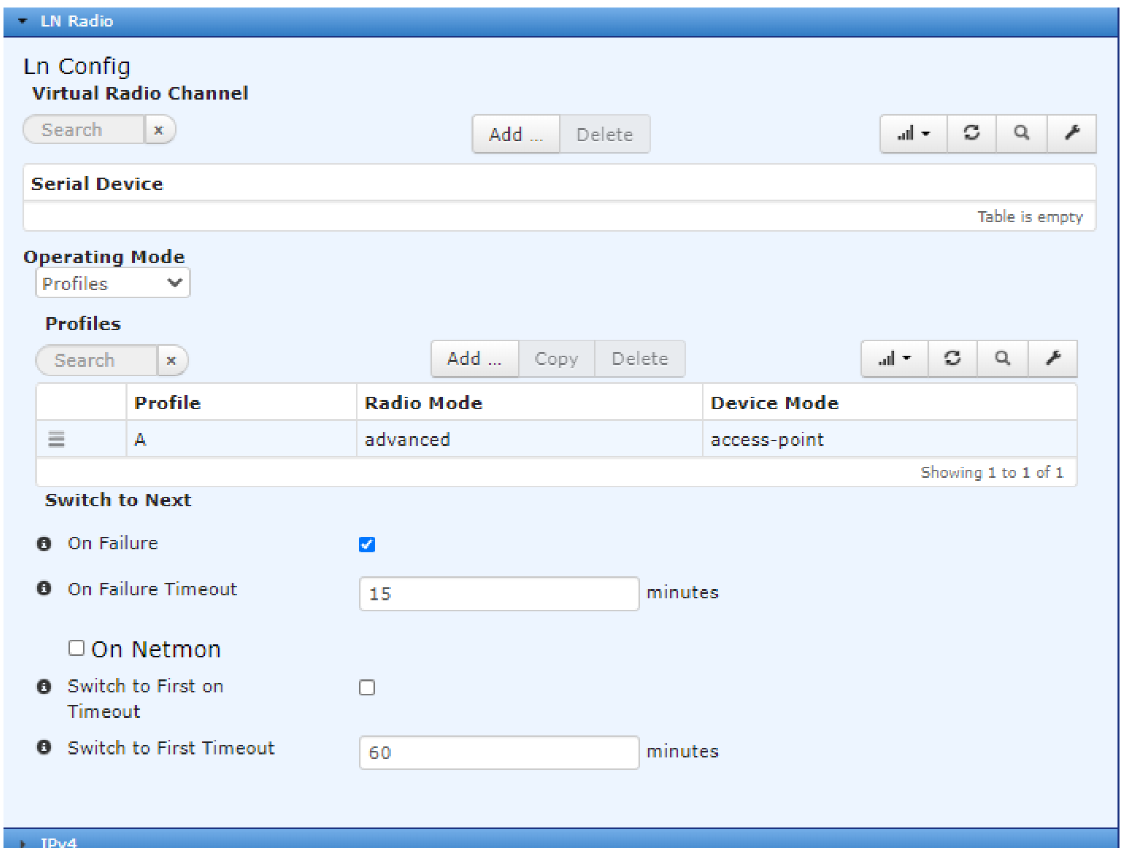
Understanding LN Profiles

LN profiles allow multiple radio configurations to be stored and automatically accessible in a single device. Only one profile is active at a time. The LN starts with the first profile, then upon failover criteria it will automatically advance to the next profile and load a new set of radio configuration choices.

For example, an Orbit unit could be provisioned to search among of set of multiple base stations each using a different frequency channel plan. When deployed the Orbit will cycle through the set profiles until it finds the first base that it can connect to.

As another example, if new radio settings are to be pushed to the network, then the new settings can be added to a different profile in all the remotes before the AP is switched over. This provides a safety net for the whole network to easily be brought back to its former state if there is an error with the new configuration.

Upon changing the *Operating Mode* to Profiles, previous configuration will be removed and a table will be displayed that can be configured with multiple profiles. Selecting a row of a profile will open a section below the table that will allow the user to configure all of the radio parameters (both basic and advanced).

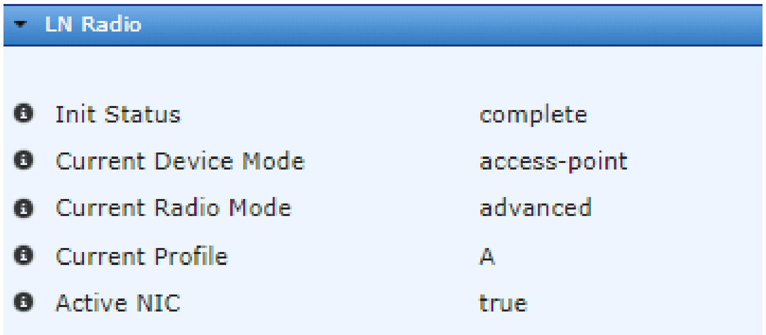


Once profiles are configured, Switch to Next settings can be configured to control how the system advances to the next profile. The *On Failure* check box will cause the profile to advance whenever the radio fails to connect to another for the configured time.

If *On Netmon* is selected, the profile will advance based on any configured Netmon trigger.

Profiles behave as a prioritized, ordered list. After successfully connecting on a given profile the radio will maintain that profile, unless connectivity is lost or unless *Switch to First on Timeout* is selected. If *Switch to First on Timeout* is selected the radio will to go back to the first profile after the specified *Switch to First Timeout* duration elapses.

The current active profile can be viewed in the status tab of the web page, or in the CLI under ln-status.



3.5.5.1 *QAM Operating Concepts*

Table 3-17. LNxxx Interface LED Descriptions, QAM operation

LED - NIC2	State	Description
LnRadio Interface	Off	Interface disabled
Access Point Mode	Blink Red Solid Red Solid Green	NIC Initialization No Remotes connected Linked with at least 1 Remote
Remote Mode	Blink Red Solid Green	NIC Initialization / Not linked to an Access Point Linked with Access Point

Multiple QAM modulation rate / bandwidth combinations are provided below. Some options may be restricted due to regulatory controls or hardware type .

Table 3-18. QAM Modulation and Bandwidth for LN radios

RF Channel Bandwidth	Modem Symbol Rate	QPSK (x2) OTA rate	16QAM (x4) OTA rate	*32QAM (x5) OTA rate	64QAM (x6) OTA rate
12.5 KHz	10000 sps	20000 bps	40000 bps	50000 bps	60000 bps
25.0KHz	16000 sps	32000 bps	64000 bps	80000 bps	96000 bps
25.0KHz	20000 sps	40000 bps	80000 bps	100000 bps	120000 bps
50.0KHz	40000 sps	80000 bps	160000 bps	200000 bps	240000 bps

NOTE *32QAM is only available in Advanced and Advanced-polling Radio Modes

Important Notes and Information Regarding EVM

For QAM, EVM (error vector magnitude) provides a relative measurement of the link quality. Acceptable EVM is dependent on the modulation format. A low EVM value indicates a better link quality than a high value. Algorithmically, using QAM modulation, the transceiver calculates the value by measuring the sample points of each "bit" and comparing it with the expected constellation based on the modem type.

- EVM is a metric of the quality of the received signal. It is a dynamic value that is computed only when data is received on the RF interface and should be refreshed accordingly.
- Unlike RSSI which simply measures signal strength, EVM is a measurement of the "correctness" of this signal. (This means how easily the received signal can be correctly demodulated.)
- In general, the lower the EVM the better the quality. A strong link will typically show an EVM below 5.
- See the chart below for general guidance

EVM	QPSK	16QAM	32QAM	64QAM
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
> 10				

Excellent
Usable
Poor

Adaptive Modulation

The adaptive modulation mode (modulation automatic) allows directed traffic to adjust which modem is used on a per-transmission basis. Adaptive modulation works in both upstream and downstream directions. Modem selection varies between QPSK, 16QAM, and 64QAM. A signal metric score is used to decide which modem selection to use. The score is determined based on signal strength and packets received. Advanced configuration can be used to provide some control over the adaptive modulation thresholds.

The primary use case for this feature is if an AP has some remotes that are close to the AP and could support a higher data rate and some farther away (or obstructed) that can only support a lower data rate. This mode allows the close remotes to take advantage of the higher data rate for the directed messages, when otherwise the whole network would have had to be run at the lower data rate. Note that broadcast or multicast data must always be transmitted at the lowest rate.

We recommend keeping adaptive modulation set for most installations.

Security

Setting the security mode to EAP or PSK will enable device authentication. When enabled, the remotes will authenticate with the AP (PSK) or a backend RADIUS server (EAP) before they are allowed to pass data on the network. The authentication protocol is compliant with IEEE 802.1X. If device authentication is enabled, over the air data encryption can also be enabled. This ensures all over the air traffic is protected. When encryption is enabled, the device must occasionally rotate the encryption keys. This rotation is logged in the event log with event type nx_auth. These events can be suppressed in the event log configuration to prevent them from filling the event log. See section 3.6.2 for instruction on controlling the event log.

Simplified Serial Operation in QAM modes

The MDS Orbit is inherently an Ethernet based router. IP messages typically route through the system over-the-air which adds significant overhead compared to traditional serial polling. To address this Orbit LN offers a short-cut to allow serial data to be sent over-the-air directly without requiring conversion to IP.

In QAM operation, a Virtual Radio Channel (VRC) can be added to create a virtual serial port. Virtual serial ports can then be linked to “Terminal Server” or “Pass-Through” facilities.

- The Pass-Through facility can link a physical COM port (e.g., COM1 or COM2) to the VRC. Setting this up at the AP and corresponding remotes behaves much like a multicast UDP network without the configuration complexity or channel overhead associated with conversion to and from IP.
- The Terminal Server facility is typically used to convert IP data that has been received over-the-air, into serial data at a remote. By using VRCs it is also possible convert data from an ethernet host into a serial stream before sending it over the air. (This feature was commonly referred to as IP/Payload in the legacy MDS SD radio). In this scenario, in addition to being more efficient, the remote ends need only configure a Pass-Through instance to a serial port instead of requiring a terminal server configuration at each site.

A quick guide to configuration for Serial Operation is presented in the table below:

Table 3-19. Guide to Serial Operation

Desired Operation	Configuration Summary
Accept serial at the AP, send serial through the system, and deliver serial at the remote	At the AP: 1)Create a Virtual Radio Channel vrcX which automatically creates vrcX-serial 2)Setup pass-through instance with vrcx-serial port and desired AP COM port At the Remote: 3)Create a Virtual Radio Channel vrcR which automatically creates vrcR-serial 4)Setup pass-through instance with vrcR-serial port and desired remote COM port
Accept ethernet at the AP, convert to serial over-the-air (a.k.a. “IP/Payload”), and deliver serial at the remote	At the AP: 1)Create a Virtual Radio Channel vrcX which automatically creates vrcX-serial 2)Setup terminal server with vrcx-serial port and desired TCP/UDP port At the Remote: 3)Create a Virtual Radio Channel vrcR which automatically creates vrcR serial 4)Setup pass-through instance with vrcR serial port and desired remote COM port
Accept ethernet at the AP, preserve IP addressing over-the-air, and convert to serial at the remote	No need to use a Virtual Radio Channel. At the AP: 1)No special setup required At the Remote: 2)Setup terminal server directly to map an IP address and port, to a desired remote COM port

NOTE All Orbit LN radio operating modes automatically present a virtual serial port called "LnRadio-serial". For simple applications, this port can be substituted in any of the examples above *without* the need to create a VRC.

3.5.5.2 FSK Operating Concepts

Table 3-20. LNxxx Interface LED Descriptions, FSK operation

LED - NIC2	State	Description
LnRadio Interface	Off	Interface disabled
transparent-serial mode	Blink Red	NIC Initialization
packet-with-mac mode	Solid Red	No Payload received for 10 seconds (or AP not heard for 10 seconds in packet-with-mac mode)
	Solid Green	Payload data is periodically being received
	Blink Green	Payload data actively being received.

Multiple FSK modulation rate / bandwidth combinations are provided as shown here.

Table 3-21. FSK Modulation and Bandwidth for LN radios

RF Channel Bandwidth	Modulation Selection	Corresponding X710 / SD Modem Selection	Modulation OTA rate
12.5 KHz	9600-3FSK	MODEM 9600	9600 bps
12.5 KHz	9600M-3FSK	MODEM 9600M	9600 bps
12.5 KHz	19200N-7FSK	MODEM 19200N	19200bps
12.5 KHz	19200E-7FSK	MODEM 19200E	19200bps
25.0KHz	19200-3FSK	MODEM 19200	19200bps
25.0KHz	B-3FSK	MODEM 19200M	19200bps
25.0KHz	38400N-7FSK	MODEM 38400N	38400bps
25.0KHz	38400E-7FSK	MODEM 38400E	38400bps

Understanding Backward Compatibility

Orbit LN backward compatibility is designed to support functional substitution of an equivalent x710A/C/M or SD remote radio. The LN NIC provides operating modes for X710-compatible *transparent-serial* and SD-compatible *packet-with-mac* modes.

The MDS Orbit is inherently an Ethernet based router. Most NIC interfaces within the Orbit operate by sending packetized data over-the-air. In *packet-with-mac* mode, Ethernet data is transported over the air, in legacy SD radio packet format which can be directly translated to native Orbit functionality.

For serial operation, Orbit offers "Terminal Server" and "Pass-Through" services. The Terminal Server facility provides translation between serial port data and IP packets. The Pass-Through facility provides a way to create a virtual pipe to pass serial data, byte-by-byte, from one port to another.

In *transparent-serial* and *packet-with-mac* modes, serial data is sent over-the-air directly without requiring conversion to IP. Orbit provides a means to capture this data and present it as a virtual serial port. This allows it to be treated like any other type of serial port, thereby offering the full suite of Orbit serial services. This means that data can be presented directly to a COM port (serial streaming, byte-by-byte) or it can be routed through a terminal server to function like SD's IP/payload feature.

A quick guide to required configuration for Legacy Operation is presented in the table below:

Table 3-22. Guide to Configuration for Legacy Operation

Desired Legacy Operation	Configuration Summary
Streaming Serial (byte by byte) in x710 or Transparent mode	1)Configure Orbit LN in transparent-serial mode 2)Setup pass-through instance with LnRadio-serial port and desired COM port
IP/Payload in x710 or Transparent mode	1)Configure Orbit LN in transparent-serial mode 2)Setup terminal server with LnRadio-serial port and desired TCP/UDP port
Serial Data in packet w/ MAC mode	1)Configure Orbit LN in packet-with-mode 2)Create a Virtual Radio Channel *vrcX* which automatically creates vrcX-serial 3)Setup pass-through instance with vrcx-serial port and desired COM port
IP/Payload in packet w/ MAC mode	1)Configure Orbit LN in packet-with-mode 2)Create a Virtual Radio Channel *vrcX* which automatically creates vrcX-serial 3)Setup terminal server with vrcx-serial port and desired TCP/UDP port
Ethernet Data	1)Configure Orbit LN in packet-with-mac mode

Backward Compatibility Limitations

Orbit LN backward compatibility provides powerful functionality to act as an x710A/C/M or SD remote, but it is important to be aware of system limitations. A summary list is provided below:

- Power output is limited to 37dbm.
- Operation is intended for use with a switched-carrier master
- No support for MDS Legacy "B" modems or analog operation
- No support for operation as AP (*i.e., in SD packet w/ MAC mode*)
- No support for streaming encryption in transparent serial mode
- Limited support for firmware upgrades (over-the-air support not provided)
- Limited support for over-the-air configuration and diagnostics (DLINK)
- Small Latency differences may introduce challenges and incompatibilities in some configurations particularly those involving repeaters

Legacy Remote Diagnostics (DLINK)

Limited support is provided for operation with legacy networks and products that use DLINK for over-the-air system management. Examples include PulseNET, Field Network Manager, and Insite.

NOTE The network management tool is expected to be directly connected to a legacy X790, X710, SD, or MPRS. The Orbit LN will respond to over-the-air DLINK messages. The Orbit LN does not support direct connection of a DLINK-enabled network management tool.

The intent of DLINK support in these configurations is not full emulation of an X710 but rather to provide a convenient means to manage Orbit LN in backward compatible mode using the same tools used to manage x710 (or SD).

NOTE In FIPS mode, DLINK messages are blocked.

When using network management software, the Orbit LN interface will appear "spoofed" as an x710 unit. Many values used to manage an x710 radio do not have an equivalent attribute on the Orbit. In these cases, the LN radio will return a fixed-constant (typically 0) or if applicable a derived-value intended to approximate an x710 result (e.g. SNR). Also, when appropriate some X710 responses have been modified to return information significant to Orbit. For example, if any Orbit alarm is active the X710 alarm field will return a fixed value of 0x00001000.

DLINK unit address is set by default but can be configured as shown ***Interfaces / LnRadio / Advanced Config***, below.

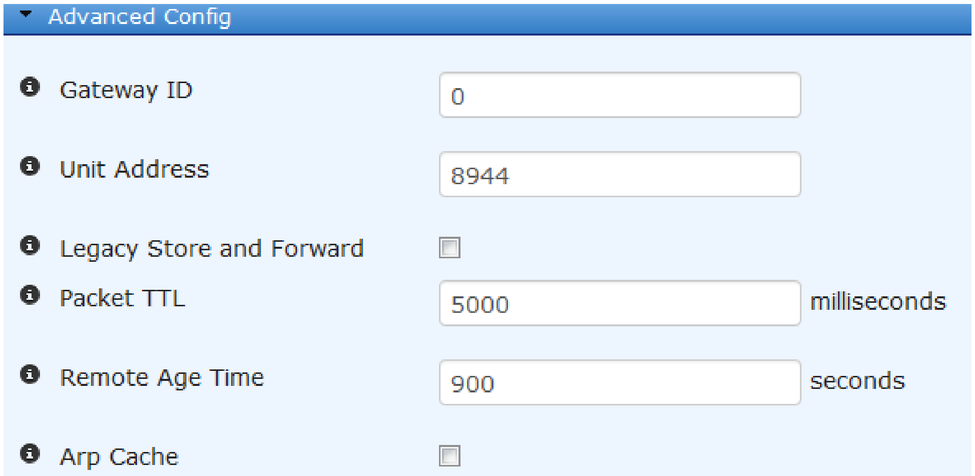


Figure 3-63. Advanced Config menu

- **Unit Address** – Legacy DLINK unit address. Valid values are:
  - The last 4 digits of the Orbit device serial number (DEFAULT)
  - 10000-65000

NOTE CAUTION: Do not set values below 10000 other than the default. This may cause remote configuration and management operations to fail.

Important Notes and Information Regarding EVM / Error Magnitude

For FSK, EVM (error vector magnitude) is really just "error magnitude". It provides a relative measurement of the link quality. A low error magnitude value indicates a better link quality than a high value. Algorithmically, the transceiver calculates the value by measuring the sample points of each "bit" and comparing it with the expected eye diagram of the FSK modem.

- Error Magnitude is a metric of the quality of the received signal. It is a dynamic value that is computed only when data is received on the RF interface and should be refreshed accordingly.
- Unlike RSSI which simply measures signal strength, Error Magnitude is a measurement of the "correctness" of this signal. (This means how easily the received signal can be correctly demodulated.)
- In general, the lower the value the better the quality. A strong link will typically show an error magnitude below 5.

3.5.5.3 QAM Mode Configuration

By default, an Orbit with an LN radio ships from the factory with a 12.5KHz bandwidth, radio mode standard (QAM), with a 10k-symbol/sec data rate. Modem operation is configured for Adaptive Modulation with FEC off. Transmit and Receive frequencies are unprogrammed and left to field installation personnel to prevent inadvertent operation on the wrong channel.

For the advanced user, the module supports configuring more items including:

- **Data Retries** - Number of times to retry unicast data before declaring NACK.

- **Power** – RF output power control.
- **ARP Cache** – Feature that limits over-the-air ARP traffic
- **Data** and **Header Compression** – facilities to use LZO data compression for payload and robust header compression to reduce packet overhead
- **FEC** – facility to selectively enable Forward Error Correction trading off speed and robustness
- **Allow Retransmit** – facility to enable peer-to-peer traffic

In general, it is recommended that users start with the simplest configuration and then make parameter changes as necessary to meet specific needs.

Configuring

Basic configuration with defaults

Navigate to: ***Interfaces / LnRadio ---> Basic Config / LN Radio***

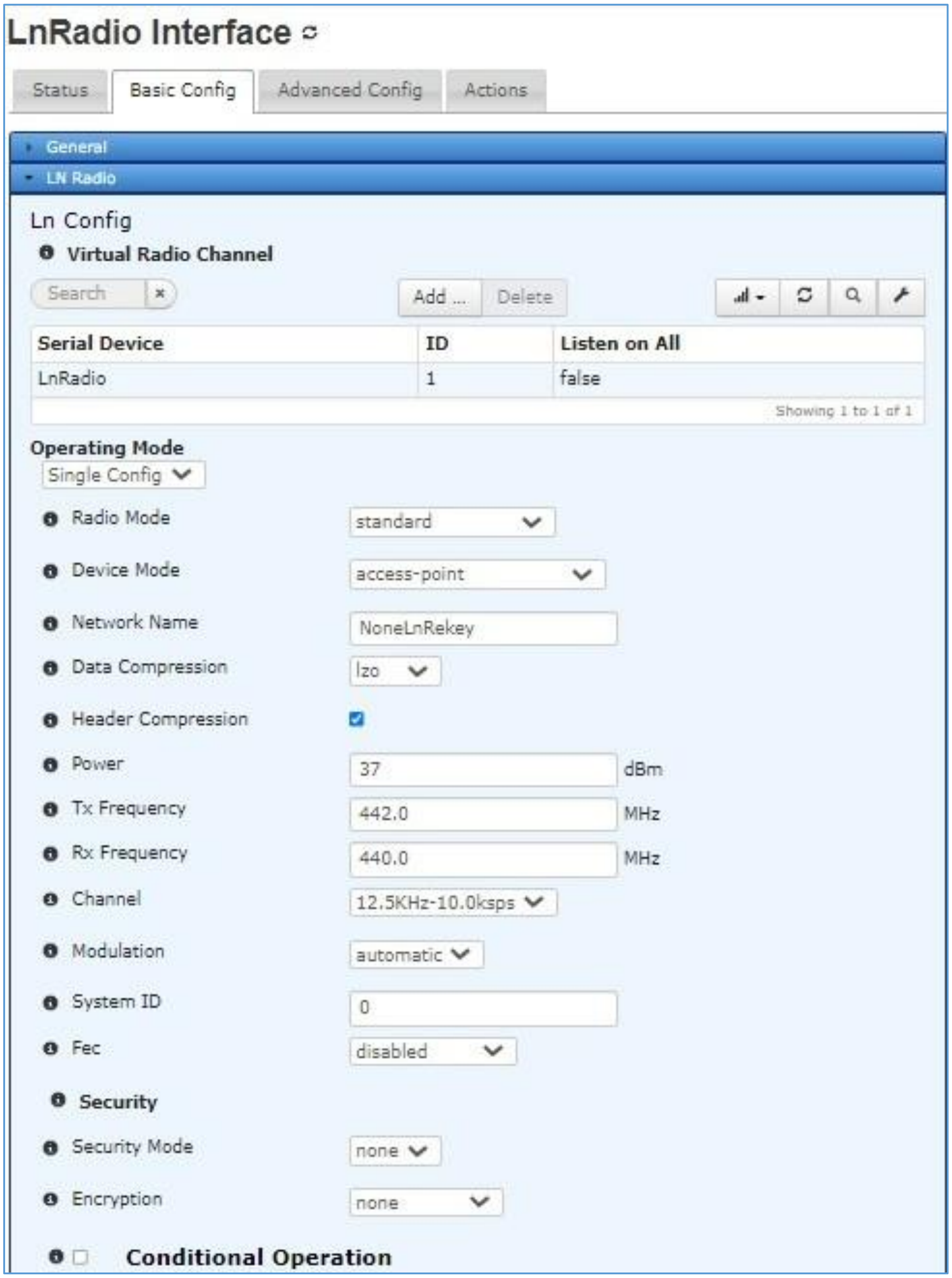


Figure 3-64. Licensed Narrowband (LN) Configuration Settings

- **VRC –** Select "Add…" to define a new Virtual Radio Channel. (See Simplified Serial Operation in QAM modes

- **Device Mode** - Sets the role the radio will assume in the network.
  - **remote** (DEFAULT)
  - **access-point**
- **Network Name** - The name of the network. Used to control what networks the radio connects to. Valid values: 1 to 31 letters (DEFAULT is *mds_ln*). The network name string is used to identify the logical network that the device should join. If the network name does not match, the device will log an event to identify network name collisions.
  - **Data Compression** – Over the air compression
    - **lzo -** Compresses the over the air traffic with the LZO algorithm (DEFAULT)
    - **none** - No data compression
- **Header Compression –** Enabled by DEFAULT. Enable/disable over the air robust header compression. This feature compresses IP headers to improve system performance and is most useful in applications that rely on IP packets with small payloads, such as terminal server operations or MODBUS polling. This setting must match on each radio (Remote and AP).

NOTE Header Compression and packet concatenation should be disabled when using links with marginal RF performance, due to higher probability of packet errors.

- **Power** - The transmit power of the radio: Valid values: 20 - 40 dBm – DEFAULT is 40dBm
- **TX Frequency** – The frequency at which the radio transmits. DEFAULT is none.
- **RX Frequency** – The frequency at which the radio receives. DEFAULT is none.
- **Channel** - Controls the channel bandwidth and symbol rate of the radio.
  - **6.25 kHz-4.8 ksps** - Channel width 6.25 kHz, symbol rate of 4.8 ksps
  - **12.5 kHz-9.6 ksps -** Channel width 12.5 kHz, symbol rate of 9.6 kbps (DEFAULT)
  - **12.5 kHz-10 ksps -** Channel width 12.5 kHz, symbol rate of 10 kbps
  - **25 kHz-16 ksps** - Channel width 25 kHz, symbol rate of 16 kbps
  - **25 kHz-20 ksps** - Channel width 25 kHz, symbol rate of 20 kbps
  - **50 kHz-40 ksps** - Channel width 50 kHz, symbol rate of 40 kbps
- **Modulation –** Sets the radio's modulation. You may select automatic (adaptive modulation) or choose from three fixed modulations.
  - **Adaptive** modulation (DEFAULT)
  - **QPSK**
  - **16QAM**
  - **64QAM**

  Automatic modulation adaptively selects which modem (QPSK, 16QAM, or 64QAM) is used on a per-transmission basis. This is useful in networks with some remotes close to the Access Point, and others farther away or obstructed. This mode allows the close remotes to take advantage of the higher data rate for the directed messages, while the remotes use a more conservative modulation.

  Radios with fixed modulation settings will operate only at the modulation that you specify. If the specified modulation is higher than the connection can support, no traffic will flow. If the connection can support a higher modulation than the selected modulation, the radio will not take advantage of this and will continue to use the fixed modulation. **We recommend that Adaptive Modulation be used in all cases other than bench tests.**

  Theoretical throughput is based on modulation and channel settings. Please refer to above.

- **System ID** – Sets the radio's system ID. System ID is a form of secondary addressing in the modulated signal that strengthens co-channel rejection from other MDS radios (i.e., devices operating on the same frequency in a frequency reuse deployment). Use "0" to set compatibility with older devices that did not support this option. The range of valid values depends on the radio modulation style. QAM, valid values: 0-5 – DEFAULT is 0.
- **FEC --** Forward Error Correction is useful in controlling errors in weak connections. FEC encodes data in a redundant fashion to allow data correction in a noisy or weak connection without the additional overhead of retransmission.
  - **Disabled** (DEFAULT). No Forward Error Correction will be used. This option provides the highest throughput and standard sensitivity and is suitable for strong connections.
  - **Low Gain** – Provides better sensitivity, while still offering good throughput.
  - **Adaptive** – Provides the best sensitivity and standard throughput. Adaptive on a per-packet basis.

NOTE It is critical to have FEC set identically on the AP and all Remotes.

Figure 3-65. Licensed Narrowband (LN) PSK Security Settings

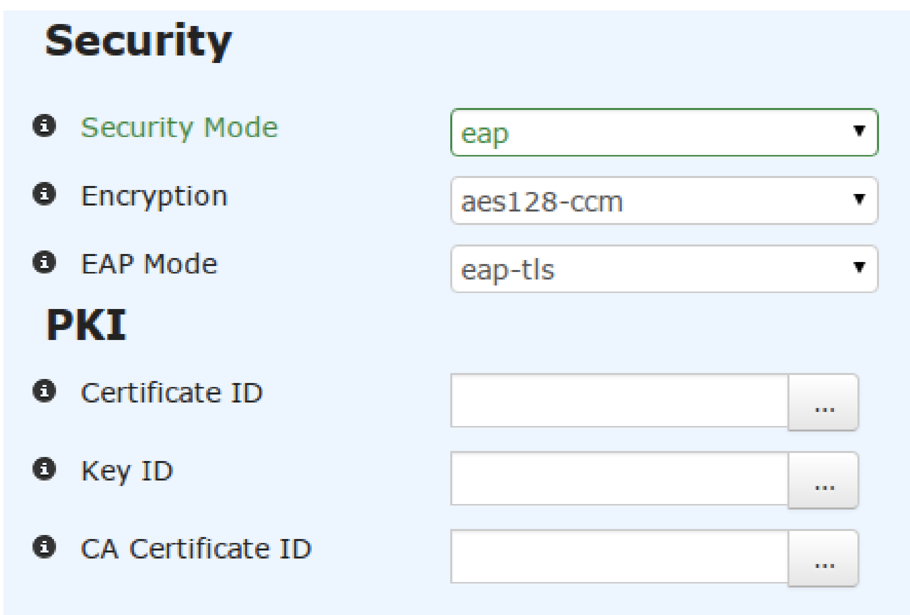


Figure 3-66. Licensed Narrowband (LN) EAP on remote Security Settings

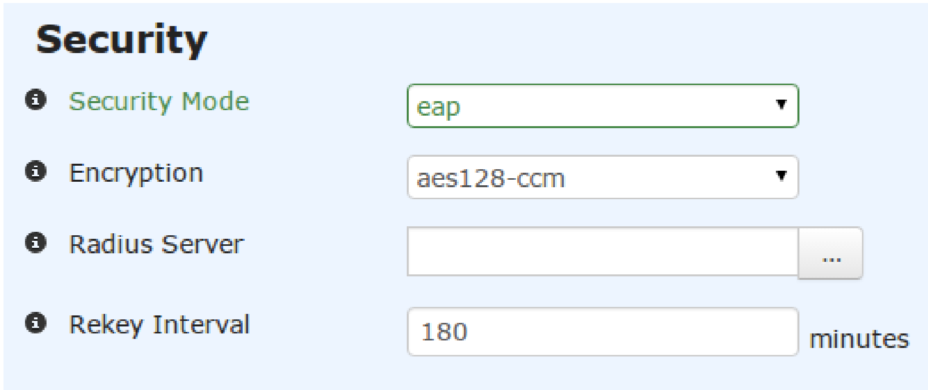


Figure 3-67. Licensed Narrowband (LN) EAP on an access point Security Settings

- **Security Mode** - The type of over the air authentication to perform
  - **none** - Provide no device authentication or data privacy (DEFAULT)
  - **psk** - Use pre-shared key authentication protocol
  - **eap** - Use Encapsulated Authentication Protocol - will change the fields displayed and give the user the ability to enter radius info on the AP and certificate info on the remote.
- **Encryption** - The type of over the air encryption to perform
  - **none** - No data privacy (DEFAULT)
  - **aes128-ccm** - Protect data with 128-bit AES encryption using CCM mode
  - **aes256-ccm** - Protect data with 256-bit AES encryption using CCM mode
- **Passphrase** - The key material used in PSK mode. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. (DEFAULT=blank)

NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **Certificate ID, Key ID, CA Certificate ID** ***(Remote EAP mode only)*** **–** Reference to the remotes certificate material loaded through the Certificate Management side menu (section 3.9).
- **Radius Server** ***(AP EAP mode only)*** – A reference to the RADIUS server configuration configured through the System – RADIUS side menu item (section 3.7.6).
- **Rekey Interval** ***(AP only)*** – The session key for an active secure link changes at a regular basis. You may increase the length of the rekey interval in order to reduce overhead caused by the rekeying communications between radios on a narrowband channel. Valid values:
  - 0 – Rekeying will not be time-based but will instead occur every one million packets.
  - 30-525600 minutes, DEFAULT 180.

NOTE Remember to click on the **Save** button when finished.

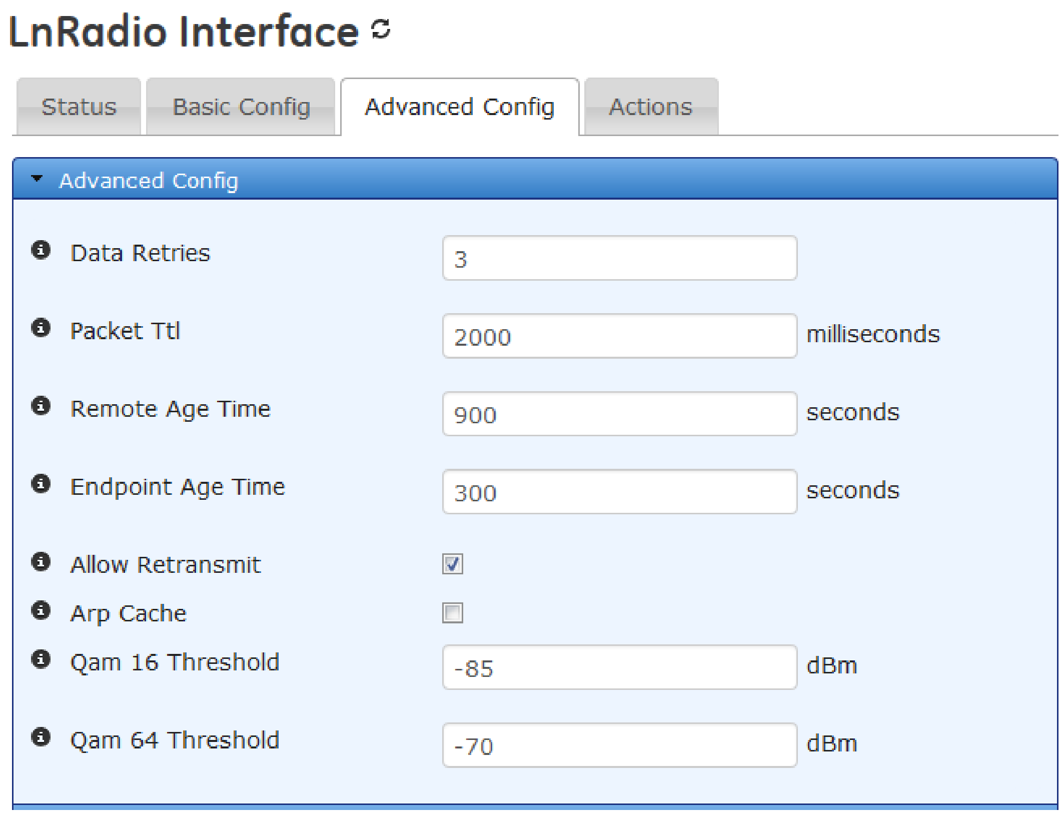


Figure 3-68. Licensed Narrowband AP Advanced Settings

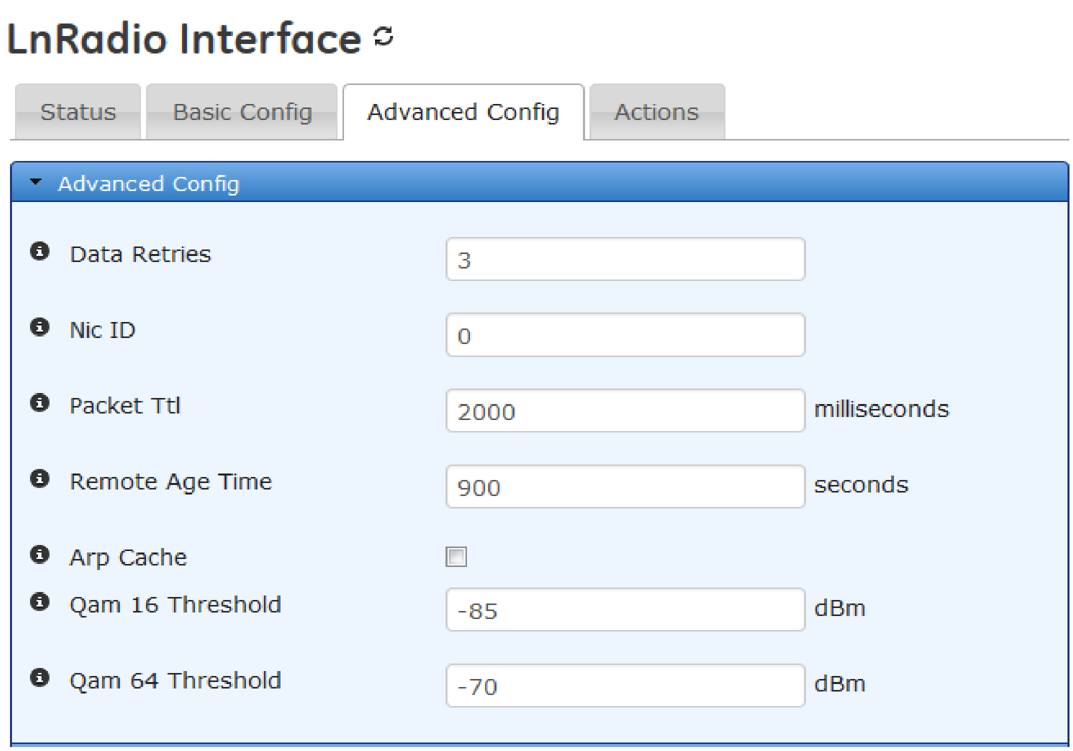


Figure 3-69 Licensed Narrowband (LN) Remote Advanced Settings

The Advanced Setting menu appears slightly different on APs than on Remotes.

- **Data Retries -** Number of times to retry unicast data before declaring failure. Valid values: 0—15, DEFAULT = 3.

- **Packet TTL (Time-to-Live)** – Length of time, in milliseconds, of inactivity of all over-the-air traffic before registering a disconnection. The radio will then attempt to reconnect to the network. Valid values: 100 to 65535 ms, DEFAULT = 2000 (2 seconds).
- **Remote Age Time** – Length of time, in seconds, of inactivity of a remote before it is disconnected. Valid values: 180-4294967295 seconds, DEFAULT = 600 (10 minutes).
- **Endpoint Age Time *(AP only)*** - Length of time in seconds of inactivity on an endpoint before it is removed from the endpoint database. Range of 0 to 4294967295 seconds. DEFAULT = 300 (5 minutes).
- **Allow Retransmit *(AP only)*** – All traffic from the remotes is sent to the AP. When enabled the AP will retransmit traffic from one remote to another based on the MAC address. It will also resend any remotes broadcast traffic to all other remotes. Disabled by DEFAULT.
- **NIC ID *(Remote only)* – ADVANCED SETTING - DO NOT CHANGE** - Manually overrides the NIC identifier.
- **ARP Cache** – Enabled by DEFAULT. When enabled, the radio will respond to ARP requests intended for other network devices with known addresses. It will not forward the ARP to the intended device. This is similar to ARP proxy. See APPENDIX L – Understanding ARP Cache
- **QAM 16 Threshold** – When the radio is using automatic modulation, it will automatically switch to QAM 16 modulation when the averaged calculated RSSI value drops below this value. Valid values: -100 to 0 dBm, DEFAULT = -85 dBm. If you set the value to 0, this modulation is disabled.
- **QAM 64 Threshold** – When the radio is using automatic modulation, it will automatically switch to QAM 64 modulation when the averaged calculated RSSI value drops below this value. Valid values: -90 to 0 dBm, DEFAULT = -70 dBm. If you set the value to 0, this modulation is disabled.

3.5.5.3.1 Store and Forward Radio Mode

Store and forward radio mode is an extension to Standard mode that adds Store and Forward (SAF) support. In this mode a new Device mode ‘store-and-forward’ is available that enables range extension for the radio network.

- **Device-Mode** - Sets the role the radio will assume in the network.
  - Remote (DEFAULT)
  - AP
  - Store-and-Forward

In this mode, remotes can connect to the network directly through the AP or via any SAF device. This provides an additional hop to the radio network. Multiple SAFs devices are supported in a network. However each new SAF device will require its own timeslot to provide access of any serviced remotes. As more SAFs are added overall network performance will decrease as more timeslots are required. Full bi-directional Adaptive Modulation is supported on both direct, and SAF links.

By default, in the event of multiple links being available (direct and SAF) remote devices will always favor the direct link. In certain scenarios however it may be desirable to force a remote to use a particular link, if link quality for example is better on the SAF link. This can be achieved through the use of Gateway-Id.

- **Gateway-Id** – Sets the routing behavior of a SAF network
  - 0 – Automatic, use AP if available otherwise use any SAF
  - 240..254 – Static Gateway Id. Only connect to the network via SAF matching this NIC Gateway Id

When using Gateway-Id you assign a SAF NIC a specific Gateway Id in the range of 240-254. Each SAF Gateway-Id should be unique, do not have multiple SAFs using the same Gateway-Id. Then for specific remote(s), you would set the Gateway-Id to the SAF Gateway you wish for it to connect through.

NOTE On Remote devices once a Gateway-Id is set it will only connect to the network if that specific Gateway-Id is available. If the AP or other SAFs without that Gateway-Id are available they will be ignored.

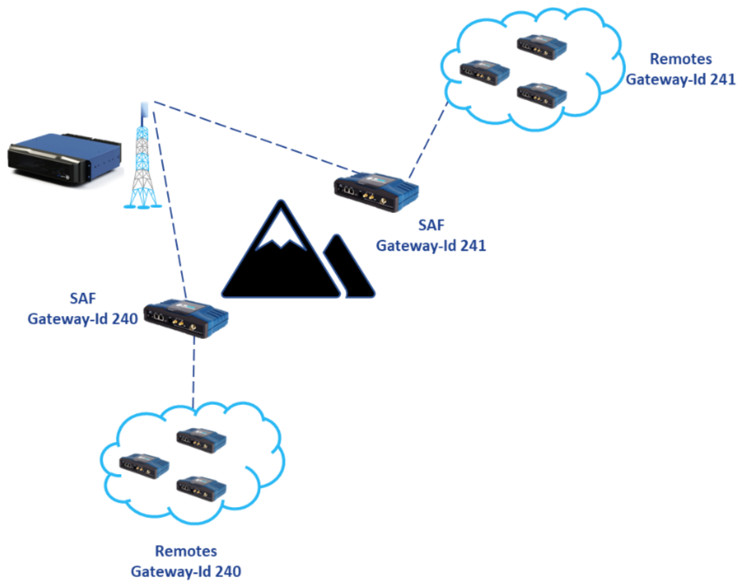


Figure 3-70 Example 2 Gateway-Id SAF Network

3.5.5.3.2 Advanced Radio Mode

Advanced Radio Mode is the newest evolution of QAM operation. Advanced mode offers enhanced robustness with additional FEC options, improved latency, improved point to multi-point performance, fast Store and Forward functionality, and additional modulation support of 32QAM.

It is recommended that all new networks take advantage of Advanced radio mode. For compatibility purposes however Standard radio mode remains the default configuration.

Advanced mode offers an overall simplified configuration. Remote devices automatically learn most configuration settings such as supported modulations and FEC. Simply change the AP configuration and remotes will automatically update their own configuration. Full bi-directional Adaptive Modulation is supported in Advanced mode, and this configuration has also been simplified.

Advanced mode has several new basic and advanced configuration options.

- **Device-Mode** - Sets the role the radio will assume in the network.
  - Remote (DEFAULT)
  - AP
  - Store-and-Forward-Node
- **Use-store-and-forward *(AP only)*** – Sets SAF functionality of the radio network.
  - True
  - False
- **Force-store-and-forward *(Remote only)*** – Force a remote device to use a SAF link
  - True
  - False

NOTE On Remote devices if 'force-store-and-forward' is set to True, they will only connect if a SAF device is available, even if a direct link to the AP is present.

- **FEC-Mode *(AP only)*** - Sets the FEC level for the radio network. The higher the level the higher amount of FEC used. Recommended to use default Level-3. In certain conditions where very strong signals are present, Level-2 and Level-1 may be considered.
  - Level-3 (DEFAULT)
  - Level-2
  - Level-1
- **Modulation-Mask *(AP only)*** - Sets the active modulations supported in the network. The radio will automatically adjust to the highest supportable modulation.
  - 4QAM
  - 16QAM
  - 32QAM
  - 64QAM
- **Automatic Power Control** – Disabled by DEFAULT. When enabled, the radio will reduce transmit power to the lowest 4 possible settings that maintain reliable 64QAM modulation. Power starts out at its current setting, then incrementally reduces by 5db to a new threshold once reliable communication is confirmed. The preset levels for power attenuation are 0, 5, 10, and 15db. This setting may be useful for preventing self-blocking of remotes in a dense radio deployment with strong signal. This setting is generally recommended for remotes, not APs.

Advanced mode intrinsically supports SAF functionality. In Advanced mode SAF is enabled when 'use-store-and-forward' is set to True in the AP's configuration. SAF functionality provides a single hop extension to the radio network and also supports bi-directional Adaptive Modulation through the direct and SAF link. Multiple SAF devices are supported in a radio network. Advanced mode operation of Store-and-Forward differs significantly from Orbit's original Store-and-Forward *radio mode*. In Advanced mode as more SAF devices are added to the network, performance does not decrease. This is because Advanced mode SAF operation immediately forwards any SAF traffic by all SAF devices simultaneously. This provides an overall faster SAF performance when compared to earlier Store-and-Forward mode. The tradeoff is that that since all SAF devices transmit simultaneously, any remote device connecting to the network through an SAF must be restricted only hear a *single* SAF device. If a remote can hear from two or more SAF devices this is likely to cause reception errors.

3.5.5.3.3 Advanced-Polling Radio Mode

Advanced-Polling radio mode is variant of Advanced mode. It provides all the same enhancements as Advanced mode but has been specifically designed for large scale networks supporting up to 250 active remotes per AP.

To support such large scale networks the radio must take care to not generate excessive or synchronized internal traffic. Advanced-polling mode follows an on-demand philosophy where no internal generated traffic (association) will be created until application traffic is available. Only then will the radio associate by piggy backing internal traffic on the initial application traffic request. Using this philosophy allows for very large networks to be supported especially when using a polled data model. As the application polls each device, on the first poll response all radio association takes place. This avoids traditional broadcast association storms that would occur on power-up of a network when hundreds of devices that attempt to associate simultaneously.

- **Polling-Id** – Sets the unique identifying radio ID

Advanced-polling using a static addressing scheme. A 16-bit polling-id is used to uniquely identify each radio device. This defaults to the last 16-bits of the platform serial number. There is a very small likelihood of a polling-id conflict between multiple devices, however polling-id is configurable and you may wish to assign each radio your own unique id.

NOTE Since Advanced-polling mode does not generate internal traffic, fec-mode and modulation-mask must be configured on all individual devices and certain security methods are not available.

See **APPENDIX K** for a table summarizing LN Radio Modes, recommended operation and supported features list.

3.5.5.4 Backward Compatible FSK Mode Configuration

For backward compatible operation it is necessary at minimum to change radio mode, modulation, and TX/RX frequency. For transparent-serial mode or packet-with-mac mode with serial data it is also necessary to setup a terminal server or a pass-through instance to the desired serial COM port.

NOTE In FIPS mode, in packet-with-mac configuration, Security Mode must be set to NONE.

Configuring

Basic transparent serial configuration with defaults

Navigate to: ***Interfaces / LnRadio ---> Basic Config / LN Radio***

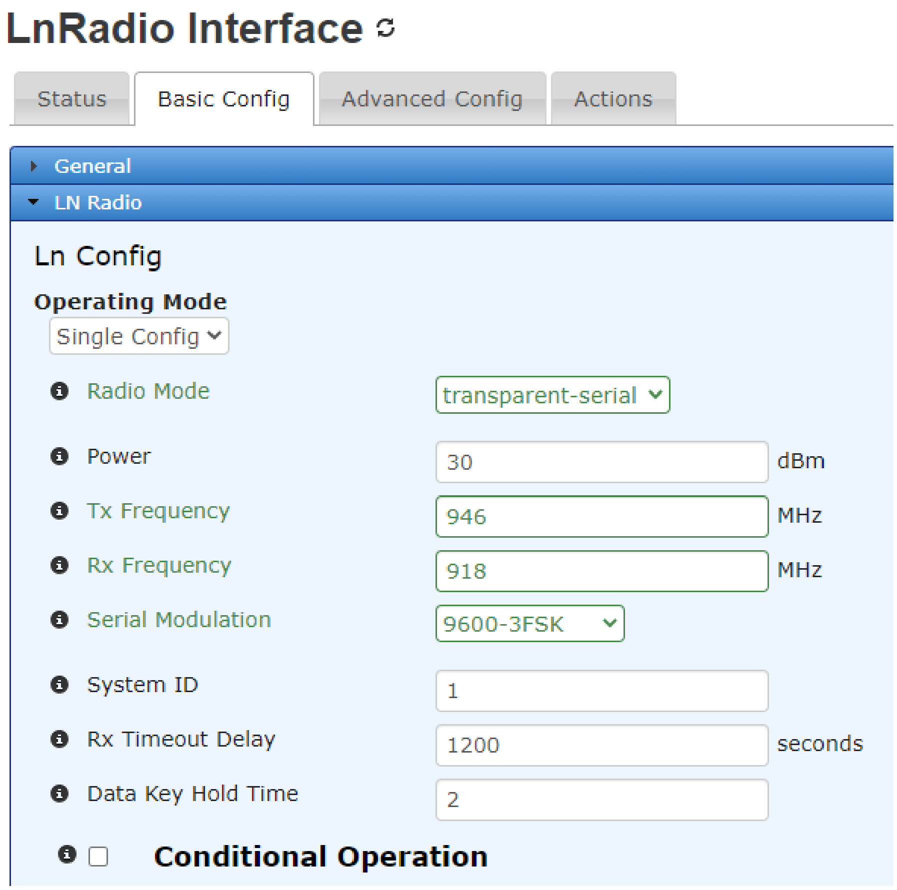


Figure 3-71. LN, Backward Compatible, transparent serial

- **Radio Mode**
    - **transparent-serial** – FSK mode supporting x710 backward compatibility
- **Power** - The transmit power of the radio: Valid values: 20 - 37 dBm – DEFAULT is 37dBm
- **TX Frequency** – The frequency at which the radio transmits. DEFAULT is none.
- **RX Frequency** – The frequency at which the radio receives. DEFAULT is none.
- **Serial Modulation** – Sets the radio's modulation (which also determines bandwidth).
    - **9600-3FSK -** 9600bps, 12.5KHz channel, (legacy MODEM 9600) (DEFAULT)
    - **9600M-3FSK -** 9600bps, 12.5KHz channel, (legacy MODEM 9600M)
    - **19200-3FSK -** 19200bps, 25.0KHz channel, (legacy MODEM 19200)
    - **19200N-7FSK -** 19200bps, 12.5KHz channel , (legacy MODEM 19200N)
    - **19200E-7FSK -** 19200bps, 12.5KHz channel , (legacy MODEM 19200E)
    - **19200M-3FSK -** 19200bps, 25.0KHz channel, (legacy MODEM 19200M)

- **38400N-7FSK -** 38400bps, 25.0KHz channel, (legacy MODEM 38400N)
- **38400E-7FSK -** 38400bps, 25.0KHz channel, (legacy MODEM 38400E)

- **System ID** – Sets the radio's system ID. System ID is a form of secondary addressing in the modulated signal that strengthens co-channel rejection from other MDS radios (i.e., devices operating on the same frequency in a frequency reuse deployment). Use "0" to set compatibility with older devices that did not support this option. The range of valid values depends on the radio modulation style. FSK, valid values: 0-8 – DEFAULT is 0.
- **Data Key Hold Time** – default delay in milliseconds before marking a data stream complete and invoking a key-down. Similar to SCD in legacy MDS products

Basic packet-with-mac configuration

Navigate to: ***Interfaces / LnRadio ---> Basic Config / LN Radio***

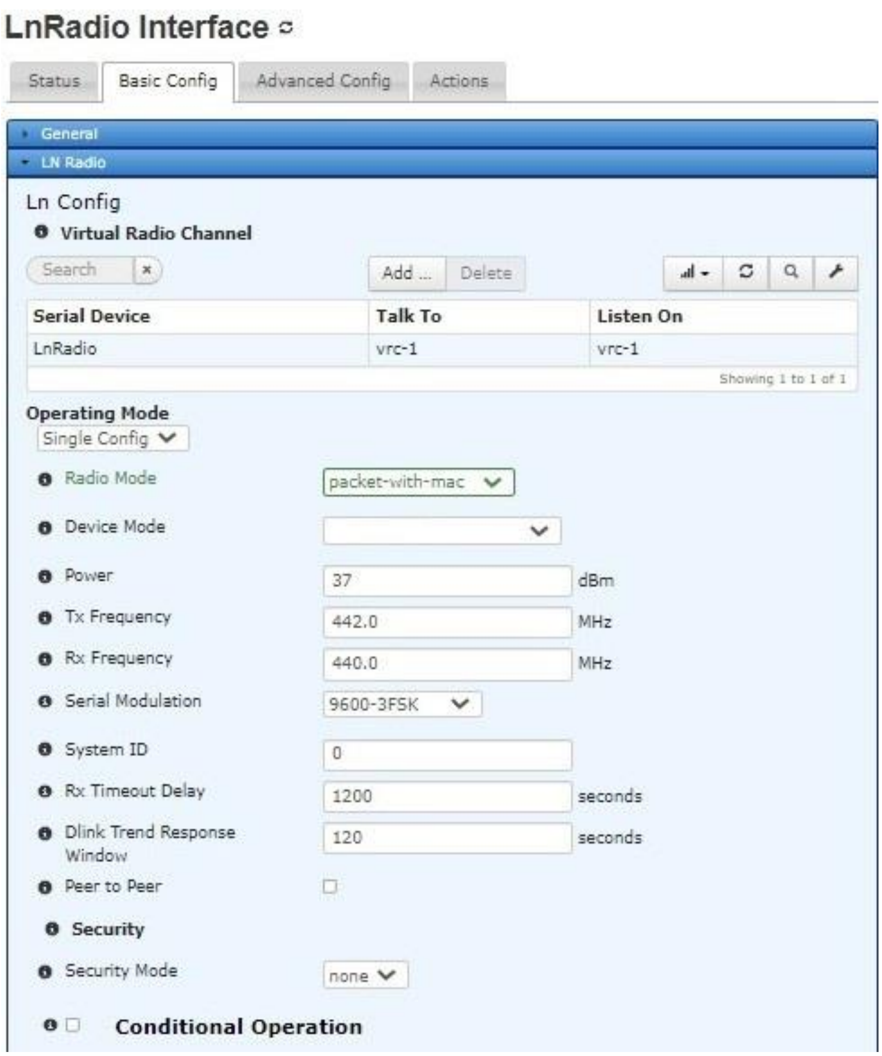


Figure 3-72. LN, Backward Compatible, packet-with-MAC

- **Radio Mode**
  - **packet-with-mac** – FSK mode supporting SD backward compatibility

- **Device Mode**
  - **access-point** – *not supported/do not use*
  - **remote** – operate as an SD remote (DEFAULT)
  - **store-and-forward –** operate as an SD store-and-forward unit
- **Power** - The transmit power of the radio: Valid values: 20 - 37 dBm – DEFAULT is 37dBm
- **TX Frequency** – The frequency at which the radio transmits. DEFAULT is none.
- **RX Frequency** – The frequency at which the radio receives. DEFAULT is none.
- **Serial Modulation** – Sets the radio's modulation (which also determines bandwidth).
  - **9600-3FSK -** 9600bps, 12.5KHz channel, (legacy MODEM 9600) (DEFAULT)
  - **9600M-3FSK -** 9600bps, 12.5KHz channel, (legacy MODEM 9600M)
  - **19200-3FSK -** 19200bps, 25.0KHz channel, (legacy MODEM 19200)
  - **19200N-7FSK -** 19200bps, 12.5KHz channel , (legacy MODEM 19200N)
  - **19200E-7FSK -** 19200bps, 12.5KHz channel , (legacy MODEM 19200E)
  - **19200M-3FSK -** 19200bps, 25.0KHz channel, (legacy MODEM 19200M)
  - **38400N-7FSK -** 38400bps, 25.0KHz channel, (legacy MODEM 38400N)
  - **38400E-7FSK -** 38400bps, 25.0KHz channel, (legacy MODEM 38400E)
- **System ID** – Sets the radio's system ID. System ID is a form of secondary addressing in the modulated signal that strengthens co-channel rejection from other MDS radios (i.e., devices operating on the same frequency in a frequency reuse deployment). Use "0" to set compatibility with older devices that did not support this option. The range of valid values depends on the radio modulation style. FSK, valid values: 0-8 – DEFAULT is 0.

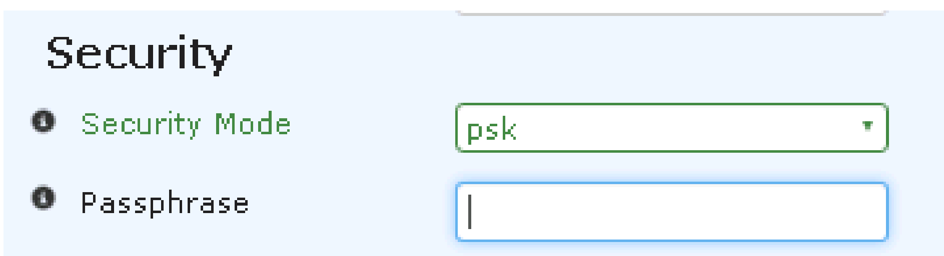


Figure 3-73. Licensed Narrowband (LN) PSK Security Settings

- **Security Mode** - The type of over the air encryption to perform
  - **none** - Provide no encryption or data privacy (DEFAULT)
  - **psk** - Use pre-shared key for SD-compatible AES-128 Encryption
  - **eap** - *not supported/do not use*
- **Passphrase** - The passphrase used for legacy AES-128 Encryption. (DEFAULT=blank)

Configuring a Virtual Radio Channel / serial port

In the example below defining Virtual Radio Channel *vrcX* automatically creates serial port vrcX-serial. Serial port vrcX-serial can then be used by Terminal Server and Pass-Through services to directly access the serial data stream of the SD radio network.

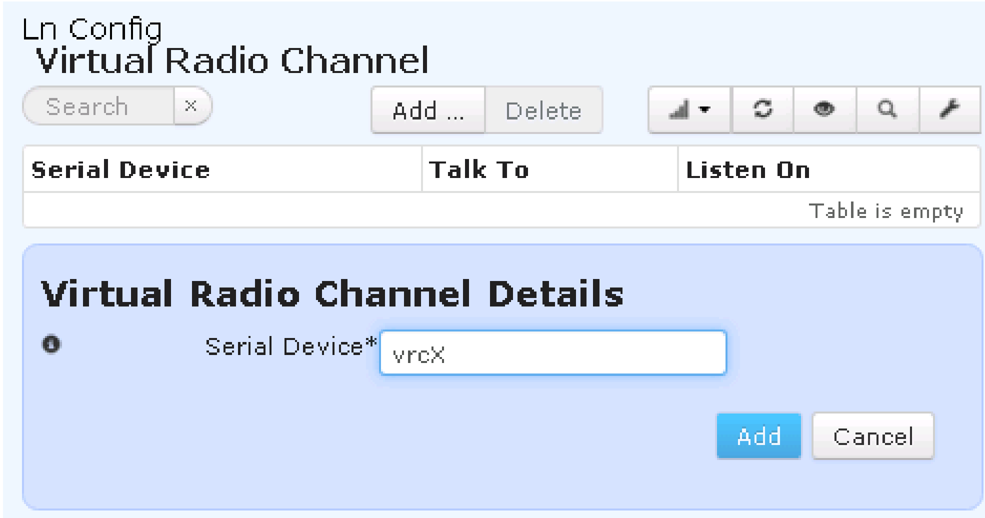


Figure 3-74. LN, Configuring a Virtual Radio Channel – creates vrcX-serial port

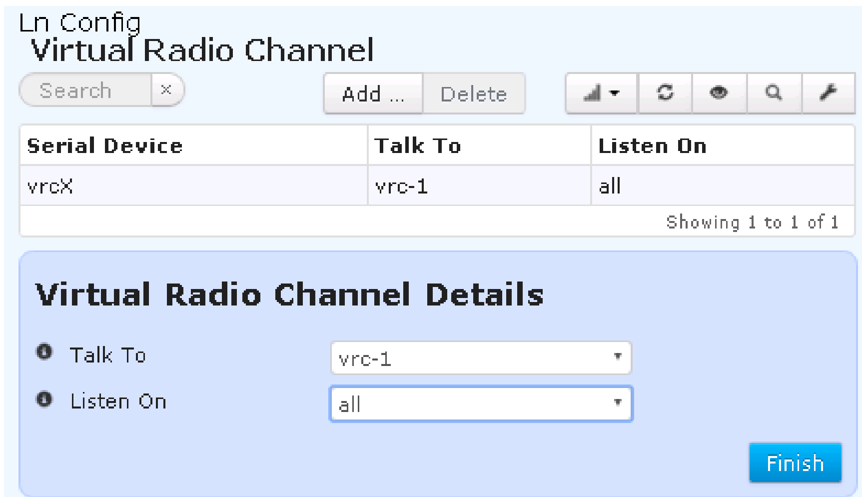


Figure 3-75. LN, VRCs use SD-style talk/listen parameters

Note that SD supports up to 3 virtual radios channels (vrc-1, vrc-2, vrc-3) corresponding to 3 different serial data streams. In the example above, Orbit's *vrcX* was set-up to communicate to the SD network's vrc-1. Orbit supports definition of multiple Virtual Radio Channels as needed to communicate with any corresponding SD configuration.

Advanced Configuration

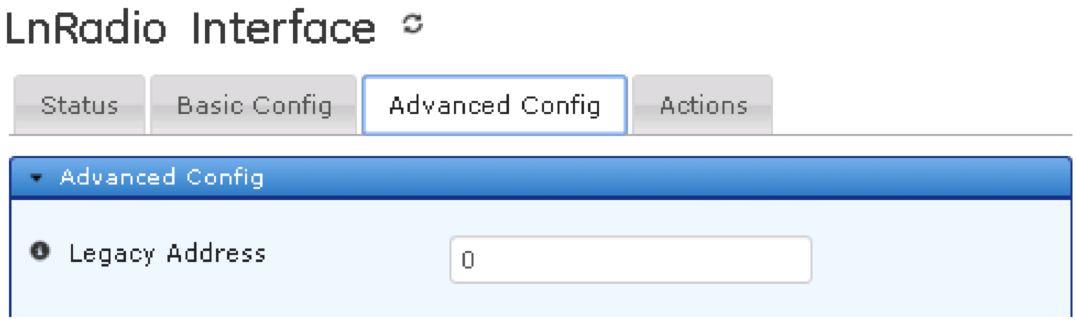


Figure 3-76. LN, Backward Compatible Advanced Settings

The Advanced Setting menu allows configuration of the following.

- **Legacy Address** - The legacy-style UNIT address for DLINK.
  - The last 4 digits of the Orbit device serial number (DEFAULT)
  - 10000-65000

NOTE CAUTION: Do not set values below 10000 other than the default. This may cause remote configuration and management operations to fail.

3.5.5.5 Additional Information

Monitoring

General Interface information: ***Interfaces / LnRadio ---> Status / General***

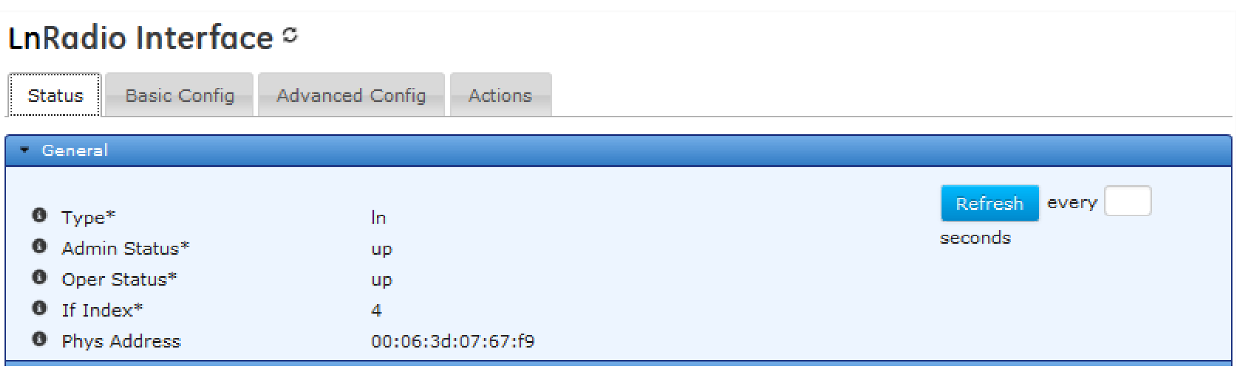


Figure 3-77. Licensed Narrowband (LN) AP Status

- **Type** - The type of the interface. Licensed Narrowband radios appear as "ln."
- **Admin Status** - The desired state of the interface.
- **Oper Status** - The current operational state of the interface.
- **If Index** - The index value for this interface in the Orbit's interface table. Valid values are: 1-2147483647
- **Phys Address**- The interface's address at its protocol sub-layer. For a LN module, this object normally contains a MAC address.

Statistics - A collection of interface-related statistics objects.

Figure 3-78. Licensed Narrowband (LN) Statistics

- **Discontinuity Time** - The time on the most recent occasion at which one or more of this interface's counters suffered a discontinuity.
- **In Octets** - The total number of octets received on the interface, including framing characters.
- **In Unicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
- **In Multicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer.
- **In Discards** - The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
- **In Errors** - For packet-oriented interfaces, the number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
- **Out Octets** - The total number of octets transmitted out of the interface, including framing characters.
- **Out Unicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Discards** - The number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted.
- **Out Errors** - For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors.

Ln Radio Status Monitoring:

Interfaces / LnRadio ---> Status / Ln Radio

Figure 3-79. Licensed Narrowband (LN) Status

The following status items appear on both APs and Remotes (unless stated otherwise)

General

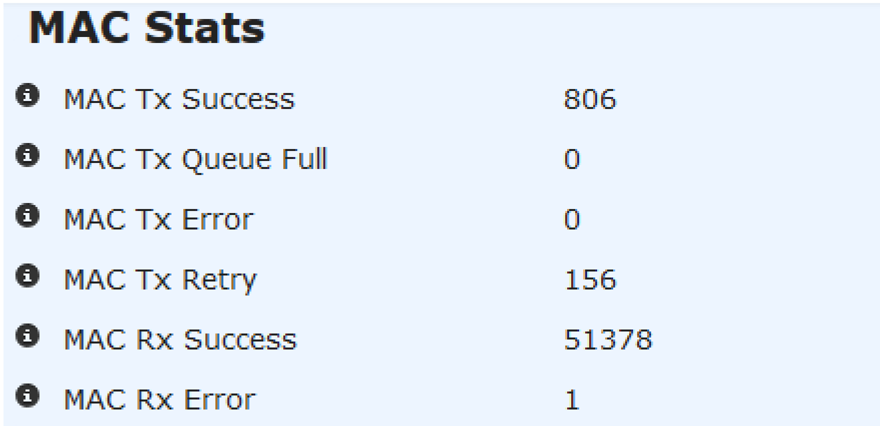
- **Init Status** - State of the NIC Initialization
  - **Off -** Not operating
  - **Initializing -** Powering on the NIC
  - **Discovering -** Determining the NIC address
  - **Reprogramming** - Programming the NIC firmware
  - **Configuring -** Configuring the NIC
  - **Complete -** Initialization complete
- **Current Device Mode** – Read-only display of the active mode the LnRadio is operating.
- **Alarms** - The current NIC alarms**:**
  - synthesizer-out-of-lock: Synthesizer is out of lock. Call GE Vernova tech support for assistance.
  - radio-not-calibrated: Radio was not calibrated. Call GE Vernova tech support for assistance.
  - internal-temp: The radio's internal temperature exceeds the operating threshold.
- **Firmware Revision** - NIC Firmware Revision.
- **Temperature** - The transceiver temperature in degrees C.

Modem Stats

- **Modem Tx Success** – Number of packets successfully transmitted by the modem.
- **Modem Tx Error** – Number of transmit errors reported by the modem.

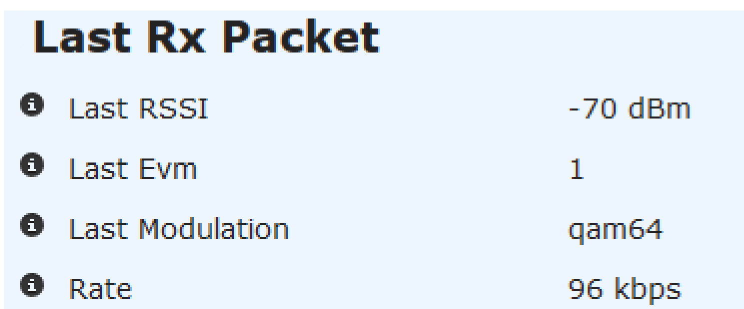
- **Modem Rx Success** – Number of packets successfully received by the modem.
- **Modem Rx Error** – Number of receive errors reported by the modem.

MAC Stats



- **MAC Tx Success** - Successful transmissions.
- **MAC Tx Queue Full -** Failed transmissions, MAC queue full.
- **MAC Tx Error -** Packets dropped for other reasons.
- **MAC Tx Retry -** Re-transmission count due to previously unsuccessful transmission.
- **MAC Rx Success** - Valid packet received.
- **MAC Rx Error** – Received packets dropped due to error.

Last RX Packet



- **Last RSSI –** The RSSI measured at the time of the last received packet.
- **Last Error Vector Magnitude** – The EVM measured at the time of the last received packet. For more information, refer to *Important Notes and Information Regarding EVM*
- **Last Modulation** – The modulation measured at the time of the last received packet.
- **Rate** – The calculated over the air rate.

Hardware Info

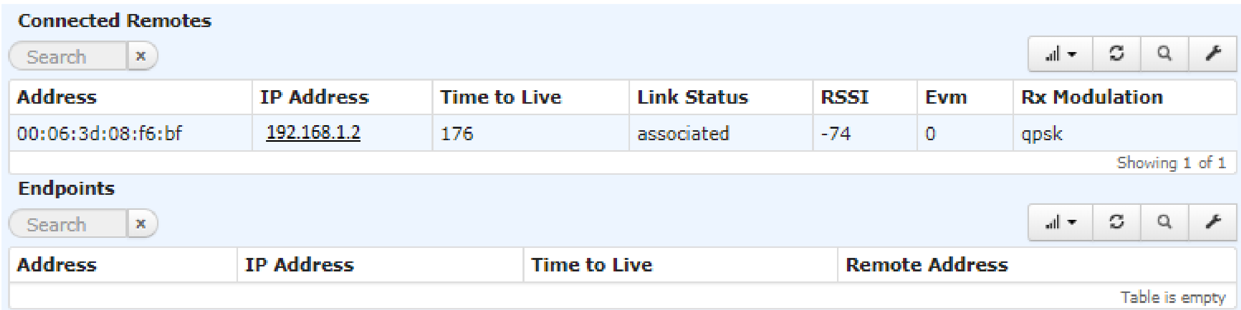
Figure 3-80 Licensed Narrowband (LN) Hardware Info

Information about the Licensed Narrowband NIC's hardware is also displayed on the LN Radio's Statistics menu. This information may be helpful when calling technical support.

Connections Status (AP Only)

In AP mode the “Connected Remotes” and “Endpoints” information will be displayed in addition to the Active Channel.

NOTE Highlighting an IP address of a Connected Remote and clicking will open a remote web UI session to the selected remote. See Section 3.8.18, Remote Management Service, for more information.



Connected Remotes

Address	IP Address	Time to Live	Link Status	RSSI	Evm	Rx Modulation
00:06:3d:08:f6:bf	192.168.1.2	176	associated	-74	0	qpsk

Showing 1 of 1

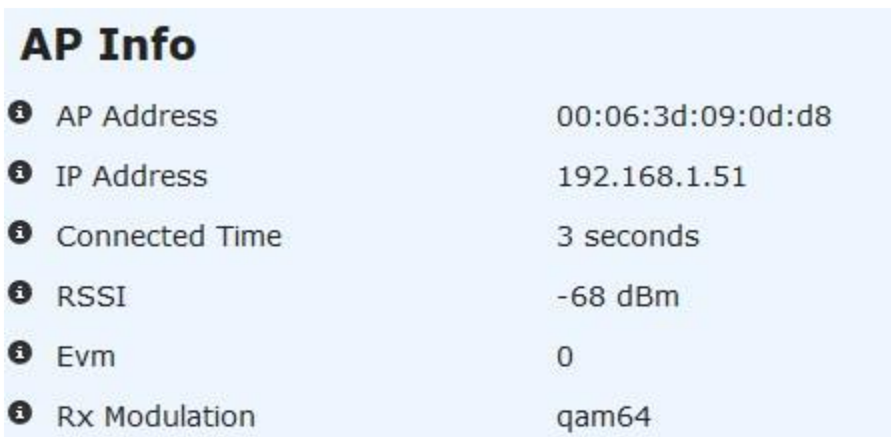
Endpoints

Address	IP Address	Time to Live	Remote Address

Table is empty

Figure 3-81. Licensed Narrowband (LN) AP Connection Status

Remote’s AP Info (Remote Only):



AP Info

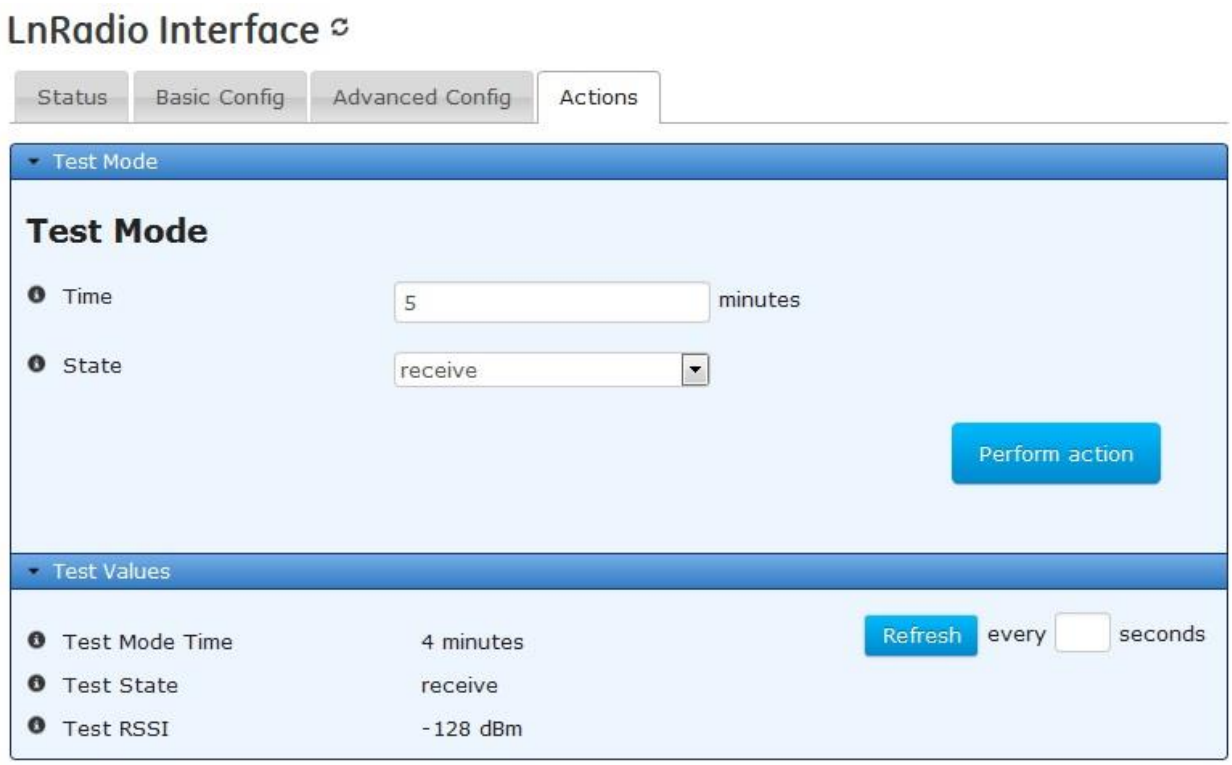
AP Address	00:06:3d:09:0d:d8
IP Address	192.168.1.51
Connected Time	3 seconds
RSSI	-68 dBm
Evm	0
Rx Modulation	qam64

Figure 3-82. Licensed Narrowband (LN) Remote’s AP Information

- **AP Address** - MAC address of access point this device is linked to.
- **IP Address** - IP address of access point this device is linked to.
- **Connected Time** - Time elapsed in seconds since link established. After 4294967295 seconds, the value displayed rolls over to 0.
- **RSSI** - The RSSI measured at the time of the last received packet. If using this reading to align an antenna or gather link status information, we recommend setting the page refresh to 3 seconds.
- **EVM** - The Error Vector Magnitude measured at the time of the last received packet. For more information, refer to *Important Notes and Information Regarding EVM*
- **Rx Modulation** - The modulation measured at the time of the last received packet.

Test Mode

Interfaces / LnRadio ---> Actions / Test Mode



Test Mode provides a way to place the transmitter on the air to check the measured RF power output, measure reflected power from an antenna system, or to provide a signal at a receiving station so that RSSI can be checked. While in Test Mode, a radio will not operate normally and does not communicate with the narrowband network.

To enter or exit Test Mode, select the desired test state from the **State** drop-down box and click ***Perform Action.***

- **Time** – The time, in minutes, to remain in test mode before automatically resuming normal operation. We recommend that you remain in test mode 10 minutes or less.
- **State** -
  - **Receive** – Enter Receive mode to check the RSSI of a received signal.
  - **Keyed** – Key the transmitter. To prevent damage to the radio, the unit will stop keying after one minute and automatically transition to the Receive state.
  - **Stop** – Stop all test operations and exit test mode.

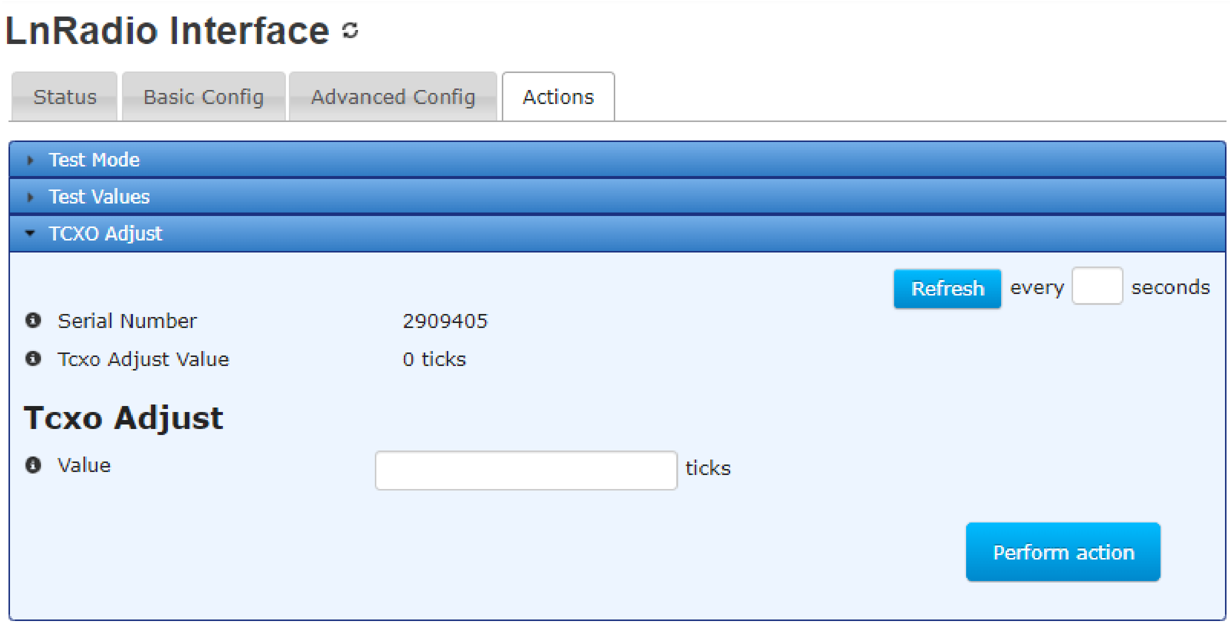
Test Values

- **Test Mode Time** – The length of time test mode has been running.
- **Test State –** *Receive, Keyed, Stop.* The current test state.
- **Test RSSI** (Receive Mode only) – The current signal RSSI.

TCXO Maintenance

LN radios provide a facility for TCXO maintenance. For units that have been deployed for long periods of time this offers a means to correct for normal TCXO aging and ensure optimal performance.

Interfaces / LnRadio ---> Actions / TCXO Adjust



This facility provides a low-level control to adjust TCXO frequency up or down. The ticks value can be PLUS (+) or MINUS (-) with the reasonable range of control varying per device.

Once a change is made it is persistent.

A typical use case would involve manually tweaking the ticks value a little bit, up or down, keying, and measuring for performance improvement or degradation. If there is improvement, then adjust a little further in the same direction. If there is degradation adjust in the opposite direction of the last change. Continue the process until the units is tuned to satisfaction. Ideally a measurement instrument would be used to measure frequency offset. Lacking measurement equipment, field adjustment can be made by gaging SNR/EVM and polling response, though this is less definitive.

NOTE For Orbit Master Stations the same same TCXO tuning facility is available. For a redundant system, once one radio is fully tuned switch to the standby radio and repeat the process.

CLI Configuration Examples

AP Mode

On the next page, the example will display how to configure the LN module as an access point with the network name of 'MyNetwork' and default settings. For this example, we assume a transmit frequency of 451.4 MHz and a receive frequency of 456.4 MHz. Your own LN frequencies must be set according to your user license.

% set interfaces interface *LnRadio* **ln-config device-mode access-point network-name** *MyNetwork* **tx-frequency** *451.4* **rx-frequency** *456.4*

% show interfaces interface *LnRadio* **ln-config | details**

```
radio-mode               standard;
device-mode              access-point;
network-name             MyNetwork;
data-compression         lzo;
header-compression       true;
power                    40;
tx-frequency             451.4;
rx-frequency             456.4;
channel                  12.5KHz-9.6ksps;
modulation               automatic;
fec                      false;
security {
   security-mode         none;
   encryption            none;
}
advanced-config {
   data-retries          3;
   packet-ttl            600;
   remote-age-time       600;
   endpoint-age-time     300;
   allow-retransmit      true;
   arp-cache             false;
   qam16-threshold       -85;
   qam64-threshold       -70;

}
```

Security configuration

The default security mode, as shown above, is none.

The following configures the LN module to use pre-shared key authentication with the passphrase 'mypassphrase' and aes256-ccm encryption.

NOTE When viewing the configuration, the passphrase that you entered is not displayed in plaintext. This is a security measure.

```
% set interfaces interface LnRadio ln-config security encryption aes256-ccm security-mode
   psk passphrase mypassphrase
% show interfaces interface LnRadio ln-config | details
radio-mode               standard;
device-mode              access-point;
network-name             MyNetwork;
data-compression         lzo;
header-compression       true;
power                    40;
tx-frequency             451.4;
rx-frequency             456.4;
channel                  12.5KHz-9.6ksps;
modulation               automatic;
fec                      false;
security {
   security-mode         psk;
   encryption            aes256-ccm;
   passphrase            $4$BfPtSlDWFNhtqe4ZcJTWQQ==;
```

```
}
advanced-config {
    data-retries          3;
    packet-ttl            600;
    remote-age-time       600;
    endpoint-age-time     300;
    allow-retransmit      true;
    arp-cache             false;
    qam16-threshold       -85;
    qam64-threshold       -70;

}
```

The following configures the LN module to use data compression, EAP authentication and aes256-ccm encryption. The RADIUS server used by the EAP authentication is selected from a list of configured RADIUS servers.

```
% set interfaces interface LnRadio ln-config security encryption aes256-ccm security-mode
    eap radius-server RADIUS_SERVER
% show interfaces interface LnRadio ln-config | details
radio-mode            standard;
device-mode           access-point;
network-name          MyNetwork;
data-compression      lzo;
header-compression    true;
power                 40;
tx-frequency          451.4;
rx-frequency          456.4;
channel               12.5KHz-9.6ksps;
modulation            automatic;
fec                   false;
    security {
    security-mode     eap;
    encryption        aes256-ccm;
    radius-server     RADIUS_SERVER;
}
advanced-config {
    data-retries          3;
    packet-ttl            600;
    remote-age-time       600;
    endpoint-age-time     300;
    allow-retransmit      true;
    arp-cache             false;
    qam16-threshold       -85;
    qam64-threshold       -70;
}
```

Remote Mode

The following will configure the LN module as a Remote with the network name of 'MyNetwork' and default settings. For this example, we assume the inverse of the AP frequency plan – a transmit frequency of 456.4 MHz and a receive frequency of 451.4 MHz. Your own LN frequencies must be set according to your user license.

```
% set interfaces interface LnRadio ln-config device-mode remote network-name MyNetwork tx-
   frequency 456.4 rx-frequency 451.4
% show interfaces interface LnRadio ln-config | details
radio-mode            standard;
device-mode           remote;
network-name          MyNetwork;
data-compression      lzo;
header-compression    true;
power                 40;
tx-frequency          456.4;
rx-frequency          451.4;
channel               12.5KHz-9.6ksps;
modulation            automatic;
fec                   false;
security {
   security-mode      none;
   encryption         none;
}
advanced-config {
   data-retries       3;
   nic-id             0;
   inactivity-timeout 600;
   remote-age-time    600;
   arp-cache          false;
   qam16-threshold    -85;
   qam64-threshold    -70;
}
```

Security Configuration

The default security mode, as shown above, is none. The following configures the LN module to use pre-shared key authentication with the passphrase "mypassphrase" and aes256-ccm encryption.

NOTE When viewing the configuration, the passphrase that you entered is not displayed in plaintext. This is a security measure.

```
% set interfaces interface LnRadio ln-config security encryption aes256-ccm security-mode
   psk passphrase mypassphrase
% show interfaces interface LnRadio ln-config | details
radio-mode            standard;
device-mode           remote;
network-name          MyNetwork;
data-compression      lzo;
header-compression    true;
power                 40;
tx-frequency          456.4;
rx-frequency          451.4;
;
channel               12.5KHz-9.6ksps;
modulation            automatic;
fec                   false;
security {
   security-mode      psk;
   encryption         aes256-ccm;
   passphrase         $4$BfPtSlDWFNhtqe4ZcJTWQQ==;
```

```
}
advanced-config {
   data-retries          3;
   nic-id                0;
   inactivity-timeout    600;
   remote-age-time       600;
   arp-cache             false;
   qam16-threshold       -85;
   qam64-threshold       -70;
}
```

The following configures the LN module to use data compression, EAP authentication and aes128-ccm encryption. The EAP mode currently supports only EAP-TLS. This requires configuring the appropriate PKI Certificates and Keys to use in the TLS authentication. This information is selected from the PKI configuration.

```
% set interfaces interface LnRadio ln-config security encryption aes128-ccm security-mode
   eap eap-mode eap-tls pki ca-cert-id CACert key-id DevicePrivKey cert-id DevicePubCert
% show interfaces interface LnRadio ln-config | details
radio-mode               standard;
device-mode              remote;
network-name             MyNetwork;
data-compression         lzo;
header-compression       true;
power                    40;
tx-frequency             456.4;
rx-frequency             451.4;
channel                  12.5KHz-9.6ksps;
modulation               automatic;
fec                      false;
security {
   security-mode         eap;
   encryption            aes128-ccm;
   eap-mode              eap-tls;
   pki {
      cert-id            DevicePubCert;
      key-id             DevicePrivKey;
      ca-cert-id         CACert;
   }
}
advanced-config {
   data-retries          3;
   nic-id                0;
   inactivity-timeout    600;
   remote-age-time       600;
   arp-cache             false;
   qam16-threshold       -85;
   qam64-threshold       -70;
}
```

Monitoring

Ensure the CLI is in operational mode.

Access Point Mode

The following shows status with a single station connected.

```
> show interfaces-state interface LnRadio ln-status
ln-status init-status complete
ln-status current-device-mode access-point
ln-status alarms    ""
ln-status firmware-revision 0.2.4
ln-status temperature 45
ln-status modem-stats modem-tx-success 5401378
ln-status modem-stats modem-tx-error 0
ln-status modem-stats modem-rx-success 37645
ln-status modem-stats modem-rx-error 11
ln-status mac-stats mac-tx-success 72699
ln-status mac-stats mac-tx-queue-full 0
ln-status mac-stats mac-tx-error 0
ln-status mac-stats mac-tx-retry 132
ln-status mac-stats mac-rx-success 17952
ln-status mac-stats mac-rx-error 498
ln-status last-rx-packet last-rssi -128
ln-status last-rx-packet last-evm 255
ln-status last-rx-packet last-modulation qam64
ln-status last-rx-packet rate 96
ln-status hardware-info serial-number 2673840
ln-status hardware-info hardware-id 0
ln-status hardware-info hardware-revision 0
ln-status test test-mode-time 0
ln-status test test-state stop
ln-status connected-remotes 00:06:3d:09:14:7d
 ip-address    10.15.65.145
 time-to-live  767
 link-status   associated
 rssi          -67
 evm           0
 rx-modulation qam64
 device-stats tx-packets 730
 device-stats tx-bytes 108661
 device-stats rx-packets 721
 device-stats rx-bytes 215575
 device-stats tx-error 10
 device-stats rx-error 0
 device-stats tx-drop 0
 device-stats rx-drop 0
 nic-id        1
```

Remote Mode

The following shows status when connected to a configured Access Point.

```
> show interfaces-state interface LnRadio ln-status
ln-status link-status associated
ln-status init-status complete
ln-status current-device-mode remote
ln-status alarms    ""
```

ln-status firmware-revision 0.2.4
ln-status temperature 43
ln-status modem-stats modem-tx-success 33116
ln-status modem-stats modem-tx-error 0
ln-status modem-stats modem-rx-success 197463
ln-status modem-stats modem-rx-error 55283
ln-status mac-stats mac-tx-success 11424
ln-status mac-stats mac-tx-queue-full 0
ln-status mac-stats mac-tx-error 0
ln-status mac-stats mac-tx-retry 0
ln-status mac-stats mac-rx-success 13390
ln-status mac-stats mac-rx-error 1
ln-status ap-info ap-address 00:06:3d:09:0d:d8
ln-status ap-info ip-address 192.168.1.51
ln-status ap-info connected-time 174
ln-status ap-info rssi -68
ln-status ap-info evm 0
ln-status ap-info rx-modulation qpsk
ln-status last-rx-packet last-rssi -68
ln-status modem-stats modem-tx-success 33116
ln-status modem-stats modem-tx-error 0
ln-status modem-stats modem-rx-success 198622
ln-status modem-stats modem-rx-error 55283
ln-status mac-stats mac-tx-success 11424
ln-status mac-stats mac-tx-queue-full 0
ln-status mac-stats mac-tx-error 0
ln-status mac-stats mac-tx-retry 0
ln-status mac-stats mac-rx-success 13390
ln-status mac-stats mac-rx-error 1
ln-status ap-info ap-address 00:06:3d:09:0d:d8
ln-status ap-info ip-address 192.168.1.51
ln-status ap-info connected-time 226
ln-status ap-info rssi -68
ln-status ap-info evm 0
ln-status ap-info rx-modulation qpsk
ln-status last-rx-packet last-rssi -68
ln-status last-rx-packet last-evm 0
ln-status hardware-info serial-number 2661832
ln-status hardware-info hardware-id 0
ln-status hardware-info hardware-revision 0
ln-status test test-mode-time 0
ln-status test test-state stop

Test Mode

Ensure the CLI is in operational mode.

To enter Test Mode and key the transmitter for 5 minutes:

> request interfaces-state interface *LnRadio* ln-status test-mode state keyed time *5*

To enter Test Mode's receive state for 5 minutes:

> request interfaces-state interface *LnRadio* ln-status test-mode state receive time *5*

To exit Test Mode:

> **request interfaces-state interface** *LnRadio* **ln-status test-mode state** *stop*

To display the current test state:

> **show interfaces-state interface** *LnRadio* **ln-status test**

3.5.5.6 3-Port LN Interface

Understanding

Select Orbit MCR models allow Licensed Narrowband transceivers to be paired with Licensed Receive-Only modules providing advanced filtering options.

Units ordered in this configuration have a TNC connected to the transceiver, and 2 SMAs connected to the receiver. For easy configuration and maintenance the paired units present to the users as a single standard LN interface with some additional options.

The interface can operate in multiple different software-selectable antenna configurations:

- tx-rx-single-port (1-port, 'Classic' TX-RX)
- split-tx-rx (2-Port 'Split TX-RX' Duplexer Ready)
- rx-filter-mode (3-Port 'Enhanced RX')

NOTE For best performance and system redundancy GE Vernova recommends the Orbit Master Station for AP/base station sites.

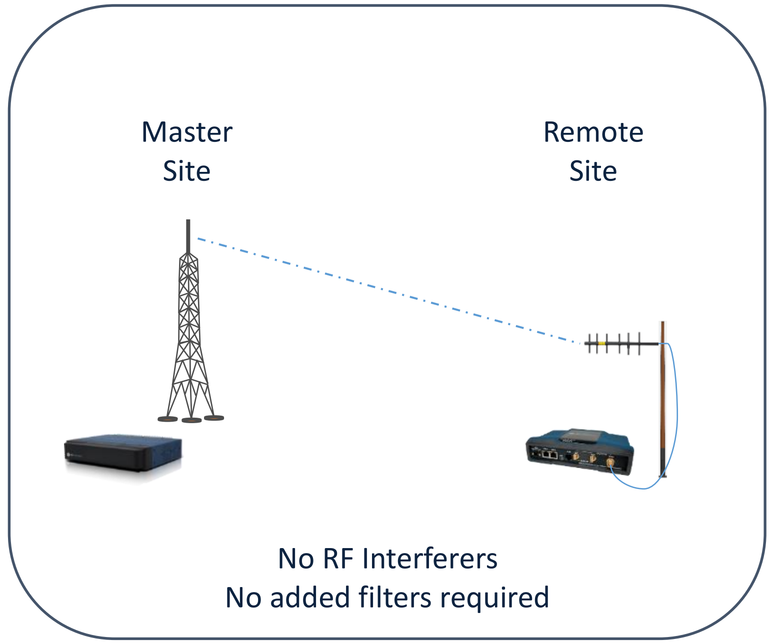
Key Benefits of Advanced Filtering:

- No insertion loss on the TX path – full output power is maintained
- Seamless duplexer integration
- RX-Only filtering for simplex
- RX-Only filtering for split-frequency
- Smaller external filter options than traditional duplexers

Specific use cases follow.

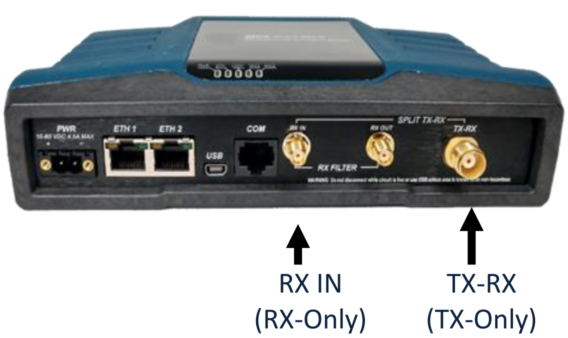
3.5.5.6.1 1-antenna port operation (tx-rx-single-port)

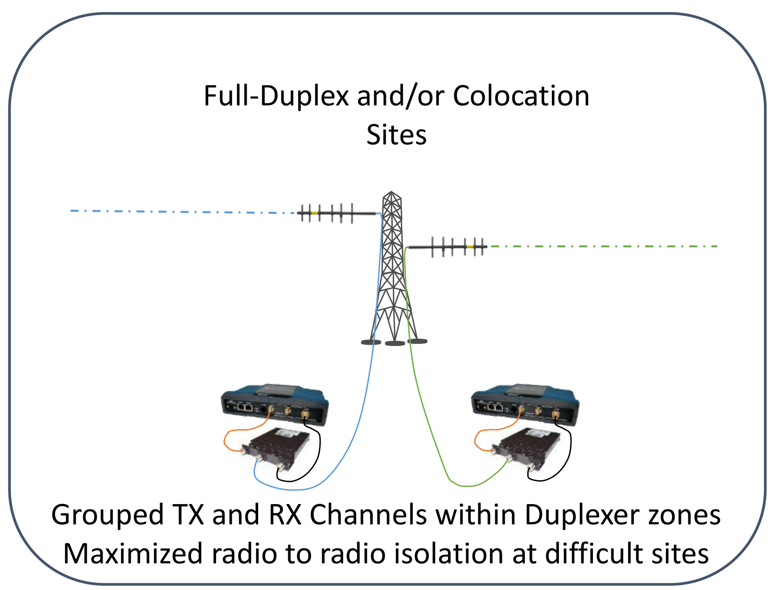
Traditional single port operation is the most common deployment method requiring minimal infrastructure support. The antenna is connected directly to the TNC port labeled TX-RX as shown.



3.5.5.6.2 2-antenna port operation (split-tx-rx)

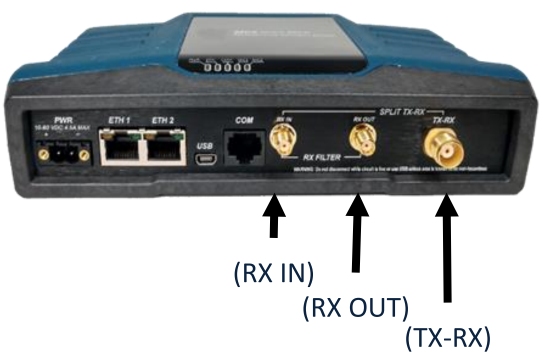
Dual port operation is targeted for managing colocation interference at congested sites. This configuration provides a cost-effective duplexer-ready alternative for applications that forgo a traditional master station deployment. The transmit path to the duplexer is connected to the TNC port labeled TX-RX; the receive path from the duplexer is connected to the SMA port labeled RX IN.

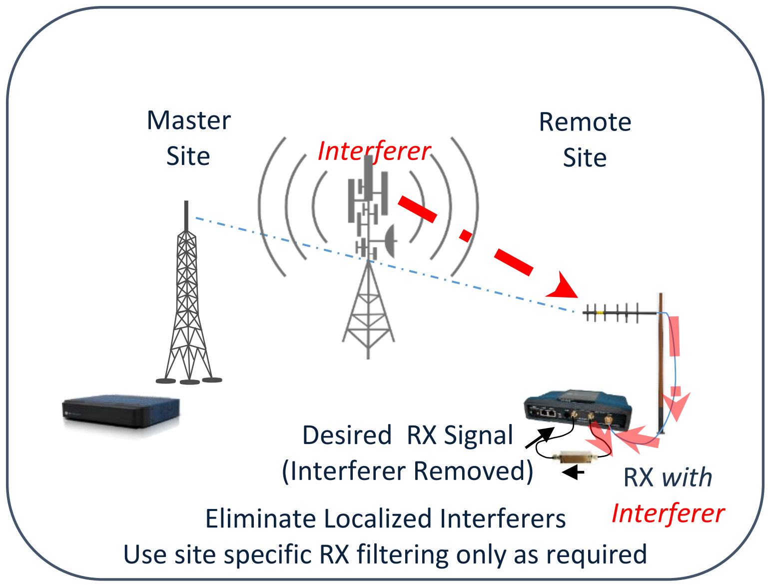




3.5.5.6.3 3-antenna port operation (rx-filter-mode)

Three port Enhanced RX filtering is a special patent pending mode to provide better filtering without using a duplexer or introducing loss on the transmit path. In this mode, the antenna is connected directly to the TNC port labeled TX-RX (like a traditional connection). But a simple external filter is added and is inserted by connecting to the two SMA ports labled RX IN and RX OUT, respectively. This option facilitates the ability to add smaller, cheaper, and higher performance RF filters tailored to resolve site specific interference.





Configuring

Configuring the 3-port LN interface is nearly identical to configuring a standard LN transceiver radio. The only unique option presented is Antenna Mode:

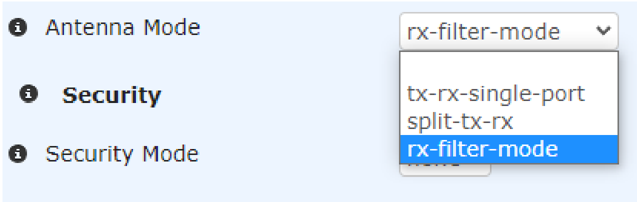


Figure 3-83. 3-Port LN Antenna Mode options

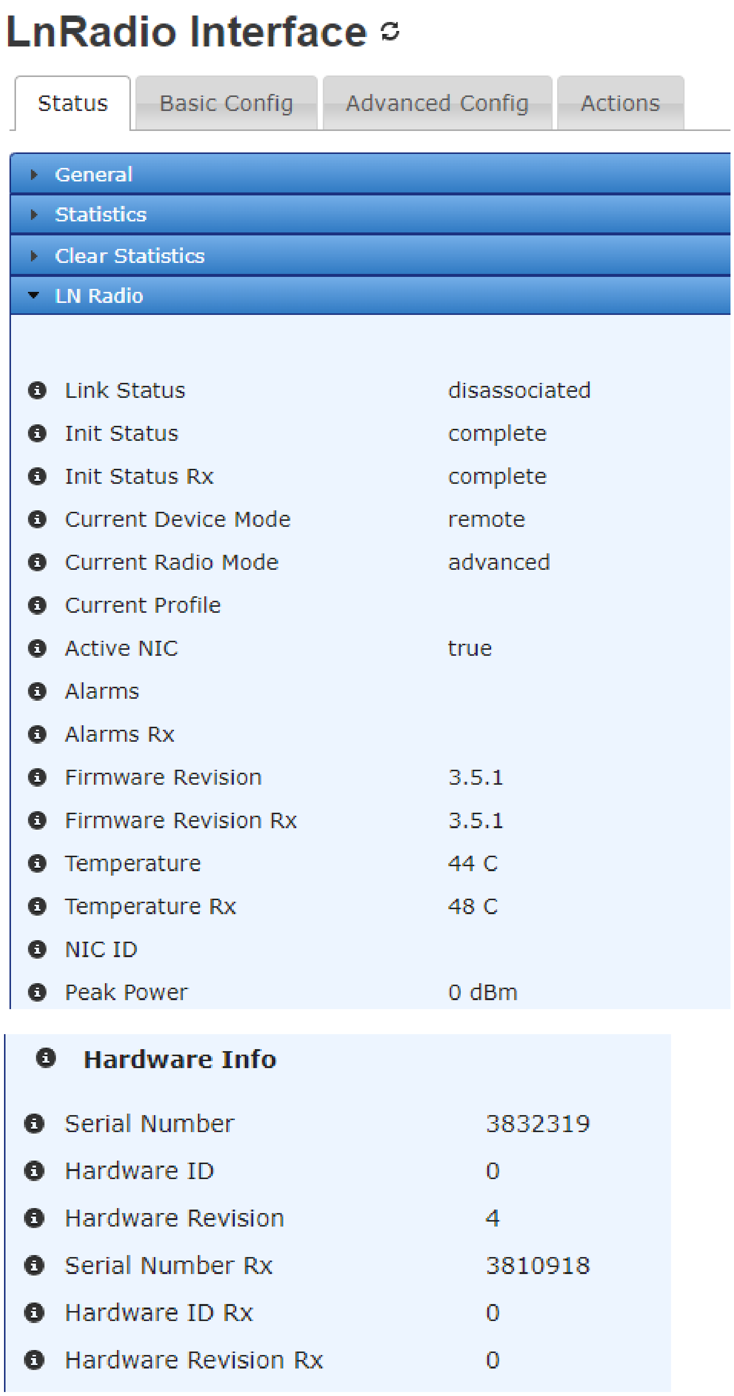
- **Antenna Mode** - Sets the RF operating configuration for the 3-port LN interface.
  - **tx-rx-single-port** – selects 1-port, 'Classic' TX-RX (DEFAULT)
  - **split-tx-rx** - selects 2-Port 'Split TX-RX' Duplexer Ready
  - **rx-filter-mode** - selects 3-Port 'Enhanced RX'

Monitoring

Status output for the 3-port LN interface appears identical to a standard LN transceiver radio with some additions where applicable. Additional information specific to the RX-only interface is presented with an "RX" suffix. This includes the following CLI items from the "`show interfaces-state interface LnRadio ln-status`" command:

- ln-status init-status-rx
- ln-status alarms-rx
- ln-status firmware-revision
- ln-status temperature-rx
- ln-status hardware-info serial-number-rx
- ln-status hardware-info hardware-id-rx
- ln-status hardware-info hardware-revision-rx

From the web UI this appears as:



3.5.6 Licensed Wideband (LW)

Understanding

Licensed Wideband operation is provided by the LW7 module. Orbit's Licensed Wideband uses OFDM (orthogonal frequency-division multiplexing) technology to offer higher data rates than traditional narrowband radios, while still providing very robust long-distance communication.

LW7 can act as a higher capacity interface for Ethernet and Serial controllers such as PLCs, RTUs and SCADA systems or act as a backhaul for lower capacity systems. The LW7 operates in channel sizes of 195 KHz, 315 KHz, and 570 KHz offering gross date rates from 100 kbps to 1.6 Mbps.

The specifications for the 700 MHz LW NIC module:

- Frequency Range: 757-758 MHz and 787-788 MHz
- Max Power Output: 20 dBm to 30 dBm in 1.0 dBm steps (DEFAULT = 30 dBm)
- Antenna Connector: TNC female
- 15 modulation rate / bandwidth combinations; as seen in Table 3-23
- 6 predefined channels; as seen in Table 3-24
- Channel Separation: 307.5 kHz minimum
- Operating Modes: Access Point, Remote, Store & Forward
- Point-to-Point, Point-to-multipoint
- FEC Rates: 1/2, 3/4
- Hybrid ARQ
- Gross Data Rates: 100 to 1600 kbps (depending on modulation)
- Net Data Rates: 50 to 1200 kbps (after FEC)
- TDD or FDD operation
- FCC ID: E5MDS-LW700
- Built in digital attenuator to enhance blocking in high noise environments

Table 3-23. Modulation and Bandwidth Combinations

	Net Data Rates (after FEC) & Sensitivity (10% PER rate)					
Channel	**570 KHz**	**Sensitivity dBm**	**315 KHz**	**Sensitivity dBm**	**195 KHz**	**Sensitivity dBm**
QPSK 1/2	200 kbps	-108	100 kbps	-109	50 kbps	-111
QPSK 1/2	400 kbps	-106	200 kbps	-107	100 kbps	-109
QPSK 3/4	600 kbps	-104	300 kbps	-106	150 kbps	-108
16-QAM 1/2	800 kbps	-101	400 kbps	-102	200 kbps	-105
16-QAM 3/4	1200 kbps	-96	600 kbps	-97	300 kbps	-101

Table 3-24. LW700 Channel Plan

Center Frequency (MHz)		Bandwidth (kHz)		
Low	**High**	**570**	**315**	**195**
757.00000	787.00000	FCC Band Edge Limit N/A		
757.17000	787.17000		-	1
757.24500	787.24500		1	
757.30125	787.30125		-	2
757.43375	787.43375		-	3
757.50000	787.50000	1	2	
757.56500	787.56500	-	-	4
757.69750	787.69750	-	-	5
757.75500	787.75500	-	3	
757.83000	787.83000	-	-	6
758.00000	788.00000	FCC Band Edge Limit N/A		

NOTE The only required steps for basic configuration are programing a network name in all units and establishing one unit as the AP.

Minimal configuration is necessary, but several advanced tuning facilities are provided.

By default, an LW unit will ship as a remote, set to automatically discover settings from an AP. When reconfigured as an AP the user must specify a Channel ID (1-6), a Duplex Setting, and Channel Size. The default AP settings from the factory specify Channel set to 1, Duplex Setting set to FDD TX low/RX high, and the 315kbps modem selected.

With advanced configuration, it is possible to restrict the range of adaptive modulation, set alarm thresholders, and specify other attributes.

Adaptive Data Rate

The adaptive data rate mode allows the traffic to adjust which modem and FEC rate is used bi-directionally, on a per remote basis. This works for direct and Store and Forward networks.

The primary use case for this feature is if an AP has some remotes that are close to the AP and could support a higher data rate and some farther away that can only support a lower data rate. This mode allows the close remotes to take advantage of the higher data rate for the uplink, when otherwise the whole network would have had to be run at the lower data rate. Downstream broadcast and multicast traffic is always sent at the lower data rate defined by Modulation Low in the Advanced Menu.

Security

Setting the security mode to EAP or PSK will enable device authentication. When enabled, the remotes will authenticate with the AP (PSK) or a backend RADIUS server (EAP) before they are allowed to pass data on the network. The authentication protocol is compliant with IEEE 802.1X. If device authentication is enabled, over the air data encryption can also be enabled. This ensures all over the air traffic is protected. When encryption is enabled, the device must occasionally rotate the encryption keys. This rotation is logged in the event log with event type nx_auth. These events can be suppressed in the event log configuration to prevent them from filling the event log. See section 3.6.2 for instruction on controlling the event log.

Configuring

Basic configuration with defaults

Navigate to: ***Interfaces / LwRadio ---> Basic Config / Lw Radio***

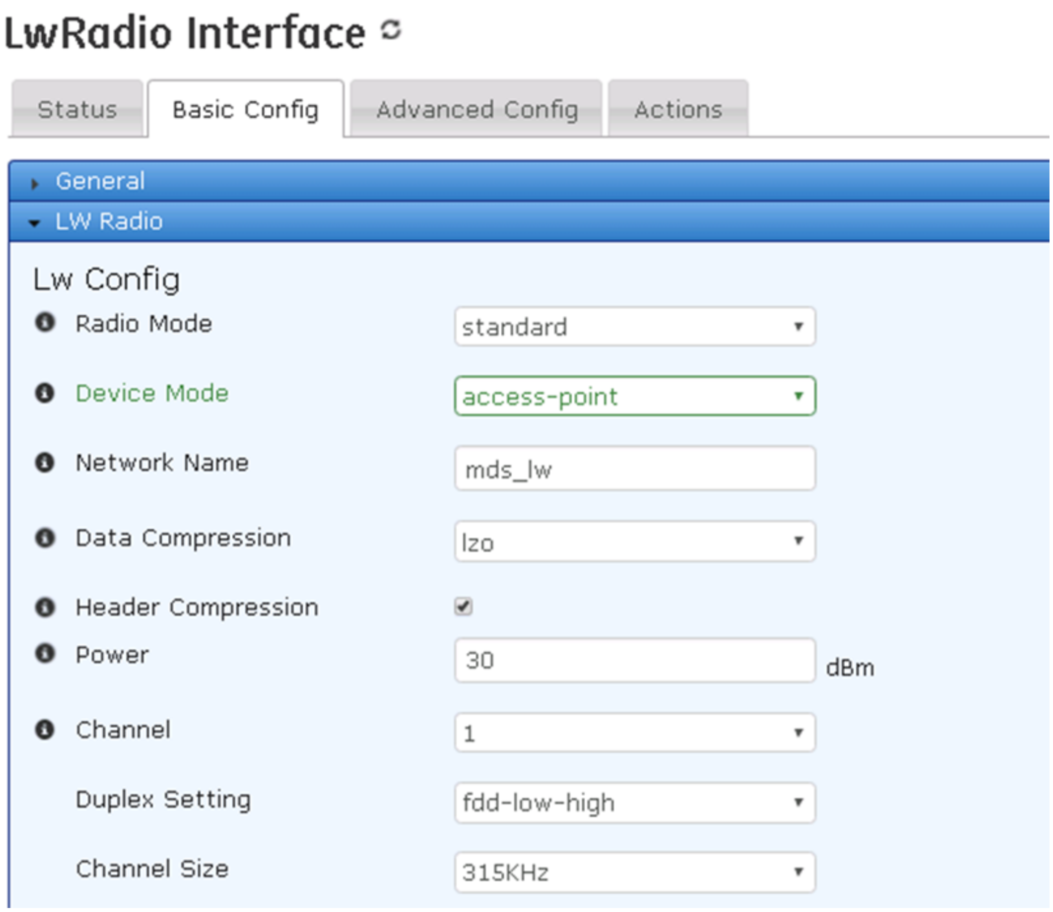


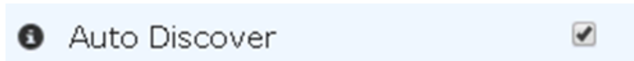
Figure 3-84. LW7 AP Configuration Settings

- **Radio Mode**
    - **standard –** standard operating mode (DEFAULT)
- **Device Mode** - Sets the role the radio will assume in the network.
    - Remote (DEFAULT)
    - Access Point
    - Store and Forward Node
- **Network Name** - The name of the network. Used to control what networks is connected to. Valid values: 1 to 31 letters (DEFAULT is mds_lw). The network name string is used to identify the logical network the device as a member of a network. If the network name does not match, the device will log an event, to identify network name collisions.
- **Data Compression** – Over the air compression
    - lzo - Compresses the over the air traffic with the LZO algorithm
    - none - No data compression (DEFAULT)
- **Header Compression –** Disabled by DEFAULT. Enable/disable over the air robust header compression. This feature compresses IP headers to improve system performance and is most

useful in applications that rely on IP packets with small payloads, such as terminal server operations or MODBUS polling. This setting must match on each radio (Remote and AP).

NOTE Header Compression and packet concatenation should be disabled when using links with marginal RF performance, due to higher probability of packet errors.

- **Power** - The transmit power of the radio: Valid values: 20 - 30 dBm – DEFAULT is 30dBm



- **Auto Discover (*Remotes only*)** – Enabled by DEFAULT. When enabled Remotes learn Channel, Duplex Setting, and Channel Size from the corresponding AP. Disabling Auto Discover enables manual configuration of these items. Manual settings may be helpful for bench testing but are discouraged for typical deployments. Auto Discover enabled is the recommended mode.
- **Channel (*typically AP only*)** – Logical Channel Section, Valid Values 1-6 - DEFAULT is 1
  - Channel selection provides a method to support simple configuration of overlapping networks. See Table 3-24. Consult GE Vernova MDS for channel reuse recommendations.
- **Duplex Setting (*typically AP only*)** – Channel Split configuration - DEFAULT is fdd-low-high
  - fdd-low-high –split frequency, TX Low and RX High (recommended for masters) (DEFAULT)
  - fdd-high-low – split frequency, TX High and RX Low (recommend for remotes)
  - tdd-low – Single frequency operation in the 757-758MHz range
  - tdd-high – Single frequency operation in the 787-788MHz range
- **Channel Size (*typically AP only*) –** Channel Size choice offers the ability to trade throughput for range and channel reusability. Setting will depend on application need.
  - 570KHz – 570KHz channel, w/ net data throughput of 200 to 1200 kbps
  - 315KHz – 315KHz channel, w/ net data throughput of 100 to 600 kbps (DEFAULT)
  - 195KHz – 195KHz channel, w/ net data throughput of 50 to 300 kbps

Figure 3-85. LW EAP Security Settings

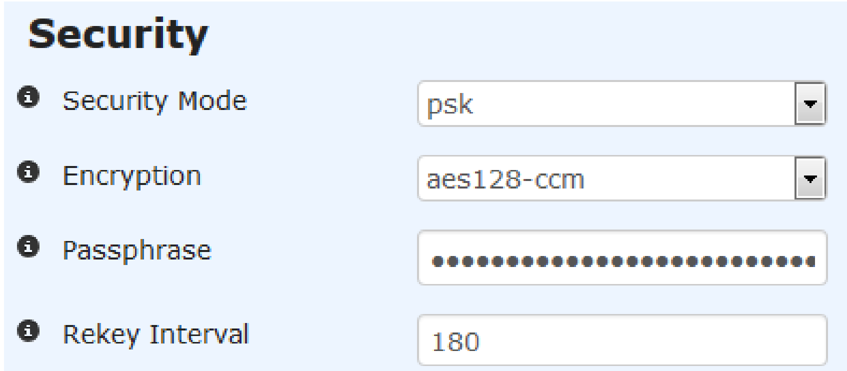


Figure 3-86. LW PSK Security Settings

- **Security Mode** - The type of authentication to perform
    - none - Provide no device authentication or data privacy (DEFAULT)
    - psk - Use pre-shared key authentication protocol
    - eap - Use Encapsulated Authentication Protocol - will change the fields displayed and give the user the ability to enter radius info on the AP and certificate info on the remote.
- **Encryption** - The type of encryption to perform
    - none - No data privacy (DEFAULT)
    - aes128-ccm - Protect data with 128-bit AES encryption using CCM mode
    - aes256-ccm - Protect data with 256-bit AES encryption using CCM mode
- **Passphrase** -The key material used in PSK mode. This may be a passphrase 8-64 characters long, or a hexadecimal value (0-9, a-f, A-F) of 64 characters. (DEFAULT=blank)

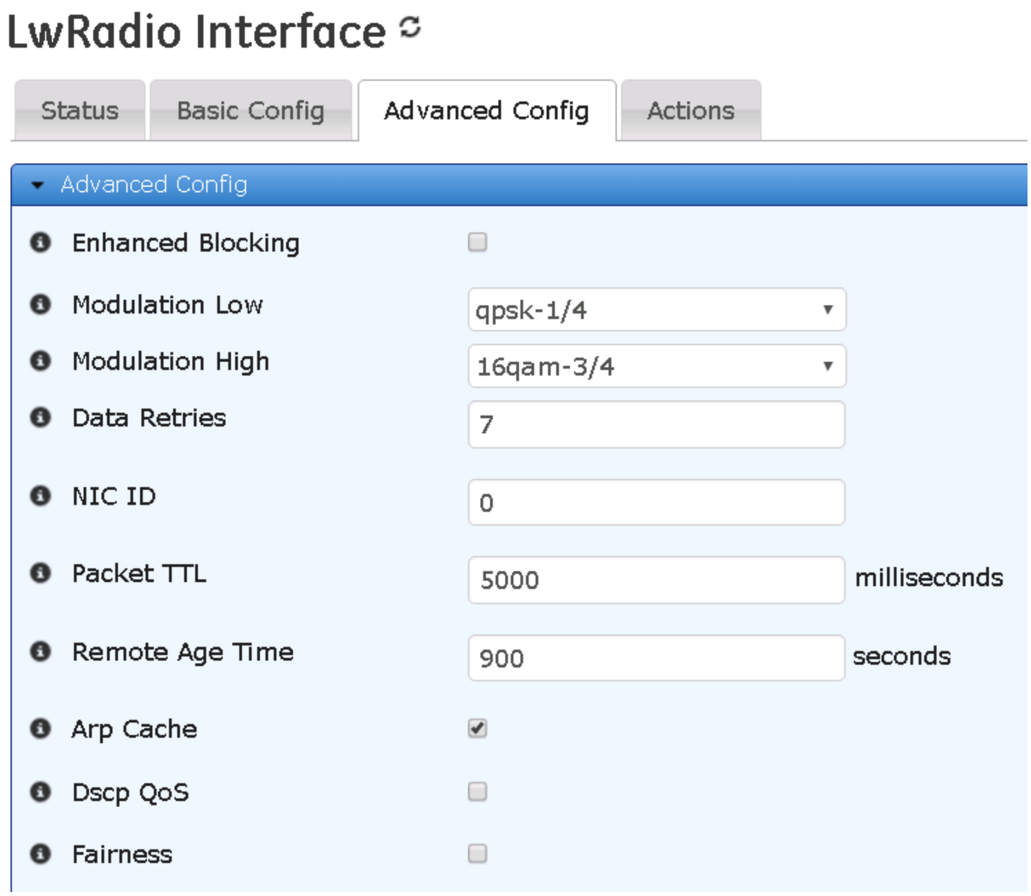
NOTE In FIPS mode, passphrases are not allowed. Only a 64-character hexadecimal value is permitted.

- **Radius Server** – A reference to the RADIUS server configuration configured through the System – RADIUS side menu item (section 3.7.6).
- **Rekey Interval –** The session key for an active secure link changes at a regular basis. You may increase the length of the rekey interval in order to reduce overhead caused by the rekeying communications between radios on a narrowband channel. Valid values:
    - 0 – Rekeying will not be time-based but will instead occur every one million packets.
    - 30-525600 minutes, DEFAULT 180

NOTE Remember to click on the **Save** button when finished.

Advanced configuration with defaults

Navigate to: ***Interfaces / LwRadio ---> Advanced Config / Advanced Config***



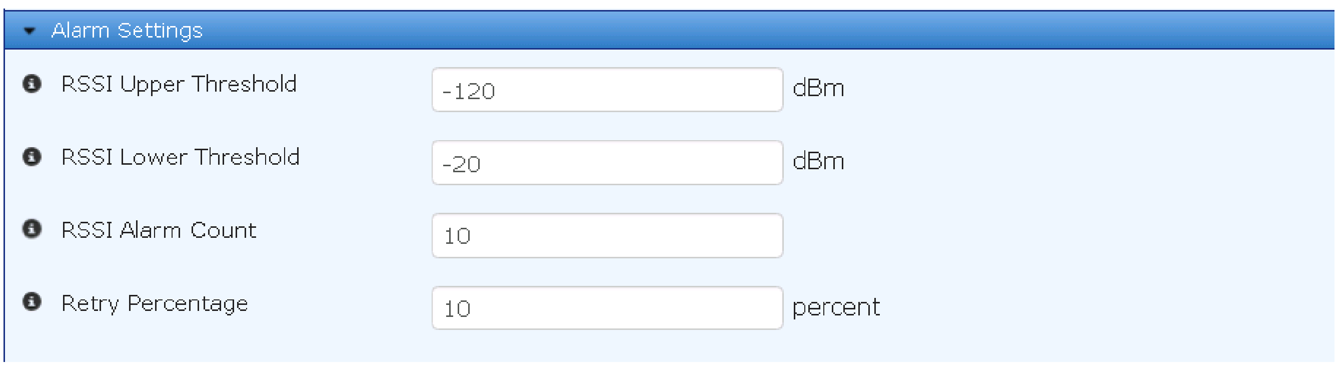
- **Enhanced Blocking -** Disabled by DEFAULT. When enabled the LW7 will be more immune to interference, but sensitivity will be slightly reduced. Recommended for high RF noise environments.
- **Modulation Low -** Controls the lower bound for Adaptive Modulation
- **Modulation High -** Controls the upper bound for Adaptive Modulation

  Lower Modulation has highest sensitivity. Higher Modulation has higher throughput.
  - qpsk-1/4 – OFDM QPSK with 1/4 FEC encoding
  - qpsk-1/2 – OFDM QPSK with 1/2 FEC encoding
  - qpsk-3/4 – OFDM QPSK with 3/4 FEC encoding
  - 16qam-1/2 – OFDM 16QAM with 1/2 FEC encoding
  - 16qam-3/4 – OFDM 16QAM with 3/4 FEC encoding (DEFAULT for Modulation High)
- **Data Retries** - Number of times to retry unicast data before declaring failure. Valid values: 0—15, DEFAULT = 3.
- **NIC ID – ADVANCED SETTING - DO NOT CHANGE** - Manually overrides the NIC identifier.
- **Packet TTL (Time-to-Live)** – Length of time, in milliseconds, of inactivity of all over-the-air traffic before registering a disconnection. The radio will then attempt to reconnect to the network. Valid values: 100 to 65535 ms, DEFAULT = 2000 (2 seconds).

- **Remote Age Time** – Length of time, in seconds, of inactivity of a remote before it is disconnected. Valid values: 180-4294967295 seconds, DEFAULT = 600 (10 minutes).
- **Endpoint Age Time *(AP only)*** **-** Length of time in seconds of inactivity on an endpoint before it is removed from the endpoint database. Range of 0 to 4294967295 seconds. DEFAULT = 300 (5 minutes).
- **Allow Retransmit *(AP only)*** – All traffic from the remotes is sent to the AP. When enabled the AP will retransmit traffic from one remote to another based on the MAC address. It will also resend any remotes broadcast traffic to all other remotes. Disabled by DEFAULT.
- **ARP Cache** – Enabled by DEFAULT. When enabled, the radio will respond to ARP requests intended for other network devices with known addresses. It will not forward the ARP to the intended device. This is similar to ARP proxy. See APPENDIX L – Understanding ARP Cache
- **DSCP QoS** – Disabled by DEFAULT. When enabled, the radio will use the QOS field of DSCP to prioritize access to the RF channel. This provides an opportunity for high priority data to get through in the event of a network congestion event where multiple remotes request simultaneous access to the channel. Use this option with caution. Enabling this option will typically decrease system throughput and will increase latency for all non-prioritized traffic.
- **Fairness** – Disabled by DEFAULT. Enabling fairness will keep a nearby remote starving a distant remote when both have data to send at the same time. Enabling Fairness may increase average system latency for accessing the channel.

To configure radio based alarm thresholds use the following:

Navigate to: ***Interfaces / LwRadio ---> Advanced Config / Alarm Settings***



- **RSSI Upper Threshold** – If the received RSSI signal is stronger than this value for more than “RSSI Alarm Count” samples, then the unit will generate an alarm. Valid values: -20 to -120 dBm, DEFAULT = -120
- **RSSI Lower Threshold** – If the received RSSI signal is weaker than this value for more than “RSSI Alarm Count” samples, then the unit will generate an alarm. Valid values: -20 to -120 dBm, DEFAULT = -120
- **RSSI Alarm Count** – This is the number of failed threshold samples prior to issuing an alarm. It provides a mechanism to introduce hysteresis into the RSSI alarm reporting mechanism.
- **Retry Percentage** – This is a threshold applied to a running average of the number of retries required to transmit a data packet. If the retry percentage is above the threshold an alarm is issued.

Monitoring

General Interface information: ***Interfaces / LwRadio ---> Status / General***

Monitoring facilities for LW7 are similar to the monitoring capabilities provided for NX and LN radios.

Test Mode

Test modes are available from the web and from the CLI. The example below is for the CLI.

To enter Test Mode and key the transmitter with random data for 5 minutes:

> **request interfaces-state interface *LwRadio* lw-status test-mode state keyed-random time *5***

To enter Test Mode's receive state for 5 minutes:

> **request interfaces-state interface *LwRadio* lw-status test-mode state receive time *5***

To exit Test Mode:

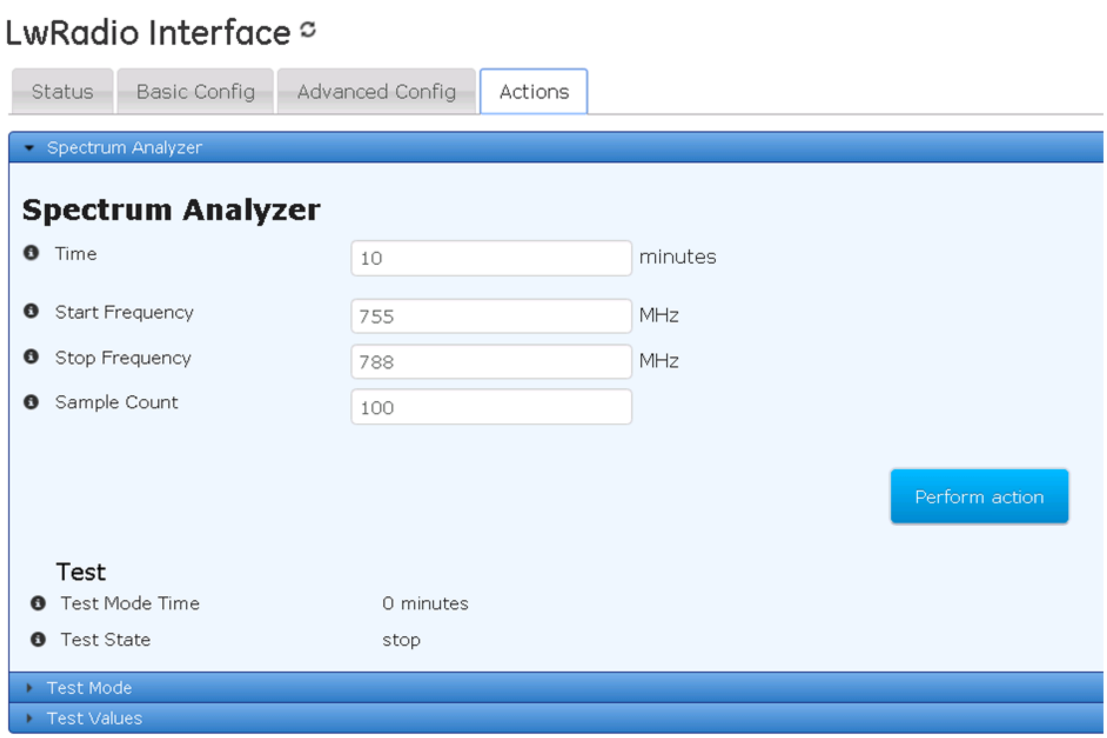
> **request interfaces-state interface *LwRadio* lw-status test-mode state** *stop*

To display the current test state:

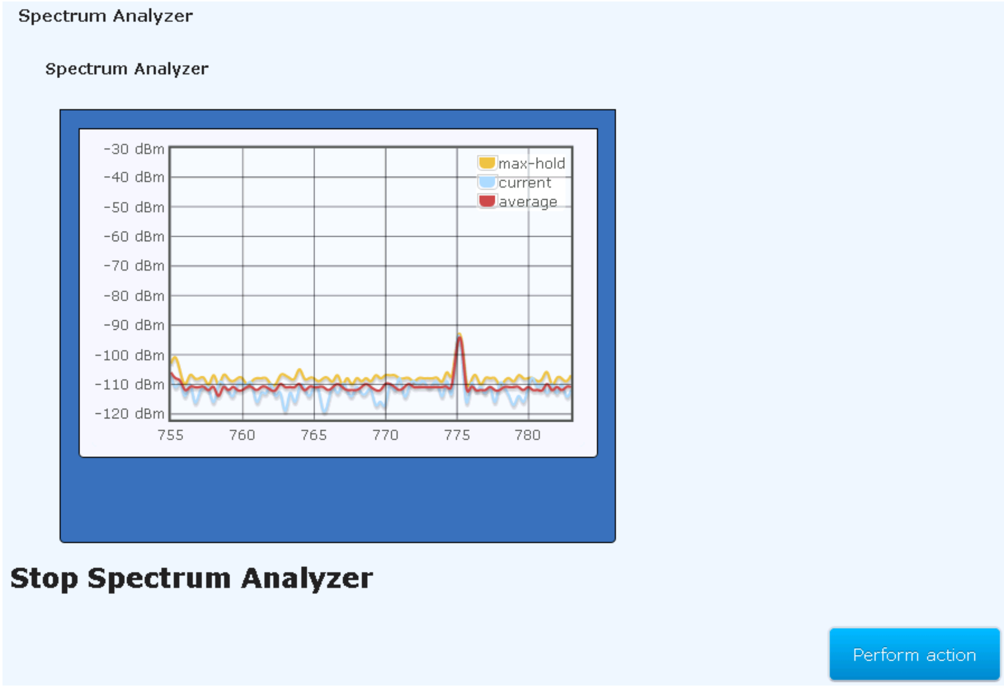
> **show interfaces-state interface *LwRadio* lw-status test**

LW7 introduces a spectrum analyzer useful for analyzing channel interference when verifying a channel re-use plan.

From the web: Navigate to: ***Interfaces / LwRadio ---> Actions / Spectrum Analyzer***



Select the "Perform Action" button to start gathering data.



The display will continually refresh until the “Perform action” button is selected again.

3.5.7 BPL (PL1)

Understanding

Broadband over Power Lines (BPL) is a a form of Power Line Communication (PLC) technology. By utilizing existing power lines for data transmission, BPL can expand broadband availability in areas where traditional connectivity options may be limited

Orbit implements a BPL NIC based on Nessum WIRE technology rooted in two international standards: IEEE 1901:2020 and ITU G.9905. In addition to power lines it can be used for other lines such twisted pair and coaxial cable.

The Nessum wire interface enables operators to extend broadband secure and reliable network for critical applications. The Nessum wire interface facilitates reuse of existing cables for signal transmission: power lines or signal cables such as pilot wires.

The specifications for the PL1 NIC module:

- Frequency Range (based on two selectable channels):
  - Channel ‘x-4’: 1.7 to 7 MHz
  - Channel ‘x-5’: 8 to 15 MHz
- Maximum Data Rate:
  - Channel ‘x-4’: 34 Mbps
  - Channel ‘x-5’: 42 Mbps
- Modulation: Wavelet OFDM (per IEEE 1901:2020)
- Real Time adaptive modulation (2-PAM to 16-PAM) and FEC per carrier
- Maximum Power Output (PSD): -35dBm/Hz
- Typical Power Output (PSD): -48dbm/Hz
- Power control (fine adjustment): 0 to -42db
- Power control boost (coarse adjustment): 0db, 6db, 12db
- Operating Modes: Master, Terminal
- Point-to-Point, Point-to-multipoint
- Scalable networks using CSMR auto routing protocol ITU-T G.9905
- Output Impedance: 50 Ohms
- Connector: 6-Pin Phoenix (Cable adapter available to split into 2 BNCs)

NOTE The only required steps for basic configuration are programing all units to the desired channel and establishing one unit as the master.

Minimal configuration is necessary, but advanced tuning facilities are provided to adjust power and create notches in the transmit frequency allocation.

By default, a BPL unit will ship as a terminal, with channel set to “x-4”, no notch filters defined, and power set to a nominal -47dbm/Hz (TX Power = 0, and TX Offset = 0). For Medium power use TX Power = 0 and TX Offset = 6; for High power use TX Power = -3 and TX Offset = 12.

The table below describes the LED behavior for a BPL Interface.

Table 3-25. BPL Interface LED Descriptions

LED – NIC2	State	Description
BPL Interface	Off	Interface disabled
	Solid Green	Interface enabled
	Solid Red	Interface in errored state

Security

Orbit provides the ability to program an allow (pass) or disallow (block) list of MAC address associated with the BPL interface. This provides an initial defense against unauthorized connections.

In system, BPL acts as a layer 2 bridge therefore all other higher layer Orbit security methods are still applicable and can be applied.

Configuring

Basic configuration with defaults

Navigate to: ***Interfaces / BPL ---> Basic Config / BPL***

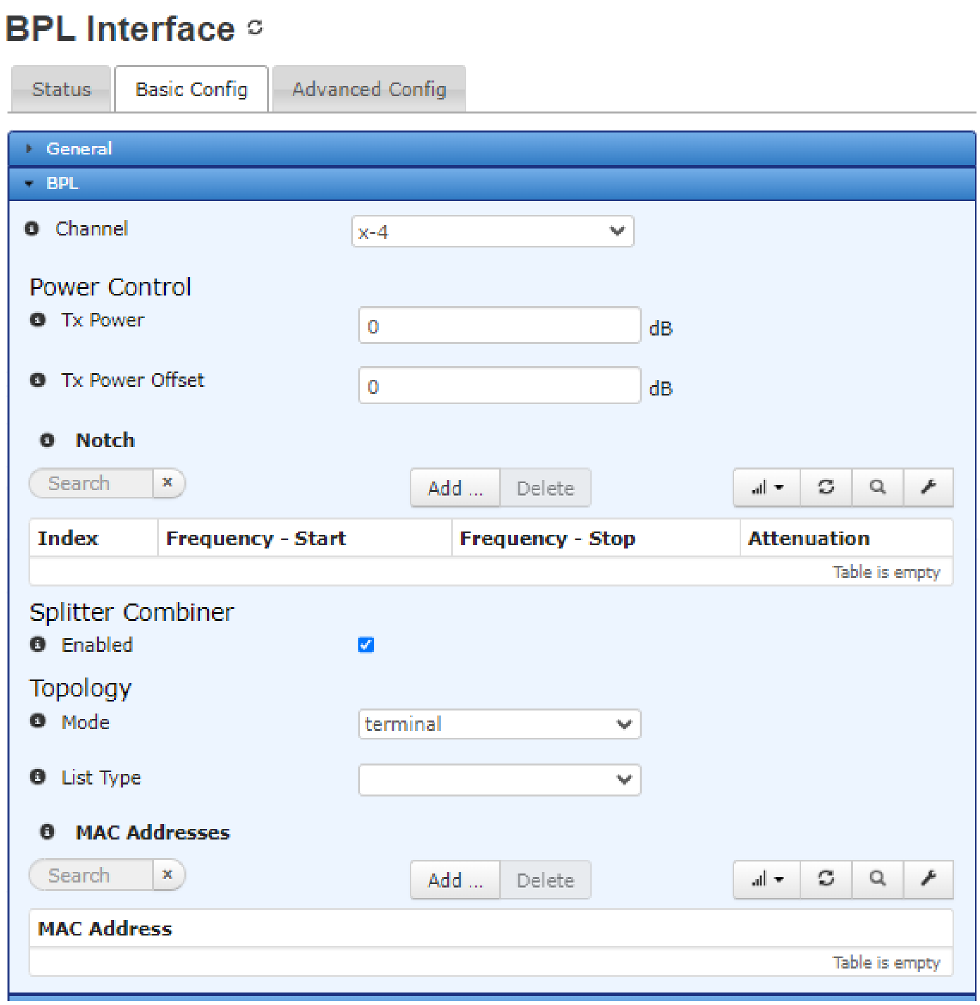


Figure 3-87. BPL Configuration Settings

- **Channel** – sets the BPL operating frequency range
  - x-4 – selects operation from 1.7 to 7 MHz (DEFAULT)
  - x-5 – selects operation from 8 to 15 MHz
- **Tx Power** – sets BPL fine power control: Valid values: 0 - -127 dB– DEFAULT is 0db
- **Tx Power Offset** – sets BPL coarse power control (power boost) in dB.
  - 0 – output power (with TX Power 0) is nominally -47 dBm/Hz (DEFAULT)
  - 6 – output power (with TX Power 0) is nominally -41 dBm/Hz
  - 12 – output power (with TX Power 0) is nominally -35 dBm/Hz

---

NOTE To avoid saturation, for maximum power we recommend setting **Tx Power** to -3 and **Tx Power Offset** to 12.

- **Notch** – This attribute sets one or more transmit spectrum notches. Notches apply attenuation at select frequency ranges to control interference with other systems as needed. Select "Add…" to define a new notch. Each entry require an index, a start frequency, a stop frequency, and an attenuation (specified as a negative gain).

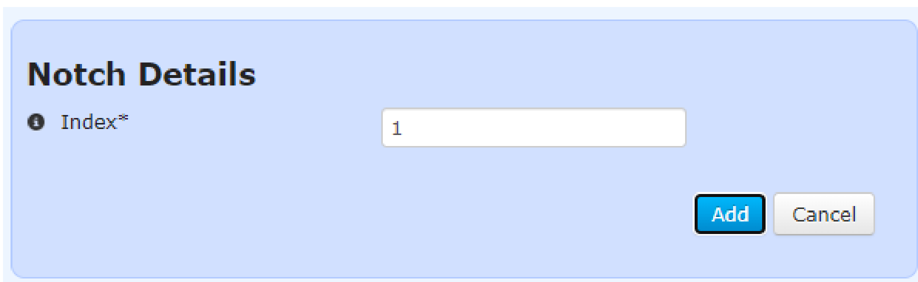


Figure 3-88. BPL notch index

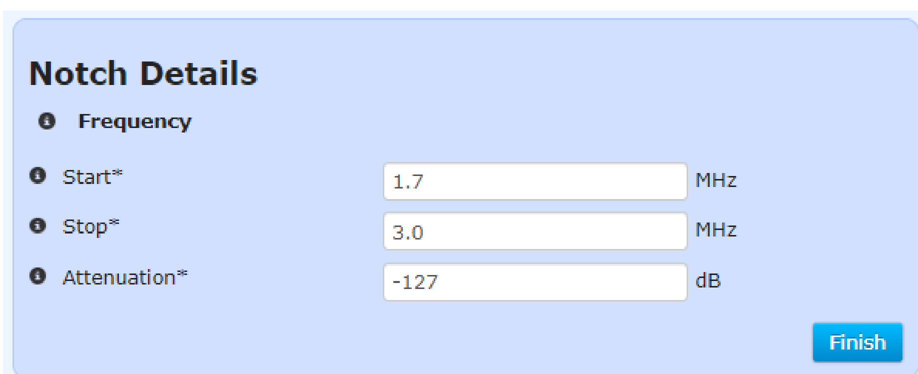


Figure 3-89. BPL notch details

- **Splitter/Combiner** - *This checkbox setting is reserved for future use*
- **Mode -** Sets the role the BPL device will assume in the network.
  - terminal (DEFAULT)
  - master (note that only 1 master should exist in a given network)
- **List Type** – Establishes the type of Layer 2 access control list, implemented in the NIC
  - pass – MAC addresses represent a list of BPL interfaces allowed in the network
  - block – MAC addresses represent a list of BPL interfaces to disallow in the network
  - (blank) – If neither is specified and no MAC addresses are entered, setting is N/A

- **MAC Addresses** – Defines the list of MAC addresses for the access control list above. Select "Add…" to enter a new MAC address to the list.

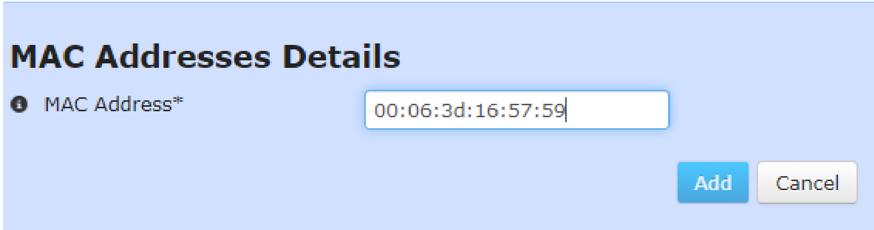


Figure 3-90. Adding a MAC address for BPL access list control

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NOTE Remember to click on the **Save** button when finished.

Monitoring

For General Interface information: ***Interfaces / BPL ---> Status / General***

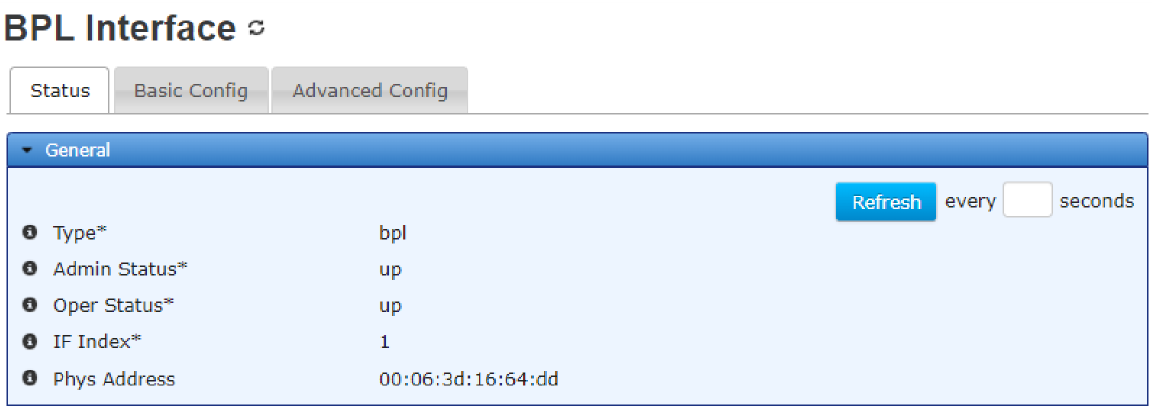


Figure 3-91. BPL general status

- **Type** - The type of the interface. BPL modules appear as "bpl."
- **Admin Status** - The desired state of the interface.
- **Oper Status** - The current operational state of the interface.
- **If Index** - The index value for this interface in the Orbit's interface table. Valid values are: 1-2147483647
- **Phys Address**- The interface's address at its protocol sub-layer. For a BPL module, this object normally contains a MAC address.

For statistics: ***Interfaces / BPL ---> Status / Statistics***

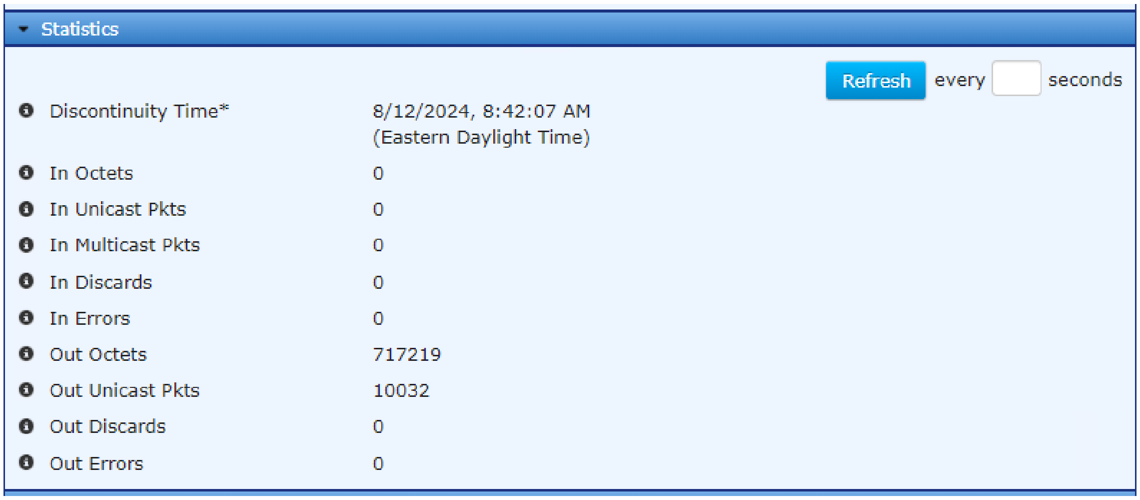


Figure 3-92. BPL statistics

- **Discontinuity Time** - The time on the most recent occasion at which one or more of this interface's counters suffered a discontinuity.
- **In Octets** - The total number of octets received on the interface, including framing characters.
- **In Unicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
- **In Multicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer.
- **In Discards** - The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
- **In Errors** - For packet-oriented interfaces, the number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
- **Out Octets** - The total number of octets transmitted out of the interface, including framing characters.
- **Out Unicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Discards** - The number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted.
- **Out Errors** - For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors.

For BPL specific data: ***Interfaces / BPL ---> Status / BPL***

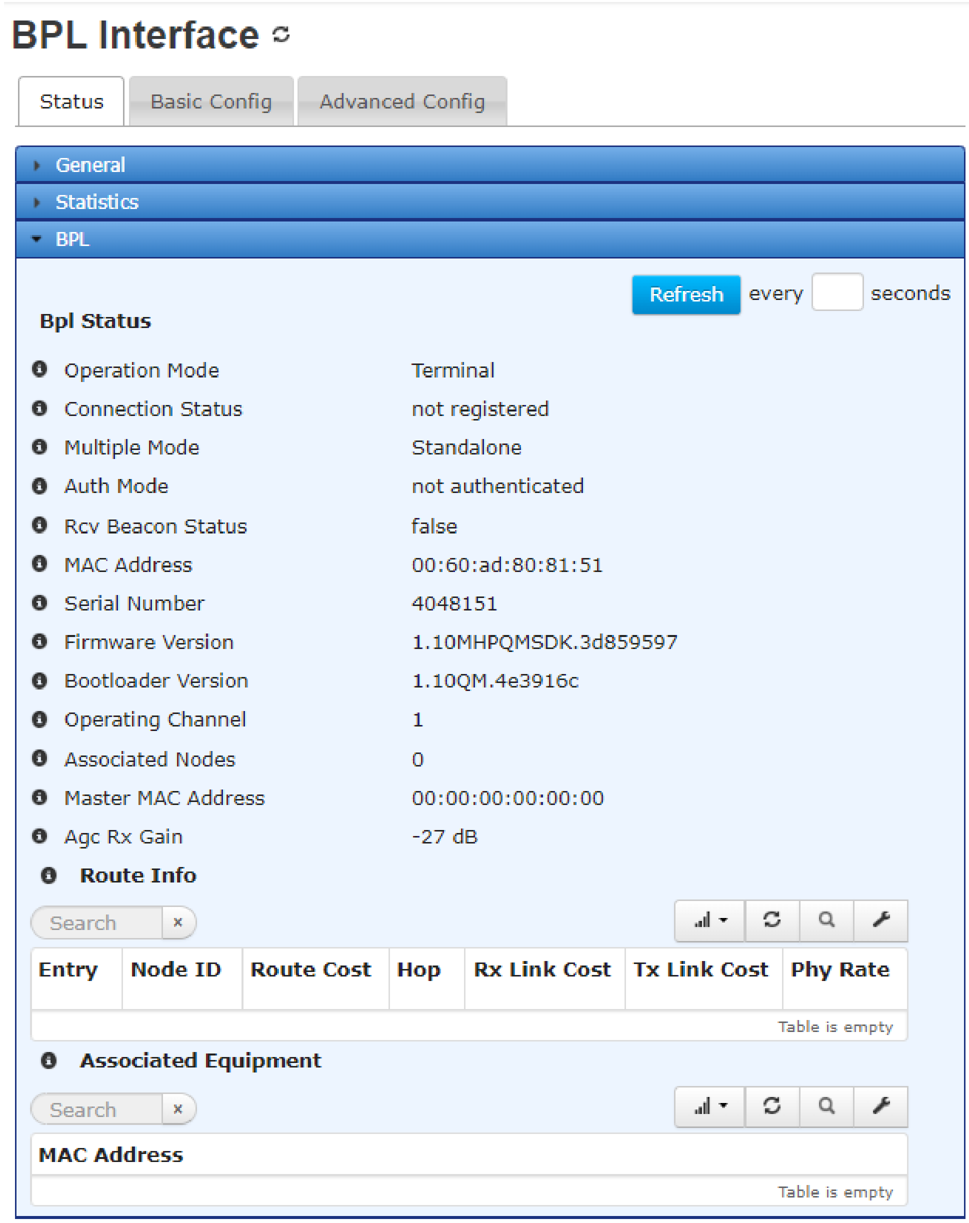


Figure 3-93. BPL interface status

- **Operation Mode** – How the device is configured
  - Terminal – terminal device
  - Master
- **Connection Status –**
  - registered – the device is connected to a master
  - not registered – the device is not connected
- **Multiple Mode –**
  - Standalone
  - Subnet-Mode

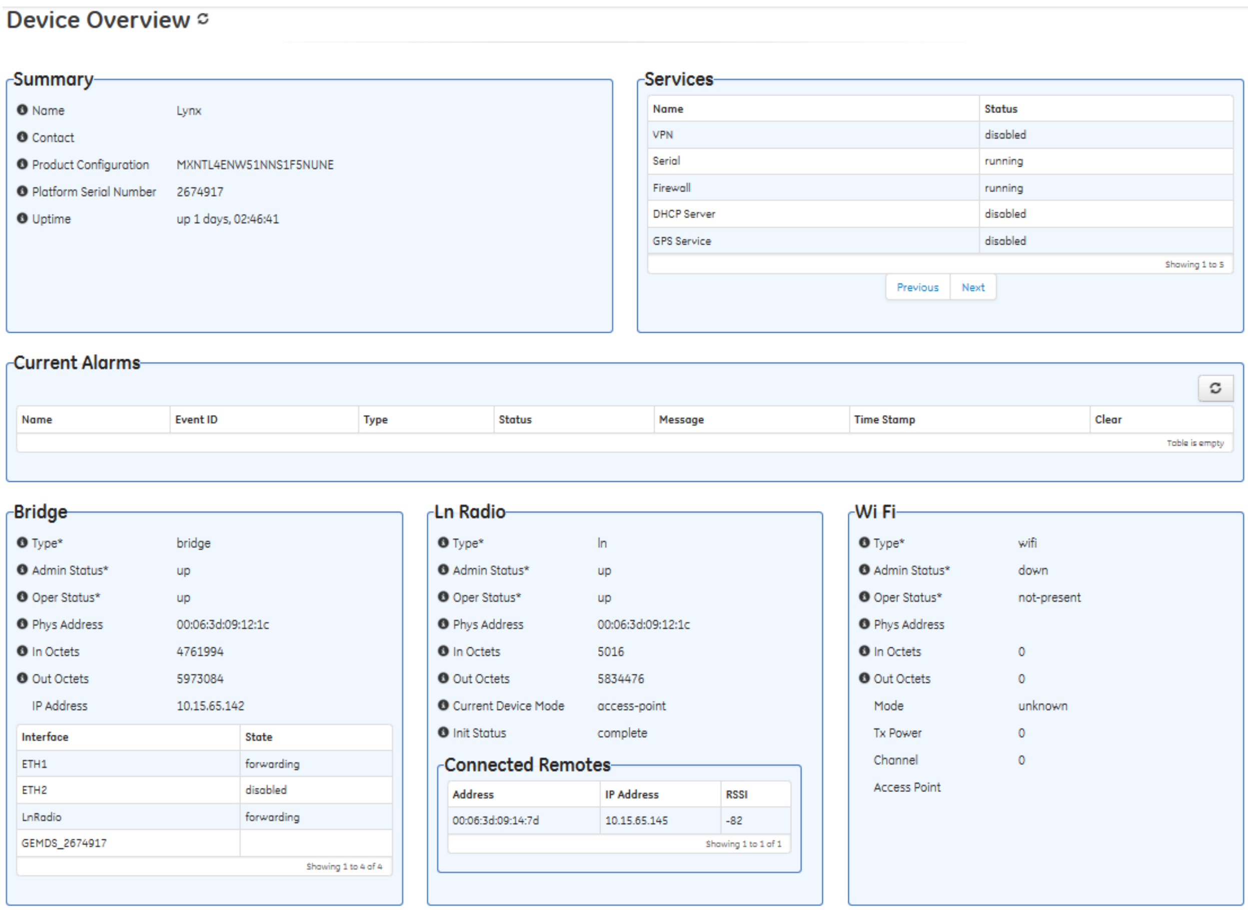
- **Auth Mode –**
  - Not authenticated – terminal does not see master
  - (For a terminal) Mac Address of Master if authenticated
  - (For a master) Count of the number of connected terminals
- **Rcv Beacon Status**
  - False (if a terminal is not seeing beacons from a master)
  - True (if a master or if a terminal seeing beacons from a master)
- **MAC Address** – MAC address of the device
- **Serial Number** – Serial Number of the Orbit device
- **Firmware Version** – Application Firmware version of the NIC
- **Bootloader Version** – Bootloader Firmware version of the NIC
- **Operating Channel** – Current operating channel
- **Associated Nodes**
  - (For a terminal) – always returns 0
  - (For a master) Count of connected nodes
- **Master MAC Address**
  - (For a terminal) – if connected, returns the Master's MAC address
- **Agc Rx Gain –**receiver automatic gain value
- **Route Info –** displays topology for connected nodes
- **Associated Equipment –** displays MAC addresses for all managed devices

3.6 System Health and Status

3.6.1 Device Overview

Understanding

The *Device Overview* screen is displayed upon initial UI logon and provides a quick view of the device status including the product identification information, alarms and interface status.



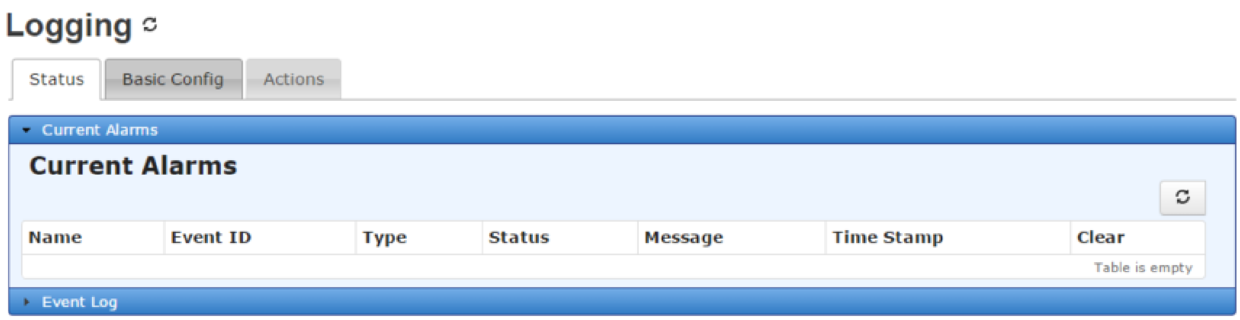
3.6.2 Event Logging

Understanding

An event is a notification that something meaningful occurred on the unit. Events contain information about the occurrence that may be useful for administrators. *An alarm is different from an event*. All alarms are caused by events; but not all events generate alarms.

Default behaviors can be viewed by examining entries under the “Default Event Rule” and “Default Alarm Output” tabs. Overriding of default behaviors is effected by adding entries under the “Event Rule” and “Alarm Output” tabs. The designation of whether an event triggers an alarm is user configurable. (Refer to “Alarms” on Page 209 for more detail).

Events can be stored locally and/or transported to a remote server by using the log export feature and then clearing the log.



Also the device supports external logging using SysLog or the Netconf - as described below. Administrators can override the default event handling of the unit.

The unit is designed to store up to 10100 events before rolling over losing event history. An alarm (**eventlog_high_water**) is generated when approaching the maximum event storage limit. Another alarm (**eventlog_full**) is generated when the maximum value is reached. Each time the log reaches the maximum the value 100 oldest events will be deleted.

By default for security the logging is configured to be verbose and the log file may fill in a relatively short time for a very active system.

All events can be configured to be logged to any combination of the following locations based on the event type:

- **Local**: Store event in the local event log.
- **Netconf-notification**: generate a NETCONF notification
- **Syslog**: Forward events to a remote syslog server.

There are a number of default rules which can be modified to be active on the web UI. Refer to the **Default Event Rule** table located on the page ***Logging---> Basic Config.***

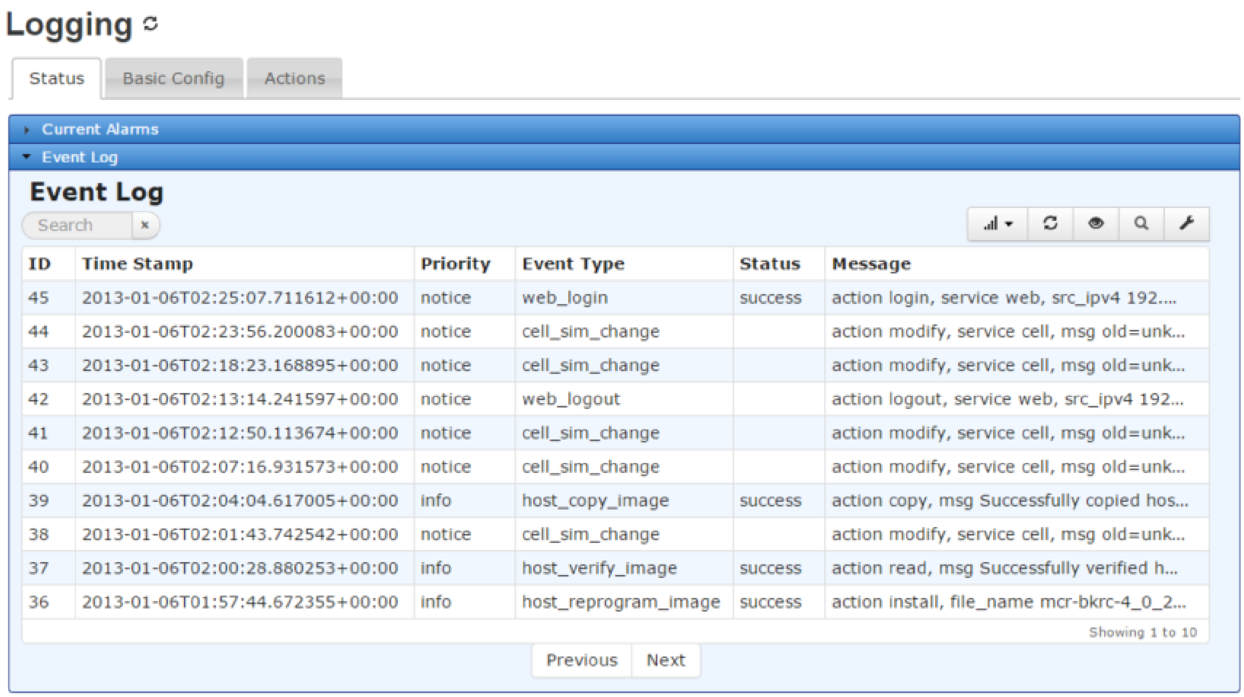
Each rule has the following setting types:

- **Name** - system recognized short name
- **Description** - Supplied descriptive text
- **Local** - If true, this event is stored in the local event log. True/False
- **Priority** - If logging to Syslog
  - alert - action must be taken immediately
  - crit - critical condition
  - debug - debug-level messages
  - emerg - system is unusable
  - err - error condition
  - info - informational set
  - notice - normal but significant condition
  - warning - warning condition
- **Syslog Facility** - If logging to SysLog selection of : auth, authpriv, cron, daemon, ftp, kern, lpr, mail, news, syslog, user, uucp, local0, local1, local2, local3, local4, local5, local6, local7
- **Syslog** - If true, forward events of this type to a syslog server.
- **SNMP Notification** - If true, generate an SNMP notification (trap or inform) for events of this type.
- **SNMP Notify Name** - Selection of a set of management targets which should receive notifications, as well as the type of notification (trap/inform). These should be sent to each

selected management target. If the notify-name is not configured, the notification is sent to all configured targets

- **NETCONF Notification** - If true, generate a NETCONF notification for events of this type.
- **Alarm** - If true, generate an alarm for events of this type.
- **Alarm Outputs** – Define which outputs are associated with the alarm for events of this type. (Outputs may include flashing the POWER_LED, asserting a COM1_PIN output, and a BOOT_ERROR which drives an error message display on next boot-up)

Logs are stored in the Event Log, which may be viewed on the Web UI by navigating to ***Logging ---> Status*** and scrolling down to ***Event Log*** section, as shown in the following example.



ID	Time Stamp	Priority	Event Type	Status	Message
45	2013-01-06T02:25:07.711612+00:00	notice	web_login	success	action login, service web, src_ipv4 192....
44	2013-01-06T02:23:56.200083+00:00	notice	cell_sim_change		action modify, service cell, msg old=unk...
43	2013-01-06T02:18:23.168895+00:00	notice	cell_sim_change		action modify, service cell, msg old=unk...
42	2013-01-06T02:13:14.241597+00:00	notice	web_logout		action logout, service web, src_ipv4 192...
41	2013-01-06T02:12:50.113674+00:00	notice	cell_sim_change		action modify, service cell, msg old=unk...
40	2013-01-06T02:07:16.931573+00:00	notice	cell_sim_change		action modify, service cell, msg old=unk...
39	2013-01-06T02:04:04.617005+00:00	info	host_copy_image	success	action copy, msg Successfully copied hos...
38	2013-01-06T02:01:43.742542+00:00	notice	cell_sim_change		action modify, service cell, msg old=unk...
37	2013-01-06T02:00:28.880253+00:00	info	host_verify_image	success	action read, msg Successfully verified h...
36	2013-01-06T01:57:44.672355+00:00	info	host_reprogram_image	success	action install, file_name mcr-bkrc-4_0_2...

From the CLI this can be viewed with the command:

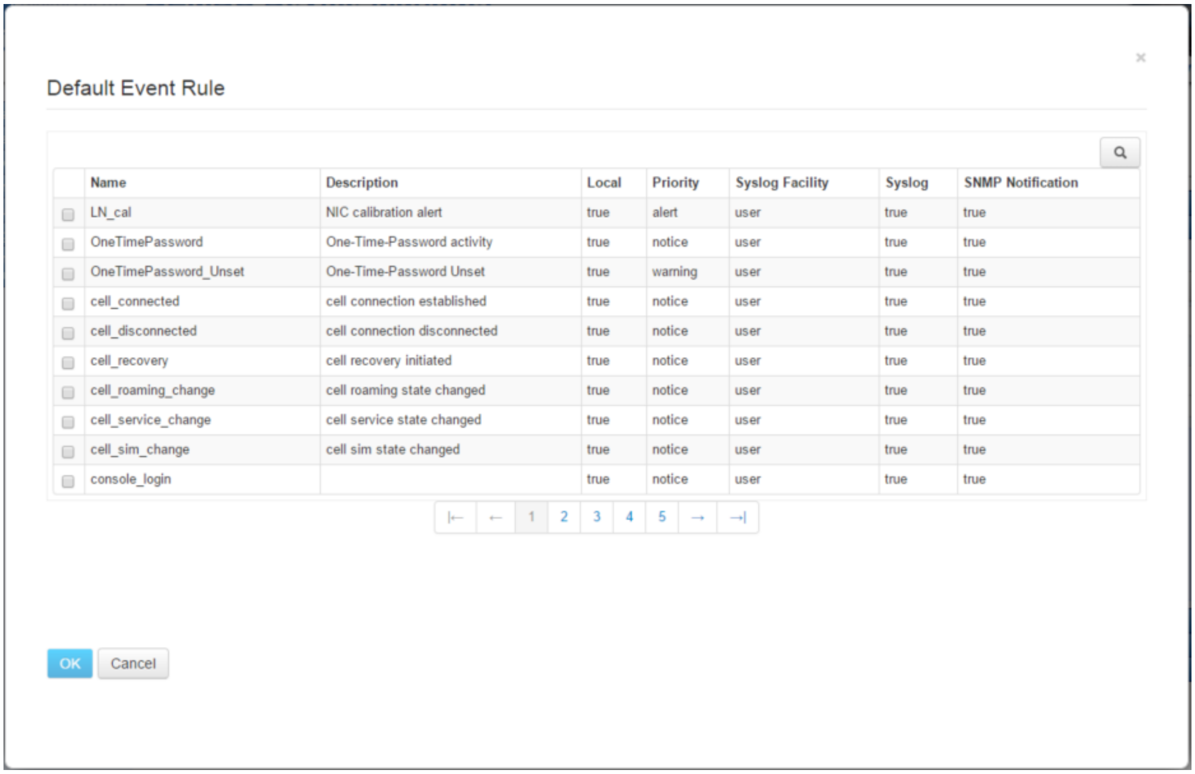
> **show table logging event-log**

The default setting may be overridden by adding an event rule. For example the follow shows the cell connect/disconnect disabled for local logging - this would be useful in an environment where the cell modem reconnects many times as part of normal operations.

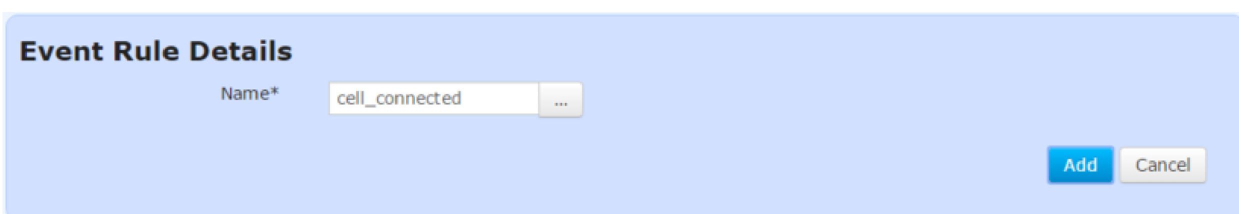
Name	Description	Local	Priority	Syslog Facility	Syslog	SNMP Notification
cell_connected		true	notice	user	false	false
cell_disconnected		true	notice	user	false	false

Click on **Add…** and the *Event Rules Details* option will appear.

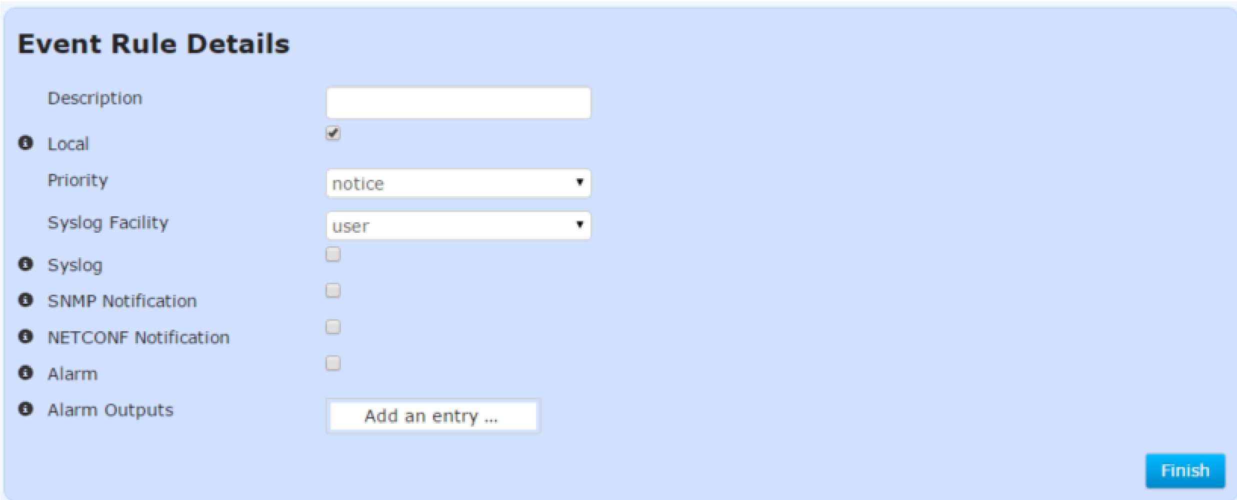
Click on the button to the right of the Name field to locate the event rule to configure. This will automatically bring up the popup shown on the previous page.



Once selected, click the **OK** button to close the popup and then click on the **Add** button when finished.



Clicking on the add buton will display the *Event Rule Details* option. Clicking the **Finish** button will add the event rule.



From the CLI this modification can be made with the commands:

% set logging event-rule cell_disconnected **local** true
% set logging event-rule cell_connected **local** true

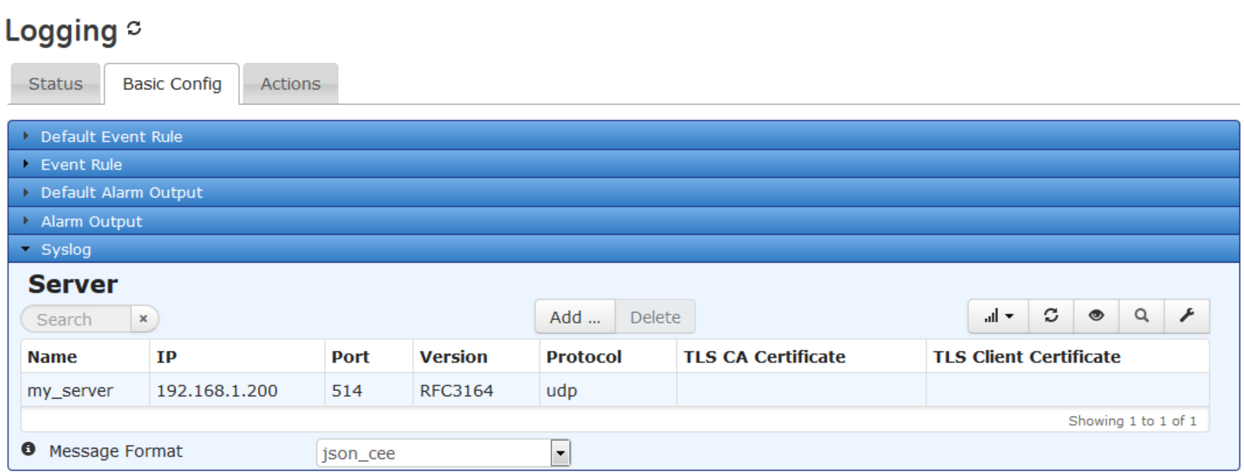
NETCONF-notifications

The events generated by the unit are converted to NETCONF notifications. NETCONF clients can subscribe to the unit to receive those notifications.

Syslog Server Setup

The events generated by the unit can be sent to remote syslog servers. The connection to the syslog server can be made secure using syslog over TLS.

For example:



- **Name -** User supplied unique name to identify this server configuration
- **IP** - The hostname or IPv4 address of the syslog server.
- **Port** - The port to connect to. DEFAULT =514
- **Version -** The syslog protocol version to use. RFC3164 (DEFAULT) or RFC5424
- **Protocol -** The transport protocol used to send syslog messages to this server. Choices: tcp, udp, tls, tcp6, udp6, tls6
- **Message Format** – Choose either json_cee or text <insert more info here>

If the TLS protocol is selected the following fields may be filled in:

- **TLS CA Certificate** - The name of the certificate of the CA server that was used to sign the certificate that the syslog server will be using.
- **TLS Client Certificate** - The client certificate to use when communicating to the syslog server over TLS.
- **TLS Client Key** - The name of the private key

To set up a syslog server, use the command:

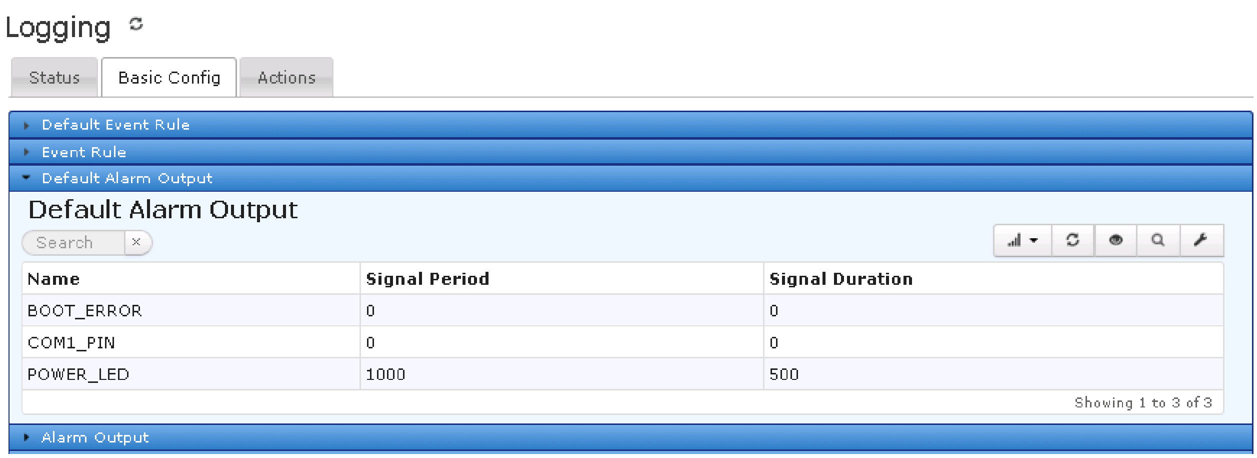
% set logging syslog server my_server **ip** 192.168.1.200

Alarms

Events can be configured by Event Rules to be Alarms which can causes the Power Light and external alarm signal to go "high" state. Refer to Section 2.5 for further details.

Alarms have factory default settings that control the behavior of the alarm outputs timing in terms of period and duration. These values can be overridden to adjust for local requirements.

From the Web UI at ***Logging ---> Basic Config*** scroll down to **Default Alarm Output** to view settings.



If desired, default alarm output behavior can be adjusted by adding entries to the **Alarm Output** table. These values supersede the defaults. For example it is possible to change the flash rate of the Power LED or cause the COM1_PIN alarm output to pulse when an alarm condition is active.

Clearing the Event Log

The user may explicitly clear the event log. To clear the event log, navigate to ***Logging ---> Actions / Clear Event Log*** and click on the **Perform Action** button.

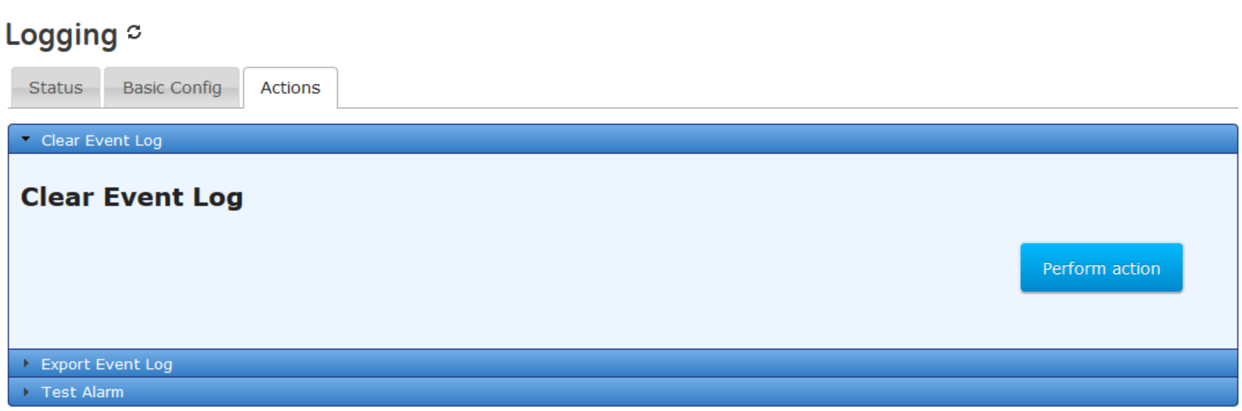


Figure 3-94. Clear Event Log

The following example shows how to clear the event log from the CLI:

> **request logging clear-event-log**

Exporting the Event Log

The following example shows how to have the device generate an exportable event log and download that log to a local file through the web browser.

Navigate to ***Logging ---> Actions / Export Event Log***

Click on the **Begin Generating** button once the file destination is configured.

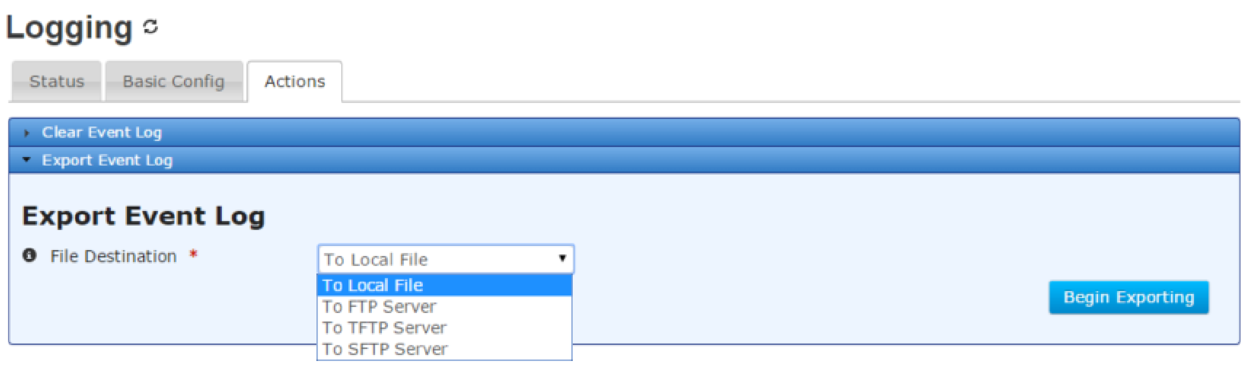


Figure 3-95. Export Event Log

The Orbit supports file downloads through a web browser to a local file on the user's PC. The Orbit also supports FTP, TFTP, and SFTP file uploads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Destination** - File transfer method to use. Available choices are To Local File (DEFAULT), To FTP Server, To TFTP Server, and To SFTP Server. Local file downloads are only available through the web UI and not through the CLI
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the destination file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device generate and transfer an exportable event log (named event-log-2016-02-04.xml) to a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the event log export from the CLI, enter the following command to upload the log file to an external TFTP server:

> **request logging export-event-log filename** event-log-2016-02-04.xml **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring

Once the export of the event log is begun, the process may be cancelled by clicking the **Cancel Exporting** button. The current status of the export process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to export an event log (in other words, if the state is "inactive").

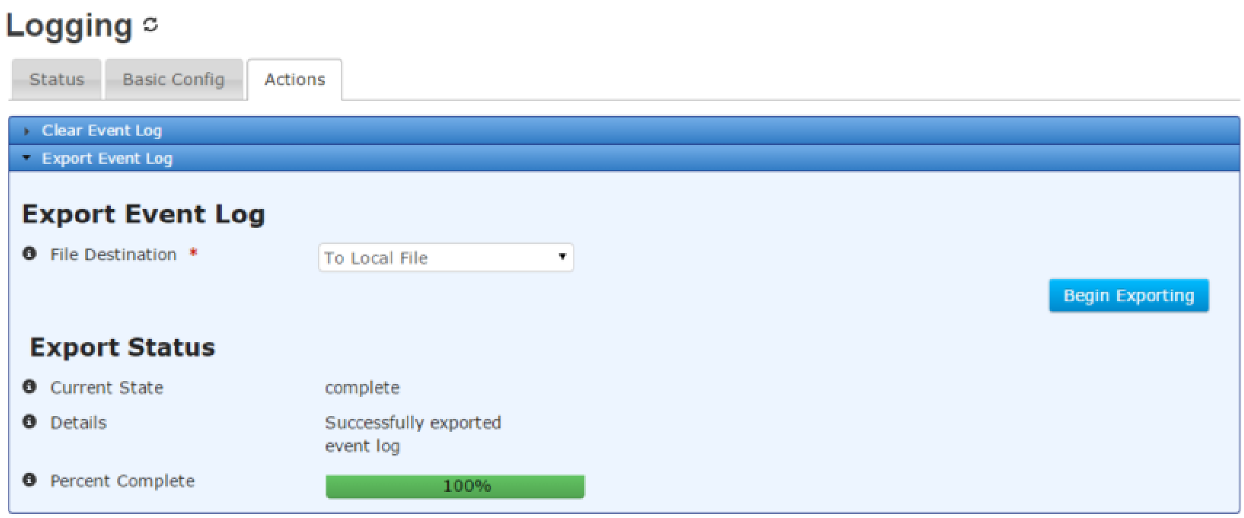


Figure 3-96. Export Event Log Monitoring

The export status contains the following items:

- **Current State** – The status of the export event log task:
  - inactive
  - preparing
  - transfering
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Generating event log*"
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already generated or transferred (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show logging export-event-log-status
  logging export-event-log-status state complete
  logging export-event-log-status detailed-message "Successfully exported event log"
  logging export-event-log-status size 345158
  logging export-event-log-status bytes-transferred 345158
  logging export-event-log-status percent-complete 100
```

3.6.3 Iperf Server Service

Understanding

Iperf is an open source network testing tool that measures throughput by sending and receiving data streams. Typically, a remote host acts as an iperf client, sending data streams to an endpoint, which acts as an iperf server.

The Orbit includes an iperf service that allows the unit to receive TCP traffic from a remote host running iperf. Currently, iperf service is hardcoded to act only as a TCP server listening on port 5001.

As an example, consider the simple private network below. The system administrator would like to test throughput from the host at 192.168.1.15 to the Orbit at 192.168.2.99. To do so, she enables the iperf service on the Orbit, which runs as an iperf server. She then starts an iperf client on the remote host and configures it to send TCP data streams to the Orbit. The iperf client on the remote host then receives replies from the Orbit and calculates the throughput of the network. Iperf is a tool that can be used to measure both TCP and UDP performance on a network. Iperf allows a user to set parameters that can test a network. Iperf reports bandwidth, delay jitter, datagram loss. This unit incorporates an Iperf server that can be utilized by an external client.

Figure 3-97. Setup using iperf for throughput testing in a private network

Iperf features:

- TCP
  - Measure bandwidth
  - Report MSS/MTU size and observed read sizes.
  - Support for TCP window size via socket buffers.
  - Multi-threaded if pthreads or Win32 threads are available. Client and server can have multiple simultaneous connections.
- UDP
  - Client can create UDP streams of specified bandwidth.
  - Measure packet loss
  - Measure delay jitter
  - Multicast capable
  - Multi-threaded if pthreads are available. Client and server can have multiple simultaneous connections (this doesn't work in Windows).

Iperf is available on many platforms, and there are also open source graphical front-ends available. For further information on iperf, see the iperf homepage at http://software.es.net/iperf/.

Enabling the Iperf service allows the unit to receive TCP traffic from remote host running iperf. Currently, iperf service running v2.0.5 and is hardcoded to act only as a TCP server listening on port 5001.

Configuring

The following shows how to enable iperf service – ***Services / Iperf Server ---> Basic Config***:

Figure 3-98. Iperf Enable Screen

From the CLI the command is:

```
% set services iperf enabled true
```

NOTE If firewall is enabled, then it must be configured to permit incoming TCP traffic on port 5001.

Monitoring

From the Services Screen the iPerf status can be checked by navigating to ***IPerf Server***

```
> show services
NAME                STATUS
--------------------------------------------------------
DHCP Server         running
Firewall            running
IPerf Server        running
NETCONF Server      running
Quality of Service  running
Serial              running
SNMP Server         running
SSH Server          running
VPN                 disabled
Web Server          running
```

3.6.4 Snapshots and System Recovery

Understanding

A "snapshot" stores the unit's configuration at the time the snapshot was taken. At any time, you may roll back the unit's settings to those contained in a specific snapshot. You may also choose which firmware image to reboot to once the snapshot is restored. Take note that restoring the unit to a snapshot will overwrite the current configuration, and that it cannot be undone.

Three types of snapshots exist on an Orbit: Factory, Automatic, and user snapshots.

- The Factory snapshot is the configuration with which the unit shipped. Rolling back to this snapshot is equivalent to performing a factory reset. Note that passwords will be reset to their default values.
- The Automatic snapshot is automatically generated after the unit boots to a new version of firmware. Rolling back to this snapshot will modify configuration but does not modify passwords.
- Up to two user snapshots can be created by a user with *admin* privileges. These can be created or deleted at any time. Rolling back to these snapshots will modify configuration but does not modify passwords.

Use the table below as a quick reference to the capabilities of each type of snapshot.

Snapshot type	User can modify?	Resets passwords?
Factory	No	Yes
Auto	No	No
User	Yes	No

Configuration

Using the WebUI

Navigate to ***System->Troubleshooting*** and click the **Actions** tab.

Rollback to a snapshot

To rollback to one of the unit's snapshots, first expand the **Recovery** menu.

Figure 3-99 Rollback menu

The **Snapshot** dropdown box lists all the snapshots available on the device. Select the desired snapshot, and the image that you wish to reboot to.

Initiating a rollback operation immediately reboots the unit to the specified firmware image and restores the unit's configuration to the specified snapshot. This operation cannot be undone.

Managing user snapshots

The **User Snapshots** menu, found under the **Rollback** menu, allows you to create, delete, and set the default user snapshot. You cannot delete or modify the unit's Factory or Auto snapshots.

You may create up to two user snapshots. These snapshots contain the system's current configuration and can be rolled back to at any time. User snapshots do *not* restore passwords. You can also specify a default user snapshot. The system may use the default user snapshot as a recovery point in the event that the unit fails to boot properly.

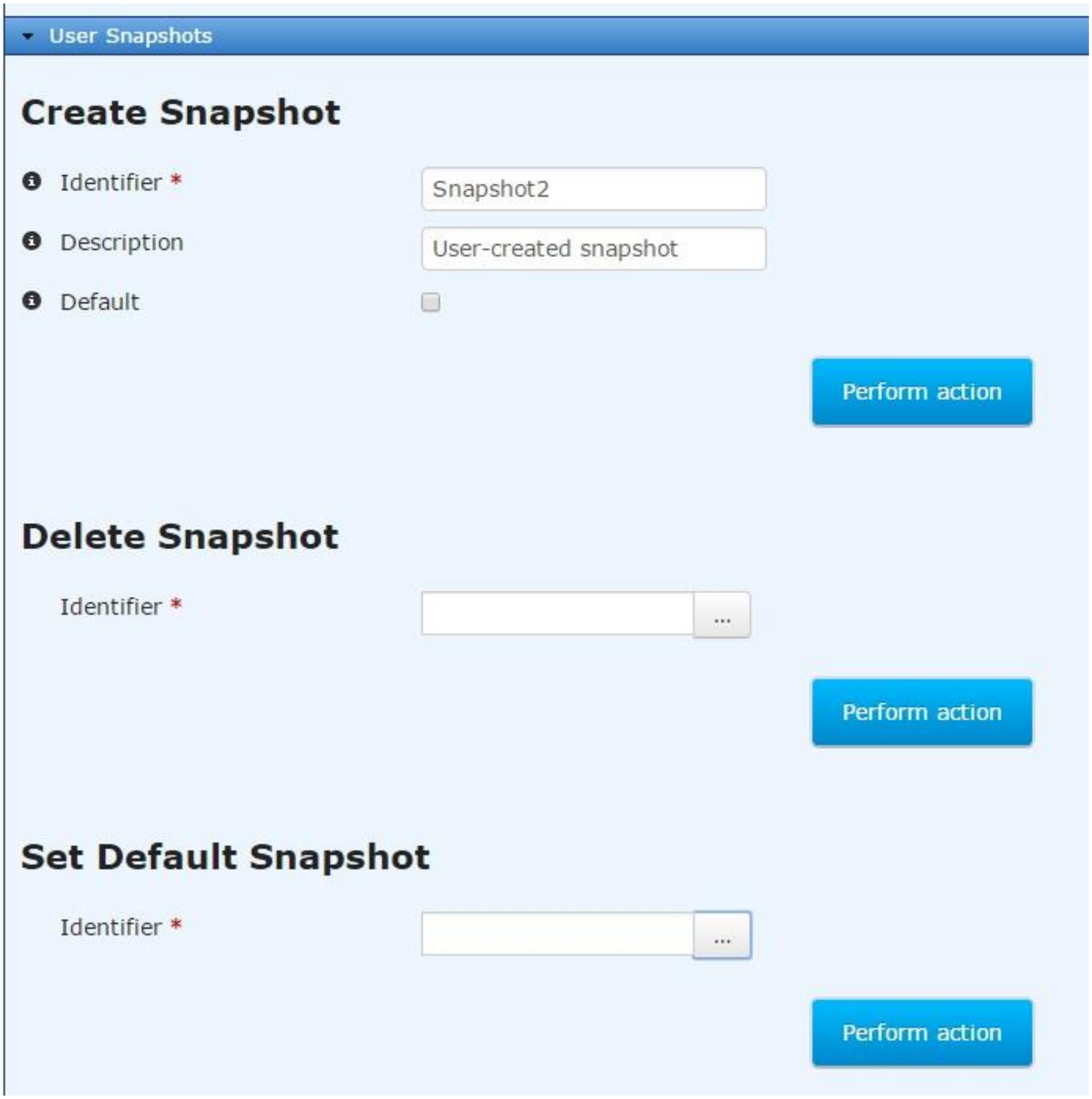


Figure 3-100 User Snapshots menu.

Create Snapshot

- **Identifier** – The name of the user snapshot. Up to 30 characters, including letters, numbers, dashes, underscores, and spaces.
- **Description** - Description of this user snapshot. Up to 127 characters, including letters, numbers, dashes, underscores, and spaces. Optional.
- **Default** - Set the default user snapshot used in error recovery. Optional.

Delete Snapshot

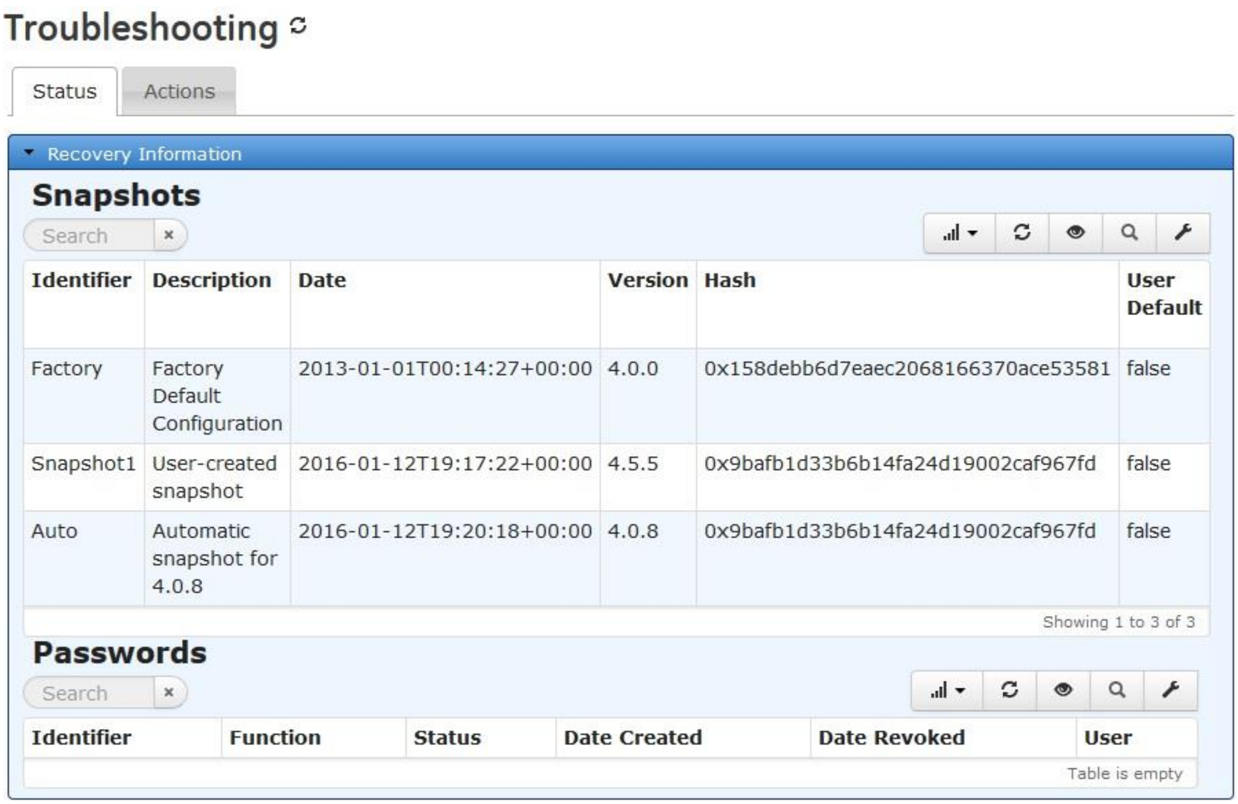
- **Identifier** – The user snapshot to delete. Once a snapshot is deleted, it cannot be recovered.

Set Default Snapshot

- **Identifier** – The user snapshot that should be used by the system as a recovery point if the unit fails to boot properly due to a configuration issue.

Status

Navigate to ***System->Troubleshooting->Status.***



Identifier	Description	Date	Version	Hash	User Default
Factory	Factory Default Configuration	2013-01-01T00:14:27+00:00	4.0.0	0x158debb6d7eaec2068166370ace53581	false
Snapshot1	User-created snapshot	2016-01-12T19:17:22+00:00	4.5.5	0x9bafb1d33b6b14fa24d19002caf967fd	false
Auto	Automatic snapshot for 4.0.8	2016-01-12T19:20:18+00:00	4.0.8	0x9bafb1d33b6b14fa24d19002caf967fd	false

Showing 1 to 3 of 3

Passwords

Search

Identifier	Function	Status	Date Created	Date Revoked	User

Table is empty

Figure 3-101 Snapshots status menu

- **Identifier –** The snapshot's name.
- **Description –** The snapshot's description.
- **Date –** This is the date that the snapshot was created.
- **Version –** This is the firmware version that the unit was running at the time the snapshot was created.
- **User Default -** Specifies the default user snapshot used in error recovery.

Using the CLI

Rollback to a snapshot

You can rollback to one of the unit's snapshots in either operational or configuration mode.

Use the following command to rollback the unit to the configuration stored in the Auto snapshot, and reboot to the current active image.

```
% request system recovery rollback snapshot Auto which-image { active }
```

The system will prompt you for confirmation before the unit proceeds with the operation. Once confirmed, the rollback cannot be undone.

```
The current system configuration will be erased and replaced with the snapshot.
Proceed? [no,yes]
```

Managing user snapshots

You can create, delete, and set the default user snapshot in either operational or configuration mode.

Use the following command to create a user snapshot named Snapshot1 and set it as the default user snapshot.

```
% request system recovery user-snapshots create identifier Snapshot1 description
    "Example snapshot" default true
```

The following command deletes the specified user snapshot.

```
% request system recovery user-snapshots delete identifier Snapshot1
```

You can set an existing snapshot as the default user snapshot with the following command.

```
% request system recovery user-snapshots set-default identifier Snapshot1
```

Monitoring

To view the device's snapshots, ensure that the CLI is in operational mode.

```
% show system recovery snapshot
system recovery snapshots Factory
 description  "Factory Default Configuration"
 date         2013-01-01T00:14:27+00:00
 version      4.0.0
 hash         0x158debb6d7eaec2068166370ace53581
 user-default false
system recovery snapshots Auto
 description  "Automatic snapshot for 4.0.8"
 date         2016-01-13T17:20:54+00:00
 version      4.0.8
 hash         0xa13ceb2d5d267341d5067d975e39131e
 user-default false
system recovery snapshots Snapshot1
 description  "Example snapshot"
 date         2016-01-13T19:53:44+00:00
 version      4.5.5
 hash         0x579b9fa00303ceb9eeb3981cc429d31b
 user-default true
```

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3.6.5 Support Bundle

Understanding

Orbit incorporates a facility to generate support package bundles that includes internal debug messages, logs, and other helpful pieces of information. These items can help factory personnel troubleshoot user issues.

Configuring

The following example shows how to have the device generate a support package bundle and download that bundle to a local file through the web browser.

Navigate to ***System / Troubleshooting ---> Actions / Support Package***

Click on the **Begin Generating** button once the file destination is configured.

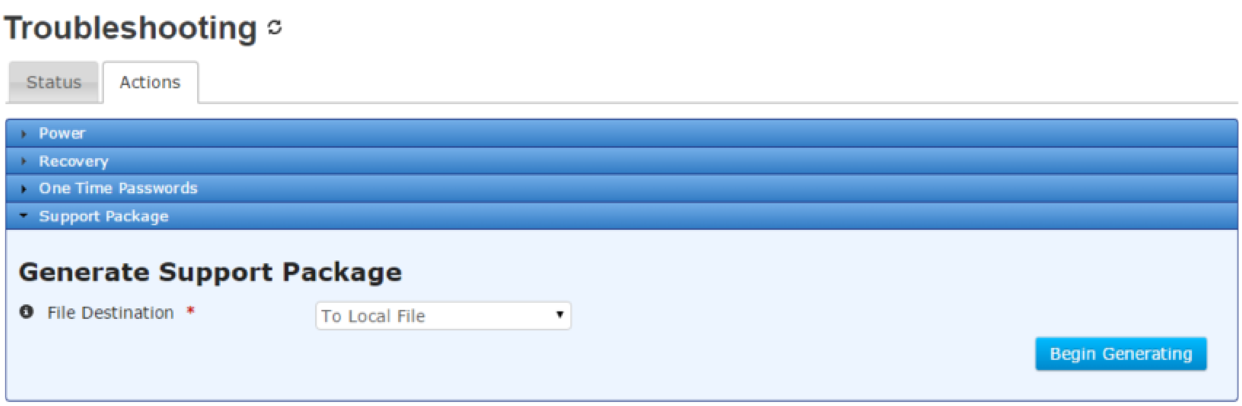


Figure 3-102. Support Package

The Orbit supports file downloads through a web browser to a local file on the user's PC. The Orbit also supports FTP, TFTP, and SFTP file uploads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Destination** - File transfer method to use. Available choices are To Local File (DEFAULT), To FTP Server, To TFTP Server, and To SFTP Server. Local file downloads are only available through the web UI and not through the CLI
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the destination file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device generate and transfer a support package bundle (named debug-2016-02-04.tgz) to a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the support package bundle generation from the CLI, enter the following command to upload the bundle to an external TFTP server:

> **request system support-package generate filename** debug-2016-02-04.tgz **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring

Once the generation of a support package bundle is begun, the process may be cancelled by clicking the **Cancel Generation** button. The current status of the generate support package process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to generate a support package bundle (in other words, if the state is “inactive”).

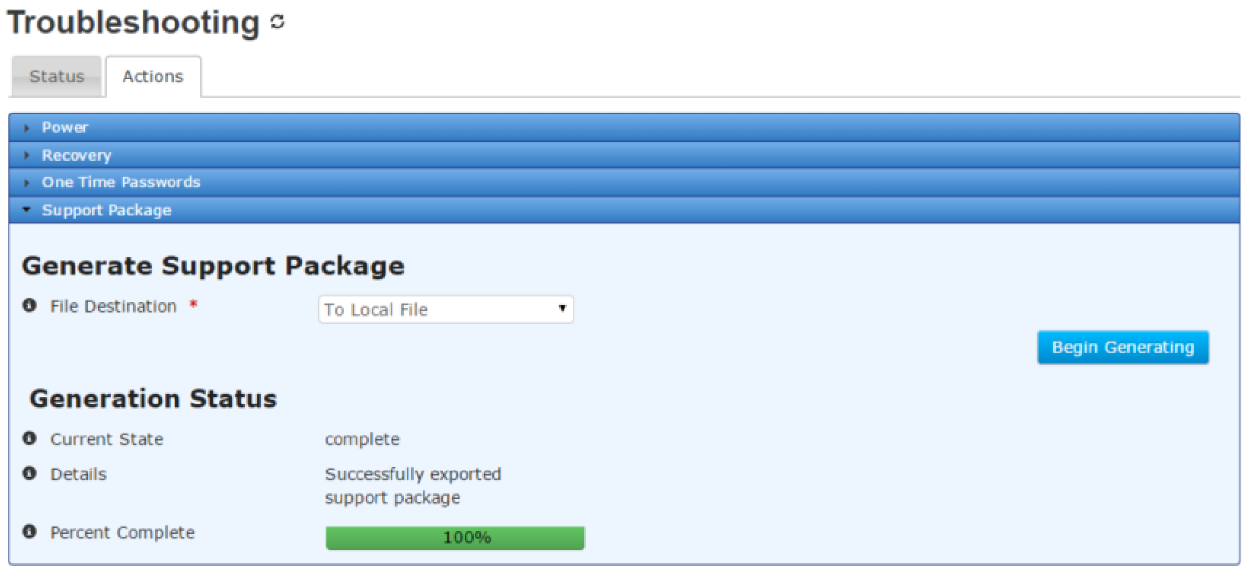


Figure 3-103. Support Package Monitoring

The generation status contains the following items:

- **Current State** – The status of the generate support package bundle task:
  - inactive
  - preparing
  - transfering
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as “*Generating support package*”
- **Size** – The total number of bytes in the package (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already generated or transferred (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system support-package generate-status
  system support-package generate-status state complete
  system support-package generate-status detailed-message “Successfully exported support
  package”
  system support-package generate-status size 2245680
  system support-package generate-status bytes-transferred 2245680
  system support-package generate-status percent-complete 100
```

3.6.6 Remote Sync facility (for LN/NX/LW interfaces)

Understanding

Orbit offers a feature for bandwidth efficiency on Orbit proprietary LN/NX/LW interfaces that facilitates collection of remote status items at the corresponding Access Point. Remote-sync provides a set of key status items from the remotes to be queried. Items include the running firmware revision, device name, system temperature, alarm status, and up to 4 quality indicators (rssi,lqi, evm, etc. ...) depending on the radio type. Data can be viewed locally at the AP or collected via PulseNET.

NOTE For users of PulseNET - to benefit from this feature you must be running a current version of PulseNET and the system should be configured to minimize collection of remote items that are not provided by the remote-sync facility. This may involve minimizing the PulseNET "Default collection schedule" and relying on the "Orbit Ln/NX AP Collection"

Functionally the remote-sync facility requires remotes to send short periodic upstream messages. The system attempts to do this efficiently by sending the information with payload data. The first message is sent out in the initial 90 seconds following remote association. Subsequent messages are offered every 10 minutes by default. The settings can be disabled and the sync time can be changed in the remotes advanced config. For LN is would be:

set interfaces interface LnRadio ln-config advanced-config

Possible completions:

remote-sync-status - **Enables pushing status to the AP on a fixed interval.**

remote-sync-time - **How often in minutes that the remote will publish** its **status.**

3.7 System Configuration and Setup

3.7.1 Date, Time and NTP

Understanding

The date and time can be set on the unit using a manually configured value or automatically via Network Time Protocol (NTP). The NTP settings take precedence over the manual settings. If NTP is enabled, then the user will not be able to set the date and time manually.

Configuring

Manual Setting of Date, Time and Timezone

To manually set the System Clock date and time on the webUI - Navigate as shown and set the date (using the calendar) , time (using the slider shown below) and timezone (offset from GMT) - Navigate to ***System / Time ---> Actions / Set Current Datetime***:

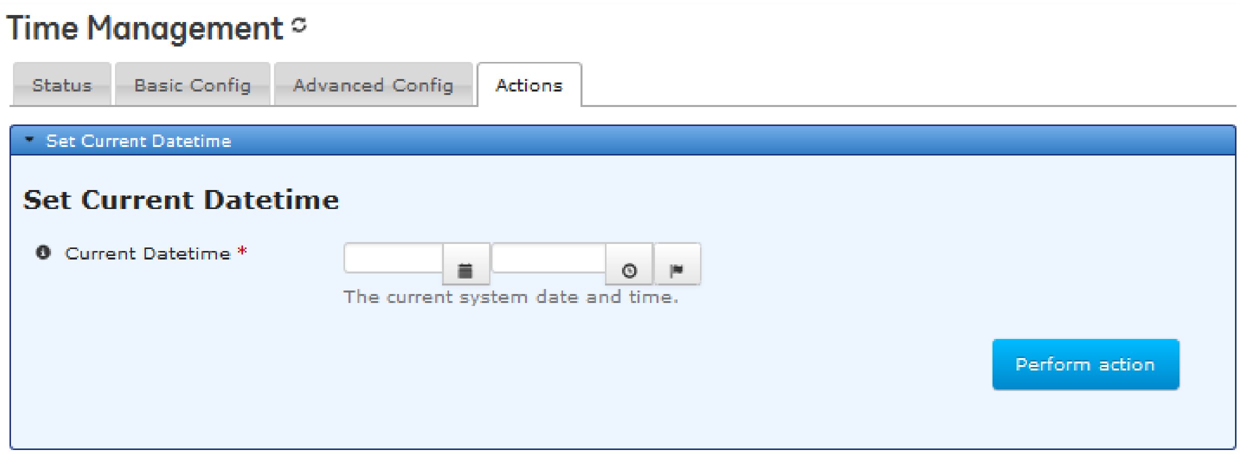


Figure 3-104. Set DateTime Screen

For setting the time use the sliders:

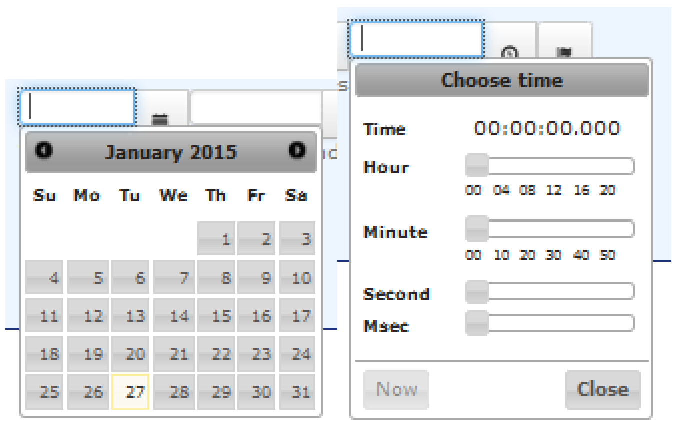
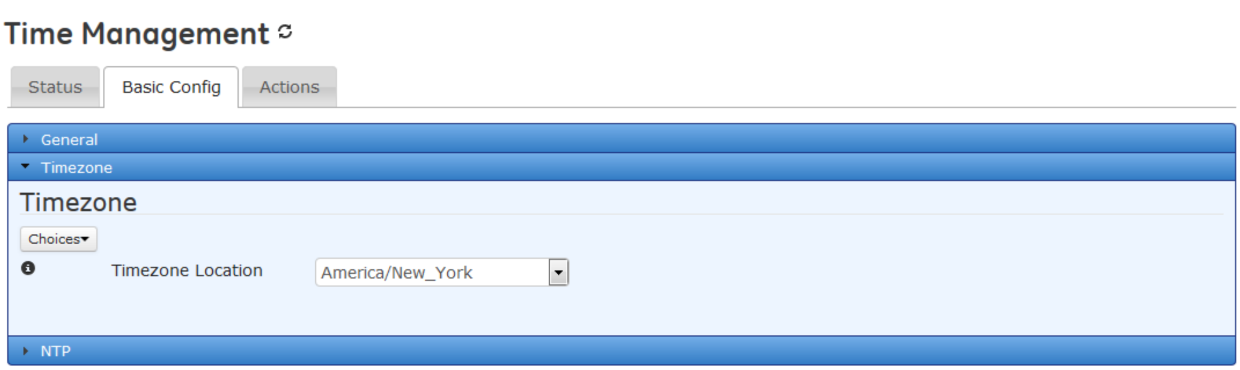


Figure 3-105. Set Date and Time Sliders Screen

The Time zone can be set on the clock page by selecting from a drop down location list or entering UTC Offset located to the right of the *Current Datetime* field or you can set the UTC location on the ***Basic Config*** tab as shown below:

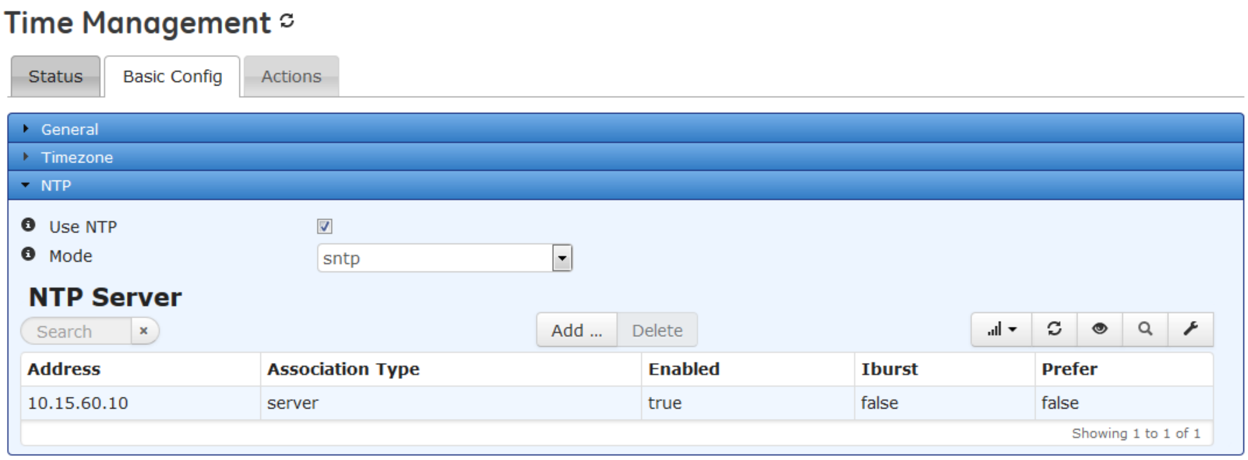


To manually set the date and time, use the request set-current-datetime:

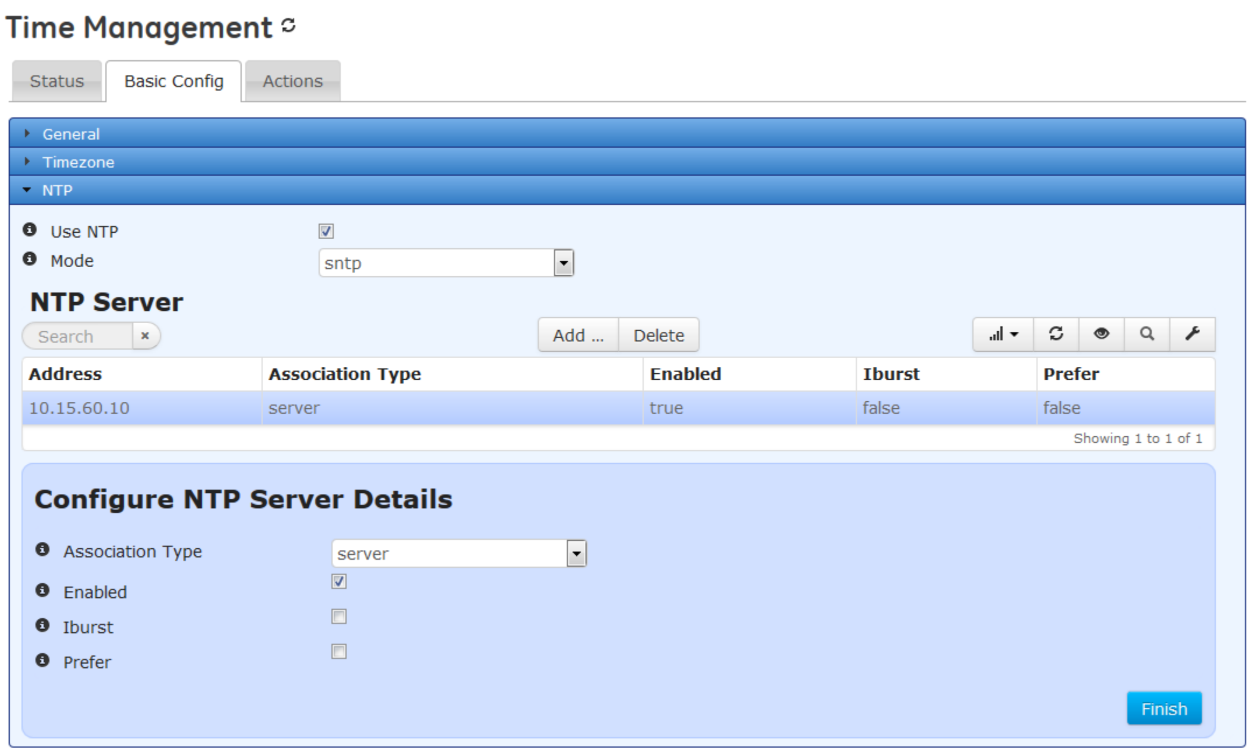
> **request system clock set-current-datetime current-datetime** 2013-10-01T8:33:45

Automatic set using NTP or SNTP Server

To use an NTP server, the NTP settings on the Orbit must be configured. From the Web UI - Navigate to the ***System / Time ---> Basic Config / NTP***



Enable NTP or SNTP by clicking the **Use NTP** checkbox. Click on the Mode option to choose which type of time server desired; NTP or SNTP and then add a server configuration by clicking the **Add** button:



- **Address** - IP address or domain name of the server
- **Association Type** - choices
  - Server - *most common* - An NTP server is configured to synchronize NTP clients. Servers will accept no synchronization information from their clients
  - Peer - each device shares its time information with the other, and each device can also provide time synchronization to the other
  - Pool - a large virtual cluster of timeservers providing reliable NTP service such as pool.ntp.org
- **Enabled** - Server enabled for use - ***check*** = True (DEFAULT)
- **Iburst** - perform burst synchronization ***check*** = True (DEFAULT)
- **Prefer** - Use as preferred server - ***check*** = True (DEFAULT)

CLI configuration

From the CLI, the NTP settings on the Orbit can be configured:

% set system ntp use-ntp true **mode** *ntp* **ntp-server** time.nist.gov

To configure a SNTP server from the CLI, use the following command as an example;

% set system ntp use-ntp *true* **mode** *sntp* **ntp-server** *server-address*

Where the **server-address** corresponds to the desired server IP address.

All time on the device is defaulted to UTC (+0:00) time. Time that is gained by an NTP server will be offset by the difference to UTC time. To properly ensure that the date and time reflected on the unit is correctly displayed, configure the time offset in respect to location or manually.

From the CLI, to manually set the time offset, enter the offset in increments of 30 minutes. For example, to enter -5 hours for the UTC offset:

% set system clock timezone-utc-offset -300

Manually setting the time offset will not take in account daylight savings. To set the time based on location; choose the location based closest to the installation site. For New York, the offset is -5 hours during daylight savings and will automatically become -4 hours when daylight savings ends.

% set system clock timezone-location America/New_York

NOTE Depending on system configuration it may be necessary to modify firewall rules to allow messages from the NTP server.

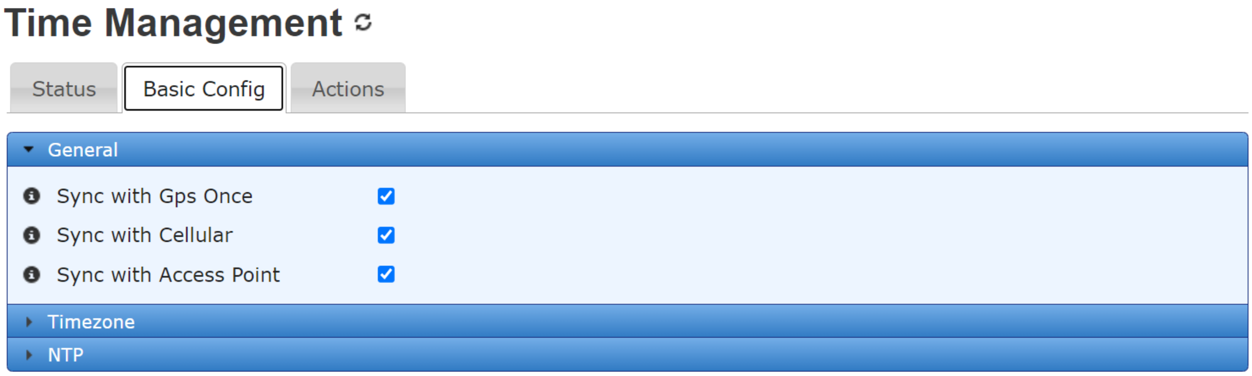
Automatic set using other time sources

If NTP is not configured, time can be established from other sources.

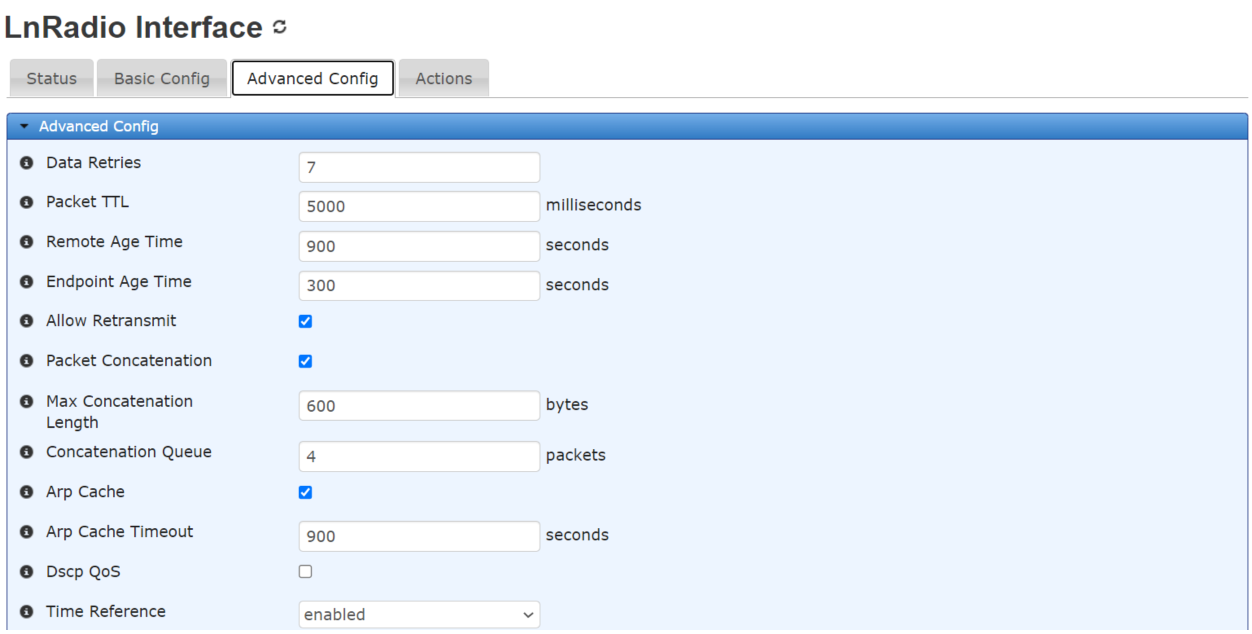
The unit will sync time and date to the first of three possible sources defined per the **default time source hierarchy** (where the sources are GPS, Cellular, and Access Point).

- First, if the unit contains a GPS module (and the gps service is enabled), the unit will sync time and date on the initial connection to the service.
- Otherwise, if the unit contains a Cellular interface (and the cellular interface is enabled), the unit will sync time and date when it is received from the Cellular network.
- Finally, if the two above conditions are not satisfied and the unit contains an LN/NX/LW radio interface (and said interface is enabled), the unit will sync time and date when it is received from the AP.

For typical applications the rules above will cause their device to automatically synchronize to the desired time source. Special applications can customize the default time source hierarchy by disabling select time sources (checkboxes in the web/UI). For example on an Orbit remote equipped with LN and Cellular, a user can uncheck the **Sync with Cellular** and **Sync with Gps Once** checkboxes (shown below) to ensure this remote only synchronizes time when it is received from its AP.



Special considerations apply for **Sync with Access Point**. For the feature to work, the AP must be configured to send a timing reference to the remote.   On the advanced config menu for the AP, the **Time Reference** setting should be set to enabled as shown in the figure below.



Finally, note that versions of Orbit host firmware prior to 9.3.3 did not support the **Sync with Access Point** feature. To use the feature it is necessary to update the firmware on both AP and remotes. Remotes that are not upgraded to new firmware will not receive the time reference information and remain unsynchronized.

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
> show system clock
  system clock current-datetime 2012-06-19T00:20:34+00:00
  system clock boot-datetime 2012-06-19T00:18:01+00:00
```

3.7.2 Geographical-location

The geographical-location of the unit can be manually configured. This information can also be configured using the initial setup wizard.

- **Latitude** - in degrees
- **Longitude** - in degrees
- **Altitude** - in meters

From the CLI:

% set system geographical-location altitude 1.0 **latitude** 43.117807 **longitude** -77.611896

3.7.3 FIPS Mode

Understanding

Running the device in FIPS 140-2 certified mode will ensure the device is compliant with NIST Cryptographic Module Validation Program (CMVP). Consult GE Vernova or the NIST Website (https://csrc.nist.gov/Projects/cryptographic-module-validation-program/Validated-Modules/Search) for additional information on Certificate number and Security Policy. In order to be fully compliant, some additional configuration is required. When running in FIPS mode, additional restrictions may apply to device configuration options.

Configuring

The attribute described below controls whether or not Orbit operates in FIPS 140-2 certified mode. This mode can be enabled to provide an elevated level of security. Changing this setting will result in a factory reset of the device, to ensure destruction of cryptographic material.

From the CLI:

% set system fips-mode true

Monitoring

Setting the system to FIPS mode is prerequisite, *but not sufficient*, to be in FIPS operational status. After the unit is configured to operate in FIPS mode, default passwords and keys must be changed before the module will report that it has reached "FIPS operational status" (FIPS certified mode + approved settings). The user can query the FIPS operational status in the System menu in the UI.

From the CLI:

% run show system fips-oper-status

To reach FIPS operational status, the following configuration is necessary:

- Change administrator password to a stronger FIPS compliant one (Section 3.7.5).
- Change the remote management shared secret (Section 3.8.18) to a 128-character hexadecimal string (0-9, a-f, A-F).
- For WiFi interfaces, change the PSK (Section 3.5.3) to a 64-character hexadecimal string (0-9, a-f, A-F).
- Change the PKI Database Key (Section X.X.X) to a 64-character hexadecimal string (0-9, a-f, A-F).
- Change the system encryption key (Section 3.7.4) to a 32-character hexadecimal string (0-9, a-f, A-F).

The current alarms view (See Section 3.6.2: Event Logging) will also inform the user which of the above items currently need to be updated.

From the CLI:

```
% run show logging current-alarms
```

3.7.4 System Encryption Key

The key used to by the system to encrypt sensitive configuration data, such as shared secrets and pre-shared keys, before storing them in the configuration database. Must be a 32 character hexadecimal string (0-9, a-f, A-F).

From the CLI:

```
% set system encryption-key 0123456789abcdef0123456789abcdef
```

3.7.5 User Management and Access Controls

Understanding

There are three user accounts/roles (administrator, technician and operator) for management access.

Users in the *admin* group have the highest privilege and can read everything in the tree that is readable, write everything that is writable and can execute any of the requests.

Users in the *tech* group have less access than admin. Generally, the tech group cannot configure any security-related configuration.

Users in the *oper* group can only view status and configuration. They do not have access to modify the device configuration.

By default, the password for each account is the same as the username. Passwords should be changed by users prior to deploying the device. For added security, the *tech* and *oper* accounts are disabled until their respective passwords are changed. They can also be manually disabled.

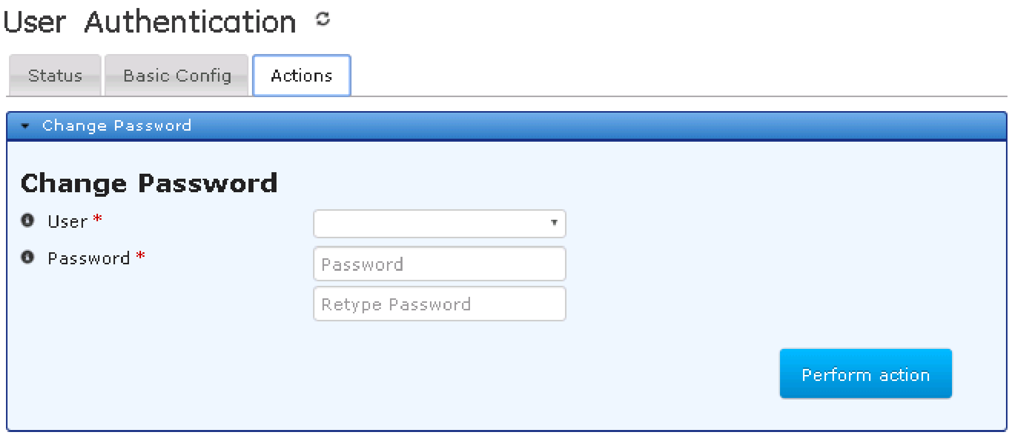
When local user management is being used, passwords are stored in non-volatile memory using PKCS#5 based encryption.

User authentication is performed using either locally stored passwords or RADIUS.

Configuring

Changing the password is accomplished by navigating to ***System / User Authentication ---> Actions / Change Password***

Select the user from the dropdown list (as shown) and enter the password desired.



The password for each user account can also be changed using a CLI request:

> **> request system authentication change-password** user **admin password** new_password

Or

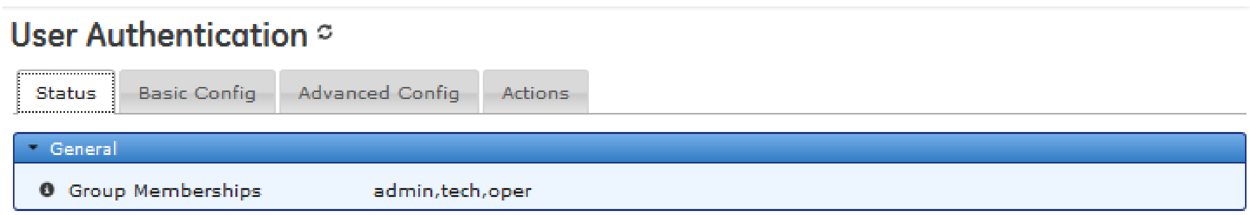
> **> change-password** user **admin** *(prompts for new password)*

NOTE If the admin password is forgotten, the method to recover the unit is by using the login One-Time-Password. This will give the user the ability to change the forgotten password. See “One-Time “Recovery” Passwords” on Page 47.

Orbit user authentication provides the capability to manage the rules regarding logins and the setup rules regarding password strength.

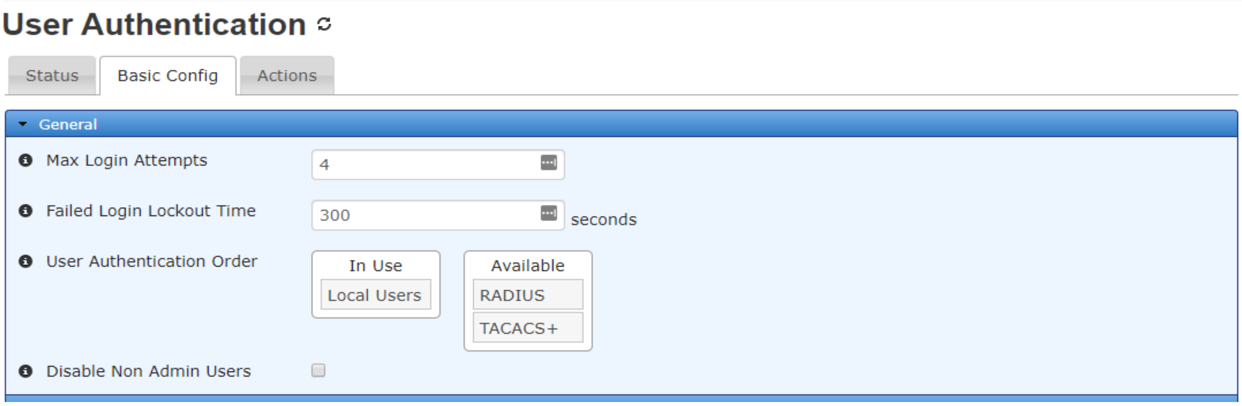
The unit has protections against repeated login attempts. The max-login-attempts configuration determines the number of failed logins that can occur in succession before the unit disables the ability to login for a specified amount of time. The amount of time is determined by failed-login-lockout-time, which represents the time in seconds.

Start by viewing the current users at ***System / User Authentication ---> Status***



- **Group Memberships** -A list of groups the current user is a member of.

To configure the password options navigate to the ***Basic Config*** tab.

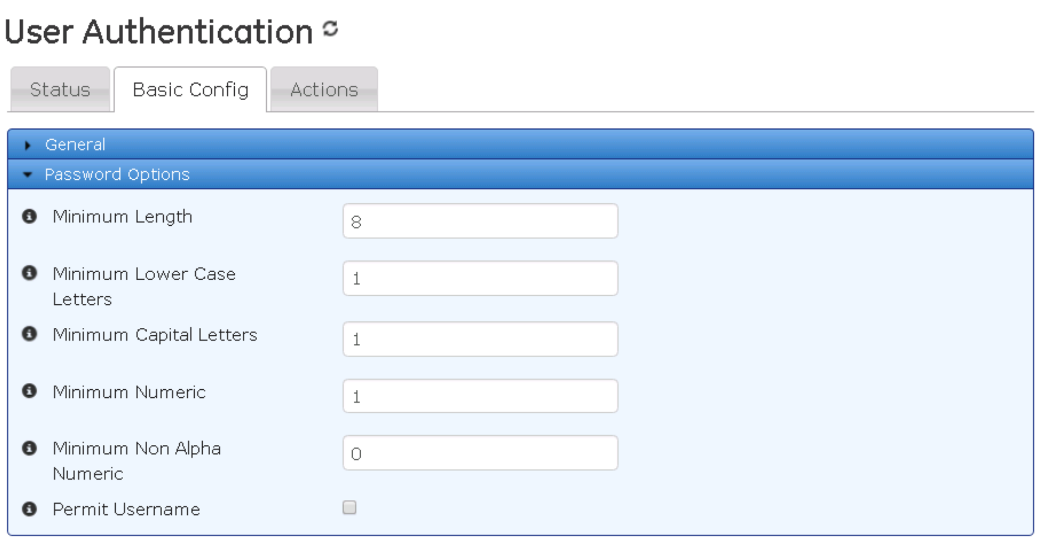


- **Max Login Attempts -** The maximum number of failed login attempts before locking out future attempts. DEFAULT 4
- **Failed Login Lockout**- The number of seconds to reject further login attempts from a host who has failed to login 'max-login-attempts' number of times. DEFAULT 300 (5 minutes)
- **User Authentication Order -** When the device authenticates a user with a password, it tries the authentication method described. Items can be moved from the "Available" to the "In Use" to select them for use. The order the entries appear in the "In Use" list will be the fallback order.
    - Local Users– authentication is based on password info stored on the device
    - RADIUS– authentication is based on password info managed by a RADIUS server
    - TACACS+ - authentication is based on password info managed by a TACACS+ server
- **Disable Non Admin Users –** Indicates whether or not *tech* and *oper* accounts are disabled. DEFAULT false (Note: these are automatically disabled until default password is changed)

From the CLI these parameters may be set:

% set system authentication max-login-attempts 30
% set system authentication failed-login-lockout-time 300
% set system authentication user-authentication-order [local-users]% set system authentication disable-non-admin-users true

To configure password rules Navigate to ***System / User Authentication ---> Basic Config / Password Options***



- **Minimum Length** - The minimum number of characters that must be in a password. DEFAULT= 8

NOTE In FIPS mode, minimum length must be greater than or equal to 8 characters.

- **Minimum Lower Case Letters** - The minimum number of lower-case letters ([a-z]) that must be in a password. DEFAULT 1 read-write uint16 1 No
- **Minimum Capital Letters -** The minimum number of capital letters ([A-Z]) that must be in a password. DEFAULT 1
- **Minimum Numeric** - The minimum number of numeric characters ([0-9]) that must be in a password. DEFAULT 1
- **Minimum Non Alphanumeric** - The minimum number of non-alpha-numeric characters that must be in a password. Non alpha-numeric characters are defined as any character that does not match the pattern [a-zA-Z0-9].DEFAULT 0
- **Permit Username** – Suppresses checking that prevents the username to be used as the password. GE strongly discourages use of this option. DEFAULT not checked/disabled.

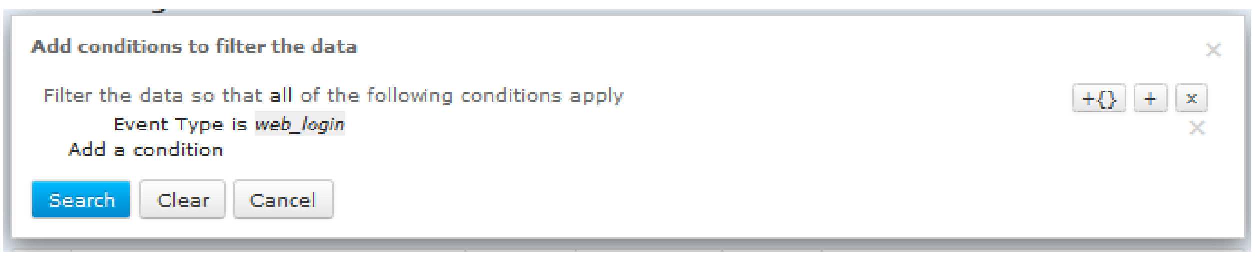
User authentication order can be specified to give preference to which method is used first when authenticating user access. In the following example, the list of RADIUS servers will be contacted first before the list of TACACS+ servers, which will be contacted before the local authentication rules are used.

NOTE If the local-users option is specified *before* RADIUS or TACACS+, then only the local-users option will be utilized; the RADIUS and TACACS+ servers will never be contacted.

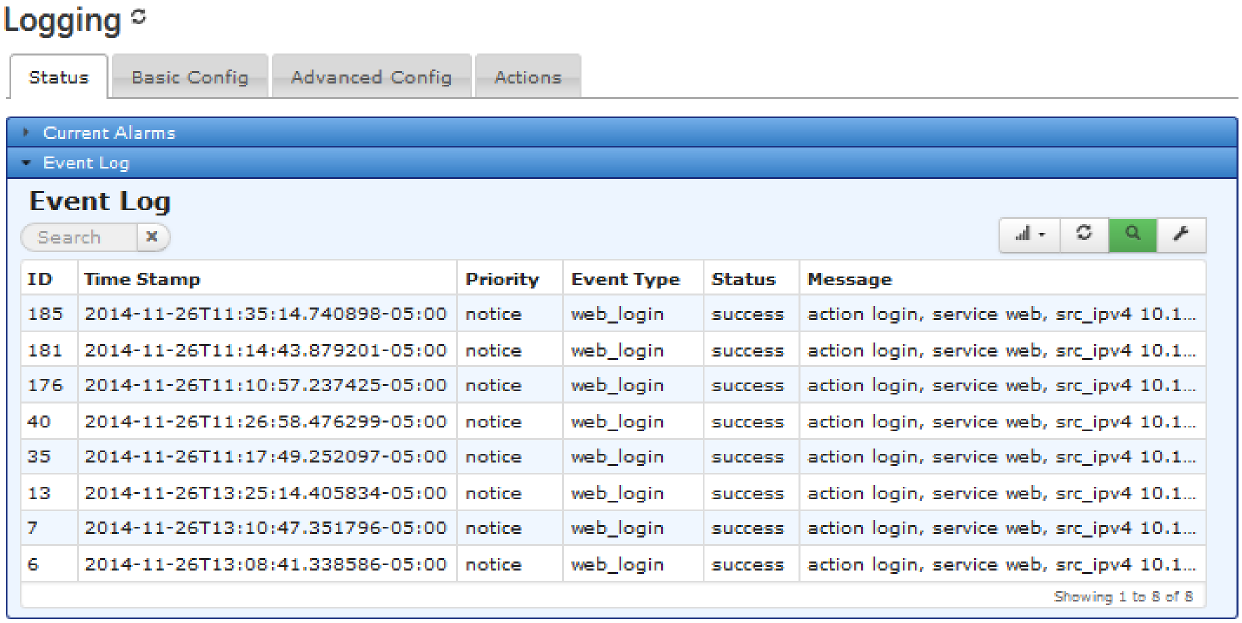
```
% set system authentication user-authentication-order [radius tacacsplus local-users]
```

Monitoring

Navigate to ***Logging***. Scroll Down to **Event Log.** Click on the magnifier to filter the data. Default is *"ID is {nothing}"* Each portion is adjustable to tailor the search. For example to find all web_login events set up the filter as shown.



Results of the search may resemble the following:



ID	Time Stamp	Priority	Event Type	Status	Message
185	2014-11-26T11:35:14.740898-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
181	2014-11-26T11:14:43.879201-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
176	2014-11-26T11:10:57.237425-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
40	2014-11-26T11:26:58.476299-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
35	2014-11-26T11:17:49.252097-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
13	2014-11-26T13:25:14.405834-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
7	2014-11-26T13:10:47.351796-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...
6	2014-11-26T13:08:41.338586-05:00	notice	web_login	success	action login, service web, src_ipv4 10.1...

Clicking on the event Id number provides detailed information regarding record. In the following example the user logged in the web from IP4 address 192.168.1.10, on port 49656 as user admin:

To do similar operations from the CLI in operational mode, follow the example below to see the history of login attempts by reviewing the event log:

```
> show logging event-log event-type web_login
  logging event-log 62625
  time-stamp 2011-12-21T01:18:08.985996+00:00
  priority   notice
  event-type web_login
  status     success
  message    "user_name oper, "
  logging event-log 62627
  time-stamp 2011-12-21T01:23:00.288046+00:00
  priority   notice
  event-type web_login
  status     failure
  message    "msg noauth, user_name admin, "
```

3.7.6 RADIUS User Management

Understanding

User accounts can be centrally managed with a RADIUS server. RADIUS accounts can be mapped to one of the three user roles.

If the RADIUS server is not accessible, users may use the local username/password to "fall back" to local authentication if the unit is configured to do so. Many RADIUS servers do not respond to an invalid login attempt. To the unit, this appears the same as if the server is not there. The consequence of this behavior is that after three (default setting) failed login attempts, the authentication will take place against the local user/password database if local fallback is enabled. Refer to the section on "Local User Management" for configuring the authentication order.

If more than one RADIUS server is configured, then the unit will attempt each RADIUS server in the order that they appear in the configuration until a successful response is received. A RADIUS server must be configured to provide the user's authentication group in its authentication reply via a "GEMDS" vendor attribute.

This can be configured in FreeRADIUS (an open source RADIUS server) by creating a dictionary file (placed usually in C:/FreeRADIUS.net/share/freeradius) with the following information:

```
VENDOR GEMDS 4130
BEGIN-VENDOR    GEMDS
ATTRIBUTE GEMDS-UserAuth-Group 1 integer
VALUE     GEMDS-UserAuth-Group Operator      0
VALUE     GEMDS-UserAuth-Group Technician    1
VALUE     GEMDS-UserAuth-Group Administrator 2
END-VENDOR GEMDS
```

And configure the users.conf file (typically found in C:/FreeRADIUS.net/etc/raddb) as follows:

```
admin Cleartext-Password := "admin"
    GEMDS-UserAuth-Group := Administrator

tech Cleartext-Password := "tech"
    GEMDS-UserAuth-Group := Technician

oper Cleartext-Password := "oper"
    GEMDS-UserAuth-Group := Operator
```

Syntax may differ from one RADIUS server platform to another. Configurations for a commercial Linux server, such as the AAA server from Interlinks Network, its dictionary file may be similar to the following:

```
GEMDS.attr    GEMDS-UserAuth-Group    1   integer (1, 0, 0)
GEMDS.value   GEMDS-UserAuth-Group    Administrator    2
GEMDS.value   GEMDS-UserAuth-Group    Technician       1
GEMDS.value   GEMDS-UserAuth-Group    Operator         0
```

The following line is required to be added to the vendors file:

```
GEMDS.attr    GEMDS.value    4130    GEMDS
```

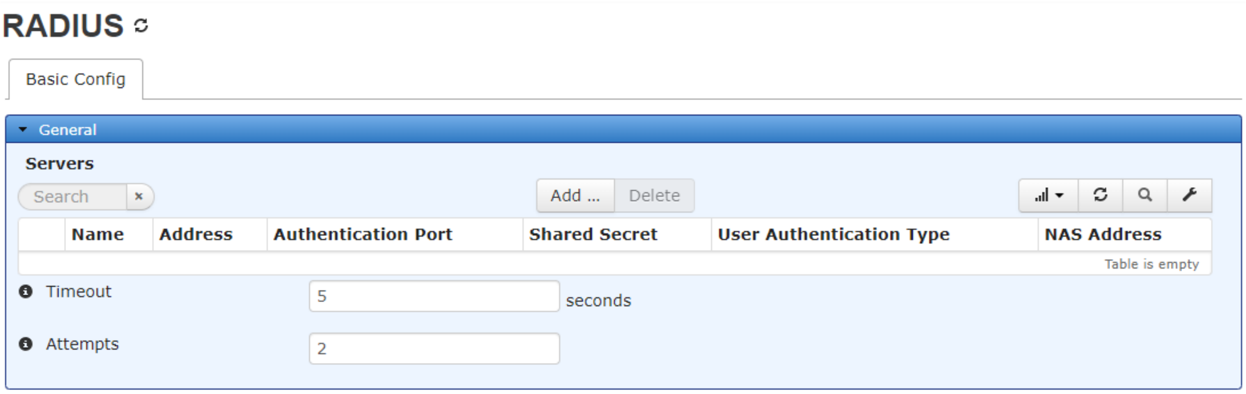
And configuring users similar to the example here:

```
admin Password = "admin"
      GEMDS: GEMDS-UserAuth-Group = "2"
tech Password = "tech"
      GEMDS: GEMDS-UserAuth-Group = "1"
oper Password = "oper"
      GEMDS: GEMDS-UserAuth-Group = "0"
```

NOTE All approved networked devices are required to be identified in the server's client file.

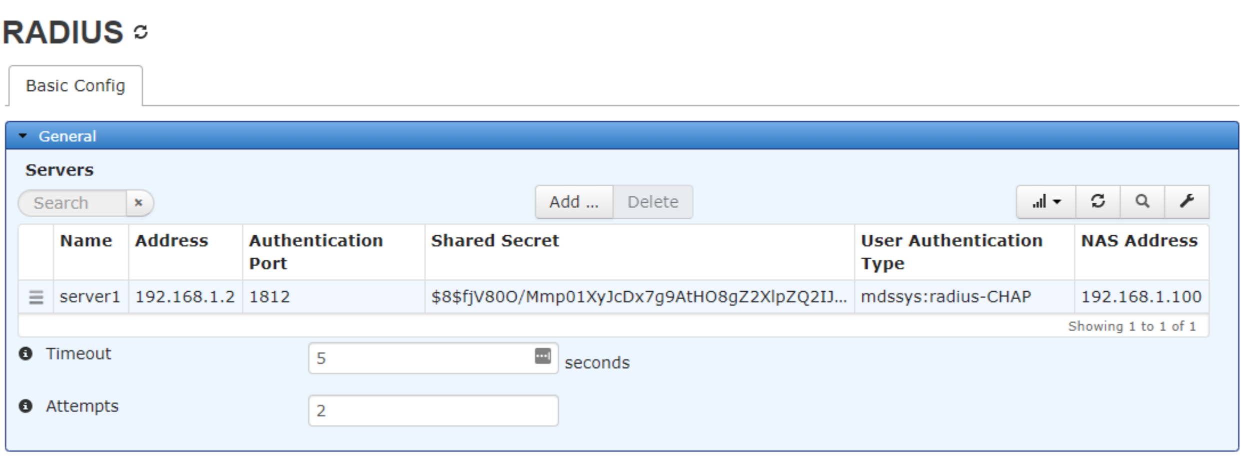
Configuring

Navigate to: ***System / RADIUS ---> Basic Config*** the main interface for adding RADIUS servers.



- **Timeout** - The number of seconds the device will wait for a response from a RADIUS server before trying with a different server. Default = 5 - max value 255.
- **Attempts** - The number of times the device will send a query to the RADIUS servers before giving up. Default = 2 - max value 255.

Click the **Add** button and add a server.



- **Name** – User defined name for the server.
- **Address** - The IPV4 address of the RADIUS server. Alternative entry is to use a "Domain Name" string
- **Authentication Port** - The port number of the RADIUS server. Default =1812
- **Shared Secret** - The shared secret which is known to both the RADIUS client and server.

NOTE In FIPS mode, Shared Secret must meet strength requirements set in Section 3.7.5.

- **User Authentication Type** - The authentication type used by the RADIUS server.
- **Nas Address** - The IPV4 address provided in the NAS address attribute of the RADIUS request. This should be the address of the interface that is making the request. If it is not provided the system will determine the address automatically. Alternative entry is to use a "Domain Name" string.

From the CLI command line, the following shows how to configure a RADIUS server on the radio:

% set system mds-radius servers server1 **address** 192.168.1.2 **shared-secret** abcd1234 **user-authentication-type** radius-CHAP **nas-address** 192.168.1.100

% show system mds-radius

```
    servers server1 {
        address                     192.168.1.2;
        authentication-port         1812;
        shared-secret               abcd1234;
        user-authentication-type    radius-CHAP;
        nas-address                 192.168.1.100;
}
```

3.7.7 TACACS+ User Management

Understanding

User accounts can be centrally managed with a TACACS+ server. TACACS+ accounts can be mapped to one of the three user roles.

If the TACACS+ server is not accessible, users may use the local username/password to “fall back” to local authentication if the unit is configured to do so. Refer to the section on “Local User Management” for configuring the authentication order.

If more than one TACACS+ server is configured, then the unit will attempt each TACACS+ server in the order that they appear in the configuration until a successful response is received. A TACACS+ server must be configured to provide the user’s authentication group in its authentication reply via a “GEMDS” vendor attribute.

This can be configured in tac_plus (an open source TACACS+ server for Linux) by modifying the server configuration file (placed usually in /etc/tac_plus/tac_plus.conf) with the following information to define the groups:

```
group = mdsadmin {
   service = "user-auth" {
      user-auth-group = admin
   }
}

group = mdstech {
   service = "user-auth" {
      user-auth-group = tech
   }
}

group = mdsoper {
   service = "user-auth" {
      user-auth-group = oper
   }
}
```

And configure the TACACS+ users to belong to one of those groups as follows for PAP authentication:

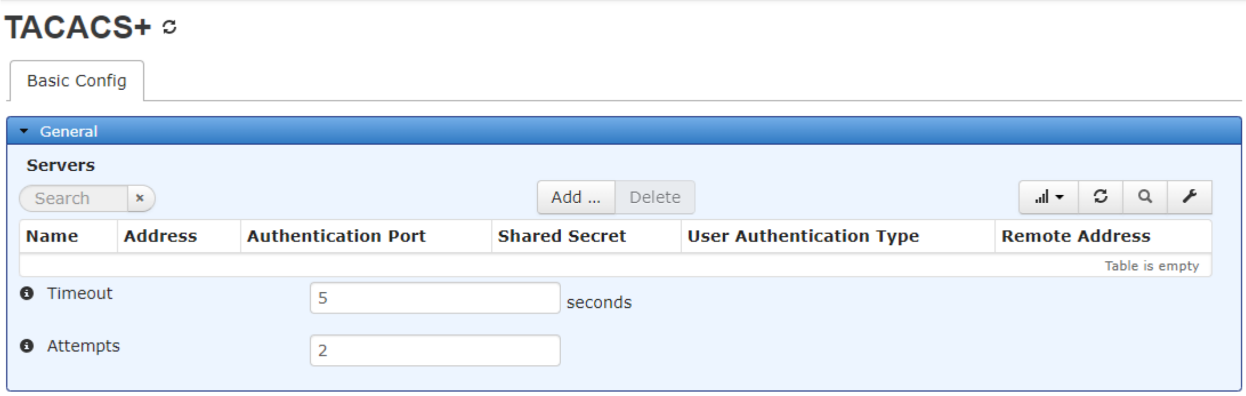
```
user = admin {
   name = "Admin User"
   member = mdsadmin
   pap = cleartext admin
}

user = tech {
   name = "Tech User"
   member = mdstech
```

```
    pap = cleartext admin
}

user = oper {
    name = "Oper User"
    member = mdsoper
    pap = cleartext admin
}
```

Syntax may differ from one TACACS+ server platform to another.

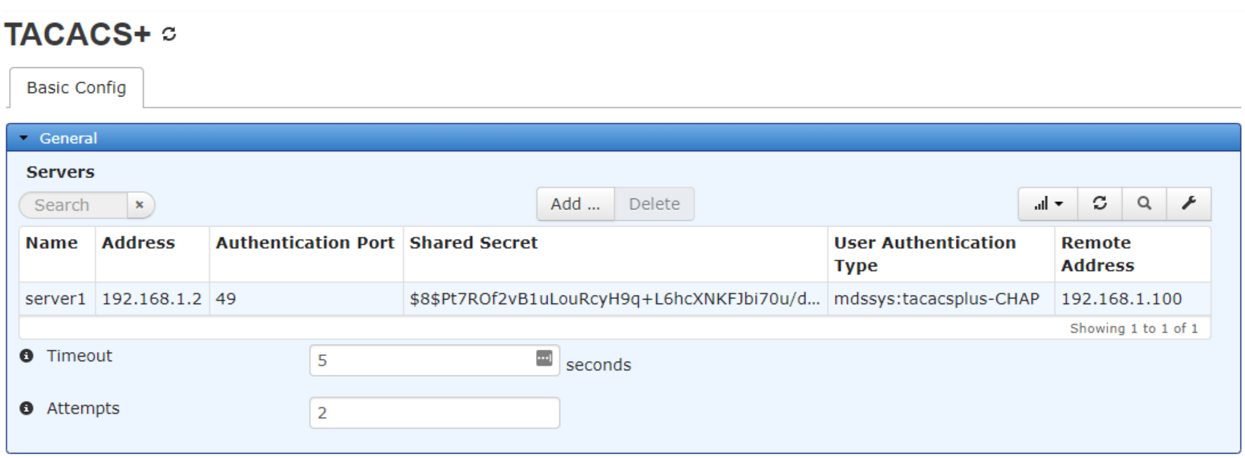
Configuring

Navigate to: ***System / TACACS+ ---> Basic Config*** the main interface for adding TACACS+ servers.



- **Timeout** - The number of seconds the device will wait for a response from a TACACS+ server before trying with a different server. Default = 5 - max value 255.
- **Attempts** - The number of times the device will send a query to the TACACS+ servers before giving up. Default = 2 - max value 255.

Click the **Add** button and add a server.



- **Name** – User defined name for the server.
- **Address** - The IPV4 address of the TACACS+ server. Alternative entry is to use a "Domain Name" string
- **Authentication Port** - The port number of the TACACS+ server. Default = 49

- **Shared Secret** - The shared secret which is known to both the TACACS+ client and server.

NOTE In FIPS mode, Shared Secret must meet strength requirements set in Section 3.7.5.

- **User Authentication Type -** The authentication type used by the TACACS+ server.
- **Remote Address -** The IPV4 address provided in the Remote Host attribute of the TACACS+ request. This should be the address of the interface that is making the request. If it is not provided the system will determine the address automatically. Alternative entry is to use a "Domain Name" string.

From the CLI command line, the following shows how to configure a TACACS+ server on the radio:

```
% set system mds-tacacsplus servers server1 address 192.168.1.2 shared-secret abcd1234
  user-authentication-type tacacsplus-CHAP remote-address 192.168.1.100

% show system mds-tacacsplus
  servers server1 {
        address                  192.168.1.2;
        authentication-port      49;
        shared-secret            $8$Pt7ROf2vB1uLouRcyH9q+L6hcXNKFJbi70u/dqD5l3A=;
        user-authentication-type tacacsplus-CHAP;
        remote-address           192.168.1.100;
}
```

3.7.8 Firmware Management

Understanding

GE periodically releases new Orbit MCR/ECR device firmware to provide new features and important updates. Firmware is provided at:
http://www.gegridsolutions.com/Communications/MDS/software.asp?directory=Orbit_MCR

The unit can have two firmware packages programmed into the device. The package that the device booted into is referred to as the *Active Firmware*. The other image is referred to as the *Inactive Firmware*.

To reprogram the device, the Active Firmware transfers the new firmware package from the network and writes the package into the Inactive Firmware location in memory. To use the new firmware package, the user must reboot the device to the Inactive Firmware. Doing so will make the Inactive Firmware the Active Firmware and vice-versa.

Firmware packages released by the factory are digitally signed using a private key. The unit will not accept firmware packages that are unsigned, nor will it accept firmware packages that fail to verify while using the public certificates loaded into the device. Therefore it is necessary to have the MDS public certificate loaded into the device to reprogram the firmware.

NOTE Beginning with Firmware revision 7.1.1, the firmware certificate has changed from a SHA1 value to a SHA256 value. When upgrading from early versions of code it is necessary to load the proper SHA256 certificate first. See the MDS product website support_items directory for more information.

NOTE https://www.gevernova.com/grid-solutions/automation/critical-infrastructure-communications/mds_software_firmware?directory=Orbit_MCR/Support_Items

Users may add their own signatures to the firmware package using the MDS code signing tool.

NOTE Any additional signatures added to a firmware package will require the corresponding public certificates to be loaded into the unit for firmware reprogramming to complete successfully. Similarly, any additional firmware-validation public certificates loaded into the unit require a firmware package to be signed with the corresponding private keys.

From the WebUI, navigate to ***System / Firmware***. The Versions section shows the firmware currently loaded in the two regions and which region is active.

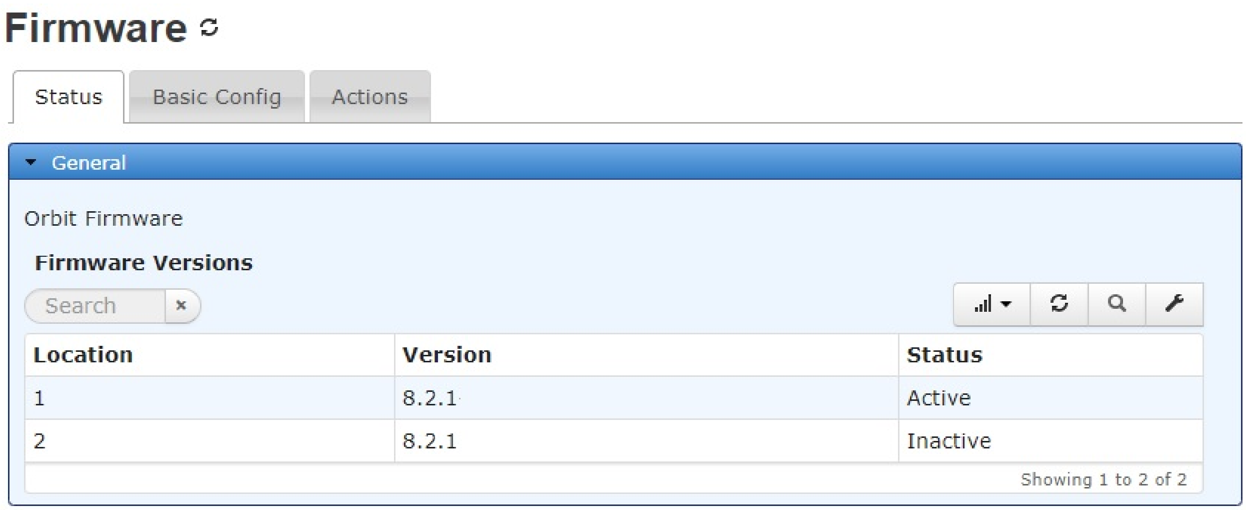


Figure 3-106. Firmware Versions Screen

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics of the currently installed firmware packages.

```
> show system firmware versions
  system firmware versions 1
  version 4.0.2
  active  true
  signatures 1
  certificate-sha256
   3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990
  system firmware versions 2
  version 4.0.2
  active  false
  signatures 1
  certificate-sha256
   3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990
```

Basic Configuration

The unit can be configured to automatically update its firmware to the latest official release. Navigating to the Basic Config tab, the following Auto Update configuration options are available.

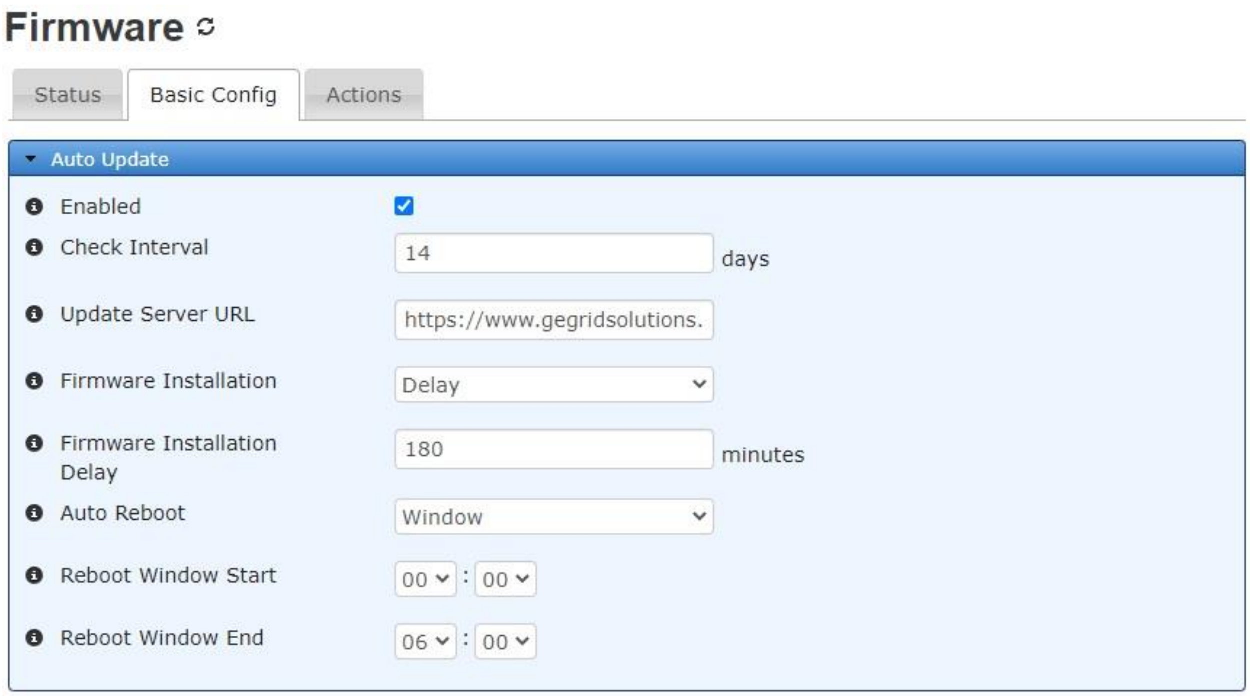


Figure 3-107. Firmware Auto Update Configuration

- **Enabled** – Allows this unit to update firmware automatically.

NOTE A user may perform a manual check and update (via the **Actions** tab) regardless of the value of this setting.

- **Check Interval** – When the **Enabled** option is set, the unit will check for updates on startup, and at every check interval thereafter. Manual checks (via the **Actions** tab) will not affect this interval. This check interval can be set from 1 to 180 days, with a default of 14 days.
- **Update Server URL** – This is the web address to contact for update information. The standard default (https://www.gegridsolutions.com/products/software/mds/orbit/autoupdate.xml) will ensure that the unit is updating to the latest general release from GE Vernova MDS. Factory default may specify an alternate location based on order entry options. This value can also be customized as needed to access a private update server. This facilitates automated firmware updates to units that may not have public internet access or to systems using special customer managed code. Please contact Customer Service/Support for more information.

NOTE This value must be a valid HTTP/HTTPS URL (begins with http:// or https://). When the unit is in FIPS-compliant mode (See Section 3.7.3), only HTTPS URLs are allowed.

NOTE **Security Tip**: HTTPS **Update Server URL**s require a CA X.509 certificate to verify the server that the device will update from. To access GE's update server, a CA certificate with identity "AutoUpdate" comes installed on the device (See CA Certificates, Section 3.9.3). If this certificate is deleted, please contact Technical Services, as the unit will **NOT** be able to connect to GE's update server.

The rest of the options below are only available if the Enabled option is set to true. Changing the Enabled setting to false will cancel any pending operations (update or reboot) that may have been scheduled. If a unit is in Updating state, the update will continue, but auto-reboot will be disabled.

- **Firmware Installation** – If a check determines that an update is available, the user may select from one of the following firmware installation options:
  - **Automatic**: If an update is available, the unit will begin the update within one minute. During this brief wait time, the unit will appear in Pending state. This is the default behavior.
  - **Delay**: If an update is available, the unit will begin the update after a specified delay. This may be useful for networks that require staggering of firmware updates to prevent network loading. During this delay, the unit will be in Pending state. This can be set from 30 minutes, to the length of the **Check Interval**. The default is 3 hours (180 minutes).
  - **Manual**: If an update is available, the unit will wait for user intervention to perform the update (via **Actions** tab).
- **Firmware Installation Delay –** This is the delay specified if the Firmware Installation option is set to **Delay**. If an update is available, the unit will wait this period (in the Pending state) before beginning the update. This delay may be bypassed manually or the pending update may be cancelled by the user (see **Actions** section below).
- **Auto-Reboot –** Once an update had completed (firmware has been reprogrammed into the inactive image), the user may select from one of the following reboot options:
  - **Disabled**: When the update is complete, the unit will wait for user intervention to reboot the unit to the new firmware (via the Power menu).
  - **Immediately** – The unit will reboot to the new firmware immediately after the update is complete.
  - **Window** – The unit will reboot to new firmware if the update completes during an allowed “time-of-day” window. This is useful when a reboot is desired at a certain time of day (i.e. when network traffic will be impacted the least). This is the default option.
- **Reboot Window Start/End** – If the **Auto-Reboot** option is set to **Window**, these options denote the start and end of the reboot window. Each one is a time-of-day in 24-hour format (between 00:00 and 23:59). If an update completes in between the start and end of the reboot window, the unit will reboot to the new firmware within one minute. If the update completes outside the window (before the window start or after the window end), it will wait until the reboot window start time to reboot. While waiting for reboot, the unit will be in Reboot-Pending state. A pending reboot may be cancelled by the user.

Actions

Navigating to the ***Actions*** tab, the following options are available for firmware maintenance.

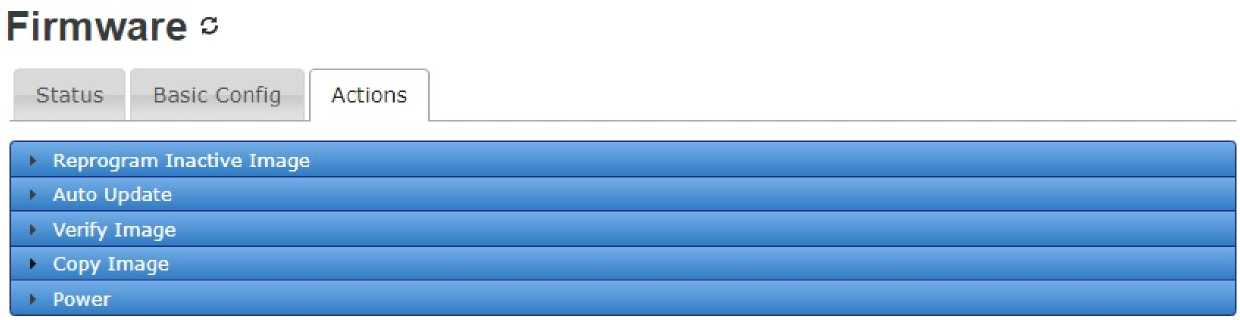


Figure 3-108. Firmware Actions

- **Reprogram Inactive Image -** Transfers a firmware package from the network and into the inactive firmware image
- **Auto Update –** Check for available updates. Perform firmware updates automatically.
- **Verify Image** - Verify the integrity of a specified firmware image
- **Copy Image** - Copy the active firmware image to the inactive region. Eliminates the need to download the image more than once
- **Power** – Reboots the device to the specified firmware image

Configuring - Reprogram

To start reprogramming the inactive firmware image, navigate to the **Reprogram Inactive Image** section**.** The following example shows how to upload a host firmware image file through the web browser and store the uploaded image file into the inactive region in memory.

Navigate to ***System / Firmware ---> Actions / Reprogram Inactive Image***

Click on the **Begin Reprogramming** button once the file source is configured.

Figure 3-109. Reprogram Inactive Image

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, and SFTP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, and From SFTP Server. Local file uploads are only available through the web UI and not through the CLI

- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device download a firmware image (named orbit-bkrc-7_1_1.mpk) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start reprogramming the inactive firmware image from the CLI, enter the following command to download the firmware image from the TFTP server:

> **request system firmware reprogram filename** orbit-bkrc-7_1_1.mpk **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring - Reprogram

Once the reprogramming is begun, the process may be cancelled by clicking the **Cancel Reprogramming** button. The current status of the reprogramming process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to reprogram (in other words, if the state is “inactive”).

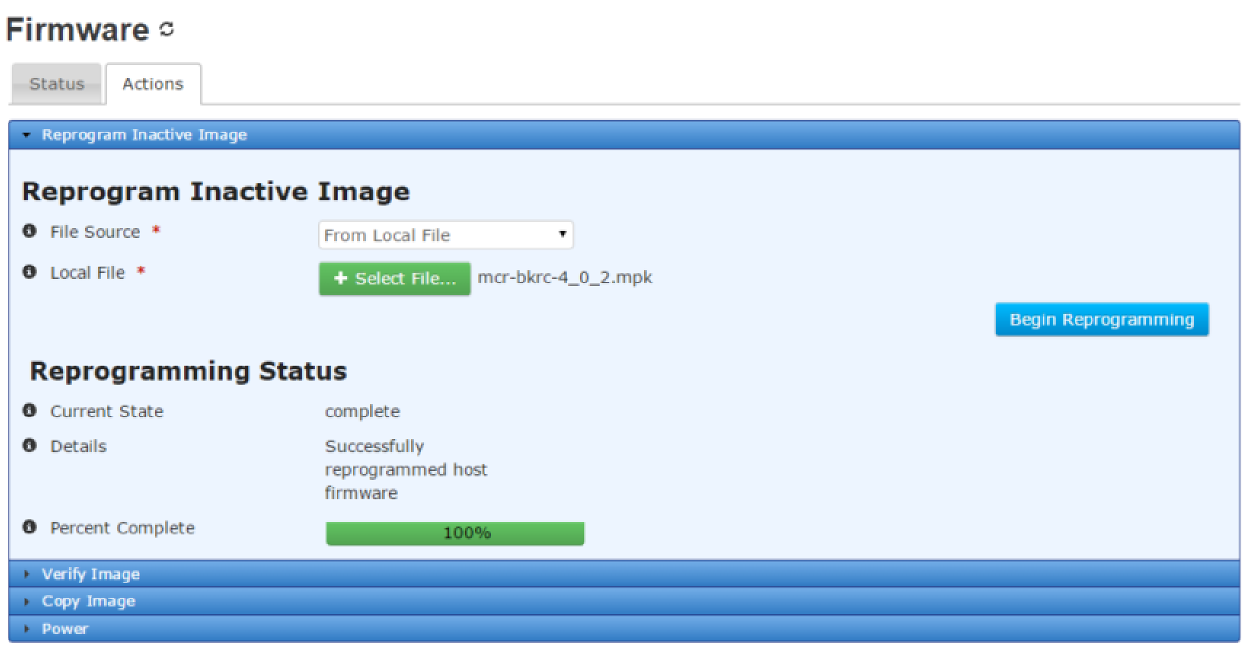


Figure 3-110. Reprogram Inactive Image Monitoring

The reprogramming status contains the following items:

- **Current State** – The status of the reprogramming task:
  - inactive
  - transfering

- processing
- cancelling
- complete
- failure
- cancelled

- **Detailed Message** – The details regarding the operation, such as "*Transferring host firmware image*"
- **Size** – The total number of bytes in the image (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the reprogramming process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system firmware reprogram-status
  system firmware reprogram-status state complete
  system firmware reprogram-status detailed-message "Successfully reprogrammed host
  firmware"
  system firmware reprogram-status size 38043384
  system firmware reprogram-status bytes-transferred 38043384
  system firmware reprogram-status percent-complete 100
```

Upon completion the unit can be re-booted to the newly loaded image by navigating to the **Power** section.

Configuring - Auto Update

The following actions may be performed in the Auto Update Actions tab:

- **Check For Update** – This action will check for the latest firmware release. The Auto Update process will contact the server specified in the Update Server URL to determine if there is an update available. The result will be displayed in the same window. In the CLI, this can be performed by entering: **request system firmware auto-update check-for-update**
  - Note: Performing a manual check will not affect when an automatic check happens. Automatic checks happen at startup, and at every check interval thereafter.
  - Note: When a check has been performed, the user will be locked out from performing another check for 10 seconds.
  - Note: If the device fails to contact the update server, the unit will display error information in the Auto Update State window. The unit will retry for up to 5 minutes before giving up. Checks for update will be locked out while the unit retries.
- **Start Update Now** – This action is available when an update is available (Update-Available state) or if an update has been scheduled (Pending state). When clicked, it will begin the firmware reprogramming process, bypassing any configured firmware installation delay. In the CLI, this can be performed by entering: **request system firmware auto-update start-update-now**

NOTE If the Zero-Touch Provisioning (ZTP) service is enabled, this function will be blocked, and the user will be notified. Furthermore, if Firmware Installation is set to **Delay** or **Automatic**, the unit will **not** perform the update. The ZTP service will supercede the Auto Update process with regard to firmware updates.

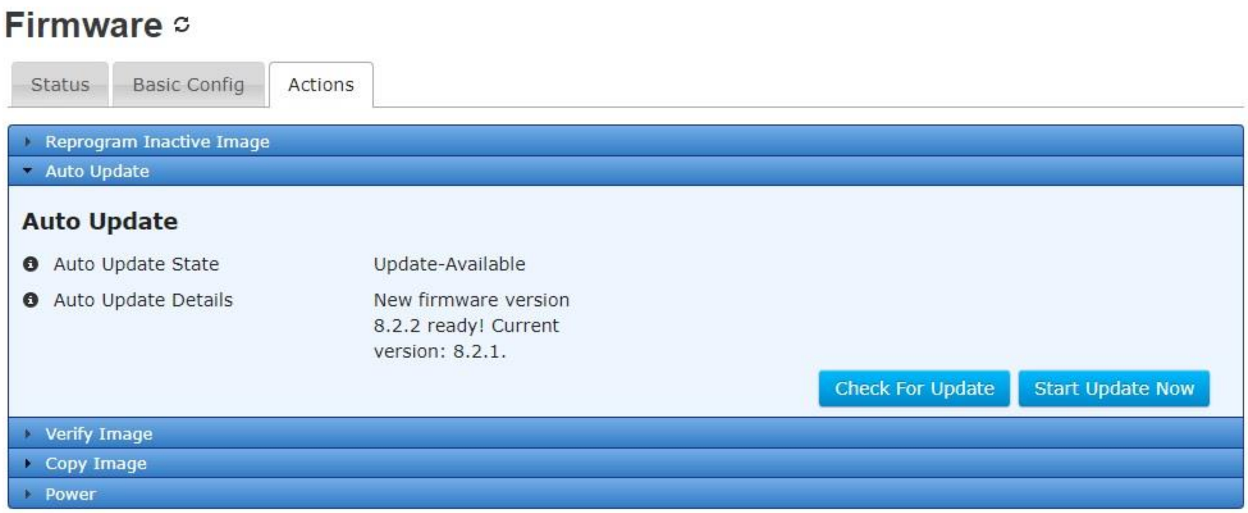


Figure 3-111. Options in Update-Available state

- **Cancel Scheduled Update** – This action is only available when an update is in Pending state (due to **Delayed** firmware installation being selected). When clicked, it will cancel the scheduled update. The user will have to manually intervene (**Check For Update** or **Start Update Now**) to schedule or start the update. In the CLI, this can be performed by entering: **request system firmware auto-update cancel-scheduled-update**

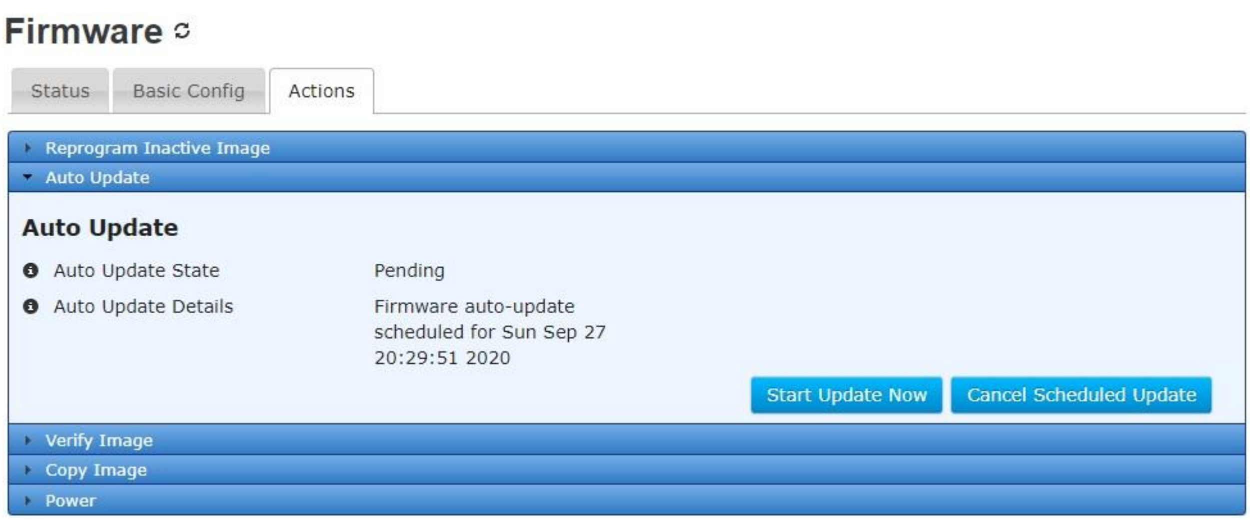


Figure 3-112. Options in Pending state

- **Cancel Update** – This action is only available in the Updating state. This will cancel the firmware upgrade in progress. In the CLI, this can be performed by entering: **request system firmware auto-update cancel-update**

Note: Since reprogramming may have begun, the firmware in the inactive image will be marked as invalid, and will no longer be functional.

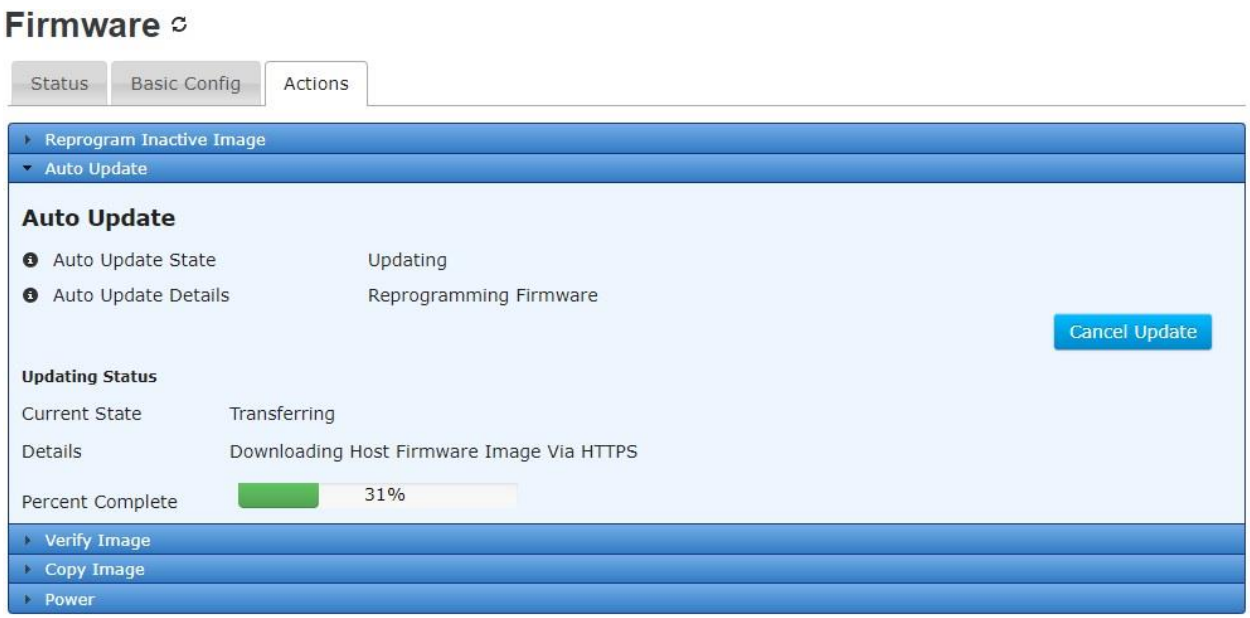


Figure 3-113. Update in progress, with option to cancel.

- **Cancel Scheduled Reboot** – This is only available if **Auto-Reboot** has been set to **Window** (see **Basic Config**). A reboot that is scheduled for the Reboot Window Start may be cancelled by the user. The new firmware will be present in the inactive image. The user will have to intervene (either reschedule reboot via a **Check For Update** or manually via Power menu) to reboot the device to the new firmware. In the CLI, this can be performed by entering: **request system firmware auto-update cancel-scheduled-reboot**

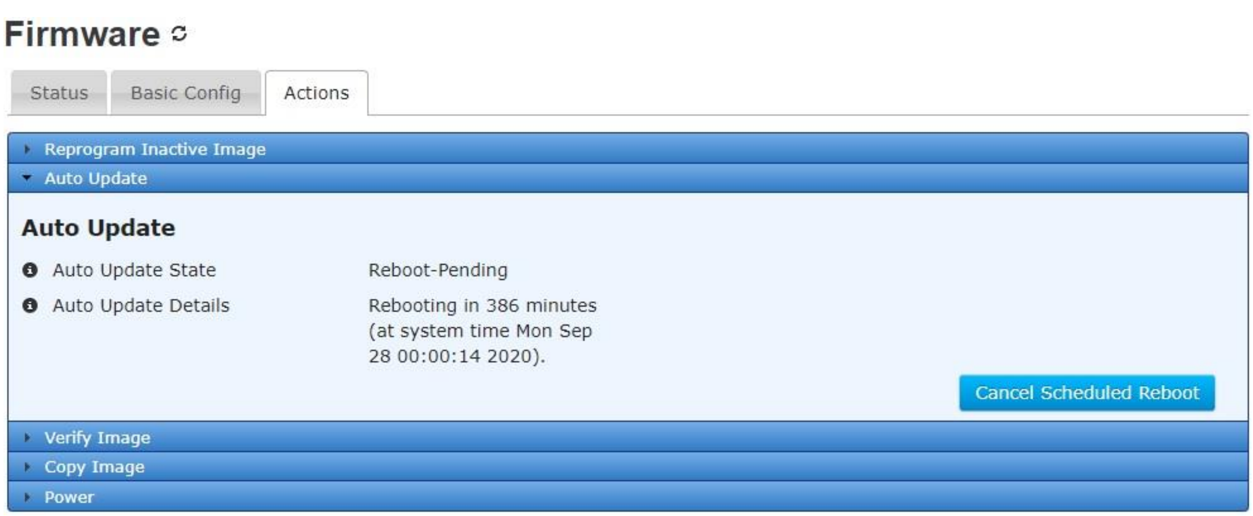


Figure 3-114. Scheduled reboot with option to cancel.

A "stale firmware" alarm will be raised if a unit has updated its firmware but has not booted to the new firmware for one-half the value of the check interval. The alarm will also be raised if a unit has Up-to-Date firmware, but is booted to out-of-date (stale) firmware.

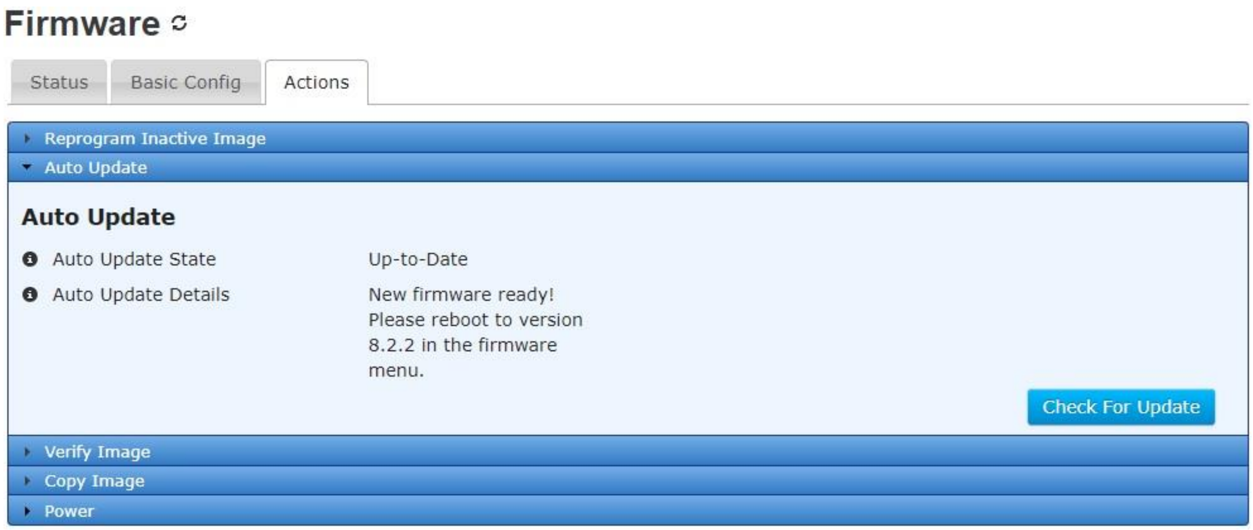


Figure 3-115. New firmware ready in the inactive image

Monitoring - Auto Update

The current state for the firmware Auto Update process can be accessed by navigating to the Auto Update section in the Actions tab. The Auto Update status contains the following:

- **Auto Update State** - This is short message giving the state of the Auto Update process.
- **Auto Update Details** – This field contains more detailed information on a particular state. This may include new version info, last check time, or any scheduled actions (reprogramming or reboot) that are awaiting.
- **Reprogramming Status –** In Updating state, the progress of the reprogramming is also displayed.

To view the status of the Auto Update process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system firmware auto-update
system firmware auto-update status auto-update-state Up-to-Date
system firmware auto-update status auto-update-details "Last check: Sun Sep 27 17:39:46
  2020"
```

Figure 3-116. Auto Update Status

Configuring - Verify

To verify a firmware image, navigate to the **Verify Image** section and select the appropriate image (1 or 2) to verify**.** Once an image is selected, click on the **Begin Reprogramming** button to begin.

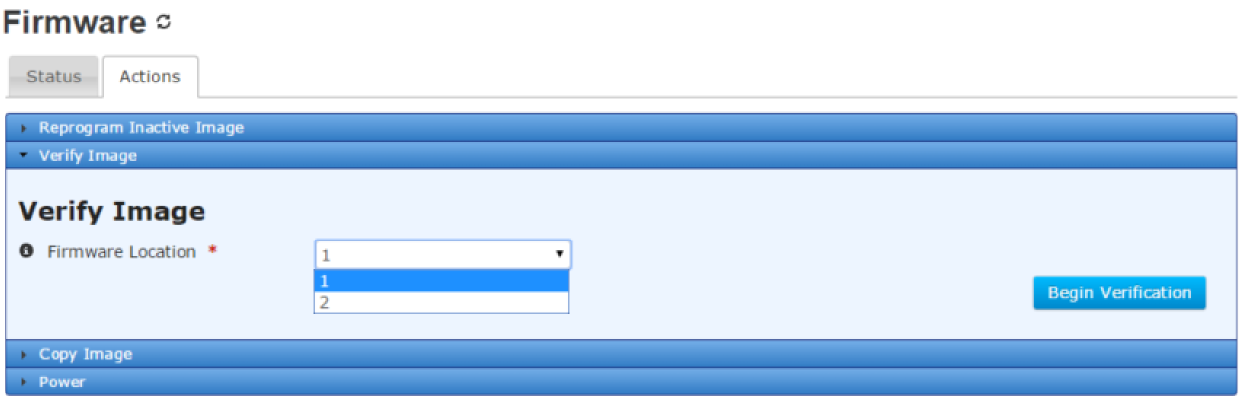


Figure 3-117. Verify Image

The following example shows how to have the device verify image 1 from the CLI:

> **> request system firmware verify-image location** 1

Monitoring - Verifying

Once the verification is begun, the current status of the verification process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to verify a firmware image (in other words, if the state is "inactive").

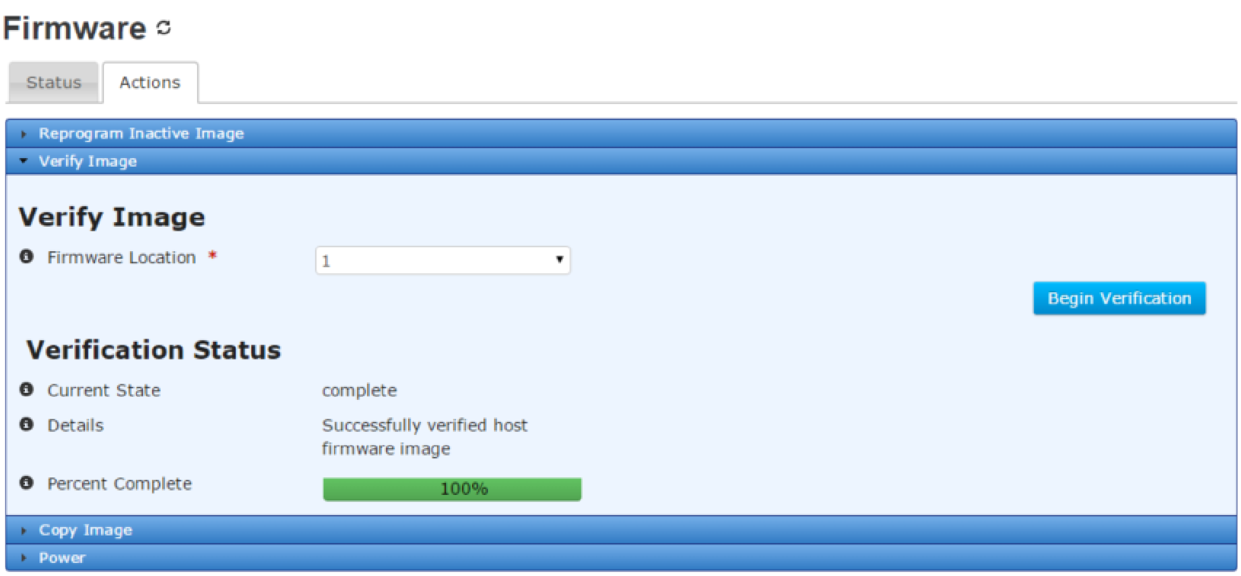


Figure 3-118. Verify Image Monitoring

The verification status contains the following items:

- **Current State** – The status of the verification task:
  - inactive
  - processing
  - complete
  - failure

- **Detailed Message** – The details regarding the operation, such as "*Verifying host firmware image*"
- **Size** – The total number of bytes in the image (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the verification process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system firmware verify-image-status
  system firmware verify-image-status state complete
  system firmware verify-image-status detailed-message "Successfully verified host
  firmware image"
  system firmware verify-image-status size 38043384
  system firmware verify-image-status bytes-transferred 38043384
  system firmware verify-image-status percent-complete 100
```

Configuring - Copy

To copy the active firmware image to the inactive firmware image, navigate to the **Copy Image** section and click on the **Begin Copying** button to begin.

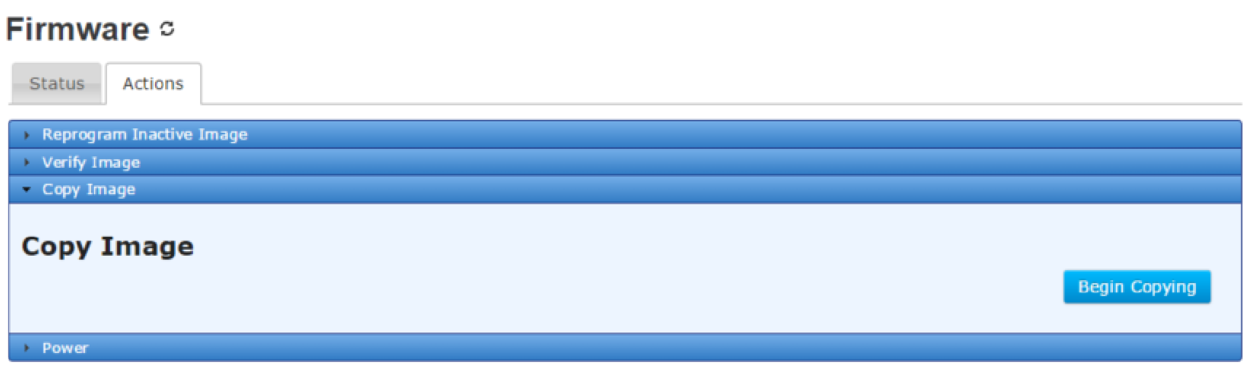


Figure 3-119. Copy Image

The following example shows how to have the device copy the active firmware image to the inactive firmware image from the CLI:

```
> request system firmware copy-image
```

Monitoring - Copy

Once the copying is begun, the current status of the copying process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to copy the firmware image (in other words, if the state is "inactive").

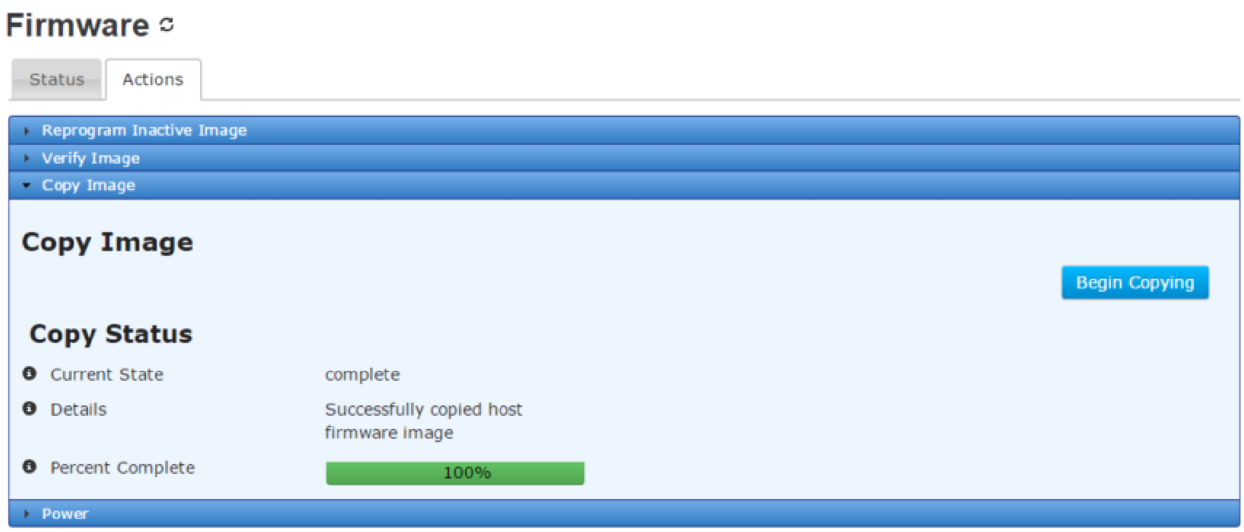


Figure 3-120. Copy Image Monitoring

The copy status contains the following items:

- **Current State** – The status of the copying task:
  - inactive
  - processing
  - complete
  - failure
- **Detailed Message** – The details regarding the operation, such as "*Copying host firmware image*"
- **Size** – The total number of bytes in the image (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the copy process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system firmware copy-image-status
  system firmware copy-image-status state complete
  system firmware copy-image-status detailed-message "Successfully copied host firmware
  image"
  system firmware copy-image-status size 38043384
  system firmware copy-image-status bytes-transferred 38043384
  system firmware copy-image-status percent-complete 100
```

Configuring – Power

To restart the device to a specified firmware image, navigate to the **Power** section and select the appropriate image (1 or 2) to restart into**.** Once an image is selected, click on the **Restart to selected** button to begin.

Allow approximately 2 minutes for the unit to complete the restarting process and refresh the screen.

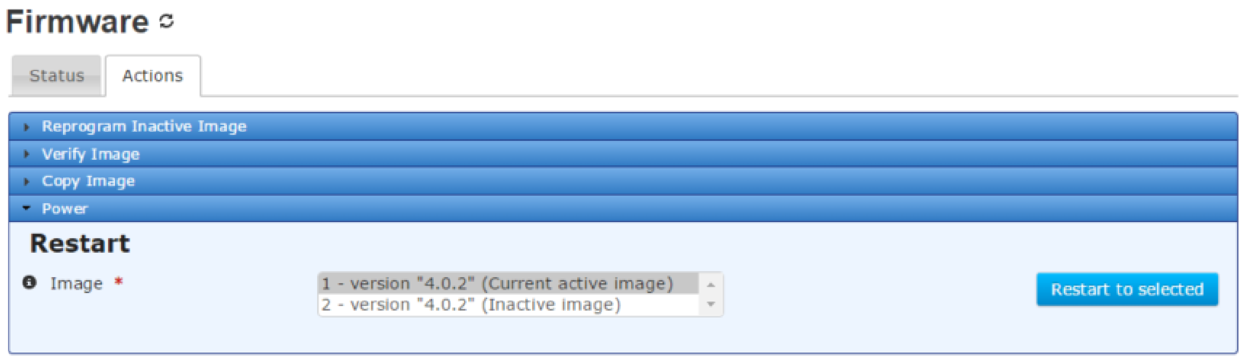


Figure 3-121. Restart to Image

To initiate a restart from the CLI, ensure the CLI is in operational mode and then follow the examples below to restart into the desired firmware image.

```
> request system power restart inactive
> request system power restart active
> request system power restart image 1
> request system power restart version 4.0.2
```

File Servers

External file servers can be pre-configured in the CLI so that the configuration can easily be referenced in other services without the need to re-enter the information. File Server Configurations can be used for reprogramming, downloading certificates, configuration script import and export and sending support bundles for debugging.

The following shows how to add a file server configuration named “GE File Server 1”:

```
% set file-servers GE_file_server_1 tftp address 192.168.1.10
% commit

> show configuration file-servers
  file-servers GE_file_server_1 {
        tftp {
                address 192.168.1.10;
  }
}
```

3.7.9 Tamper Detection

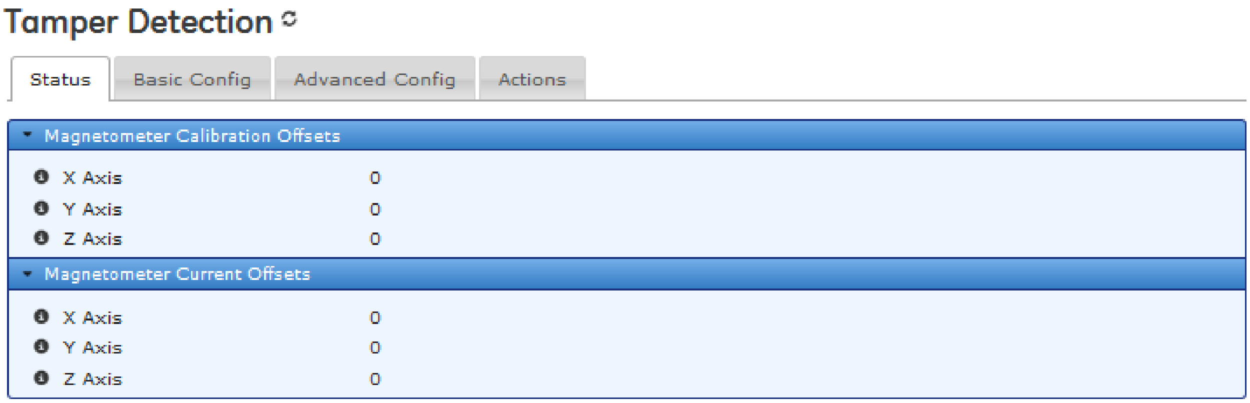
Understanding

The magnetometer detects changes in magnetic field on X, Y and Z axis. The system will generate an alarm if any one of the axis readings exceeds user configurable threshold values. The readings are based on local magnetic fields and are used to detect changes to the readings in relation to the values when tamper protection is enabled.

Operation

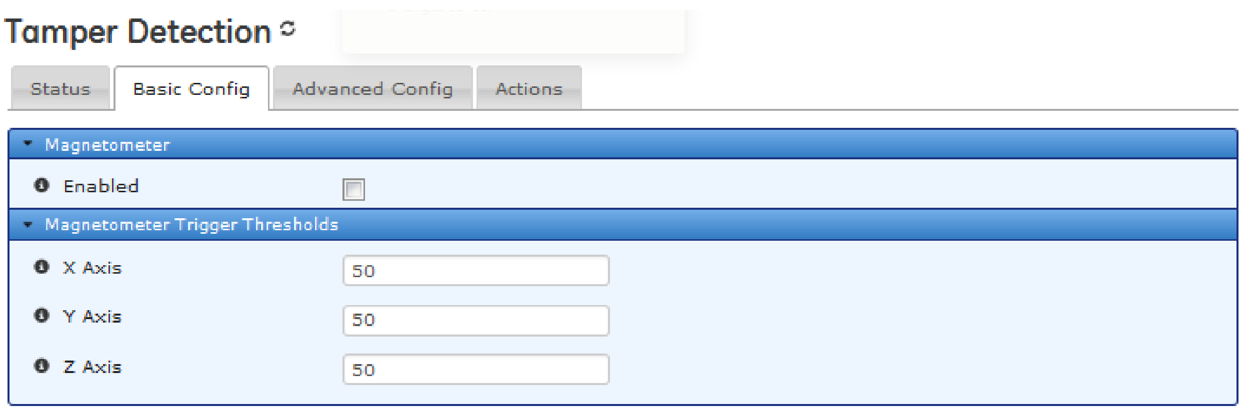
When enabled, the system calibrates the device. During calibration the axis readings are sampled to establish a baseline. When calibration is completed, the device enters operational mode. In operational mode, the axis readings, adjusted by the calibration results are used to determine current axis values. Readings which exceed the trigger thresholds on any axis, in either direction, will generate an alarm.

Default Settings



- **Calibration Offsets** - Calibrated coordinates, determined when magnetometer tamper is enabled.
  - x-axis - The raw x coordinate value.
  - y-axis - The raw y coordinate value.
  - z-axis - The raw z coordinate value.
- **Current Offsets** - Current coordinates, offset from calibrated values.
  - x-axis - The raw x coordinate value.
  - y-axis - The raw y coordinate value.
  - z-axis - The raw z coordinate value.

This can be enabled from the Web UI. Navigate to ***System / Tamper Detection ---> Basic Config.***



- **Enabled** - Indicates whether magnetometer is enabled for use. Enabling magnetometer performs a calibration to zero the current coordinate values.
- **Trigger Thresholds** - used to configure the device's sensitivity. Merely rotating the unit or moving it along any axis (for example, 6 to 12 inches) may be enough to trigger an alarm with thresholds at the minimum values. Setting the thresholds at the maximum values will prevent alarms from occurring under normal circumstances. However, unusual circumstances, such as setting a strong magnet on the unit, may still trigger an alarm
  - x-axis - alarm trigger threshold for x-axis. Default = 50 range : 25 - 2000
  - y-axis - alarm trigger threshold for y-axis. Default = 50 range : 25 - 2000
  - z-axis - alarm trigger threshold for z-axis. Default = 50 range : 25 - 2000

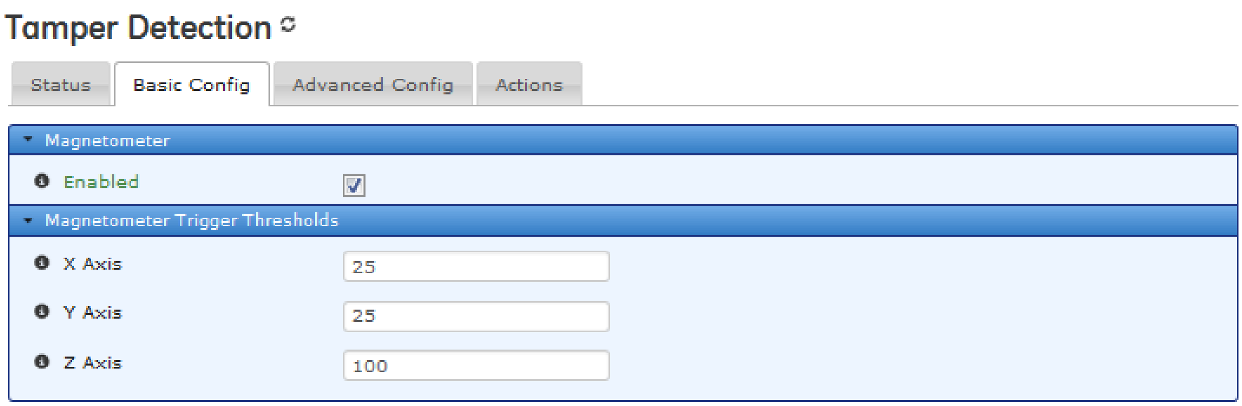
NOTE None of these numbers for coordinates or thresholds has meaningful units. They are just values that are all relative to each other. A value of 50 cannot be equated to a specific number such as 6 inches.

In the CLI to view this, enter configuration mode and execute the following command:

```
% show system tamper-detection magnetometer | details
enabled false;
trigger-thresholds {
    x-axis 50;
    y-axis 50;
    z-axis 50;
}
```

Configuring

Set trigger thresholds and enable the device. This will start the calibration process. Use the Web UI as show above, change the values, enable the device and press **Save**.

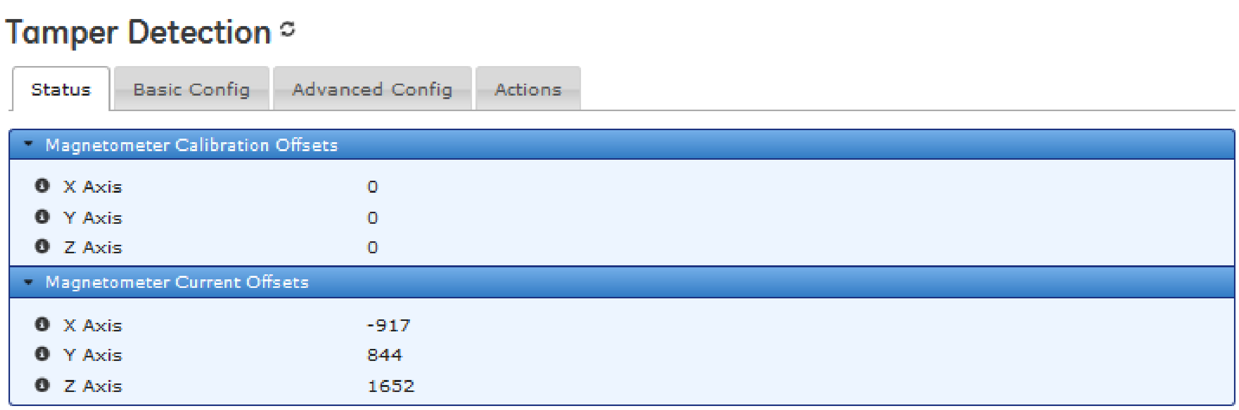


On the CLI issue the following;

```
% set system tamper-detection magnetometer trigger-thresholds x-axis 25
% set system tamper-detection magnetometer trigger-thresholds y-axis 25
% set system tamper-detection magnetometer trigger-thresholds z-axis 100
% set system tamper-detection magnetometer enabled true
```

Monitoring

Example of device status during calibration period:

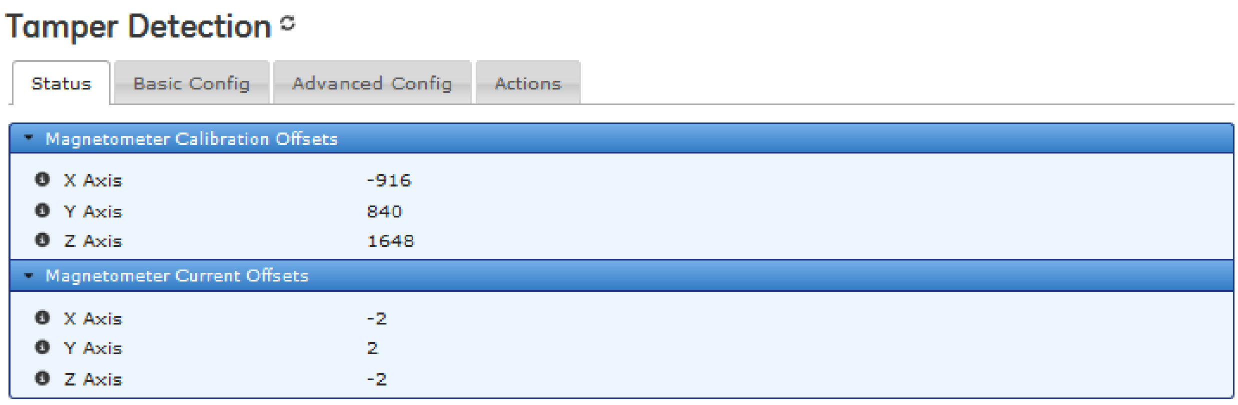


From the CLI the Device status during calibration period *could* look like this:

```
> show system tamper-detection magnetometer
  system tamper-detection magnetometer calibration-offsets x-axis 0
  system tamper-detection magnetometer calibration-offsets y-axis 0
  system tamper-detection magnetometer calibration-offsets z-axis 0
  system tamper-detection magnetometer current-offsets x-axis -917
  system tamper-detection magnetometer current-offsets y-axis 844
```

system tamper-detection magnetometer current-offsets z-axis 1652

Example of device status when operational (after calibration):

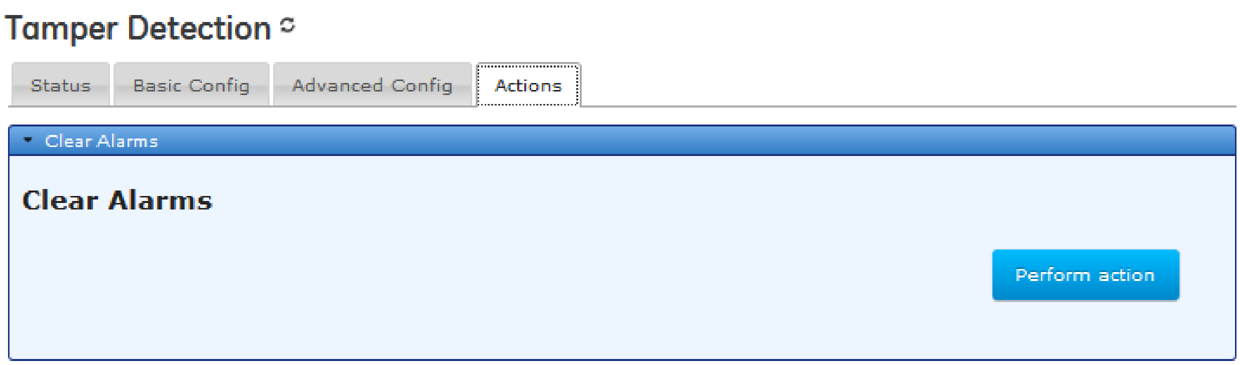


From the CLI the Device status when operational (after calibration) could be:

```
> show system tamper-detection magnetometer
  system tamper-detection magnetometer calibration-offsets x-axis -916
  system tamper-detection magnetometer calibration-offsets y-axis 840
  system tamper-detection magnetometer calibration-offsets z-axis 1648
  system tamper-detection magnetometer current-offsets x-axis -2
  system tamper-detection magnetometer current-offsets y-axis -0
  system tamper-detection magnetometer current-offsets z-axis -2
```

Tamper Alarms

Once tamper detection is enabled the alarm will be triggered when the magnetometer readings exceed the configurable offsets. To clear the alarm, navigate to ***System / Tamper Detection / ---> Actions / Clear Alarms*** and press **Perform Action**. After confirmation, the following screen will show.



From the CLI the command can be issued as follows:

```
> request system tamper-detection clear-alarms
```

3.7.10 Configuration Files

Understanding

An exported configuration script will contain all of the settable parameters of the unit for which the current user has read-access. For example, configuration scripts exported by the tech user will not contain values which only the admin user has permissions to view. Configuration scripts can be saved and used to restore known-good configurations.

NOTE A configuration file cannot be used to update a single parameter. Importing a configuration file will update all parameters that the current user has permission to change. Any parameters missing from the configuration file on import will be assumed by the radio to be deleted. Make certain that all necessary parameters are kept in the configuration file unless they are expected to be deleted.

Configuring - Export

The following example shows how to have the device export the current configuration and download that configuration to a local file through the web browser.

Navigate to ***System / Config Files ---> Actions / Export Configuration***

Click on the **Begin Exporting** button once the file destination is configured.

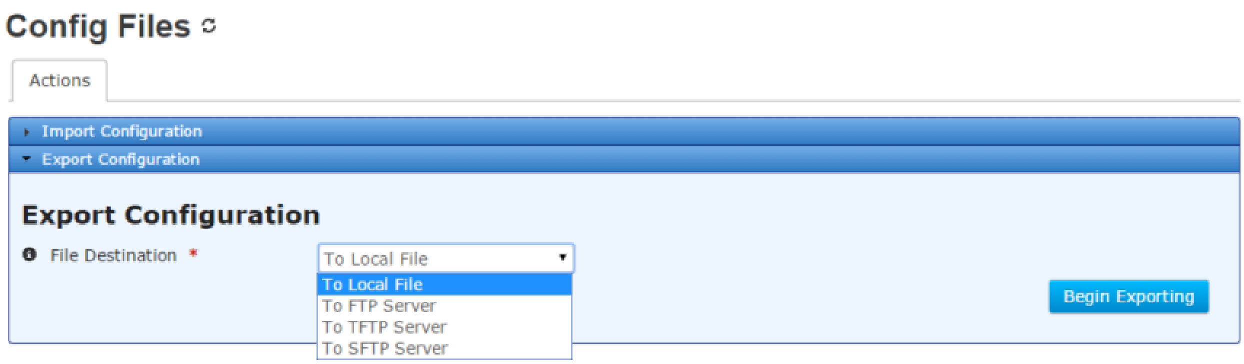


Figure 3-122. Export Configuration

The Orbit supports file downloads through a web browser to a local file on the user's PC. The Orbit also supports FTP, TFTP, and SFTP file uploads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Destination** - File transfer method to use. Available choices are To Local File (DEFAULT), To FTP Server, To TFTP Server, and To SFTP Server. Local file downloads are only available through the web UI and not through the CLI
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the destination file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device generate and export a configuration file (named config-2016-02-04.xml) to a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the configuration file export from the CLI, enter the following command to upload the configuration file to an external TFTP server:

> **request system configuration-files export filename** config-2016-02-04.xml **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring - Export

Once the export of the configuration file is begun, the process may be cancelled by clicking the **Cancel Exporting** button. The current status of the configuration file export process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to export a configuration file (in other words, if the state is “inactive”).

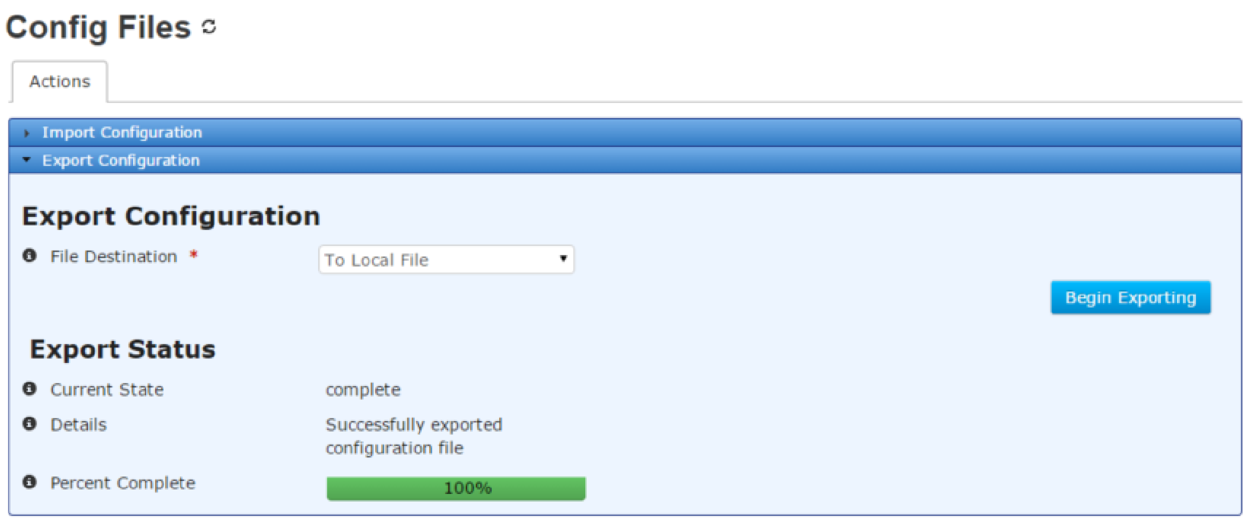


Figure 3-123. Export Configuration Monitoring

The export status contains the following items:

- **Current State** – The status of the export configuration file task:
  - inactive
  - preparing
  - transfering
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as “*Generating configuration file*”
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already generated or transferred (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system configuration-files export-status
  system configuration-files export-status state complete
  system configuration-files export-status detailed-message “Successfully exported
  configuration file”
  system configuration-files export-status size 10396
  system configuration-files export-status bytes-transferred 10396
  system configuration-files export-status percent-complete 100
```

Configuring - Import

The following example shows how to have the device import a set of configuration parameters by uploading a local file through the web browser.

Navigate to ***System / Config Files ---> Actions / Import Configuration***

Click on the **Begin Importing** button once the file source is configured.

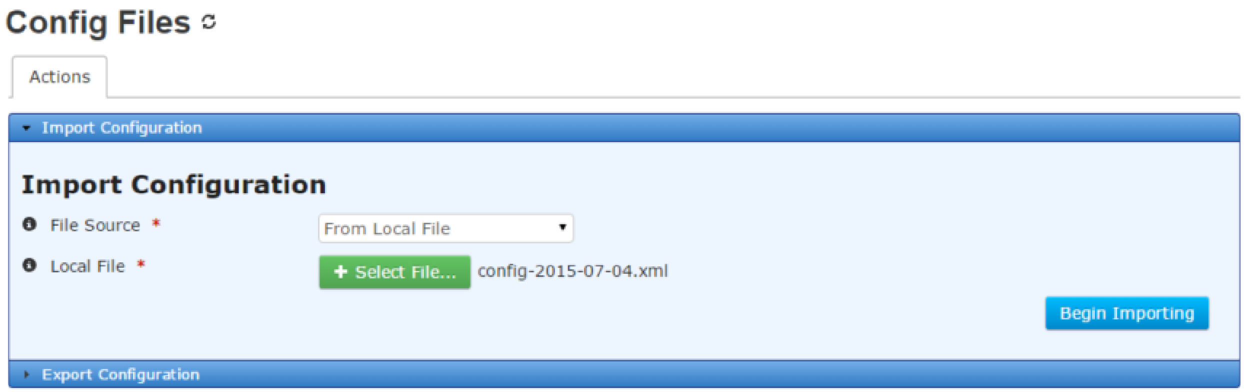


Figure 3-124. Import Configuration

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, and SFTP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, and From SFTP Server. Local file uploads are only available through the web UI and not through the CLI
- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device download a configuration file (named config-2016-02-04.xml) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the configuration file import from the CLI, enter the following command to download the configuration from the TFTP server:

> **request system configuration-files import filename** config-2016-02-04.xml **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring - Import

Once the import of a configuration file is begun, the process may be cancelled by clicking the **Cancel Import** button. The current status of the import process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to import a configuration file (in other words, if the state is "inactive").

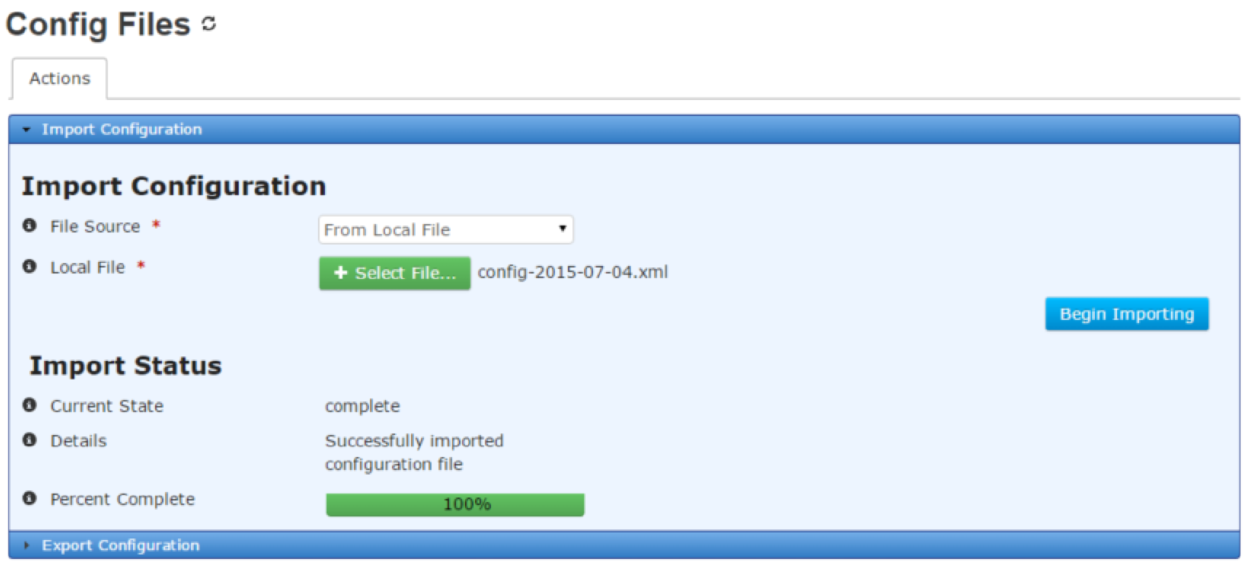


Figure 3-125. Import Configuration Monitoring

The import status contains the following items:

- **Current State** – The status of the import task:
  - inactive
  - transfering
  - processing
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Transferring configuration file*"
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the import process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show system configuration-files import-status
  system configuration-files import-status state complete
  system configuration-files import-status detailed-message "Successfully imported
  configuration file"
  system configuration-files import-status size 10396
  system configuration-files import-status bytes-transferred 10396
  system configuration-files import-status percent-complete 100
```

3.7.11 DNS

Understanding

Domain Name System (DNS) servers can be configured on the unit to facilitate the resolution of domain names to IP addresses.

NOTE Manual configuration of DNS overrides any DNS settings obtained via DHCP.

Configuring

Using the Web UI

The following example shows how to configure a DNS server with IP address 192.168.1.2 on the Orbit.

Navigate to ***System / DNS ---> Basic Config***

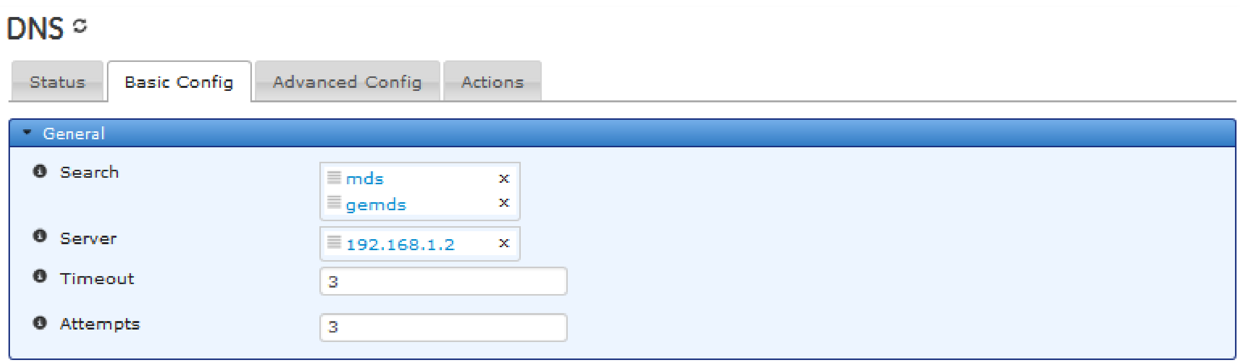


Figure 3-126. DNS Menu

The following options are available.

- **Search** – Optional parameter. A list of domains or IP addresses to add to a non-fully qualified domain name when performing a DNS query. If entering more than one value, separate them with a space.
- **Server** – The intended DNS server's IP address.
- **Timeout** – The amount of time in seconds that the unit will wait for a response from the DNS server before retrying.
- **Attempts** – The number of attempts the unit will query the DNS server before giving up.

Using the CLI

The following example shows how to configure a DNS server with IP address 192.168.1.2 on the Orbit. Note that the "search" option can take a list of arguments and in this example, there are two arguments; mds and gemds.

```
% set system dns server 192.168.1.2 search [mds gemds] options attempts 3 timeout 3
```

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics.

The ping utility can be used on the CLI when it is in operational mode to verify that DNS is working properly. If ping can resolve a name on the connected network to an IP address then DNS settings are working properly. The example below shows the resolution of the name "example.com" to the IP address "192.0.43.10" on a unit that is connected to the Internet.

Use the control sequence "CTRL-C" to stop the ping utility.

```
> ping example.com
PING example.com (192.0.43.10) 56(84) bytes of data.
```

```
64 bytes from 43-10.any.icann.org (192.0.43.10): icmp_req=1 ttl=128 time=184 ms
64 bytes from 43-10.any.icann.org (192.0.43.10): icmp_req=2 ttl=128 time=132 ms
64 bytes from 43-10.any.icann.org (192.0.43.10): icmp_req=3 ttl=128 time=172 ms

--- example ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 132.818/163.231/184.739/22.112 ms
```

3.7.12 Redundant AP Mode

Understanding

Redundant AP (Access Point) mode is hardware and software setup that uses two Orbit radio systems to provide an extra layer of resiliency at a single access point location.

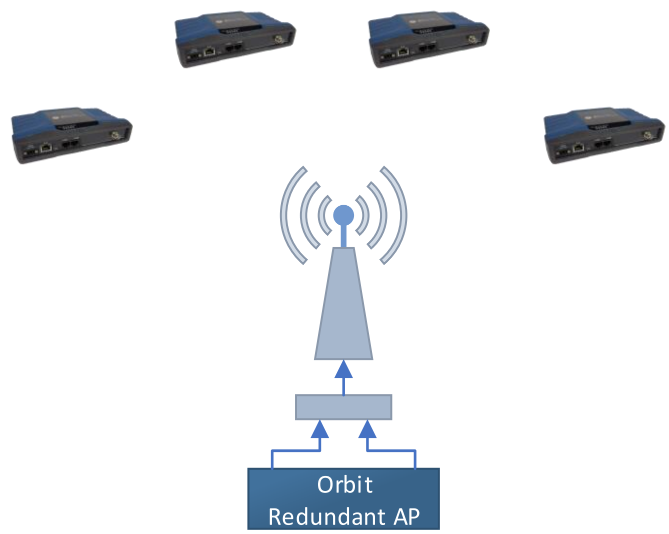


Figure 3-127. Redundant AP Network with two co-located access points

In Redundant AP operation, when a faulty situation with the primary access point is detected, the backup radio system will take over as the access point for the network. This failover operation can happen based on several user-configurable settings. Remote radios will automatically associate with the backup access point with minimal interruptions and the data paths will be re-established. This feature is intended only for access points that are co-located and servicing the same field of remote radios. All radio settings must be the same at both locations for failover to occur seamlessly.

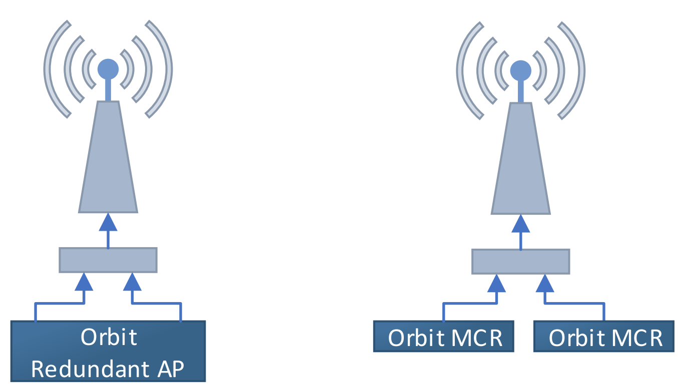


Figure 3-128. Single Chassis vs Dual Chassis Configuration

A Redundant AP system consists of two co-located access points. The access points should be hard wired to one another to facilitate the routine communication of operational status messages. GE Vernova offers a consolidated device, called MDP, that incorporates two complete radio systems in a single chassis. The MDP includes two radio systems, with each system consisting of a radio module and a platform manager module. Alternatively, a Redundant AP system can use separate devices for each access point. Any MDS Orbit form factor can be used as an access point, whether it's an MCR, ECR, or MPR.

Redundant access points must communicate with one another to relay operational status information. A robust Ethernet channel must be installed between access points to ensure reliable delivery of status messages. When failover or recovery conditions are detected at either of the access points, status messages are used to coordinate which access point is to be in the active state. Only one access point in the Redundant AP system is active at any given time.

Various settings can be configured to trigger when a failover operation should happen and when the failover condition is cleared. These settings are available in the *netmon* service configuration and in the *conditional-operation* option in the interface configuration. Redundant AP functionality becomes fully operational when netmon triggers are enabled and status message passing occurs, as depicted in the diagram below. In this example, there is a netmon that publishes the state of each AP. The Radio Module subscribes to the netmon status using the conditional-operation setting. When an AP determines it is in Master role, then the Radio Module will be activated. Conversely, when the AP determines it is in Backup mode, then the Radio Module will be deactivated. The AP components coordinate with one another to determine which AP instance is the current Master. Therefore, only one access point will be active at any given time.

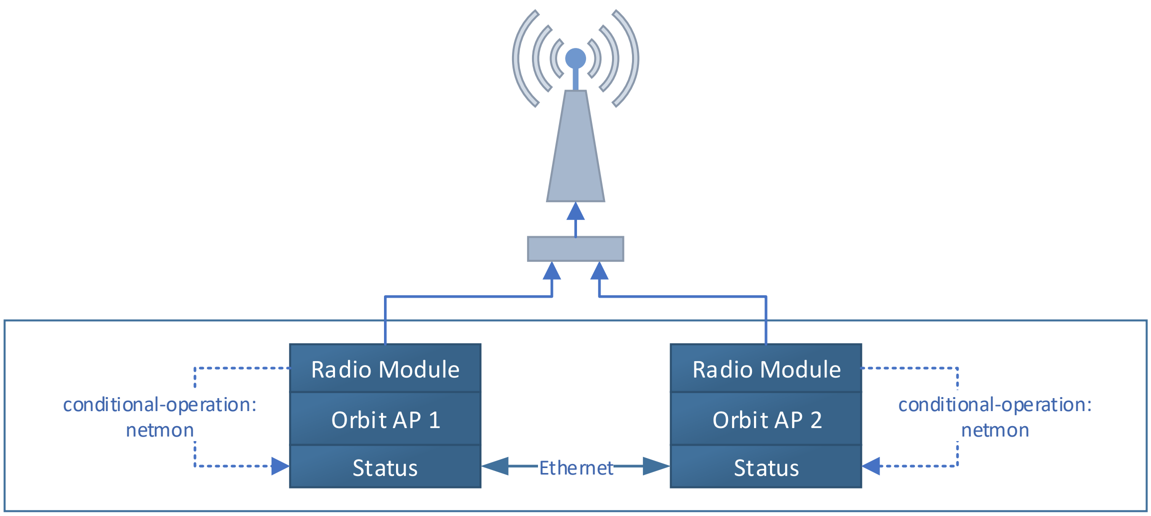


Figure 3-129. Using *netmon* for Redundant AP

Configuring

The following example shows the essential settings for the primary access point in a Redundant AP system. From the CLI:

```
% set interfaces interface ETH1 vrrp enabled true
% set interfaces interface ETH1 vrrp address 10.0.0.1
% set interfaces interface ETH1 vrrp subnet-mask 255.255.0.0
% set interfaces interface ETH1 vrrp id 123
% set interfaces interface ETH1 vrrp priority 200
% commit
```

```
% set services netmon operation NETMON-VRRP enabled true
% set services netmon operation NETMON-VRRP type vrrp-monitor
% set services netmon operation NETMON-VRRP vrrp-monitor
% set services netmon operation NETMON-VRRP vrrp-monitor interface ETH1
% commit


% set interfaces interface NxRadio nx-config conditional-operation operation [ NETMON-VRRP ]
% commit
```

The backup access point in a Redundant AP system will use similar settings, except the VRRP priority should be a lesser value:

```
% set interfaces interface ETH1 vrrp priority 100
```

A web wizard is provided to aid in the initial setup of Redundant AP mode for each access point. The wizard also configures the settings shown above, however, it configures settings for redundant VPNs as well.

Monitoring

Status parameters can be used to monitor the Redundant AP operation and to check which AP is in the active Master and Backup role.

To view the status of the netmon services, use the following command:

```
> show services Netmon
```

When the NETMON-VRRP service reports a status of *True*, then the Radio interface conditional-operation will be permitted to enable the AP as the active access point. At that time, the backup access point will show a NETMON-VRRP status of *False*, indicating that the backup access point is acting in standby mode.

The NETMON-VRRP status reflects the state of VRRP on an Ethernet interface. To view the VRRP status directly on an interface, use the following command:

```
> show interfaces-state interface vrrp
```

3.7.13 Scheduled Reboot

Understanding

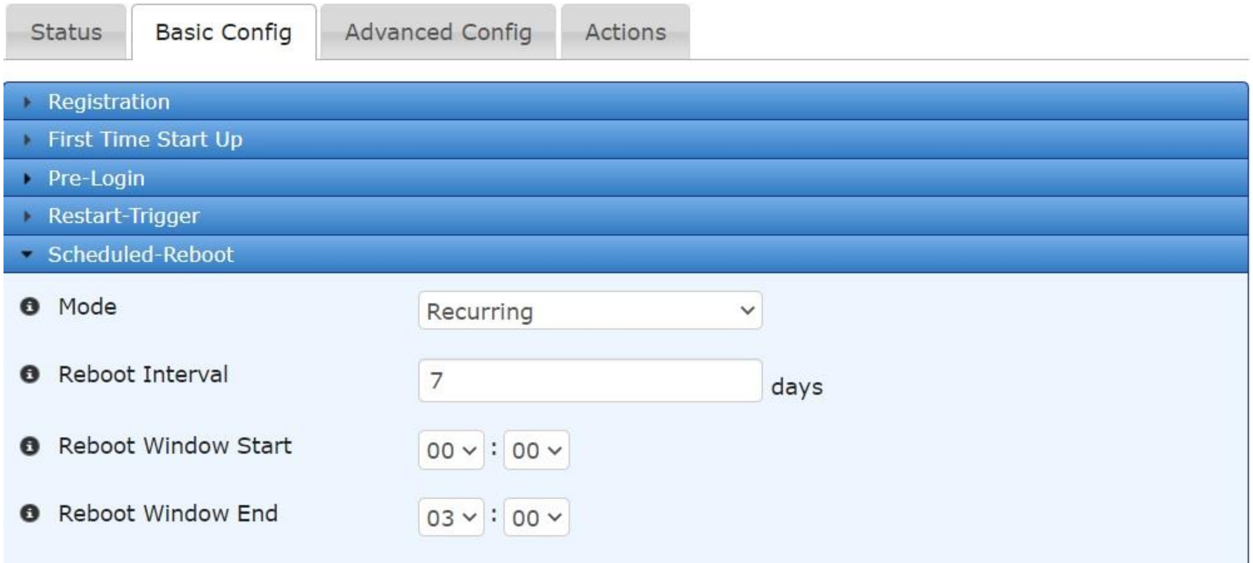
The device has a feature to allow a customer to schedule a reboot of the device. The reboot can be a one-time delayed reboot, or a recurring reboot. The feature can be employed to ensure optimal system operation in environments where an interruption can be tolerated.

Configuring

Using the Web UI

The following example shows the configuration window for Scheduled Reboot.

Navigate to ***System / General ---> Basic Config ---> Scheduled Reboot***



The following parameters can be configured:

- **Mode** – The operating mode for scheduled reboots
    - Disabled – Do not perform any scheduled reboots. **Note: Choosing this setting will also cancel any pending scheduled reboots.**
    - One-Time – Perform a single reboot after the designated interval. When the system reboots, the mode will be switched to Disabled.
    - Recurring – Perform a reboot after the designated interval. Upon reboot, another reboot will be scheduled for the same interval. This will repeat until the mode is disabled, or parameters are changed.
- **Reboot Interval** – The interval, in days, for the scheduled reboot. This can be set to 1-45 days. In One-Time mode, this can also be set to 0 for same-day reboot. The interval timer starts upon saving the settings, or at boot time.
- **Reboot Window Start/End** – A clock time, in 24-hour format (00:00-23:59), denoting the start and end of the reboot window. Upon expiration of the reboot interval, the device will reboot if the expiration occurs inside the window. If the interval expires outside the window, the system will pick a random time inside the window, then wait until then to perform the reboot.

Example: A reboot is scheduled (committed) at 5pm on June 8th with an interval of 2 days, and the reboot window set to 00:00-03:00 (12am-3am). The interval will expire at 5pm on June 10th. However, the reboot will be delayed for at least 7 hours until the 12am-3am window. The unit will then reboot at a randomly selected time between 12am and 3am on June 11th.

If the settings are saved inside the reboot window times, the device will reboot immediately upon expiration of the interval.

Using the Command-Line Interface

In the CLI configuration prompt, settings can be displayed with the following command:

```
% show system maintenance scheduled-reboot
```

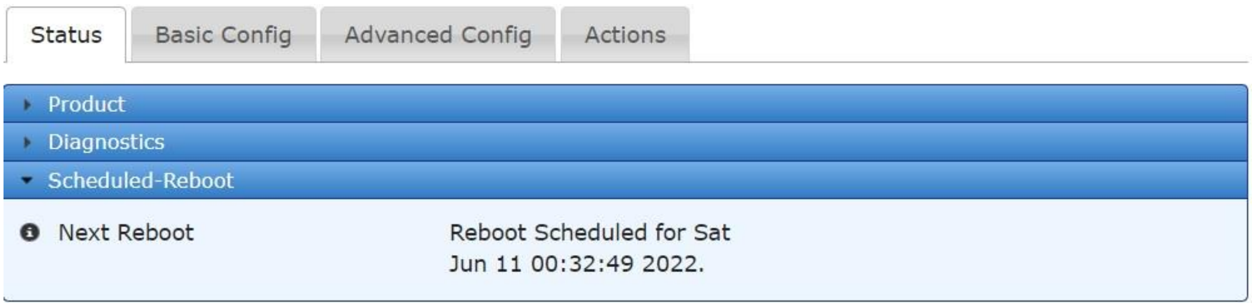
Consequently, the parameters for the example above can be set with the following:

```
% config
% set system maintenance scheduled-reboot mode Recurring
% set system maintenance scheduled-reboot reboot-interval 2
% set system maintenance scheduled-reboot reboot-window-start 00:00
% set system maintenance scheduled-reboot reboot-window-end 03:00
% commit
```

Monitoring

When Scheduled Reboot mode is set to One-Time or Recurring, the date and time of the next reboot will be displayed in the status window in the Web UI.

Navigate to ***System / General ---> Status ---> Scheduled Reboot***



In the CLI status prompt, the next reboot date/time can be displayed with the following command:

```
% show system maintenance scheduled-reboot
```

Note: If Scheduled reboot is Disabled, the status will show “Not Scheduled”.

3.8 Networking Services and Routing

3.8.1 Network

Understanding

The unit supports multiple networking features that are either implemented as virtual network interfaces (Bridge, VLAN, GRE, Bond) or as network services or applications operating on these virtual and other physical interfaces (LAN, Cell, WiFi, 900Mhz). Following provides a brief overview of these networking features:

- **Dynamic IP addressing**
  - **DHCP Client -** The units supports DHCP client operation on various physical and virtual interfaces.
  - **DHCP Server -** The units supports DHCP server operation to assign dynamic IP addresses to other devices connected to it over various network interfaces.
- **Bridging** - The unit supports bridging feature by creation of network interfaces of type 'bridge' that can contain one or more network interfaces as members of this interface. The unit also supports spanning tree protocol (STP) to prevent formation of loops in the bridged network.
- **VLAN** - The unit supports VLAN feature by creation of network interface of type 'vlan' and configuration of the other network interfaces in the system as members of this VLAN interface.
- **Firewall** - The unit supports firewall feature to accept/drop incoming or outgoing traffic by configuration of Access Control List (ACL) filters on the network interfaces.
- **Network Address Translation (NAT)** - The unit supports following types of Network Address Translation (NAT):
  - **Destination NAT (Port Forwarding)** - Translating the destination address (and/or port) of traffic ingressing the unit. Destination NAT allows forwarding of traffic directed to a public (external network) IP address (and/or port) to a private (internal network) IP address (and/or port).

  - **Source NAT (Masquerading)** - Source NAT allows private (internal network) hosts to share the same public (external net-work) IP addresses to enabling them to communicate with a host on the public/external network.
  - **Static NAT (One to One NAT)** - Translating a public (external network) address of traffic ingressing to a private (internal network) address and egressing the unit vice versa. Static NAT allows private (internal network) hosts to be accessible through a corresponding public (external network) address. This feature can be used to help connect networks with overlapping network address ranges.
- **Routing** - The unit supports static routing by allowing configuration or one or more static routes to various destination networks.
- **Virtual Private Network (VPN)** - The unit supports VPN feature by use of following types of tunnels:
- **IPsec Tunnel** - IPsec enables secure tunneling of unicast IP traffic from one private network to another over an untrusted (e.g. public) network.
- **OpenVPN Tunnel** – Provides a secure IP tunnel via a TUN/TAP interface, using TLS for authentication and OpenSSL for encryption.
- **GRE Tunnel** - Generic Routing Encapsulation (GRE) enables tunneling of unicast and multicast IP traffic (layer-3) or Ethernet (layer-2) traffic from one private network to another over another network. GRE tunnels do not provide any security. GRE and IPsec can be combined to enable following uses cases:
  - Sending multicast IP traffic securely from one private network to another over an untrusted network
  - Sending Ethernet traffic securely from one private network to another over an untrusted network.
- **Network Link Failover/Failback** - The unit supports following two types of network link failover and failback features:
  - **Route (Layer-3) Failover** - The unit supports this feature by enabling configuration of multiple routes to same destination network with different preference (metric) values, enabling traffic to be sent using the route with high preference in normal scenario and failing back to the route with lower preference when the destination network is not reachable through the higher preference route.
  - **Link (Layer-2) Failover** - The unit supports this feature by creation of a bond interface in an active-backup mode that can aggregate a primary and secondary layer-2 link. When primary link is down, the secondary link is used to send layer-2 traffic etc.

From the Interface navigation bar, the status may be displayed by clicking on the interface within the list:

Navigate to: ***Interfaces***

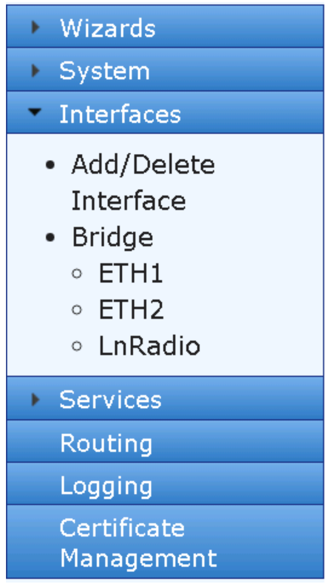
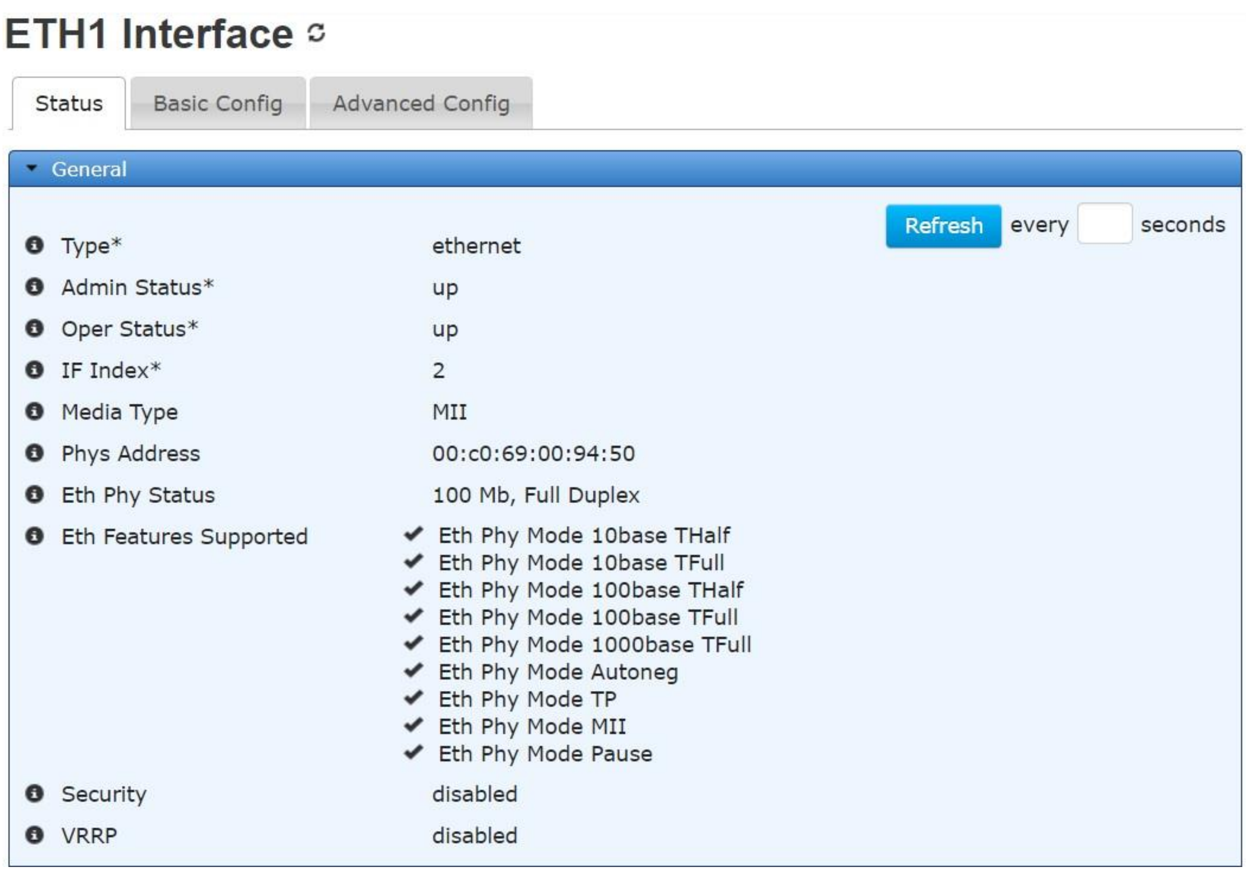


Figure 3-130. Interface Menu Bar

Each interface collects the same basic set of status information. The following example illustrates the information of the ETH1 ethernet interface. Definitions that are provided may apply to any of the interfaces.



- **Type** - Indicates the Interface type - Read only system information
- **Admin Status** - The desired state of the interface - *Up* meaning operational
- **Oper Status** - The current status of the interface - *Up* meaning operational / Down meaning non-operational or disabled
- **Last Change** - The time the interface entered its current operational state. Blank if operational from startup.
- **If Index** - Interface Index. Used for debugging information only
- **Media Type –** The physical media advertised by the port (MII, Twisted Pair, Fibre, BNC, etc).
- **Phys Address** - Generally for an 802.x interface this will be the mac address assigned to the interface. For interfaces that do not have such an address (e.g., a serial line), this node is not present.
- **Eth Phy Status** – The current detected speed and duplex of the port
- **Eth Features Supported** – Features advertised by the port
- **Higher Layer If** - A list of references to interfaces layered on top of this interface. Used for debugging information only
- **Lower Layer If** - A list of references to interfaces layered underneath this interface. Used for debugging information only
- **Speed** - An estimate of the interface's current bandwidth in bits per second. For interfaces that do not vary in bandwidth or for those where no accurate estimation can be made, this info should contain the nominal bandwidth. For interfaces that have no concept of bandwidth, this info is not present.

For SFP-equipped Orbit devices, open up the *Digital Diagnostics Monitoring* drop-down below the *General* drop-down to view diagnostic debugging information for the SFP interface:

Figure 3-131. Digital Diagnostics Monitoring Screen

- **Module Type** – The Small Form Factor (SFF) standard identifier for the module.
- **Identifier** – Form factor identifier for module (i. e. SFP, QSFP, soldered module, etc)
- **Extended Identifier** – Extra string information pertaining to the module ID
- **Transceiver Codes** – Depending on the module type, the mosule will support different features. This list enumerates features advertised by the module.
- **Extended Specification Codes** – Transceiver codes may contain extended information, which is displayed here.
- **Encoding** – The line code used by the media to transmit digital information
- **Nominal Bitrate** – The actual bandwidth of the link when using the above encoding
- **Laser Wavelength (nm)** – For Fibre media only. For Copper modules, this field will remain blank.
- **Optical Diagnostics (if equipped)** – For devices that support optical diagnostics, additional parameters will appear pertaining to the module. These may include temperature, voltage, current, and power.

Open up the *Statistics* drop-down below the *General* drop-down to view the statistics for the Bridge interface:

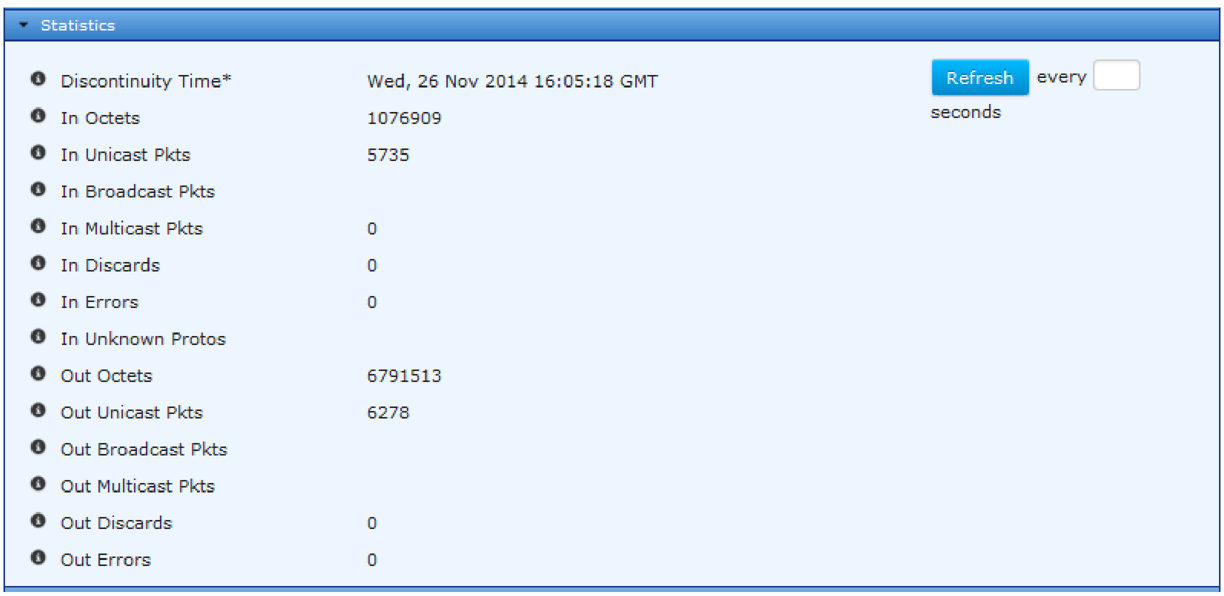


Figure 3-132. Interface Statistics Screen

- **Discontinuity Time** - The time on the most recent occasion at which any one or more of this interface's counters suffered a discontinuity or interruption of service.
- **In Octets** - The total number of octets received on the interface, including framing characters.
- **In Unicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
- **In Broadcast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a broadcast address at this sub-layer.
- **In Multicast Pkts** - The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer.

- **In Discards** - The number of inbound packets discarded even though no errors had been detected to prevent their delivery to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
- **In Errors** - For packet-oriented interfaces, the number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
- **In Unknown Protos** - For packet-oriented interfaces, the number of packets received via the interface which were discarded because of an unknown or unsupported protocol.
- **Out Octets** - The total number of octets transmitted out of the interface, including framing characters.
- **Out Unicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Broadcast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent.
- **Out Multicast Pkts** - The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent.
- **Out Discards** - The number of outbound packets discarded even though no errors had been detected to prevent their transmission.
- **Out Errors** - For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors.

Scroll down and click on to view information on IPv4 and IPv6 (not currently supported) information:

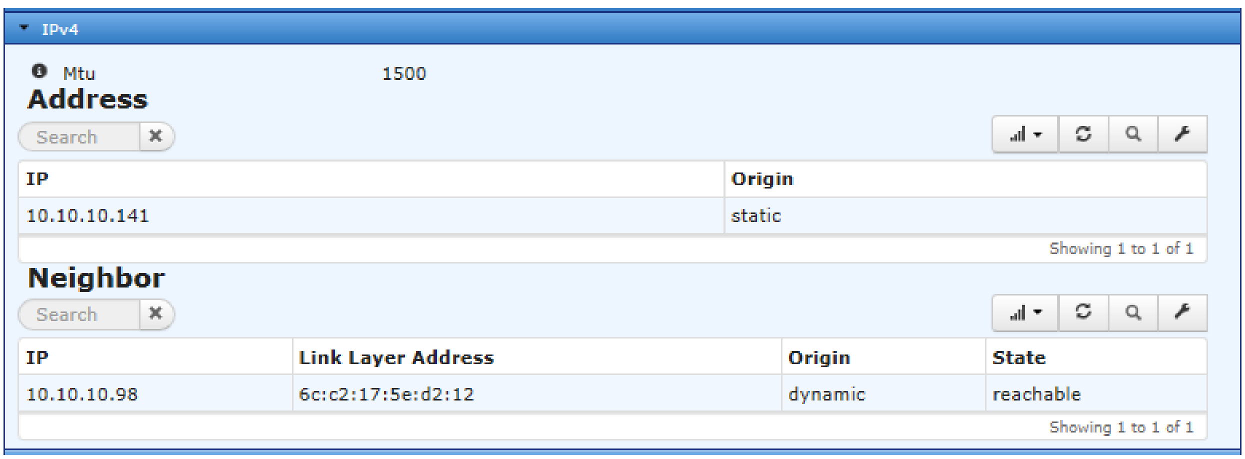


Figure 3-133. IPv4 Information Screen

IPv4 - Specific information:

- **Address** - The list of IPv4 addresses on the interface
- **Neighbor**- A list of mappings from IPv4 addresses to link-layer addresses. This list represents the ARP cache.

From the CLI in operational mode, the command below may be issued to view the state and statistics of all the network interfaces. The result of this command is very verbose and includes status and statistics for all the defined interfaces. For the sake of brevity, only the bridge interface status information is shown below (similar information will be shown for each defined interface):

```
> show interfaces-state
   interfaces-state interface Bridge
   type        bridge
   admin-status up
   oper-status  up
   if-index     1
   phys-address 00:06:3d:07:96:82
   statistics discontinuity-time 2014-02-12T14:29:35-05:00
   statistics in-octets 259644036
   statistics in-unicast-pkts 3188877
   statistics in-multicast-pkts 0
   statistics in-discards 4126
   statistics in-errors 0
   statistics out-octets 737353
   statistics out-unicast-pkts 1135
   statistics out-discards 0
   statistics out-errors 0
   ipv4 forwarding true
   ipv4 mtu   1500
                 PREFIX
IP               LENGTH  ORIGIN
-----------------------------------------------------
10.10.10.141  23         static

                    LINK LAYER
IP                  ADDRESS              ORIGIN   STATE
-----------------------------------------------------
10.10.10.109   00:11:11:e0:2e:70    dynamic  stale
10.10.10.98    80:c1:6e:f0:3b:7a    dynamic  reachable
```

3.8.2 LAN

Understanding

The unit has external Local Area Network (LAN) ports (ETH1/2 ports) that can be used to connect to a local (wired) LAN. It supports both IPv4 and IPv6 addresses and may be assigned multiple IP addresses. The LAN port can be assigned static IP addresses, or a dynamically allocated address can be assigned using DHCP.

NOTE The LAN port should be assigned IP addresses only if it is a routed interface (that is, *not* in a bridge).

Configuring

From the Interfaces screen the status may be displayed by clicking on the interface and scrolling down to the statistics information:

Navigate to: ***Interfaces / Add/Delete Interfaces***

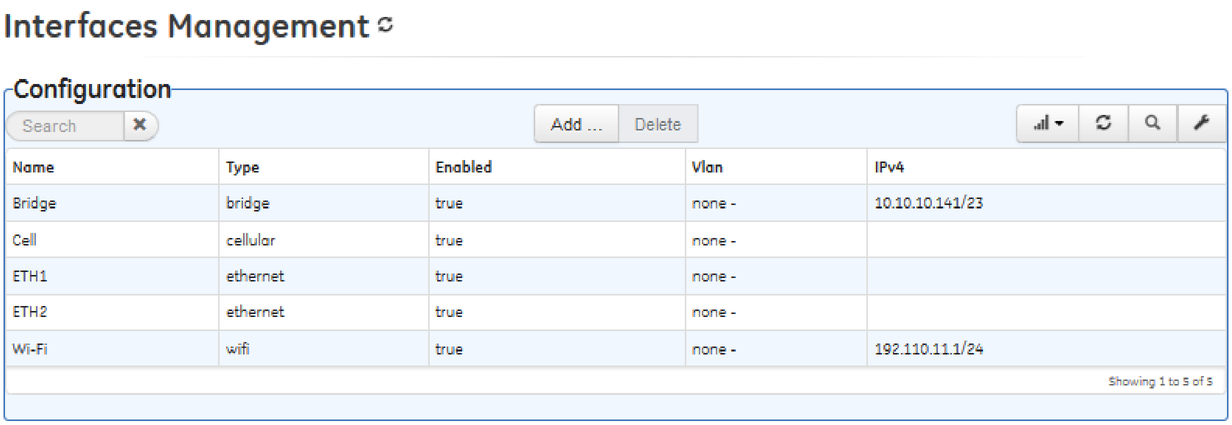


Figure 3-134. Default Interfaces Configuration Screen

To configure the LAN interface, select the ETH1 or ETH2 (if available - some units only support ETH1). As shown in the screens below, there are multiples groups of configuration settings that can be configured: General ETHx specifics, IPV4, Filter, NAT, QOS, Security, VLAN, and VRRP.

Interfaces / Add/Delete Interfaces / ETHx ---> Basic Config

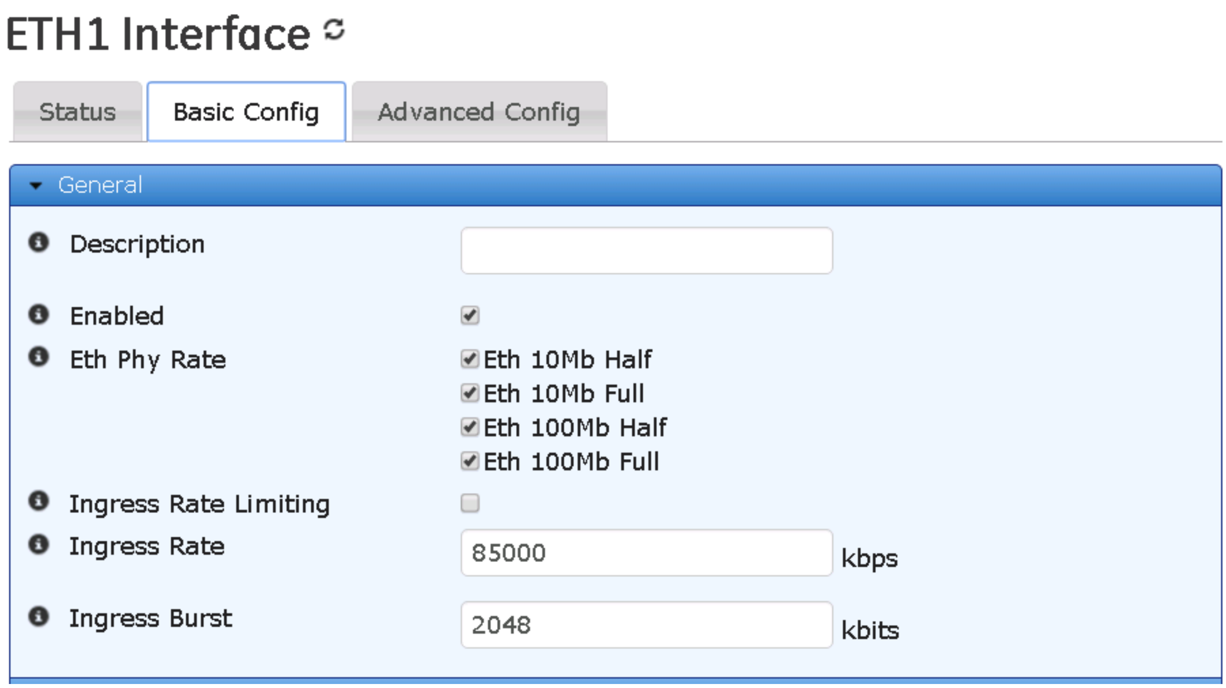


Figure 3-135. ETH1 Configuration Screen

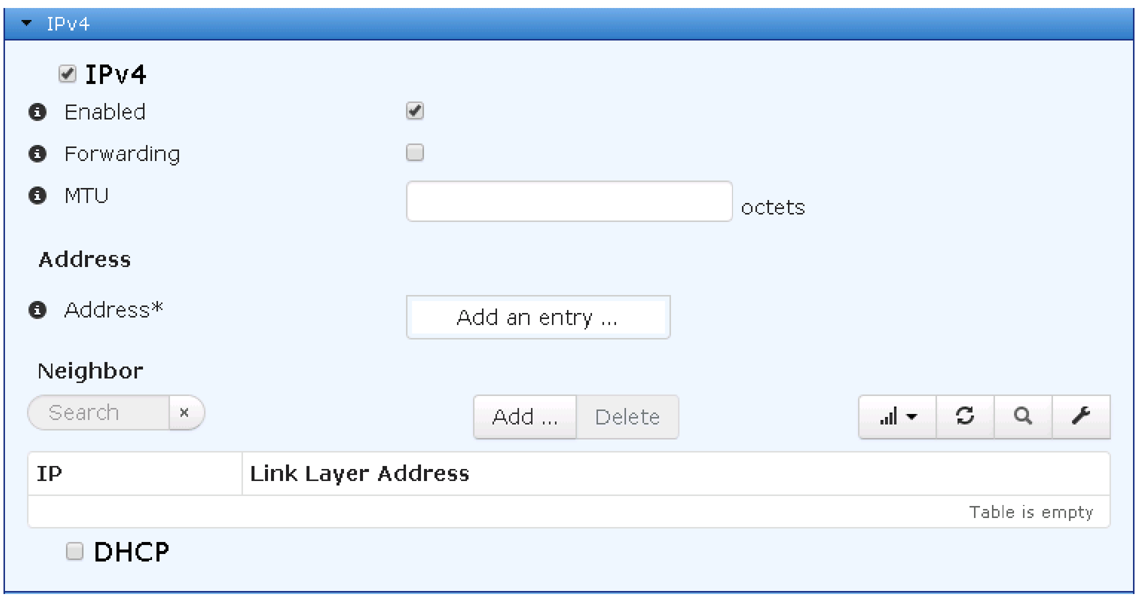
- **Description -** User defined identifier for this connection - 0-34 characters
- **Type** - Identifier of the type of interface - Do Not Change
- **Enabled -** Checked indicates Enabled (DEFAULT). Disable will prevent usage.
- **Eth Phy Rate -** Choose the Ethernet speed support setting (DEFAULT ALL)
  - Eth 10Mb Half
  - Eth 10Mb Full
  - Eth 100Mb Half
  - Eth 100Mb Full

NOTE Note: For SFP-equipped Orbit devices, Ethernet Phy Rate cannot be set.

- **Ingress Rate Limiting** – Indicates if ingress rate limiting is enabled or disabled on this interface. (This is useful to keep from saturating the Orbit when connected to a busy LAN)
- **Ingress Rate –** The maximum rate specified in kbps
- **Ingress Burst –** The maximum individual burst size in kbits/s

SFP equipped Orbit devices contain the following additional parameters:

- **Alarm on Interface Error** – The unit will alarm and log an event if the SFP module fails to initialize.
- **Alarm on Link Loss** – The unit will alarm when the interface loses link and an event will be logged. Upon link establishment, the alarm will be cleared.
- **Speed Mode** – Can be set to 1000BaseX or 100BaseFX. This will not take effect until the device is restarted (via menu or cycling power). Please consult the SFP module documentation to determine the proper setting.



- **Enabled -** Enable or disable the use of an IP address
- **Forwarding -** Indicates if IPv4 packet forwarding is enabled or disabled on this interface. **True** (DEFAULT) / **False**
- **Mtu** - The size, in octets, of the largest IPv4 packet that the interface will send and receive. Range 68-65535 - 1500 (DEFAULT). (Advanced setting)

NOTE Actual MTU size may be restricted, depending on the interface type

- **Address -** Use for creating static IPv4 IP address and removing this interface from the built-in Network Bridge.
- **Neighbor-** Use for creating mappings from IPv4 addresses to link-layer addresses.
- **DHCP** – Enable or disable DHCP for use in automatically obtaining an IP address.

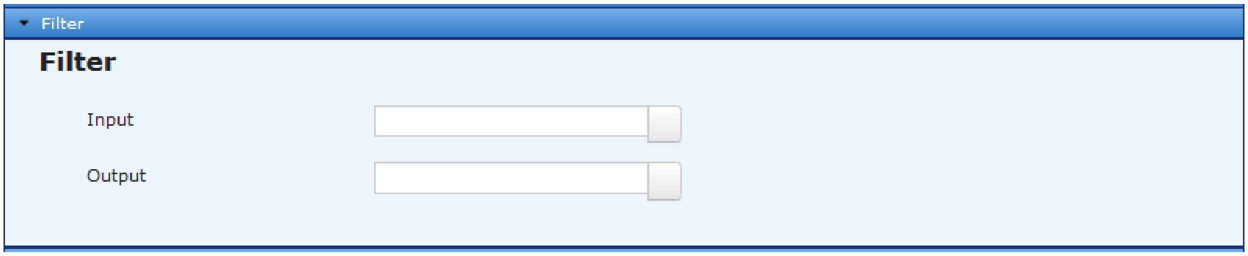


Figure 3-136. Filter Setup Screen

- **Filter Input** - Use for selecting and applying a firewall filter (from available filters) to incoming traffic on this interface.
- **Filter Output -** Use for selecting and applying a firewall filter (from available filters) to outgoing traffic on this interface.

For more information on packet filtering, refer to Access Control List (Packet Filtering / Firewall)

- **Input** - Default Selections (others may have been added) :
  - IN_TRUSTED
  - IN_UNTRUSTED
  - OUT_TRUSTED
  - OUT_UNTRUSTED
- **Output** - Default Selections (others may have been added) :
  - IN_TRUSTED
  - IN_UNTRUSTED
  - OUT_TRUSTED
  - OUT_UNTRUSTED

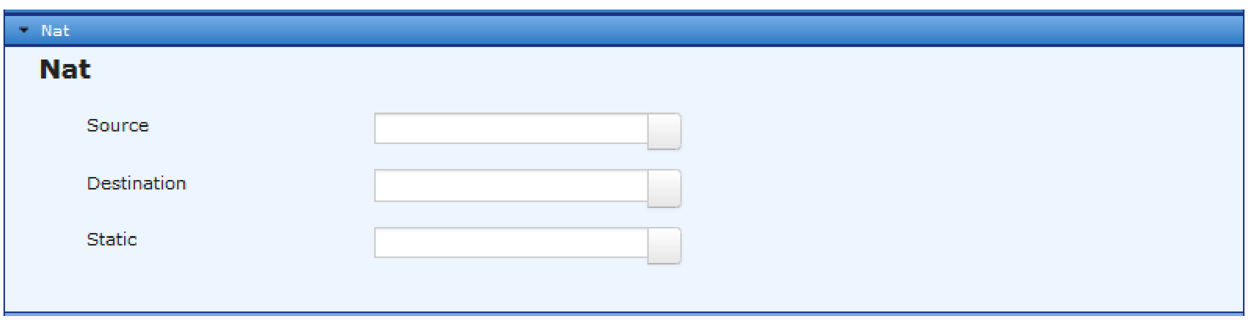
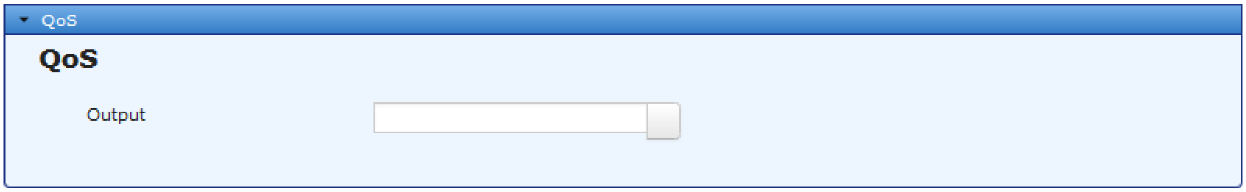


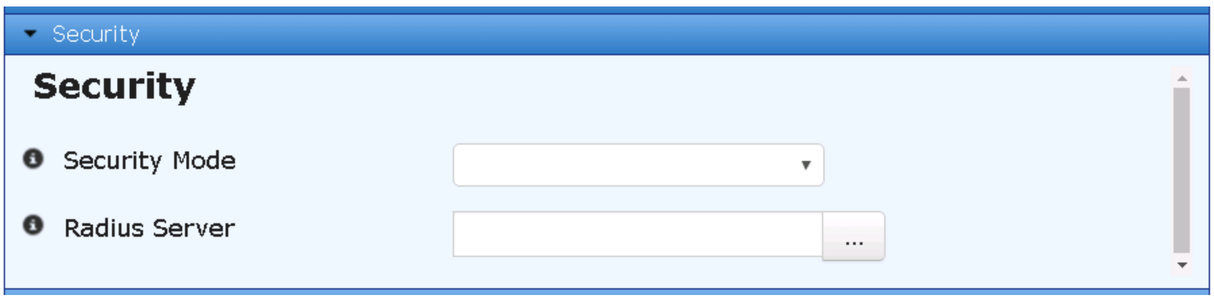
Figure 3-137. Network Address Translation (NAT) Setup

- **Source -** Source NAT performs translation of source IP address of the traffic going out of the interface. Source NAT (Masquerading). Use for selecting and applying a source NAT rule-set (from available source nat rule-sets) to outgoing traffic on this interface. Choices:
  - MASQ - MASQuerading - This rule-set translates the source address of the outgoing traffic to use the interface's IP address. In general, IP masquerading allows the user to use a private (reserved) IP network addresses on the LAN and still allow these devices to communicate with devices on the other side of the masqueraded interface that are not aware of the internal private addresses.
- **Destination-** Destination NAT performs translation of destination IP address (and, optionally, destination port) of the traffic coming into the interface**.** Destination NAT (Port Forwarding). Use for selecting and applying a destination NAT rule-set (from available destination nat rule-sets) to incoming traffic on this interface
- **Static** - Static NAT performs translation of a network address to another network address for incoming and outgoing traffic. Refer to 3.8.12 - Static NAT. Use for selecting and applying a

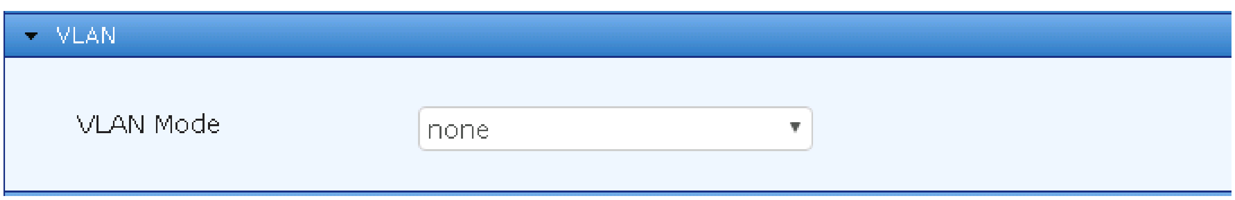
static NAT rule-set (from available static nat rule-sets) to incoming and outgoing traffic on this interface.



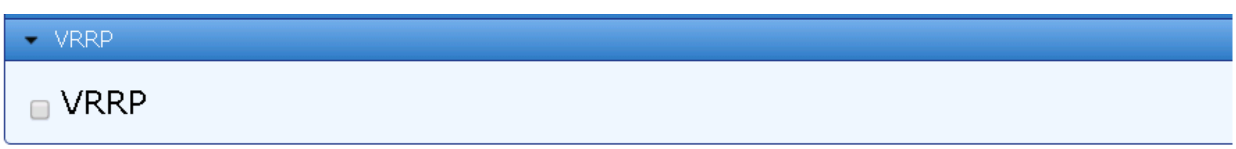
- **Output -** Use for selecting and applying a QoS policy (from the available QoS policies) to the outgoing traffic on this interface. See 3.8.19 - Quality of Service (QoS), for more information on creating QoS policies**.**



- **Security Mode** - See 3.8.3 - Ethernet port Security / Port-based Authentication for related information. Valid Choices:
  - None (DEFAULT)
  - EAP – Use Extensible Authentication Protocol mode.
  - MAB – Use MAC Authentication Bypass mode



- **Vlan Mode** - Virtual LAN Setting. Valid Choices
  - None (DEFAULT)
  - Access - Use this if this interface is intended to be a member of only a single VLAN.
  - Trunk - Use this if this interface is intended to be a member of multiple VLANs.



- **VRRP** – Enable or Disable Virtual Router Redundancy Protocol. (See 3.8.27 - VRRP – Virtual Router Redundancy Protocol)

Using the CLI, the following sequence shows how to configure the ETH1 port to obtain a dynamic IPv4 address using DHCP:

> **configure**

```
  Entering configuration mode private
% set interfaces interface ETH1 ipv4 dhcp
% commit
```

Before configuring a new IP address, be sure to remove the previous address by issuing the command

```
% delete interfaces interface ETH1 ipv4
```

The following sequence shows how to configure the ETH1 port with a static IPv4 address:

```
> configure
Entering configuration mode private
% set interfaces interface ETH1 ipv4 address 192.168.1.11 prefix-length 24
% commit
```

Monitoring

Ensure the CLI is in Operational mode. Follow the example below to view the state and statistics of the ETH1 port:

```
> show interfaces-state interface ETH1
  interfaces-state interface ETH1
  type          ethernet
  admin-status   up
  oper-status    up
  if-index       3
  phys-address   00:06:3d:07:96:82
  statistics discontinuity-time 2014-02-12T14:29:35-05:00
  statistics in-octets 497076597
  statistics in-unicast-pkts 6457046
  statistics in-multicast-pkts 0
  statistics in-discards 17
  statistics in-errors 0
  statistics out-octets 1002105
  statistics out-unicast-pkts 6480
  statistics out-discards 0
  statistics out-errors 0
  eth-phy-status "10 Mb, Half Duplex"
  ipv4 forwarding true
  ipv4 mtu   1500
                         PREFIX
  IP                     LENGTH  ORIGIN
  ------------------------------------------------------------
  10.10.10.147           23      static

                 LINK LAYER
  IP             ADDRESS          ORIGIN   STATE
  ---------------------------------------------------------------------------------
  10.10.10.98  80:c1:6e:f0:3b:7a  dynamic  reachable
```

3.8.3 Ethernet port Security / Port-based Authentication

Understanding

Orbit devices support Ethernet-port security using port-based authentication. Port-based authentication blocks traffic on the front Ethernet port(s) until a RADIUS server determines that the device connected to the port is allowed to communicate on the network. The Orbit must have a route to the RADIUS server using another network channel in order for authentication to work. Port-based authentication can be enabled in either EAP (Extensible Authentication Protocol) mode or MAB (MAC Authentication Bypass) mode. Both modes require the use of RADIUS server.

In EAP security-mode, the Orbit will block all traffic on the Ethernet port but will still capture EAP frames. These EAP frames are then forwarded via RADIUS protocol to the configured RADIUS server. The Orbit is agnostic to the EAP method used between the Peer and RADIUS, so any EAP method can be used at the peer and RADIUS server (e.g. EAP-TLS). If the RADIUS server can successfully authenticate the peer connected to the Ethernet port, then it will send a RADIUS-ACCEPT message to the Orbit. When that message is received the Orbit stops blocking traffic on the Ethernet port.

In MAB security-mode, the Orbit will block all traffic on the Ethernet port, but it still captures Ethernet frame headers so that it can read the source MAC address of ingress traffic. The Orbit sends RADIUS PAP (Password Authentication Protocol) requests for each MAC address that it captures until it receives a RADIUS-ACCEPT message from the RADIUS server. When the RADIUS-ACCEPT message is received the Orbit stops blocking traffic on the Ethernet port. The PAP requests are created with the following attributes:

Username: the MAC address, without punctuation, of the peer device connected to Ethernet port.
Example: *00063d089883*

Password: an encrypted version of the Username

Calling-Station-Id: the same as the Username but with hyphens.
Example: *00-06-3d-08-98-83*

In both security-modes, the NAS-IP address in the RADIUS request can be static or dynamic. A static NAS-IP is used when the Orbit's RADIUS configuration contains the NAS settings. If the static NAS settings are not set, the Orbit uses one its IP addresses that is able to route to the RADIUS server's address.

Configuring

Configuration of port authentication first requires a RADIUS server configuration to be added to the Orbit. For example:

```
% set system mds-radius servers MyServer address 192.168.10.100 shared-secret
      RadiusSharedSecret
% commit
```

Port authentication can now be enabled on an Ethernet port. For example:

```
% set interfaces interface ETH1 security security-mode EAP radius-server
      MyServer
% commit
```

Ethernet security settings are not set by default, so Ethernet traffic is unobstructed until security is enabled. Ethernet security settings include:

security-mode – either EAP, MAB, or none
radius-server – The name of a RADIUS server configuration in system settings

Monitoring

Read-only parameters for Ethernet ports show the state of the security on the port:

```
run show interfaces-state interface ETH1 security
```

The security status will be displayed as one of the following states:

security disabled – Security is disabled for this port and traffic is not blocked
security authorized – The port has been authorized by a RADIUS server and traffic is not blocked
security rejected – The RADIUS server rejected the last authentication request
security pending – A RADIUS request was sent and the Orbit is waiting for a response

3.8.4 VLAN Operation

Understanding

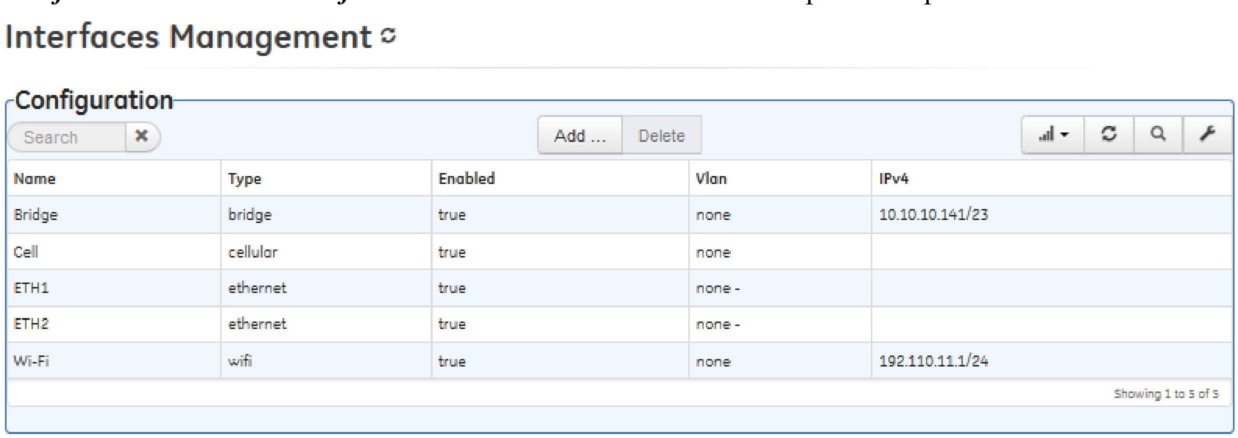
A Virtual Local Area Network (VLAN) is a logically segmented LAN network that exists across multiple physical LAN devices. The VLANs are virtual interface types in the Orbit and can be assigned unique IP addresses. They are treated the same as any other interface type, but they offer a way to link traffic between member interfaces. As such, a VLAN device can be thought of as a bridging device.

Since VLANs act as a bridge ethernet ports acting as a VLAN must first be removed from any existing bridge. For example, to delete ETH1 from the bridge, the command is:

```
% delete interfaces interface Bridge bridge-settings members port ETH1
```

Configure

To utilize VLANs, at least one or more VLAN interfaces must be created. Click on **+Add** on the ***Interfaces / Add/Delete Interface Screen***. Below are the minimal steps to set up a VLAN virtual device:



Create the VLAN as an interface with a name by clicking on the **Add** button.

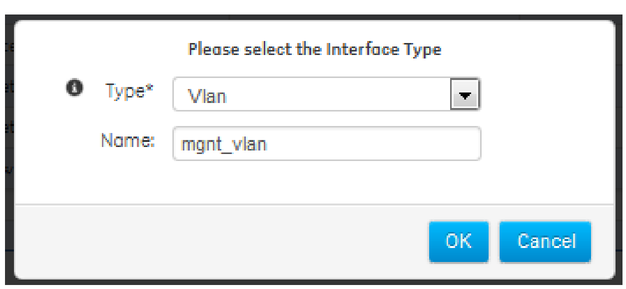
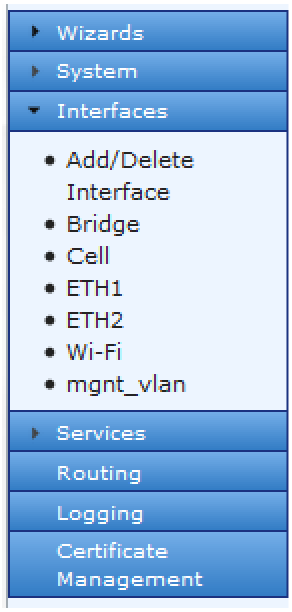


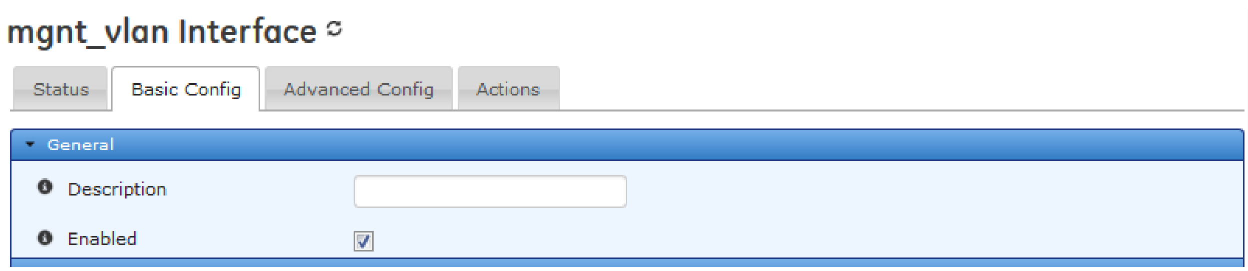
Figure 3-138. VLAN Creation

- **Type** – Interface type to be created. In this case, choose Vlan.
- **Name** - The name of the interface. Up to 48 characters.

Configure the newly created VLAN

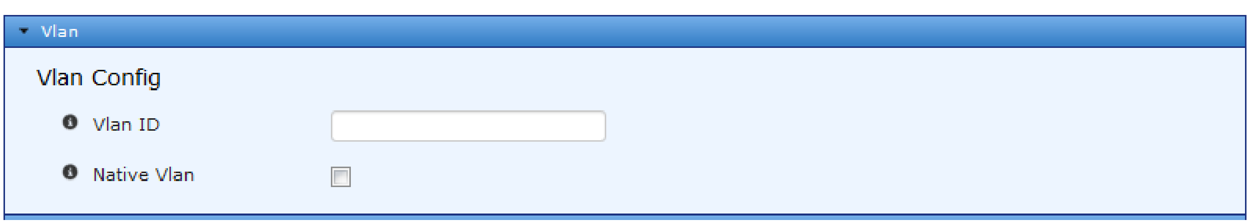
After clicking the OK button on the pop-up in Creation will automatically take the configuration screen for that interface, or click on the new interface located in the ***Interfaces*** navigation section.





- **Description -** User defined identifier for this connection up to 34 characters
- **Enabled -** Checked indicates enabled (DEFAULT). Disable will prevent usage.

Scroll down and set the VLAN ID



- **Vlan ID** - The ID of this VLAN Valid values: 1—4094
- **Native Vlan** - If true, this is the native VLAN of this device. Native VLAN packets will not egress as tagged packets.

The example that follows illustrates the result of setting up 2 VLANs; one with an ID of 99 and another with an ID of 300:

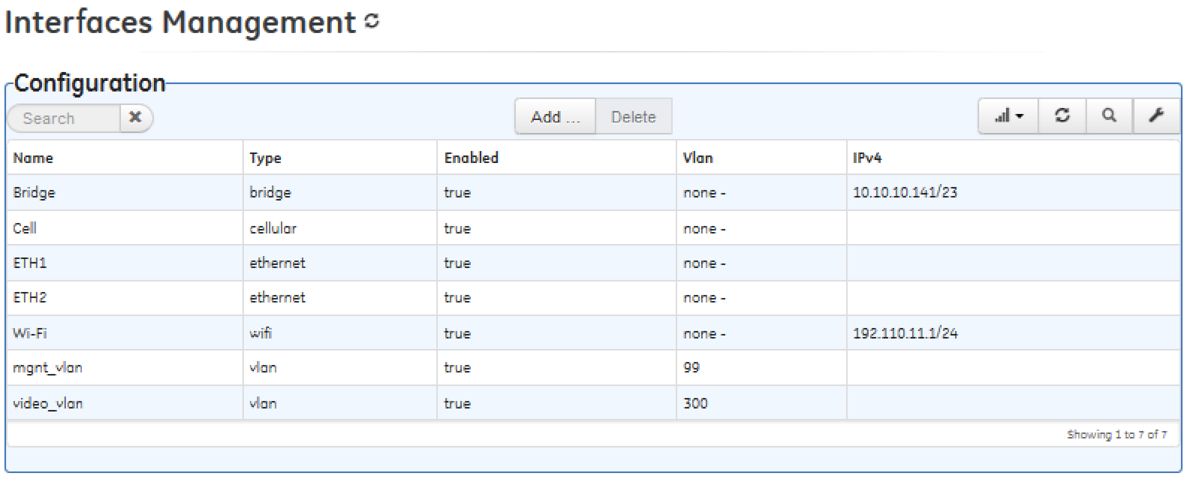


Figure 3-139. VLAN Interfaces Created

Using the CLI to set up a VLAN, four sample commands are shown below for doing this; one with an ID of 99 and another with an ID of 300:

> **% set interfaces interface** mgmt_vlan **type** vlan
> **% set interfaces interface** mgmt_vlan **vlan-config vlan-id** 99
> **% set interfaces interface** video_vlan **type** vlan
> **% set interfaces interface** video_vlan **vlan-config vlan-id** 300

Operational Modes

As previously shown in previous sections, interfaces can have three separate VLAN modes: none (default), trunk, or access. These modes are used to set interface behavior, and examples of their use are provided below.

Trunk: To add ETH1 as a trunk (tagged) port in both defined VLANs above, the command is:

> **% set interfaces interface** ETH1 **vlan-mode** trunk **vlans [**video_vlan mgmt_vlan**]**

Access: To set ETH2 as an access port for video_vlan the command is:

> **% set interfaces interface** ETH2 **vlan-mode** access **vlan** video_vlan

Native VLANs

A VLAN device may also be specified as a "native" VLAN by checking the **Native Vlan** box.

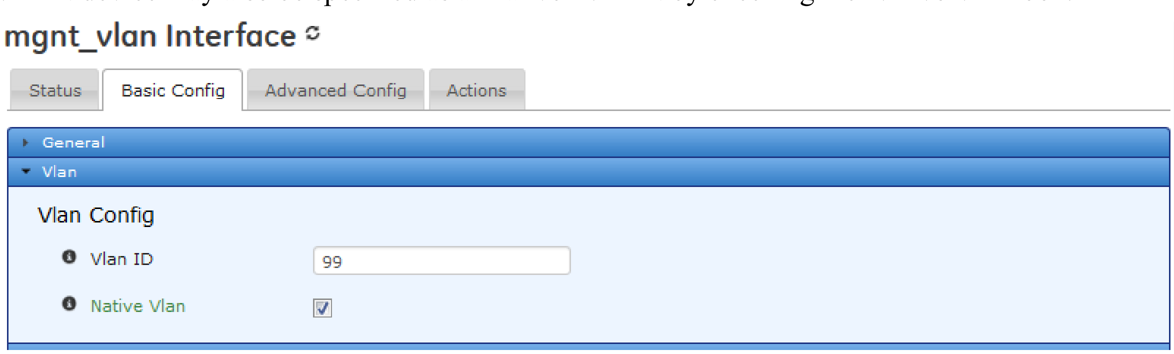


Figure 3-140. VLAN Configuration - VLAN Id

Or, using the CLI with this set command:

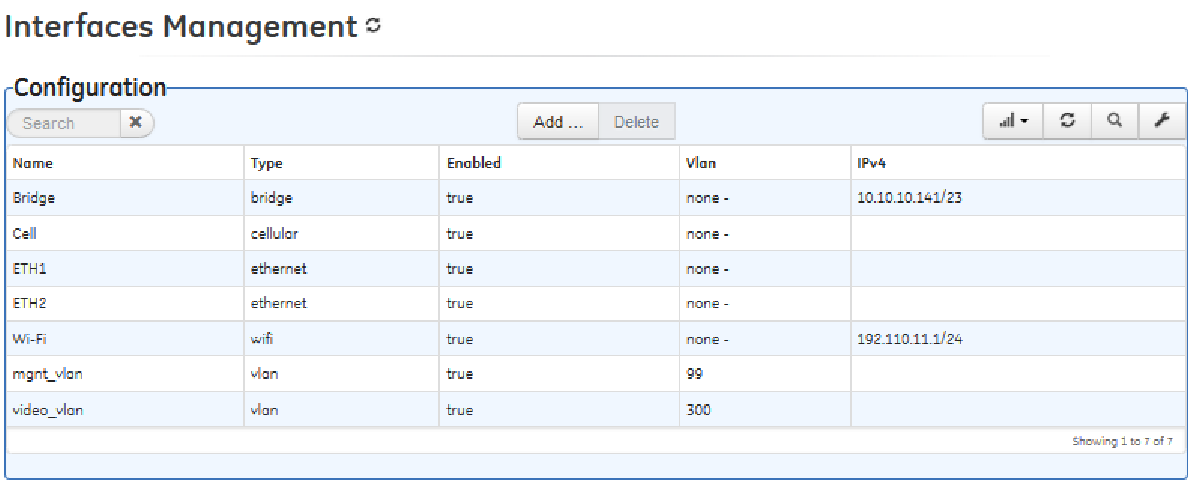
> **% set interfaces interface** my_native_vlan **type** vlan **vlan-config vlan-id** 99 **native-vlan** true

A native VLAN is conceptually the same as a standard VLAN except that the packets will never be tagged. The purpose of a native VLAN is to segregate untagged packets on a VLAN trunk port that normally only contains tagged traffic. If a VLAN trunk port receives an untagged packet, and the trunk is a member of the native VLAN, that packet will be treated as if it came from the native VLAN. If the trunk port is not a member of the native VLAN and an untagged packet arrives on that port, the packet will be dropped.

As VLANs are implemented as bridges, and it is not valid for a bridge to be a member of another bridge, it follows that a VLAN interface cannot be configured as a member of a bridge. VLANs can be configured with IP addresses just as any other interface in the system.

Monitoring

As shown previously once VLANs are created they may be monitored on the Interface status screen the same way physical interfaces appear:



Interfaces Management

Configuration

Search | Add ... | Delete

Name	Type	Enabled	Vlan	IPv4
Bridge	bridge	true	none -	10.10.10.141/23
Cell	cellular	true	none -	
ETH1	ethernet	true	none -	
ETH2	ethernet	true	none -	
Wi-Fi	wifi	true	none -	192.110.11.1/24
mgnt_vlan	vlan	true	99	
video_vlan	vlan	true	300	

Showing 1 to 7 of 7

Figure 3-141. Interface Status Screen

3.8.5 Bridging

Understanding

The unit supports transparent bridging of LAN, WiFi/900Mhz networks. The bridge forwards traffic between LAN and WiFi/900Mhz networks at the layer-2 of OSI model. This allows LAN and WiFi/900Mhz clients to be in the same IP sub-network.

The bridge learns the clients' locations by analyzing the source address of incoming frames from all attached networks (LAN and WiFi network). For example, if a bridge sees a frame arrive on LAN port from Host A, the bridge concludes that Host A can be reached through the segment connected to LAN port. Through this process, the bridge builds a forwarding table (the learning process). When a frame is received on one of the bridge's interfaces, the bridge looks up the frame's destination address in its forwarding table. If the table contains an association between the destination address and any of the bridge's ports aside from the one on which the frame was received, the frame is forwarded out the indicated port. If no association is found, the frame is flooded to all ports except the inbound port. Broadcasts and multicast also are flooded in this way.

Typically, for LAN/WiFi-to-Cellular Router use case (a.k.a. LAN/WiFi HotSpot), the LAN and WiFi interface (acting as an Access Point) are bridged. However, for security and bandwidth considerations, a user might want to remove LAN and WiFi networks from the bridge (*i.e.*, configuring LAN and WiFi networks as separate IP networks). In this network setup, broadcast/multicasts data packets coming into WiFi are not directed out the LAN connection and vice versa.

The bridged network is addressable via bridge interface (a virtual interface). The interfaces that are in the bridge are called bridged interfaces. The interfaces that are not in the bridge are called routed interfaces. Bridging is performed between bridged interfaces. Routing is performed between routed interfaces. The bridge interface itself is a routed interface.

NOTE The Cellular interface cannot be added to the bridge and is, therefore, a routed interface. However, a GRE interface in 'ethernet-over-gre' mode can be configured to operate over Cell interface and added to a bridge to enable tunneling of layer-2 traffic over the cellular network. Refer to section on GRE for more details. Advanced details of networking concepts such as routing and bridging are outside the scope of this manual but are available through various training materials freely available on the Internet.

Theory of Operation

Refer to Figure 3-142 below for this discussion. In a typical application, the Orbit provides cellular connectivity to locally connected devices that are located on the user's local/internal/private LAN or WiFi network. The Orbit acts as an Access Point on the Wi-Fi interface, providing connectivity to Wi-Fi clients. The Wi-Fi traffic is combined with the local Ethernet port traffic through a Layer 2 bridge. The serial interface is matched to a terminal server that encapsulates serial data over a TCP or UDP connection.

The Orbit provides Network Address Translation (NAT) (both Masquerading and Port Forwarding) as well as Firewalling between the cellular data interface (WAN side) and the local network (LAN/WiFi). The Orbit can also act as a VPN client to provide a secure tunnel for LAN data to the user's local network (LAN/WiFi). This configuration obviates the need for NAT, as the back-office network behind the VPN Concentrator (VPNC) can address the local LAN or WiFi network directly via the secure tunnel.

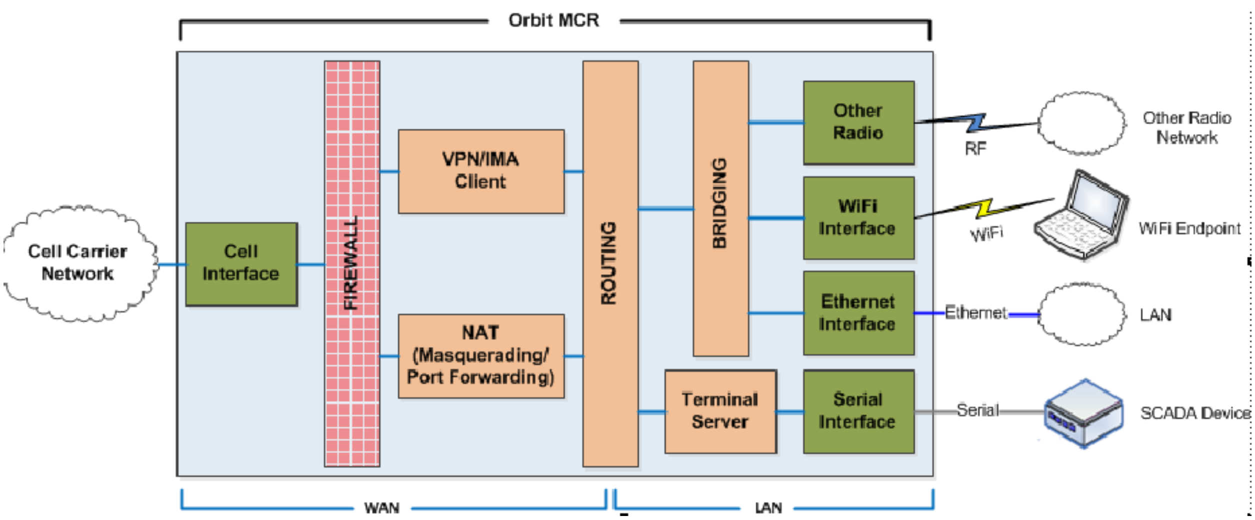


Figure 3-142. Bridging Functions Diagram

Configuring

Creating a bridge interface and assigning it an IP address:

% set interfaces interface Bridge **type bridge**
% set interfaces interface Bridge **bridge-settings ageing-time** 500
% set interfaces interface Bridge **ipv4 address** 192.168.1.10 **prefix-length** 24

Adding LAN (ETH1) interface to the bridge:

% set interfaces interface Bridge **bridge-settings members port** ETH1

Adding WiFi interface (in Access Point mode) to the bridge:

% set interfaces interface Bridge **bridge-settings members wifi-ap** myssid

OR:

Adding WiFi interface (in Station mode) to the bridge:

% set interfaces interface Bridge **bridge-settings members wifi-station interface** Wi-Fi

Removing LAN (ETH1) interface from the bridge:

% delete interfaces interface Bridge **bridge-settings members port** ETH1

Removing WiFi interface (in Access Point mode) from the bridge:

% delete interfaces interface Bridge **bridge-settings members wifi-ap** somessid

OR:

Removing WiFi interface (in Station mode) from the bridge:

% delete interfaces interface Bridge **bridge-settings members wifi-station interface Wi-Fi**

Removing the bridge interface:

% delete interfaces interface Bridge

Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics of a bridge. In this example, bridge (Bridge) is bridging the LAN (ETH1).

```
> show interfaces-state interface Bridge
  interfaces-state interface Bridge
  type        bridge
  admin-status up
  oper-status  up
  if-index     1
  phys-address 00:06:3d:07:96:82
  statistics discontinuity-time 2014-02-12T14:29:35-05:00
  statistics in-octets 263244716
  statistics in-unicast-pkts 3231995
  statistics in-multicast-pkts 0
  statistics in-discards 4126
  statistics in-errors 0
  statistics out-octets 785224
  statistics out-unicast-pkts 1362
  statistics out-discards 0
  statistics out-errors 0
  ipv4 forwarding true
  ipv4 mtu   1500
                     PREFIX
  IP                 LENGTH  ORIGIN
  ----------------------------------------------------------
  10.10.10.141    23          static

                  LINK LAYER
  IP              ADDRESS           ORIGIN      STATE
  -----------------------------------------------------------------------------
  10.10.10.98  80:c1:6e:f0:3b:7a  dynamic    delay

   bridge stp port ETH1
    number          1
    priority        0
    state           forwarding
```

path-cost 100
designated-root 7035.04fe7fe36980
designated-cost 100
designated-bridge 8000.0002fd5dd280
designated-port 32783

3.8.6 Routing

Understanding

The Orbit can forward IP packets between routed interfaces, using a network path defined by the user. These user-defined network paths are known as static routes. A static route may be configured if data intended for a specific subnet or IP address must egress a particular onboard NIC.

As an example, consider a case where the unit is connected to a local network, 10.10.0.0/24, through its ETH2 port. This network contains a gateway at IP address 10.10.10.101. This gateway is also connected to another network 216.171.112.0/24, which has an NTP server. The Orbit must use this network path to access an NTP server at IP address 216.171.112.36. A static route to network 216.171.112.0/24 via next-hop 10.10.10.101 (or a host-only route to 216.171.112.36/24 via next-hop 10.10.10.101) ensures that the unit can communicate with the NTP servers.

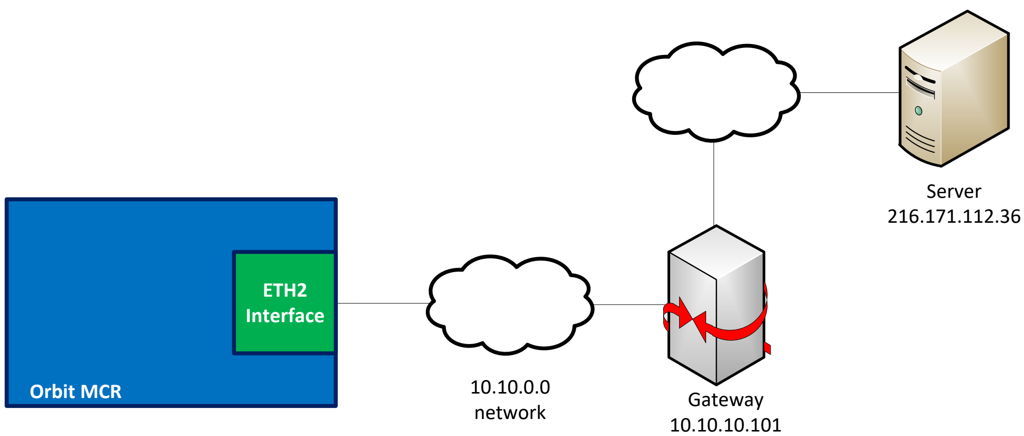


Figure 3-143. Network Path to NTP Server

In the diagram above, the gateway at 10.10.10.101 is referred to as the next hop, which means that it is the next routing device in the network path.

A default static route may also be configured. The unit will forward IP packets along this route when no other route in its routing table matches the packets' destination address. Typically, the route chosen as the default route contains a next-hop router that leads to the backhaul network.

Configuring

Current routes may be viewed on the unit at any time by navigating to ***Routing*** on the left side of the screen. The unit's current routes are displayed under the ***Status*** tab.

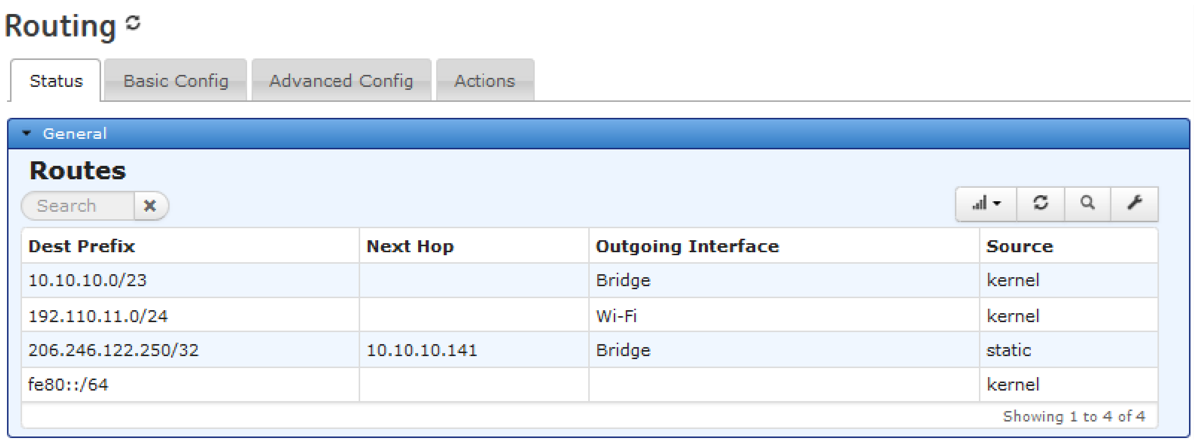
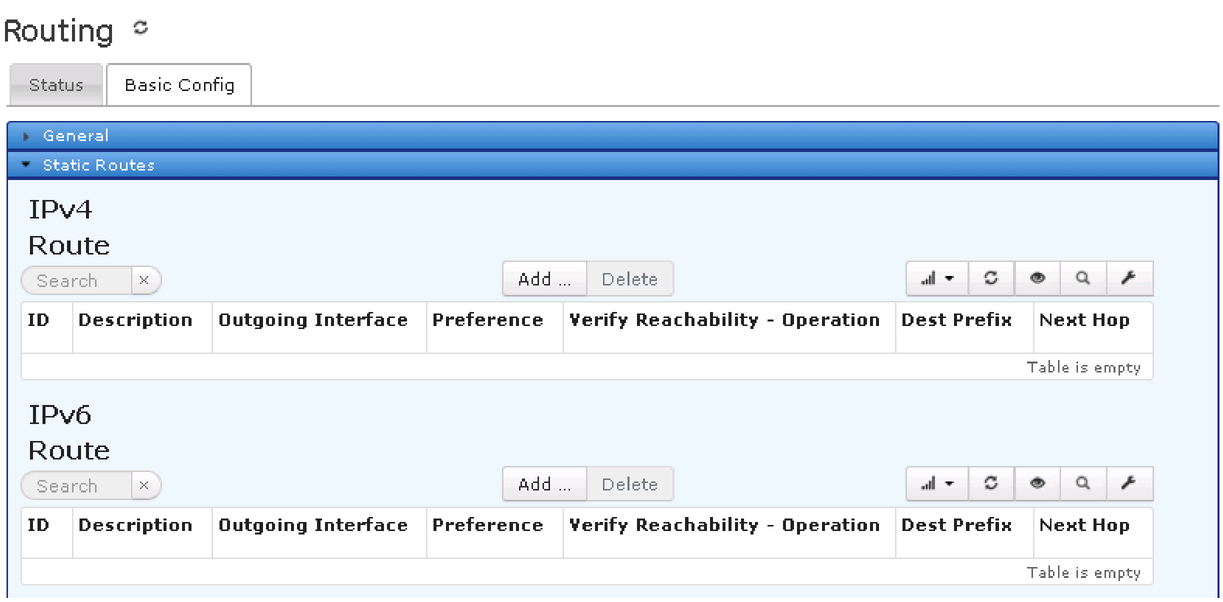


Figure 3-144. Routing status screen

The following information is available:

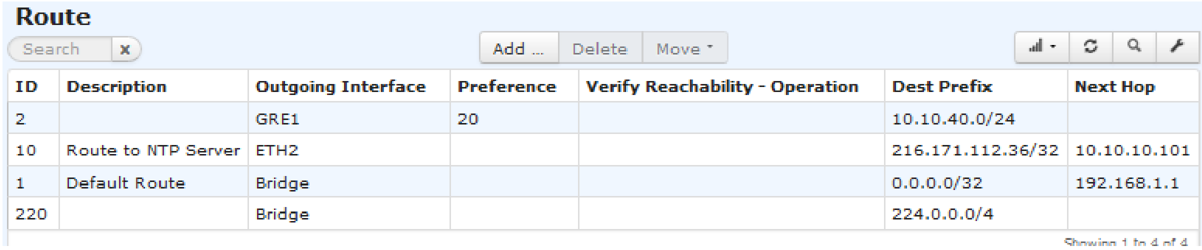
- **Dest Prefix** – Indicates the destination network's IP address and prefix in either IPv4 or IPv6 format.
- **Next Hop** – If known, the next hop router is displayed for each route.
- **Outgoing Interface –** This is the egress onboard network interface used for each route.
- **Source** – Routes are defined by either the kernel or the user (static).

To configure a static route, click the Static Routes option to navigate to ***Routing ---> Basic Config / IPV4.***



IPv4 and IPv6 routes may be configured. The example that follows shows how to configure an IPv4 route. It is important to note that IPv6 routes are created with the same input parameters. The only difference is that the format of the **Dest Prefix** and **Next Hop** input parameters varies based on whether IPv4 or IPv6 is selected.

The example network path in Figure 3-1 requires an IPv4 address. When previous routes have been configured, the IPv4 Route table will display all user-configured IPv4 static routes are listed, as shown below.



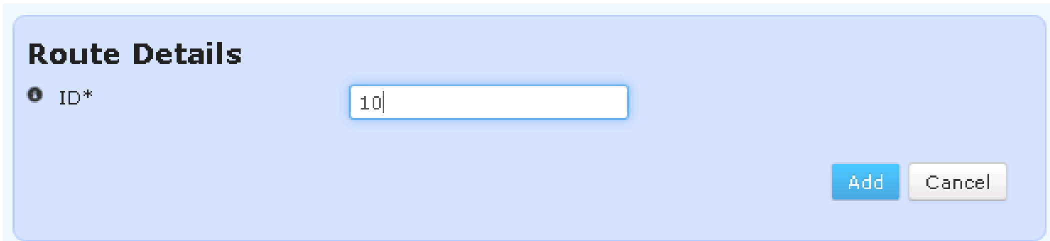
Route

ID	Description	Outgoing Interface	Preference	Verify Reachability - Operation	Dest Prefix	Next Hop
2		GRE1	20		10.10.40.0/24	
10	Route to NTP Server	ETH2			216.171.112.36/32	10.10.10.101
1	Default Route	Bridge			0.0.0.0/32	192.168.1.1
220		Bridge			224.0.0.0/4	

Figure 3-145. List of IPv4 static routes

Delete any of the routes in the table by clicking on an entry to highlight it and clicking the **Delete** button.

To add a new route, click the **Add** button. The **Route Details** menu appears.



Create a numeric ID for the new route and click **Add**. The ID acts as a label, is for reference only, and has no bearing on the route itself.

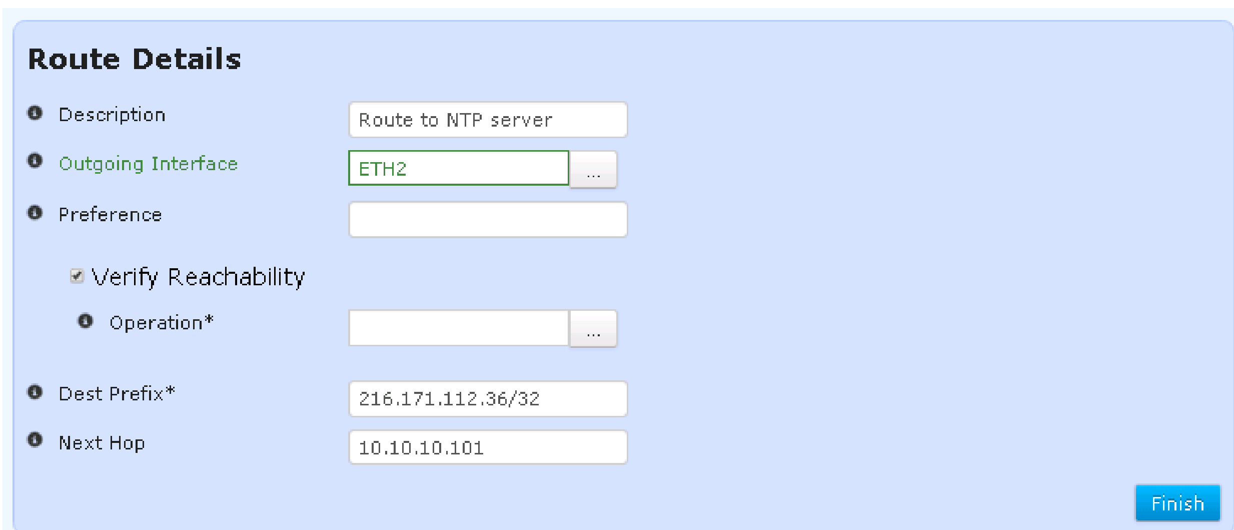


Figure 3-146. Route Setup Menu

A pop-up window bearing the route's ID appears with the following fields.

- **Description** – A user-defined string describing the route.
- **Outgoing Interface** -– This dropdown box selects the onboard networking interface that outgoing IP traffic should use.

In the example above, this would be *ETH2*.

- **Preference –** Preference value of the route (lower value implies higher preference).
- **Verify Reachability Operation -** User defined network monitor operation to use for verifying reachability. Refer to section 3.8.21 on Page 420 for more information on used of this parameter.
- **Dest Prefix –** The IPv4 address and prefix of the route's destination.

A specific server is the destination in the example above, so the server's address *216.171.112.36* is used, with a prefix of *32*.

- **Next Hop –** As mentioned above, this is the next routing device that occurs in the network path.

The example above contains a next-hop router at *10.10.10.101*.

Once all items are configured appropriately, click **Save** in the upper left corner of the screen. Refresh the screen to see the new route in the routing table. If the route does not appear in the routing table, the unit has rejected the route as an invalid network path. Ensure that the configuration entered is valid.

The CLI can also be used to configure static routes. To configure the same route via the CLI, enter the following commands:

```
% set routing static-routes ipv4 route 10 description "Route to NTP Server" outgoing-interface
  ETH2 dest-prefix 216.171.112.36/32 next-hop 10.10.10.101
```

View the static routes with the command

```
% show routing
  static-routes {
  ipv4 {
    route 10 {
      description          "Route to NTP Server";
      outgoing-interface   ETH2;
      dest-prefix          216.171.112.36/32;
      next-hop             10.10.10.101;
    }
```

Finally, save the changes.

```
% commit
```

Default Static Route

To create a default static route, simply use a Dest Prefix of 0.0.0.0/0 when creating a new route, as shown below:

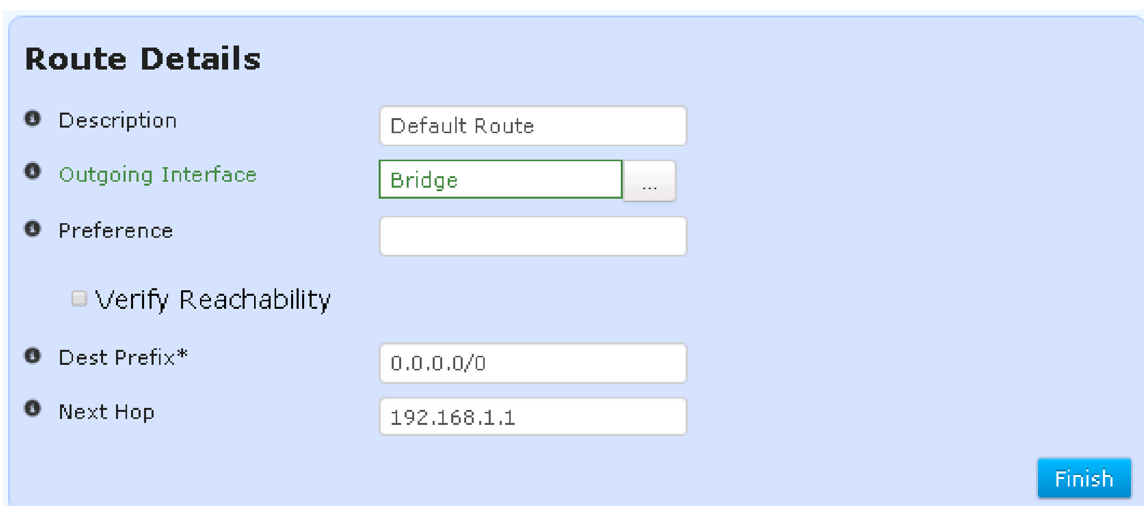


Figure 3-147. Creating a default static route

Configure a default static route from the CLI:

```
% set routing static-routes ipv4 route 1 description "Default route" outgoing-interface Bridge
  dest-prefix 0.0.0.0/0 next-hop 192.168.1.1
% commit
```

Monitoring

As mentioned in **Configuring**, the unit's routes may be viewed on the web UI by navigating to ***Routing***.

To view the list of routes in the CLI, first ensure the CLI is in operational mode. Follow the example below to view the state of the routing table:

```
> show routing
                                OUTGOING
DEST PREFIX         NEXT HOP      INTERFACE  SOURCE
-----------------------------------------------------------------------------------------
10.10.10.0/23       -             ETH2       kernel
192.110.11.0/24     -             Wi-Fi      kernel
192.168.0.0/24      -             Bridge     kernel
216.171.112.36/32   10.10.10.101  ETH2       static
fe80::/64           -                        kernel
fe80::/64           -             Bridge     kernel
fe80::/64           -             ETH1       kernel
fe80::/64           -             Wi-Fi      kernel
```

3.8.7 VRF

Understanding

Network interfaces present on a router are typically part of the main/global routing instance, which allows traffic to be routed between them based on the routes in the main/global routing table and firewall rules governing flow of traffic between the interfaces.

VRF (Virtual Routing and Forwarding) enables network interfaces to be segregated from each other by moving them into a separate routing instance with its own routing table. This enables layer-3 segmentation of the network by creating one or more isolated routing instances.

Orbit supports policy routing with multiple routing tables where the user can configure one or more routing tables along with rules to classify traffic on any IPv4 header fields and direct the matching traffic through a particular routing table. This enables routing of IPv4 traffic based on any header field rather than just destination address. VRF extends this support by allowing user creation of a virtual network interface of type 'vrf' that is associated with a routing instance. This allows other routable network interfaces like Ethernet, Bridge, Cellular etc. to be added to the VRF interface as members, thereby, confining them within the routing domain of that VRF. See Table 3-26 below for an understanding of supported features

Table 3-26. VRF feature support

Feature	Description
Creating VRF interface and adding following routable interface types as members: - Ethernet - Cellular - Cellular-PDN (second APN) - Bridge - VLAN - GRE	Each VRF interface is associated with its own routing instance/table and the member interfaces exist within this routing table segregated from default/main and other VRFs in the system.
VRF aware DMVPN	DMVPN instance can operate within a VRF, where the GRE interface uses a transport interface that is within a VRF. IPsec SA also operates within that VRF. The GRE tunnel interface itself is outside the VRF. It could be in the main/default or another VRF.
VRF aware BGPv4, RIPv2 and OSPFv2	BGPv4 (IPv4 only), RIPv2 (IPv4 only) and OSPFv2 protocols can operate within a VRF (that is they import/export routes from the routing table associated with that VRF).
VRF aware CLI commands	The following CLI commands can be passed VRF within which they need to execute: ping,ping6,ssh, telnet, traceroute,traceroute6

Configuring

Basic creation of a VRF interface via the CLI is straightword.

To create a VRF interface named MY_VRF1

configure

%set interfaces interface MY_VRF1 type vrf
%set interfaces interface MY_VRF1 type vrf-config

Add ETH1 as a member of VRF interface MY_VRF1:

%set interfaces interface MY_VRF1 vrf-config member ETH1

Set additional attributes as needed, for example:

%set interfaces interface MY_VRF1 filter input IN_TRUSTED
%set interfaces interface MY_VRF1 filter input OUT_TRUSTED

Create a routing instance aassociated with the VRF interface. It is recommended that same name be used for VRF and routing instance for convenience:

%set routing routing-instance MY_VRF1 interface MY_VRF1

Practical use cases for VRF require more extensive configuration. Consult publication *05-7230A01 Orbit VRF Feature Guide* for detailed use case examples of VRF configuration for specific applications.

3.8.8 Static Neighbor Entries

Understanding

The Orbit allows the configuration of static layer-2 MAC addresses. Normally IP neighbors are learned through protocols such as ARP or IPv6 neighbor discovery, however sometimes there is a need to statically configure an IP address to use a specific MAC address. This may occur if a neighbor does not respond to ARPs or neighbor solicitations or responds incorrectly.

Configuration

To add a static IPv4 neighbor to the Wi-Fi interface that maps the IP address 192.168.2.99 to the MAC address 00:11:22:33:44:55, first navigate to ***Interfaces / Wi-Fi.***

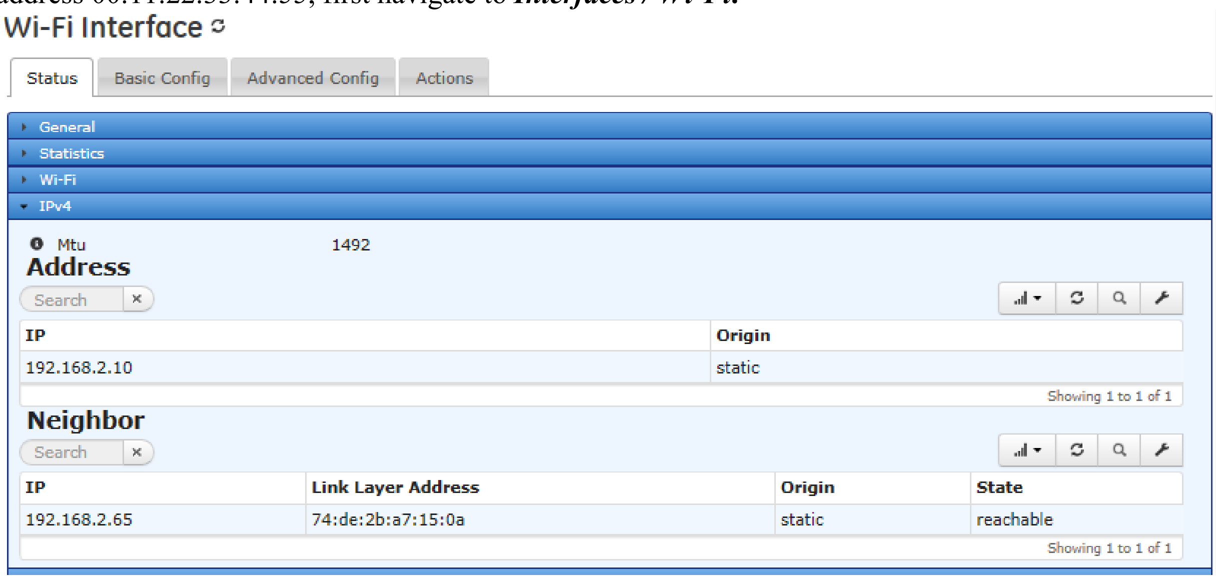


Figure 3-148. WiFi Interface Menu

Both IPv4 and IPv6 neighbors may be created. This example uses IPv4, but IPv6 neighbors are created in a similar fashion. Click the **IPv4** menu shortcut to proceed.

The **Neighbor** list on the ***Interfaces / Wi-Fi ---> Basic Config / IPv4*** menu shows all user-configured neighbors.

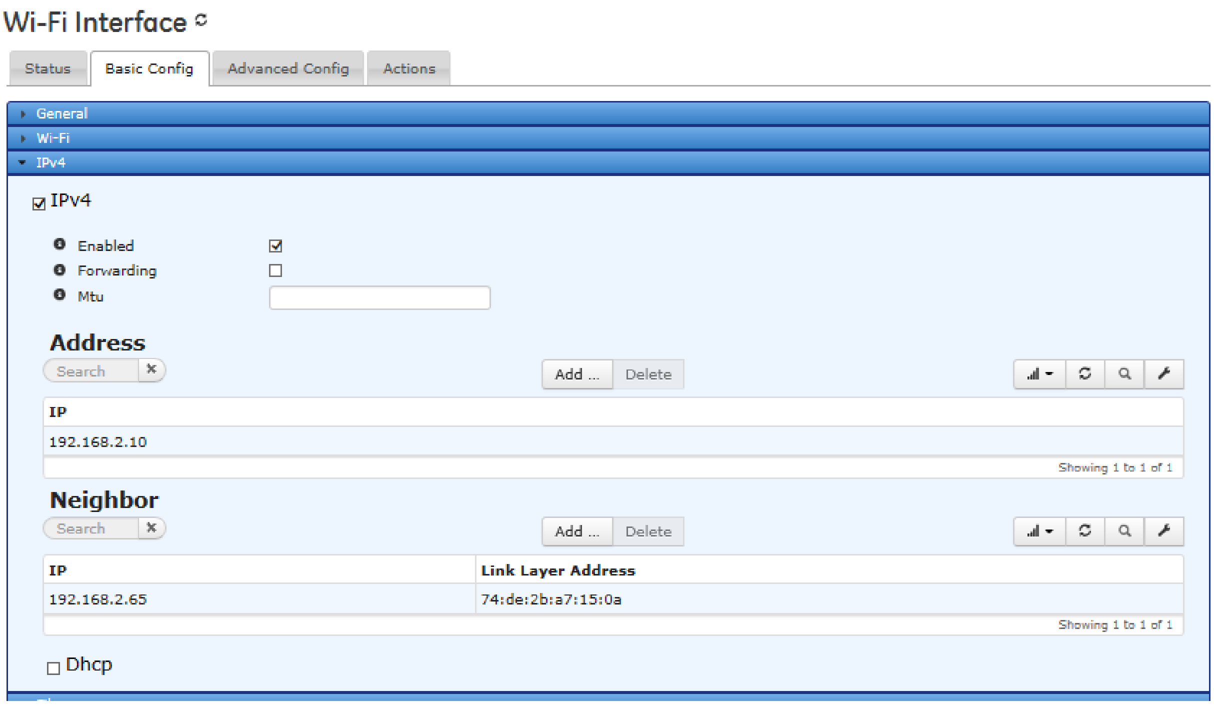


Figure 3-149. List of user-configured neighbors

To delete any of the neighbors in the table, click on an entry to highlight it, then click the *Delete* button.

To add a new neighbor, click the **Add** button. The **Configure New Neighbor** menu appears. Enter the neighbor's IP address and click **Add.**

Figure 3-150. Add New Neighbor Menu

Following the IP address, enter the neighbor's link layer address and then the **Finish** button.

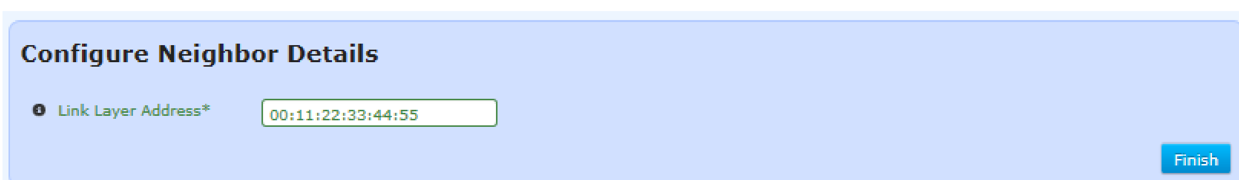
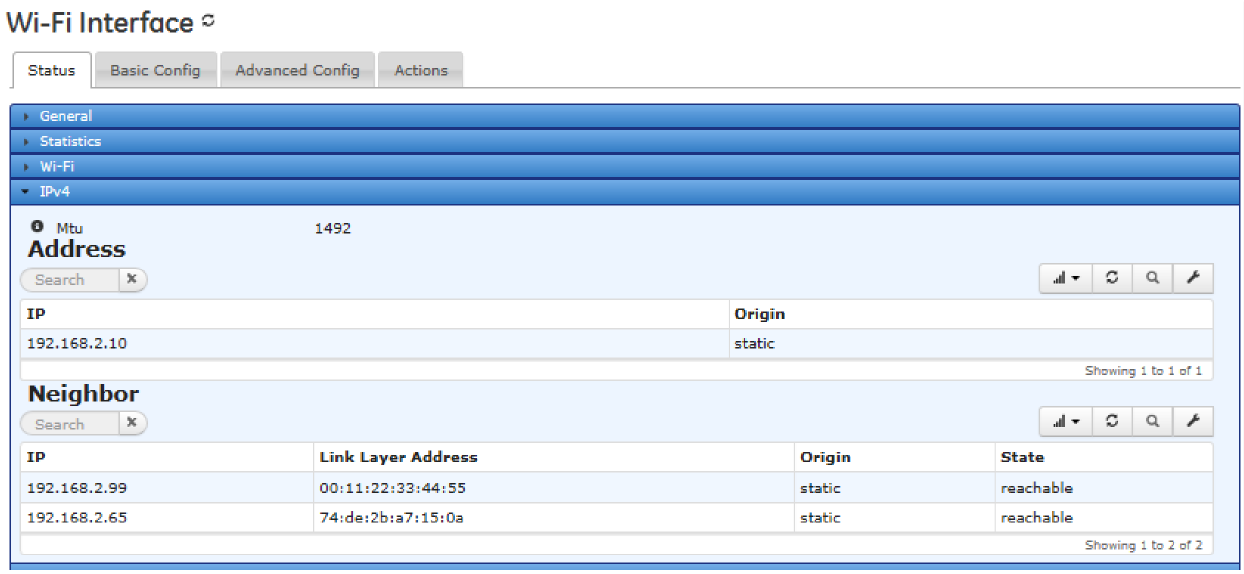


Figure 3-151. Neighbor link layer address entry

Once all items are configured appropriately, click **Save** in the upper left corner of the screen. The new neighbor will be populated into the **Neighbor** list.



The CLI can also be used to configure static routes. To configure the same route via the CLI, enter the following commands:

% set interfaces interface Bridge **ipv4 neighbor** 192.168.1.99 **phys-address** 00:11:22:33:44:55

Monitoring

As mentioned above in **Configuring,** all of the user-defined neighbors on the web UI may be viewed by navigating to ***Interfaces / Interface Name ---> Basic Config / Ipv4*** viewing the Neighbor list.

To view the entire list of known IPv4 neighbors, including those learned automatically by the unit, the following CLI command would be used in operational mode:

```
> show interfaces-state interface ipv4 neighbor
                               LINK LAYER
NAME      IP                    ADDRESS             ORIGIN    STATE
-----------------------------------------------------------------------------
Bridge    192.168.1.3          00:80:c8:3b:97:bb   dynamic   reachable
          192.168.1.2          00:12:17:5c:4f:2d   dynamic   reachable
Wi-Fi     192.168.2.65         74:de:2b:a7:15:0a   static    reachable
          192.168.2.99         00:11:22:33:44:55   static    reachable
```

The following information is available.

- **Name** - Name of the interface.
- **IP** - The neighbor's IP address.
- **Link Layer Address** - The neighbor's link-layer address.
- **Origin** - Dynamic, static.
  - Dynamic neighbors are learned by the unit automatically through ARPs or neighbor solicitations.
  - Static neighbors are those added by the user.
- **State** - Incomplete, reachable, stale, delay, probe.
  - Incomplete - Address resolution is still in progress and the neighbor's link-layer address is unknown.
  - Reachable - The neighbor is currently reachable.
  - Stale - The neighbor is not currently unreachable. The unit reevaluates the state of stale neighbors the next time it attempts to send traffic to them.

- Delay - The neighbor was formerly in a Stale state, and a recent attempt to send traffic to it failed.
- Probe - The neighbor was formerly in a Delay state, and the unit is currently sending ARPs/neighbor solicitations in an attempt to reach the neighbor.

3.8.9 Access Control List (Packet Filtering / Firewall)

Understanding

Packet filtering is a component of the firewall service. It can be used to permit or deny incoming or outgoing traffic on an interface.

Packet filtering allows configuring and applying a packet filter (also called Access Control List, or ACL) to incoming or outgoing traffic on an interface. A filter is a set of one or more rules. Each rule consists of two parts:

- Matching criteria that a packet must satisfy for the rule to be applied. Matching criteria consists of various parameters like protocol, source/destination addresses and ports etc.
- Actions that specify what to do with the packet when the matching criteria is met, for example, to drop or accept the packet.

The filter can then be applied to an interface in the incoming or outgoing direction. Typically, different filters are applied in the incoming and outgoing direction on an interface. For example, a filter applied to the cellular (WAN) interface of the Orbit is typically very restrictive, permitting only a small set of traffic to enter the unit, whereas outgoing filter might permit all outgoing traffic etc.

The Orbit includes the four pre-configured filters shown below:

Table 3-27. Predefined Filter Names and Default Settings

Filter Name	Actions
IN_TRUSTED	Allow ingress of all traffic
IN_UNTRUSTED	Allow ingress of ICMP traffic, DNS response traffic, drop all else
OUT_TRUSTED	Allow egress of all traffic
OUT_UNTRUSTED	Allow traffic originating from the interface to which this filter has been applied and from addresses specified in LOCAL-NETS address-set (typically LAN network).

If the Firewall service is enabled, filters specifying ingress and egress rules must be applied to each network interface on the device. The Orbit's network interfaces allow no traffic to pass unless a filter is applied to each one allowing them to do so. Except for the Cell, each network interface on the Orbit is preconfigured with IN_TRUSTED as an input filter, and OUT_TRUSTED as an output filter. This allows all traffic to enter and exit the unit.

The diagrams below provide a simplified view of packet flow for various categories of traffic flows going in and out of the Orbit unit when packet filtering is enabled.

Figure 3-152 shows the flow of packets terminating at the unit, such as device management traffic using SSH or NETCONF protocol terminating at local device management process within the unit.

Figure 3-152. Packets Terminated at the Unit

Figure 3-153 shows flow of packets originating from the unit, such as DNS queries and/or VPN connection setup traffic originating from local VPN service within the unit.

Figure 3-153. Packets Originating from the Unit

Figure 3-154 shows the flow of packets being forwarded (routed) through the unit, such as IP packets arriving inside IPsec VPN tunnel, being routed from cellular WAN to the local Ethernet interface.

Figure 3-154. Packets Being Forwarded Through the Unit

NOTE If the firewall service is enabled and no filter is applied to an interface, then both incoming and outgoing traffic is dropped on that interface.

Configuring

Packet filter configuration on the unit involves following these high level steps:

1. Create a filter and choose its default policy. For example, there are usually two ways to organize a filter:
   - Create a "restrictive" filter. The first rules are added to permit the desired types of traffic, and a final rule, or default policy, is created that denies all other traffic. The example filter rules below permit SSH traffic on TCP port 22, and ICMP messages such as pings and routing error notifications. All other traffic is denied.
     - Rule 1 = permit protocol=tcp, dst port=22
     - Rule 2 = permit protocol=icmp
     - Rule 3 = deny everything
   - Or create a "permissive" filter. The first rules are added to deny the undesired types of traffic, and a final rule, or default policy, is created that permits all other traffic. The example filter rules below deny HTTP traffic on TCP port 80, and ICMP message such as pings and routing error notifications. All other traffic is permitted.
     - Rule 1 = deny protocol=tcp, dst port=80
     - Rule 2 = deny protocol=icmp
     - Rule 3 = permit everything
2. Apply the filter to input or output direction of the interface. This selection depends on whether the rules should apply to traffic that ingresses or egresses the device.
3. Optionally add the “log event” attribute to the filter and set related parameters to permit tracking when filter rules are applied. (Logged tracking events can drive SNMP traps if desired)

Example

The following example describes the step-by-step configuration of example input and output filters that can be applied to cellular interface of the Orbit. Since the cellular interface is connected to public cellular network, which is inherently an untrusted network, the cellular interface can be considered untrusted as well. Therefore, this example permits all outgoing cellular traffic, but restricts incoming traffic. Incoming IPsec tunnel traffic is allowed, as are UDP services DNS, NTP, and IKE (to allow IPsec connection setup). Incoming TCP services SSH and NETCONF are also permitted to allow management of the Orbit via the cellular interface. All other incoming traffic is denied.

Using the Access Control List Wizard

The Access Control List Wizard is the web UI’s simplest way to create, delete, and manage packet filtering rules. First, navigate to ***Wizards*** and click **Access Control List (Filter)** from either the navigation bar or the main Wizards page.

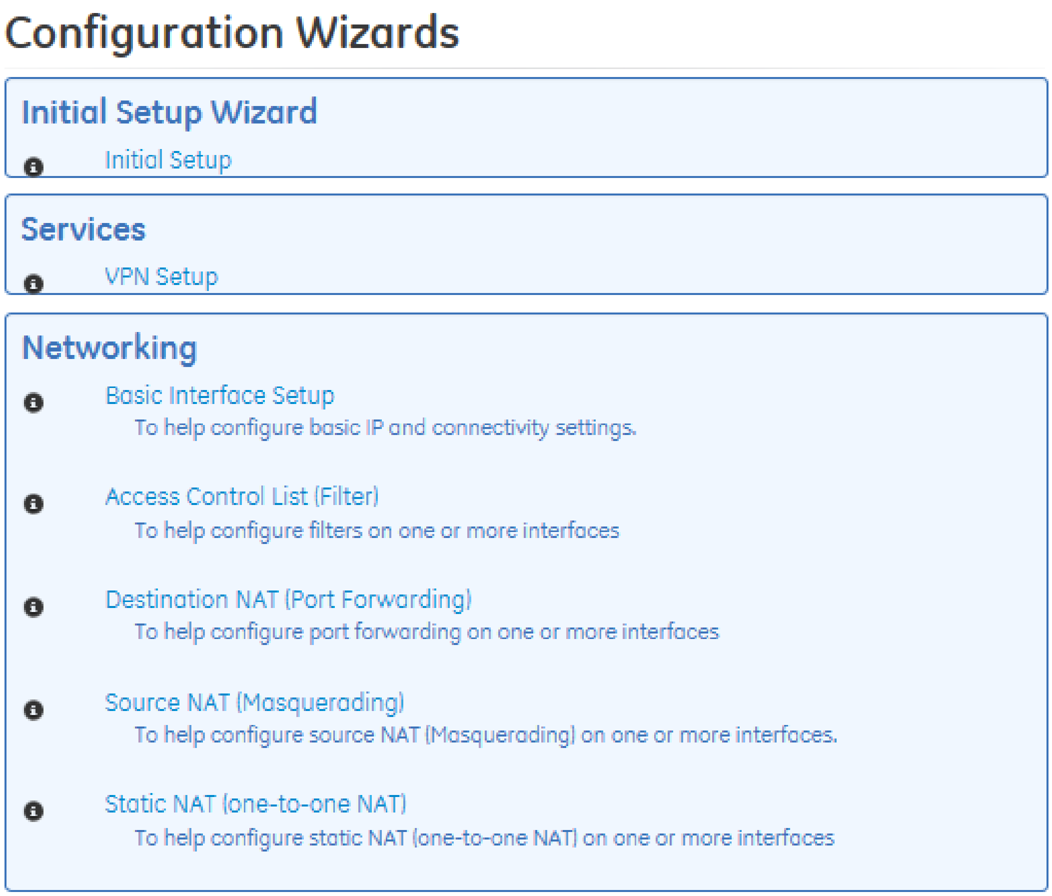


Figure 3-155. Wizards List

The Access Control List Wizard Introduction page appears. Click **Next** to continue.

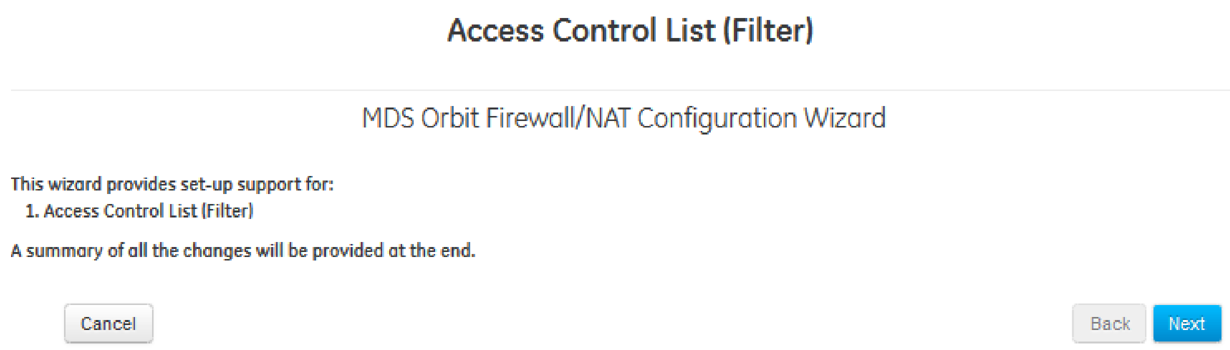


Figure 3-156. Access Control List (Filter) Introduction

The existing filters will be displayed.

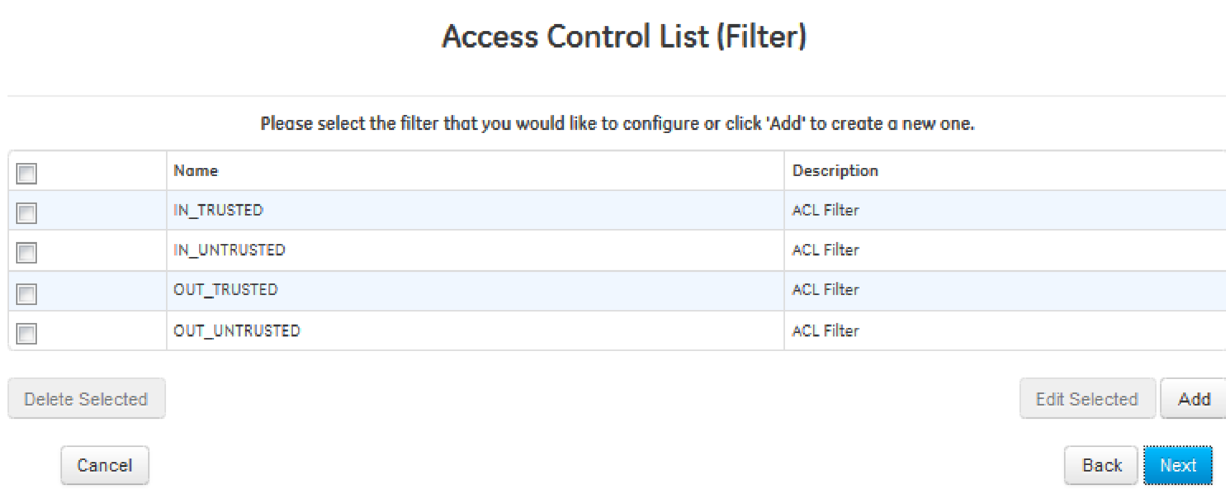
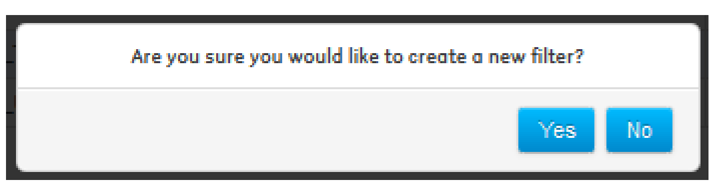


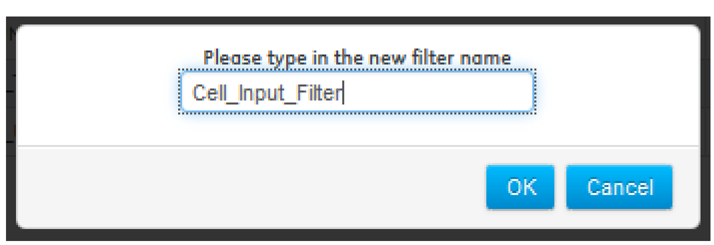
Figure 3-157. List of existing packet filters

The wizard displays the list of existing packet filtering rules on the device. The Orbit comes with four pre-configured filters: IN_TRUSTED, IN_UNTRUSTED, OUT_TRUSTED, and OUT_UNTRUSTED.

Existing filters may be edited or deleted, or a new one may be added.

To create a new filter, click **Add**, then **Yes** to verify the creation of a new filter. Enter the name of the new filter, for example "**Cell_Input_Filter**". Click **OK** to continue.





A packet filter consists of a list of rules. Rules are listed in the order of priority. To change the priority of rules in the list, click the up or down buttons in the Order column. Rules may be added or deleted.

When creating a new filter, rules must be added. Using the "Add new rule" button, enter each new rule as required.

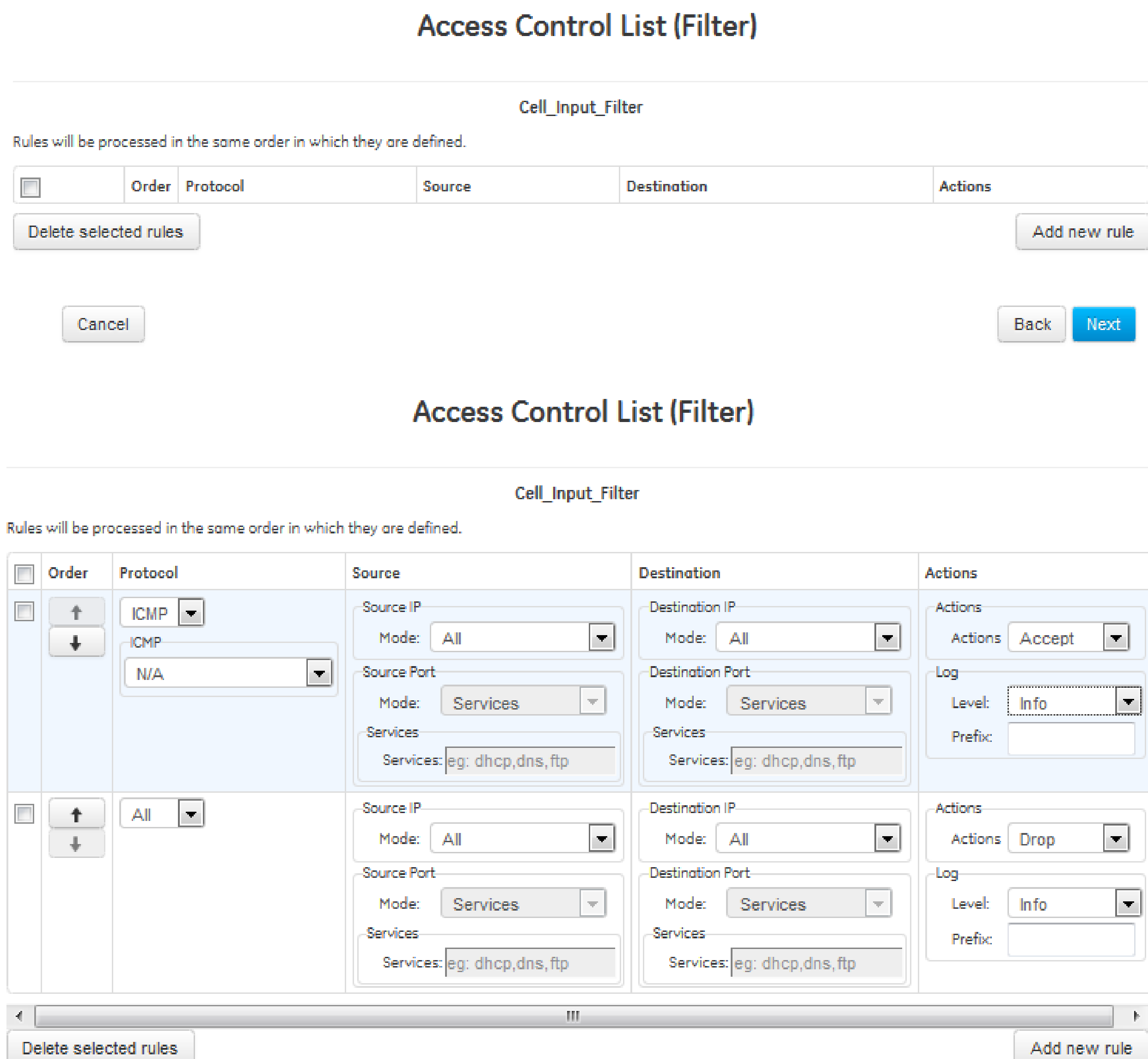


Figure 3-158. Editing/creating packet filter rules

The following options are available.

- **Order –** Click the arrows to sort rules in order of priority. Rules with higher priority are applied before rules with lower priority; rule sets containing more than one rule should be sorted accordingly.
- **Protocol –** *All, SCTP, TCP, UDP, ICMP, ESP.* Specifies the IP protocol of traffic that the rule should be applied to.

NOTE When configuring custom layer-2 protocol filters use 0x as a prefix when entering the value as Hex, otherwise enter the decimal value. Example for ARP: Enter 0x0806 or 2054.

- **ICMP** - When selected, the rule will only apply to that specific ICMP message only. For ICMP message type definitions, see *RFC792*, available from the Internet Engineering Task Force, http://www.ietf.org
  - N/A - the rule will be applied to all ICMP protocol messages.
  - Destination Unreachable
  - Echo Request
  - Echo Reply
  - Address Mask Request
  - Address Mask Reply
  - Parameter Problem
  - Redirect
  - Router Advertisement
  - Router Solicitation
  - Source Quench
  - Time Exceeded
  - Timestamp Request
  - Timestamp Reply.
- **Source IP –** Apply rule to traffic that originates at a specific source address or addresses.
  - **Mode –** Address, Address Range, Address Set, Not Address, Not Address Range, Not Address Set.
    - All – Apply rule regardless of source address.
    - Address - Apply rule to a specific source address and prefix.
    - Address Range – Apply rule to a range of source addresses.
    - Address Set – Apply rule to a non-contiguous set of source addresses.
    - Not Address - Apply rule to traffic that does *not* originate from a specific source address and prefix.
    - Not Address Range – Apply rule to traffic that does *not* originate from a source address range.
    - Not Address Set – Apply rule to traffic that does *not* originate from a non-contiguous set of source addresses.
- **Source Port** – Apply rule to traffic that originates at a specific source port. This option is available only with protocols *SCTP, TCP,* and *UDP.*
- **Services –** Services, Port Range, Not Services, Not Port Range.
  - **Services** – Apply rule to traffic originating from one or more designated well-known service source ports. The services must be specified by name and separated by commas.
    - Port Range – Apply rule to traffic originating from a specific source port or set of ports.
    - Not Services – Apply rule to traffic that does *not* originate from one or more designated well-known service source ports. The services must be specified by name and separated by commas.
    - Not Port Range – Apply rule to traffic that does *not* originate from a specific source port or set of ports.
- **Destination IP –** Apply rule to traffic intended for a specific destination address or addresses.
  - **Mode –** Address, Address Range, Address Set, Not Address, Not Address Range, Not Address Set.
    - All – Apply rule regardless of destination address.

- Address - Apply rule to a specific destination address and prefix.
- Address Range – Apply rule to a range of destination addresses.
- Address Set – Apply rule to a non-contiguous set of destination addresses.
- Not Address - Apply rule to traffic that is *not* intended for a specific destination address and prefix.
- Not Address Range – Apply rule to traffic that is *not* intended for a specific destination address range.
- Not Address Set – Apply rule to traffic that is *not* intended for a non-contiguous set of destination addresses.

- **Destination Port** – Apply rule to traffic intended for a specific destination port. This option is available only with protocols *SCTP, TCP,* and *UDP.*
- **Services –** Services, Port Range, Not Services, Not Port Range.
  - **Services** – Apply rule to traffic intended for one or more designated well-known service destination ports. The services must be specified by name and separated by commas.
    - Port Range – Apply rule to traffic intended for a specific destination port or set of ports.
    - Not Services – Apply rule to traffic that is *not* intended for one or more designated well-known service destination ports. The services must be specified by name and separated by commas.
    - Not Port Range – Apply rule to traffic that is *not* intended for a specific destination port or set of ports.
- **Actions** – *Accept, Drop, Reject.* Specifies what should be done with packets that match the rule.
    - Accept – Allow packets to ingress or egress the unit.
    - Drop – Block packets from ingress or egress.
    - Reject – Block packets from ingress or egress and send an error message to the sender. When *ICMP* protocol is selected, a rejection message may be chosen.
    - Reject Type – Net unreachable, Host unreachable, Port unreachable, Proto unreachable, Net prohibited, Host prohibited, Admin prohibited
- **Log – *Optional***. Allows packets that meet the rule to be logged to the event log.
  - **Level** – Emergency, Alert, Critical, Error, Warning, Notice, Info, Debug.
  - **Prefix** – Enter a text string to prepend to generated log entries.

Allow Select Cell Inbound traffic

In this example, the input filter will be restrictive and permit only some types of traffic: IPsec tunnel traffic, UDP services DNS, NTP, and IKE (to allow IPsec connection setup), and TCP services SSH and NETCONF (to allow management of the Orbit).

To create a rule to permit IPsec tunnel traffic, select **Protocol** ESP and ensure that **Action** is set to Accept. The **Log Level** can be set to Debug, unless incoming IPsec traffic is of interest.

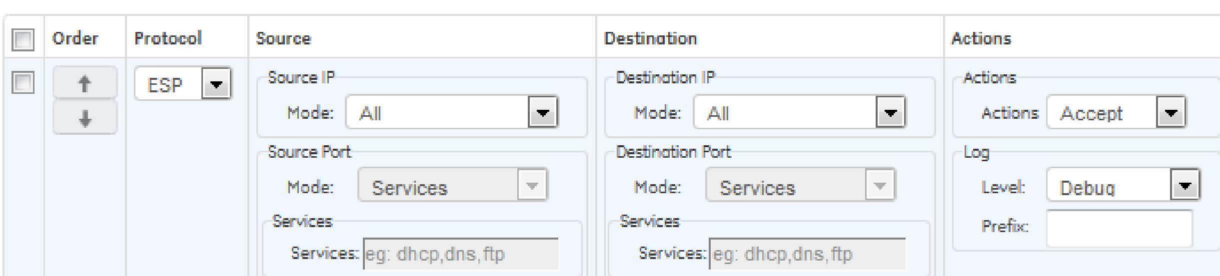


Figure 3-159. Creation of a packet filter rule to allow IPsec connections

Next, click **Add new rule** to create a rule to allow the desired UDP services. For this rule, select **Protocol** UDP and set **Source Port** to Services. The services must be entered as a comma-separated list. Since this example permits UDP services DNS, NTP, and IKE, enter dns, ntp, Ike in the textbox next to **Services.** Ensure that **Actions** is set to **Accept**. Again, **Log Level** can be set to Debug unless there is a need to view incoming UDP connections.

Note that the UDP rule appears below the ESP rule in the rule list. This indicates that the ESP rule will be applied first, and then the UDP rule. This is not a problem since the two rules are not in conflict.

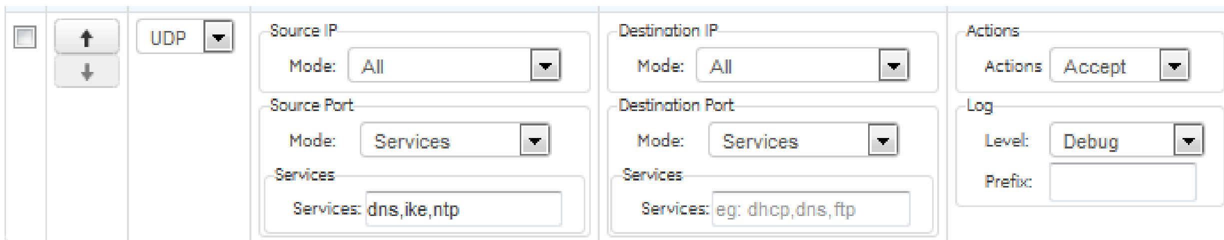


Figure 3-160. Creation of a packet filter rule for inbound UDP traffic

The next rule in this example will be used for the TCP services SSH and NETCONF. Click **Add new rule** and select **Protocol** TCP. Since SSH and NETCONF traffic is used to manage the Orbit, the traffic terminates at the Orbit. This means that the incoming traffic will have these well-known service ports as its destination port. Set **Destination Port** to *Services*, and enter netconf, Ssh in the textbox next to **Services.** Again, ensure that **Actions** is set to *Accept*, and **Log Level** can be set to *Debug*.

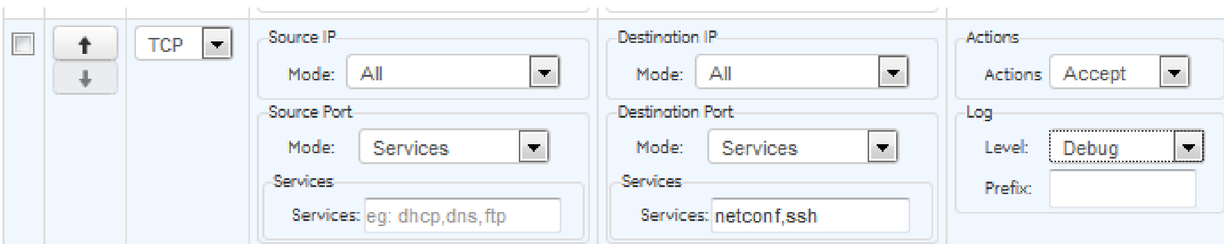


Figure 3-161. Creation of a packet filter rule for inbound TCP traffic

The last step in the creation of a restrictive filter is a default rule to deny all traffic that does not match any of the previous rules. To do this, click **Add new rule,** select **Protocol** *All*, and set **Actions** to *Drop***.** The **Log Level** is once again set to *Debug*. This rule must be at the last on the rule list. Any rules added after this last rule will have no effect, as they would match "any" traffic and be dropped.

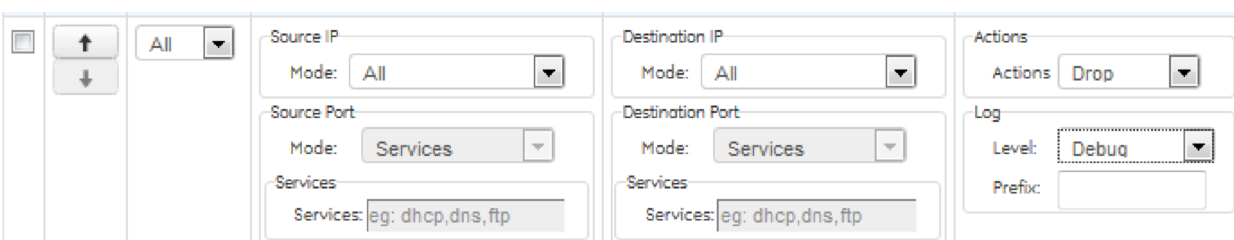


Figure 3-162. Creation of a default restrictive packet filter rule for inbound traffic

Once all changes are finished, click **Back** to return to the list of packet filters and create another.

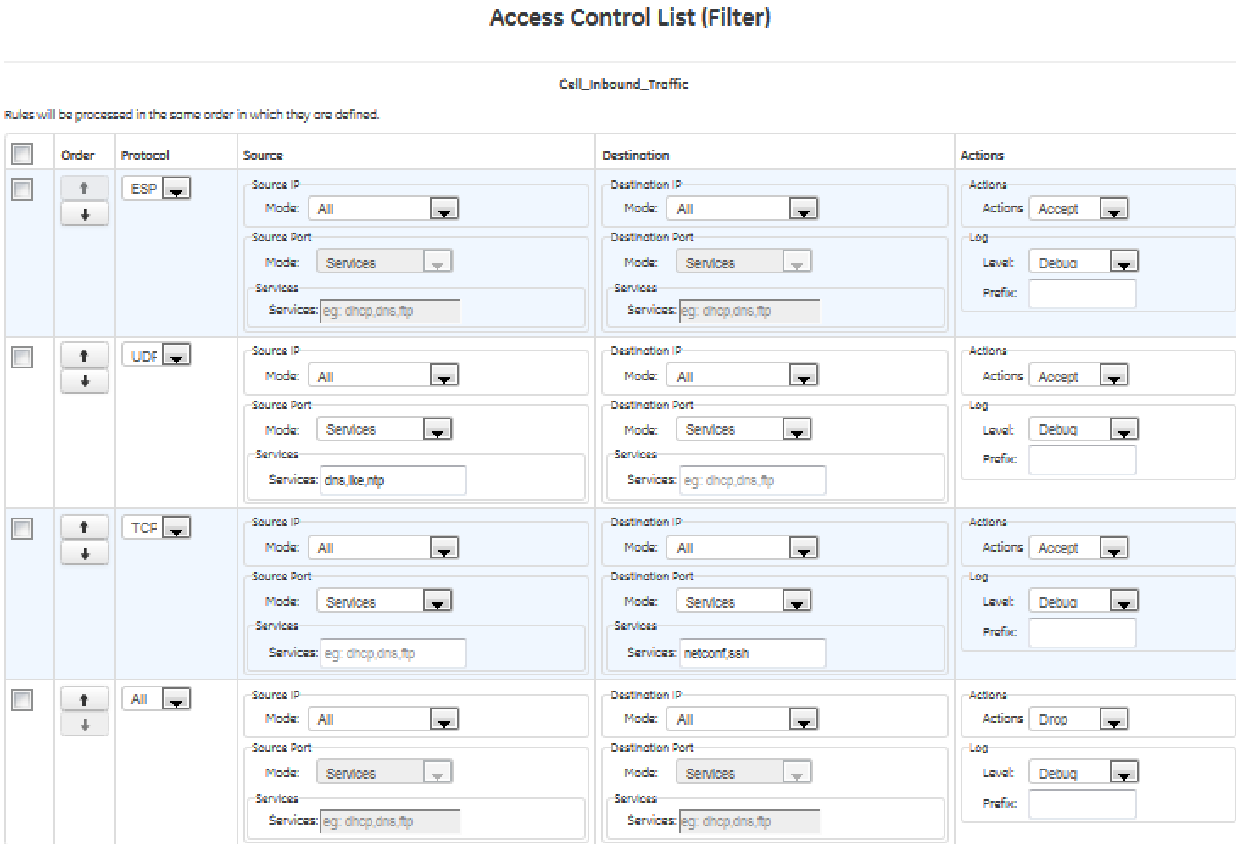


Figure 3-163. Completed rules for inbound IPsec traffic

Permit Cell Outbound Traffic

The network in this example requires that the cellular interface permit all outgoing traffic. A filter must be applied to the cellular interface that allows this. The preconfigured OUT_TRUSTED filter does this already, but since the cellular interface in this example is untrusted, we anticipate that it will require outbound traffic restrictions in the future. To allow interface-specific customization, we create a new packet filter.

To create a new filter, click **Add**, then **Yes** to verify the creation of a new filter. Enter the name of the new filter, for example “**Cell_Output_Filter**”. Click **OK** to continue. Using the “**Add new rule**” button enter each new rule as required.

After clicking **Add New Rule**, the rule creation menu appears. Select **Protocol** *All* and **Actions** *Accept*. This is a permissive filter, which allows all traffic. Later on, if needed, this filter can be enhanced to deny certain traffic from exiting the cellular interface.

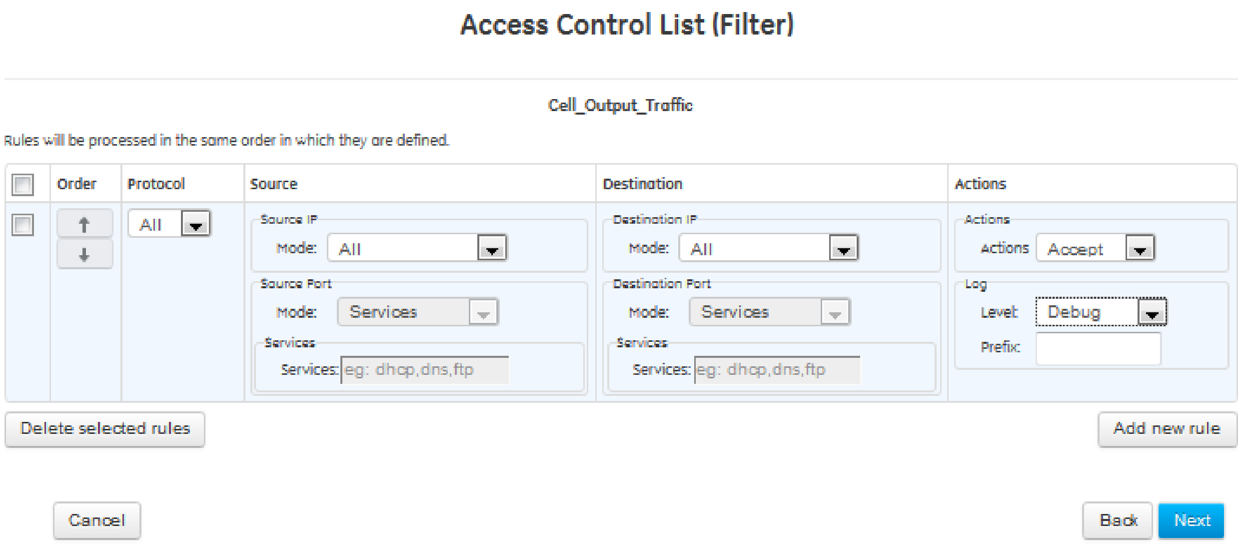


Figure 3-164. Creation of a filter rule to allow all traffic

Since there are no more filters to add, click **Next** to proceed to **Interface Selection.**

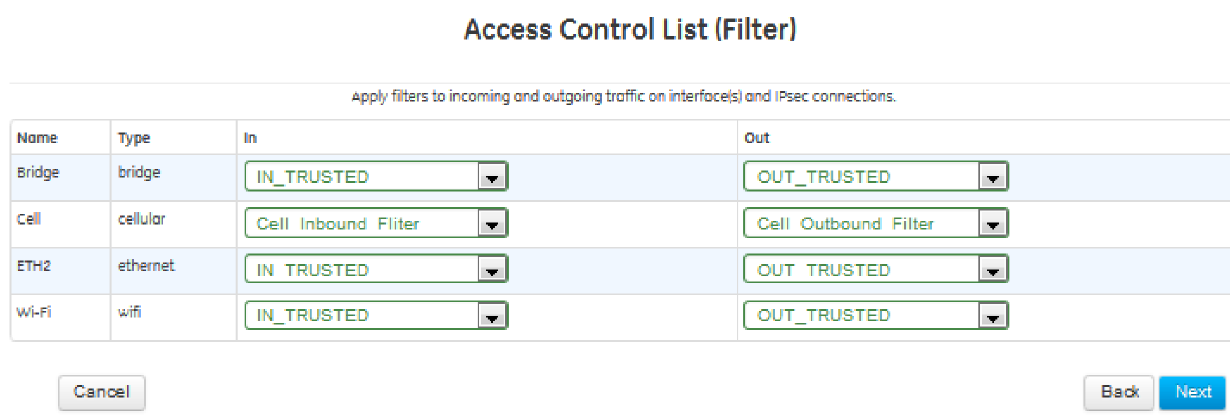


Figure 3-165. Interface Selection Menu

The **Interface Selection** menu shows each network interface and IPsec connection present on the device. When the Firewall service is running, each network interface and IPsec connection on the device must be assigned an input and output packet filter. Otherwise, no traffic will flow. By default, each network device uses IN_TRUSTED and OUT_TRUSTED as filters. Since the filters just created in this example are intended for the cellular interface, click the **In** dropdown box next to the **Cell** interface and select the newly created input filter. Next, click the **Out** dropdown next to the **Cell** interface and select the newly created output filter. Click **Next** to continue.

Access Control List (Filter)

Summary

Keypath	Change Type	Old Value	New Value
filter{Cell_Outbound_Filter}/rule{1}/actions/action	value_set		accept
filter{Cell_Outbound_Filter}/rule{1}/actions	created		
filter{Cell_Outbound_Filter}/rule{1}/match/protocol	value_set		all
filter{Cell_Outbound_Filter}/rule{1}	created		
filter{Cell_Outbound_Filter}	created		
filter{Cell_Inbound_Fliter}/rule{4}/actions/action	value_set		drop
filter{Cell_Inbound_Fliter}/rule{4}/actions	created		
filter{Cell_Inbound_Fliter}/rule{4}/match/protocol	value_set		all
filter{Cell_Inbound_Fliter}/rule{4}	created		
filter{Cell_Inbound_Fliter}/rule{3}/actions/action	value_set		accept
filter{Cell_Inbound_Fliter}/rule{3}/actions	created		
filter{Cell_Inbound_Fliter}/rule{3}/match/protocol	value_set		tcp
filter{Cell_Inbound_Fliter}/rule{3}/match/dst-port/services	value_set		netconf,ssh
filter{Cell_Inbound_Fliter}/rule{3}/match/dst-port	created		
filter{Cell_Inbound_Fliter}/rule{3}	created		
filter{Cell_Inbound_Fliter}/rule{2}/actions/action	value_set		accept
filter{Cell_Inbound_Fliter}/rule{2}/actions	created		

Figure 3-166. Subset of Access Control Wizard summary page

A summary page appears that displays the items in the configuration's data model that were changed, and type of changes that occurred. To save and apply the changes, click **Submit.**

To view the list of packet filters that exist on the device at any time, navigate to ***Firewall ---> Basic Config***, and view the list of filters in the ***Filter*** tab.

Change the packet filters applied to a network interface by navigating to ***Interfaces*** and click on the desired interface from the navigation bar. Navigate to the ***Basic Config*** tab. The input and output filters appear in the ***Filter*** drop-down.

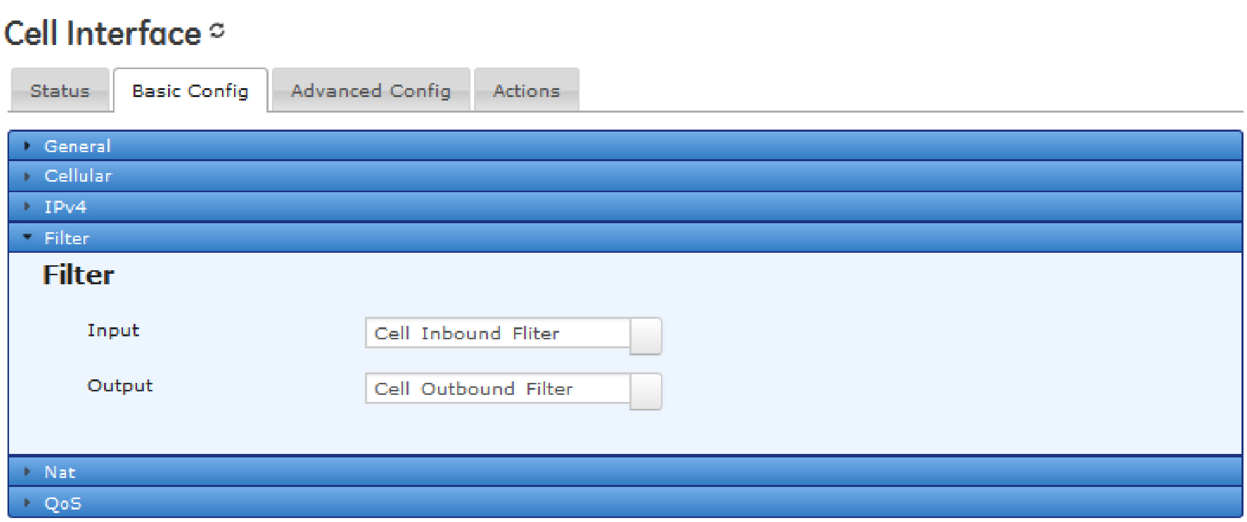


Figure 3-167. Cell interface, Filter menu

Tracking and Customizing Firewall activity

The Access Control Wizard summary provides quick setup but does not permit access to all features. To control settings directly, navigate to ***Firewall ---> Basic Config***. An example is shown below:

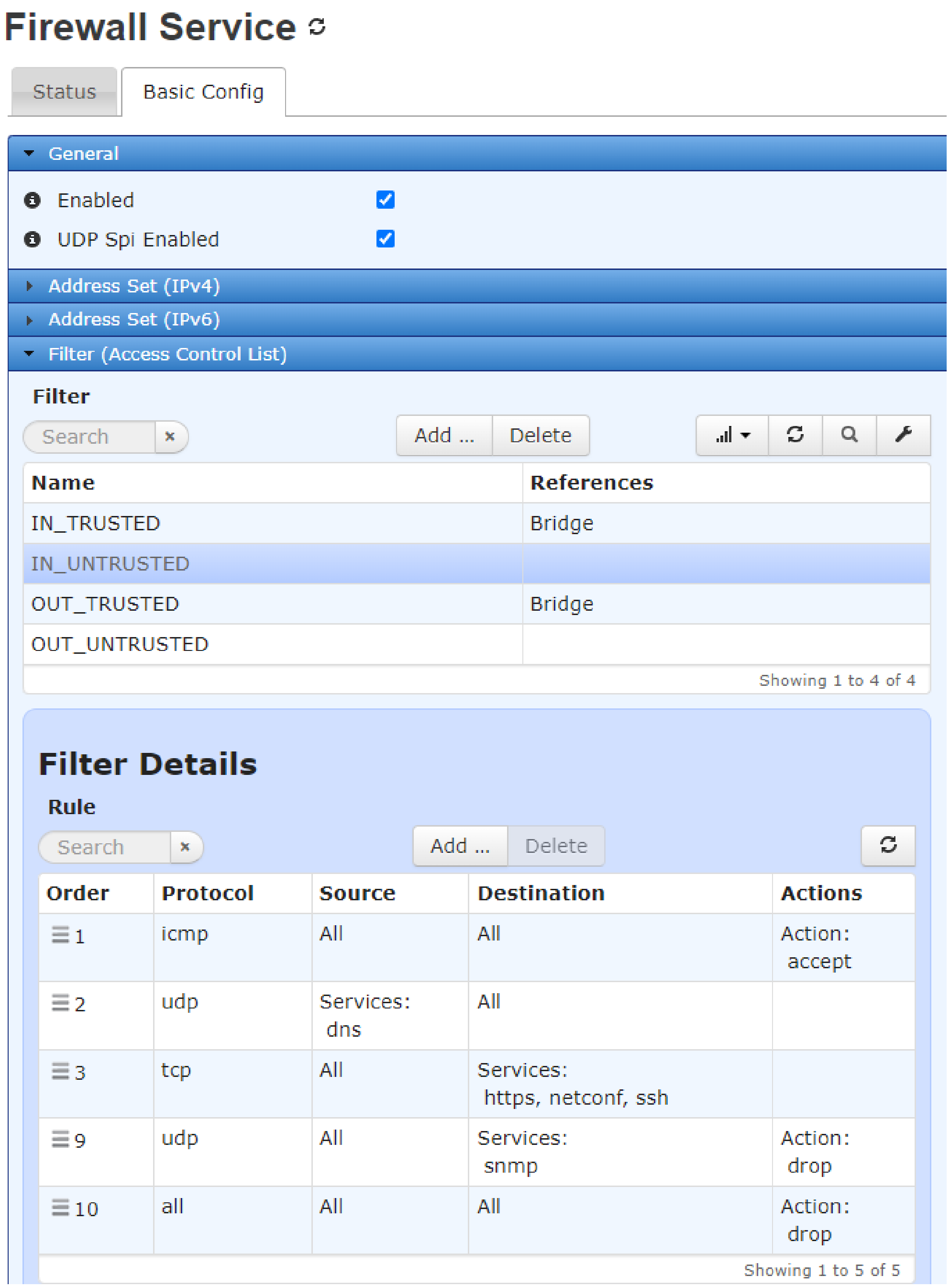


Figure 3-168. Firewall (Access Control List) Filter Details

Using the example above, clicking on rule 9 displays Rule Details as follows:

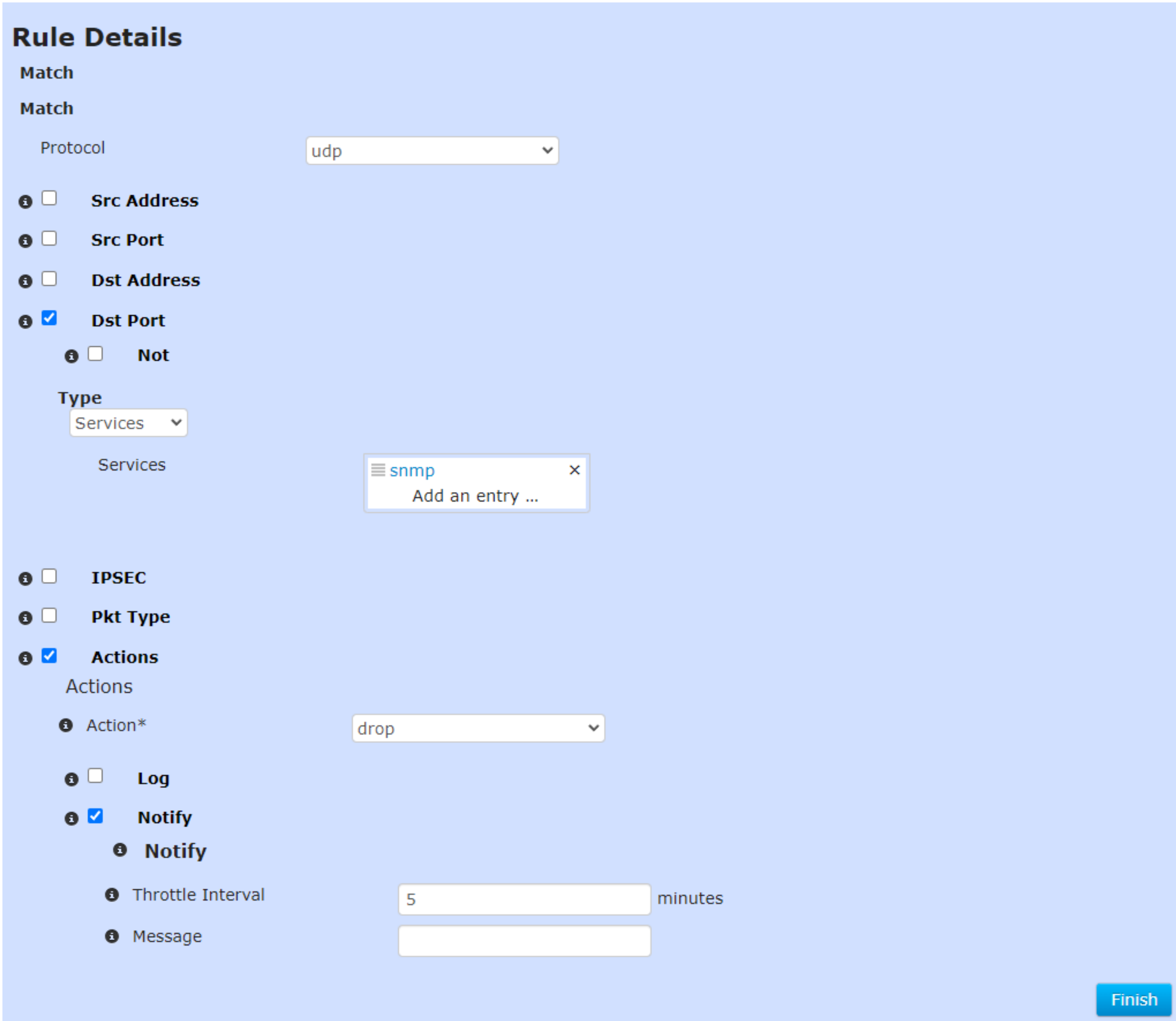


Figure 3-169. Firewall (Access Control List) Rule Details

In addition to the items configurable via the Access Control List Wizard, Rule Details provides the ability to generate notification events. To add event notification on firewall rule match, click **Notify**. A “firewall-filter” alert event will be generated approximately 1 minute after first match detection. The following options are available.

- **Throttle Interval –** The throttle interval is set to keep the event log from being rapidly filled. After an event is logged it will holdoff for the throttle interval before it logs the same event again.
- **Message –** Specifies optional unique message text to appear in the log entry for the “firewall-filter” event type.

Using the CLI

To use the CLI to create and apply the same packet filters as the example above, first change to CLI configuration mode, and follow the steps below. Change to CLI configuration mode:

1. Enable firewall service

   % set services firewall enabled true

2. Create a “restrictive” filter named ***Cell_Inbound_Traffic*** to indicate that this filter has been designed to be applied to an untrusted cellular interface of Orbit. The cellular interface can be considered untrusted as it is connected to public cellular network, which is inherently an untrusted network.

   % set services firewall filter Cell_Inbound_Traffic

3. Create rule to permit encrypted IPsec tunnel traffic i.e. traffic with protocol=ESP

   % set services firewall filter Cell_Inbound_Traffic **rule** 1 **match protocol** esp

   % set services firewall filter Cell_Inbound_Traffic **rule** 1 **actions action** accept

4. Create rule to permit traffic for the following UDP services: DNS, NTP and IKE (to allow IPsec connection setup).

   % set services firewall filter Cell_Inbound_Traffic **rule** 2 **match protocol** udp **src-port services [**dns ike ntp**]**

   % set services firewall filter Cell_Inbound_Traffic **rule** 2 **actions action** accept

5. Create rule to permit traffic for following TCP services: SSH and NETCONF (to allow management of Orbit):

   % set services firewall filter Cell_Inbound_Traffic **rule** 3 **match protocol** tcp **dst-port services [**netconf ssh**]**

   % set services firewall filter Cell_Inbound_Traffic **rule** 3 **actions action** accept

---

NOTE The rule stated in step 5 permits SSH or NETCONF connection addressed to the cellular interface’s IP address. If it is desired that SSH or NETCONF connection only be allowed via the VPN tunnel, then remove rule 3 and instead apply appropriate filter to IPsec connection.

---

6. Create the last rule for this “restrictive” filter to deny everything else. Note that rules are applied in ascending order using rule IDs. Any rules added after this last rule will have no effect, as they would match “any” traffic and be dropped. In this example rule ID 10 is chosen. This facilitates the insertion of new rules prior to this last one to support future new traffic types.

   % set services firewall filter Cell_Inbound_Traffic **rule** 10 **match protocol** all

   % set services firewall filter Cell_Inbound_Traffic **rule** 10 **actions action** drop

7. Apply this filter to incoming direction on cellular interface “Cell”.

   % set interfaces interface Cell **filter input** Cell_Inbound_Traffic

8. Create a “permissive” filter that permits all traffic. Later on, if needed, this filter can be enhanced to deny certain traffic from getting out of the cellular interface.

   % set services firewall filter Cell_Outbound_Filter **rule** 10 **match protocol** all

   % set services firewall filter Cell_Outbound_Filter **rule** 10 **actions action** accept

9. Apply this filter to outgoing direction on cellular interface “Cell”.

   % set interfaces interface *Cell* filter output Cell_Outbound_Filter

10. Commit configuration and exit configuration mode.

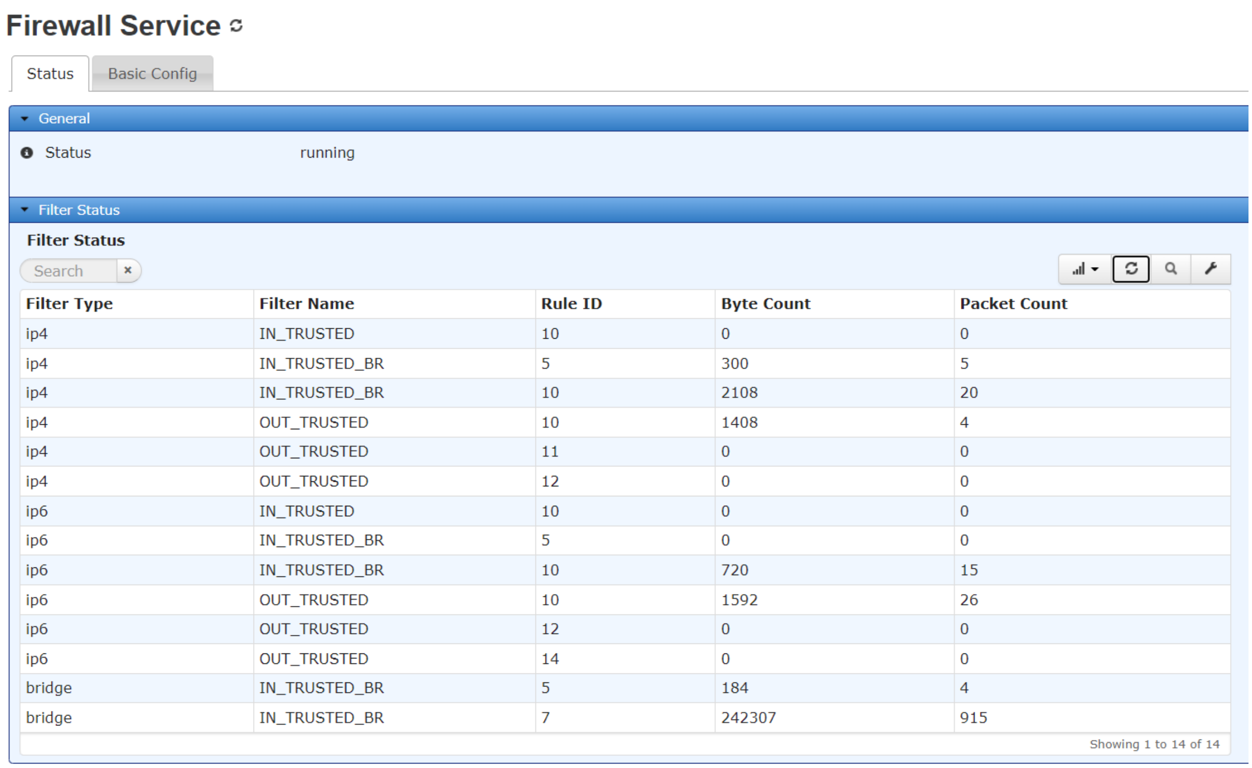
   % commit

   Commit complete.

Monitoring

Using the Web UI

To view the VPN status, navigate to ***Services->Firewall-> Status***.



Filter Type	Filter Name	Rule ID	Byte Count	Packet Count
ip4	IN_TRUSTED	10	0	0
ip4	IN_TRUSTED_BR	5	300	5
ip4	IN_TRUSTED_BR	10	2108	20
ip4	OUT_TRUSTED	10	1408	4
ip4	OUT_TRUSTED	11	0	0
ip4	OUT_TRUSTED	12	0	0
ip6	IN_TRUSTED	10	0	0
ip6	IN_TRUSTED_BR	5	0	0
ip6	IN_TRUSTED_BR	10	720	15
ip6	OUT_TRUSTED	10	1592	26
ip6	OUT_TRUSTED	12	0	0
ip6	OUT_TRUSTED	14	0	0
bridge	IN_TRUSTED_BR	5	184	4
bridge	IN_TRUSTED_BR	7	242307	915

The status tab provides the ability to monitor traffic statistics for packets being dropped or permitted by the firewall. In addition to Filter Type, Filter Name, and Rule ID, the display also provides Byte Count and Packet Count. These values can be used by a network administrator to detect possible intrusion attempts on the network.

3.8.10 Source NAT (Masquerading)

Understanding

Network address translation is a component of the firewall service provided on the Orbit. NAT allows mapping of private IP addresses to public IP addresses and vice versa. There are three basic kinds of network address translation:

- Source NAT
- Destination NAT
- Static NAT

Source NAT

Source NAT performs translation of source IP address of the traffic egressing an interface. This is typically used to provide many-to-one translation (also called masquerading) of a private network behind the Orbit to allow hosts on that private network to access a host on the public network. (See Figure 3-170.) In the figure below, this host is HOST-B. From HOST-B's point of view, all traffic originating from hosts in the private network will appear to have originated from a single IP address: The IP address of the public interface of the Orbit, typically the cellular interface. To allow return IP traffic for UDP/TCP connections to be delivered to the right private host, the Orbit also performs source port translation. Therefore, masquerading consists of Network Address and Port Translation (NAPT).

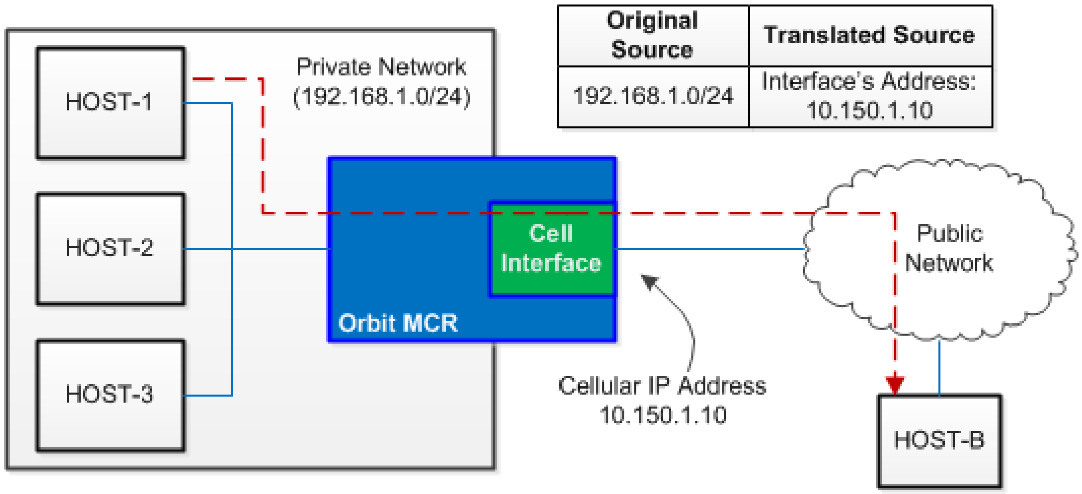


Figure 3-170. Source NAT Translation of IP Address

In the diagram above, traffic from HOST-1, HOST-2, and HOST-3 on the private network 192.168.1.0/24 egresses the Orbit's cellular interface with a translated source IP address of 10.150.1.10.

Figure 3-171 shows the flow of packets being masqueraded (source NATed) through the Orbit unit.

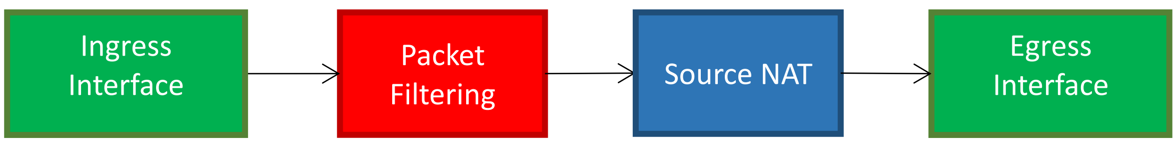


Figure 3-171. Packets Being Masqueraded Through Orbit

Configuring

Source NAT configuration on Orbit involves following high level steps:

1. Create a source NAT rule-set.
2. Add a rule to perform source NAT on the public interface.
3. Apply the source NAT rule-set to the public interface.

To perform the masquerading shown in the example network in Understanding above, a source NAT rule would be created and applied to the cell interface. The following example will illustrate the necessary steps in three ways: Using the Source NAT wizard, through the web UI, and via the CLI.

Using the Source NAT Wizard

The Source NAT Wizard allows the creation or editing of Source NAT rule sets. First, navigate to **Wizards** on the navigation pane and click **IP Masquerading (Source NAT)**.

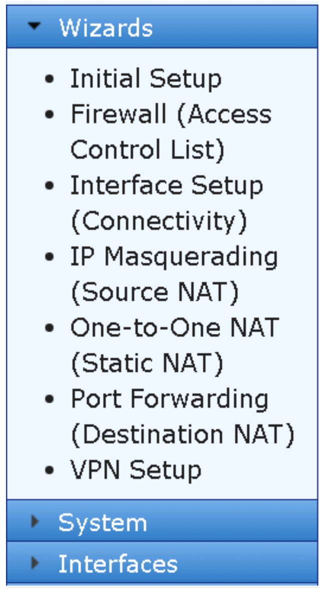
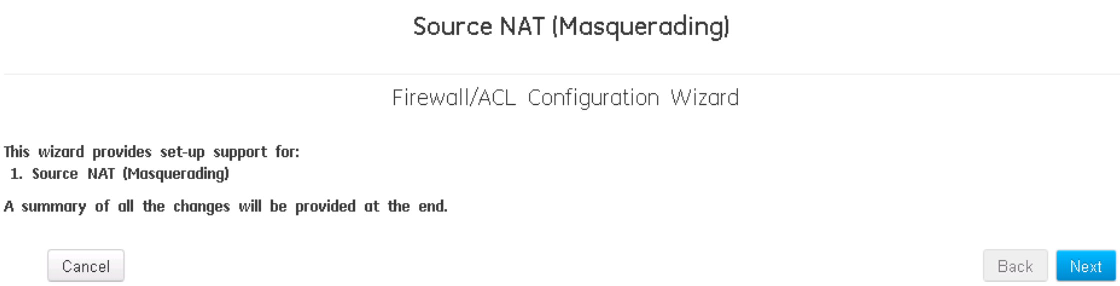


Figure 3-172. Configuration Wizards Navigation Pane

The **Source NAT Introduction** page appears.



Click **Next** to continue.

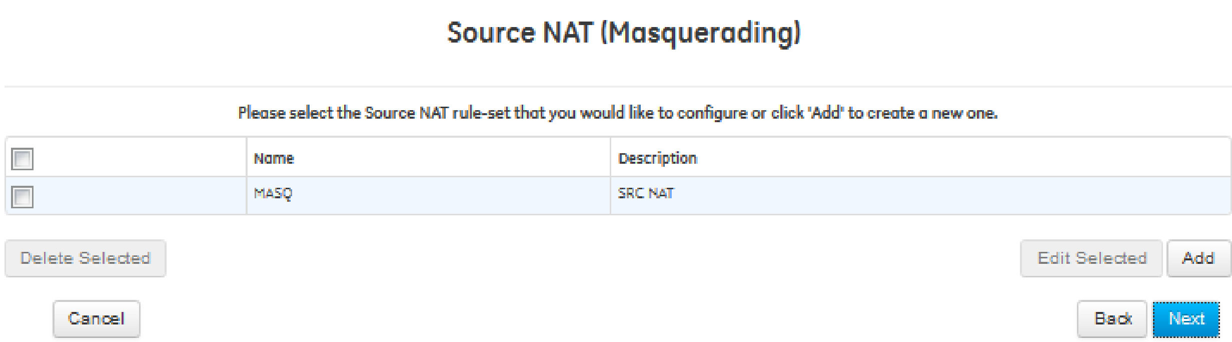
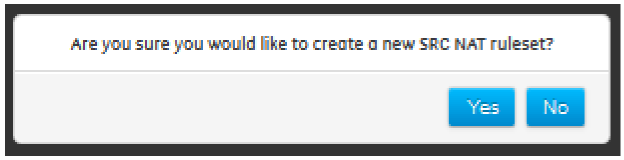
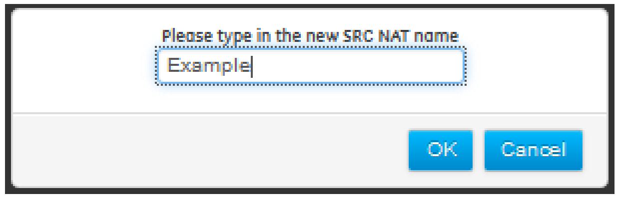


Figure 3-173. Source NAT Rule Sets

The first page in the Source NAT Wizard shows all source NAT rule sets present on the device. Click the checkbox next to an existing rule set and click **Edit Selected** or **Delete Selected** to modify existing rule sets.

To create a new rule set, click the **Add** button.





Enter a name and click **Ok** to continue.

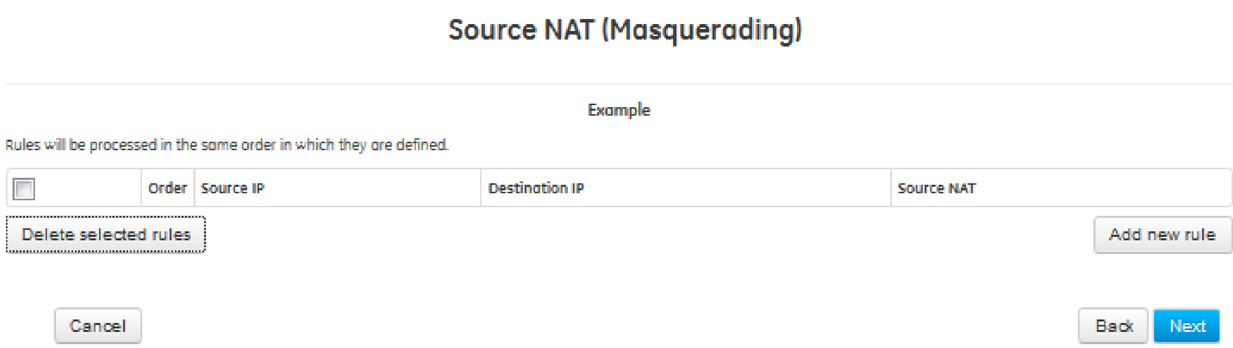
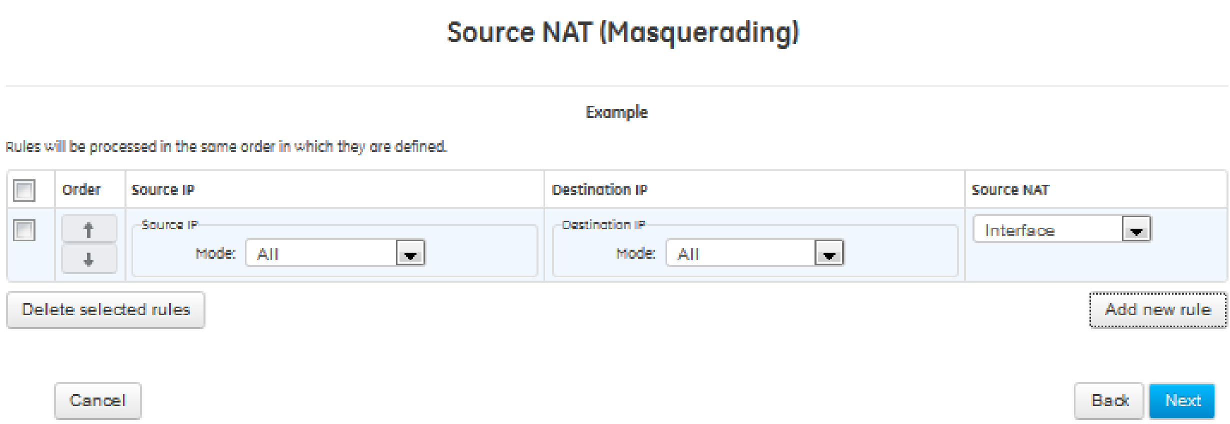


Figure 3-174. List of rules in current source NAT rule set

The next menu shows all rules contained within the new rule set. Since the rule set is new, it has none. Click **Add New Rule** to add one. The rule creation menu appears.



This menu displays a view of all rules created for the current rule set, as well as a means to create new ones. The following options are available.

- **Order –** Click the arrows to sort rules in order of priority. Rules with higher priority are applied before rules with lower priority; rule sets containing more than one rule should be sorted accordingly.
- **Source IP –** Apply rule to traffic that originates at a specific address or addresses.
- **Mode –** options:
  - All – Apply rule regardless of source address.(The example above uses this configuration.)
  - Address - Apply rule to a specific source address and prefix.

- Address Range – Apply rule to a range of source addresses.
- Address Set – Apply rule to a non-contiguous set of source addresses.
- Not Address - Apply rule to traffic that does *not* originate from a specific address and prefix.
- Not Address Range – Apply rule to traffic that does *not* originate from a specific source address range.
- Not Address Set – Apply rule to traffic that does not originate within a non-contiguous set of source addresses.

- **Destination IP –** Apply rule to traffic that ingresses the unit at a specific address or addresses.
- **Mode –** Options:
  - All – Apply rule regardless of destination address. (The example above uses this configuration.)
  - Address - Apply rule to a specific destination address and prefix.
  - Address Range – Apply rule to a range of destination addresses.
  - Address Set – Apply rule to a non-contiguous set of destination addresses.
  - Not Address - Apply rule to traffic that does *not* ingress at a specific address and prefix.
  - Not Address Range – Apply rule to traffic that does *not* ingress at a specific destination address range.
  - Not Address Set – Apply rule to traffic that does *not* ingress at a non-contiguous set of destination address
- **Source NAT** – Interface, Address.
  - Interface – - Translate the source address to the address of the interface to which this rule-set has been applied. (The example **above** uses this configuration).
  - Address – Translate the source address to the specified address.

Once all selections are complete, click **Next** to continue. The **Interface Selection** menu appears.

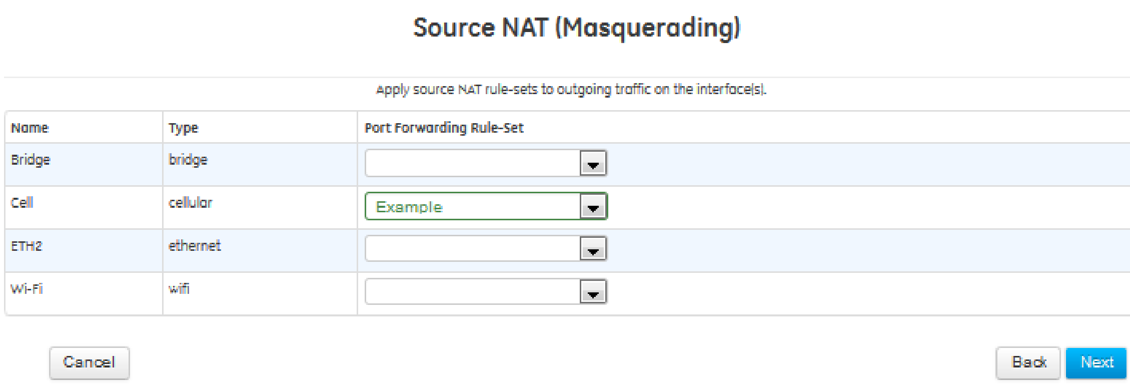


Figure 3-175. Interface Selection Menu

The Interface Selection menu allows the created rule set to be applied to one or more interfaces. To do so, click the drop-down box next to the desired interface and select the rule set name. In the example above, the new rule set should be applied to the cellular interface. Click **Next** to continue.

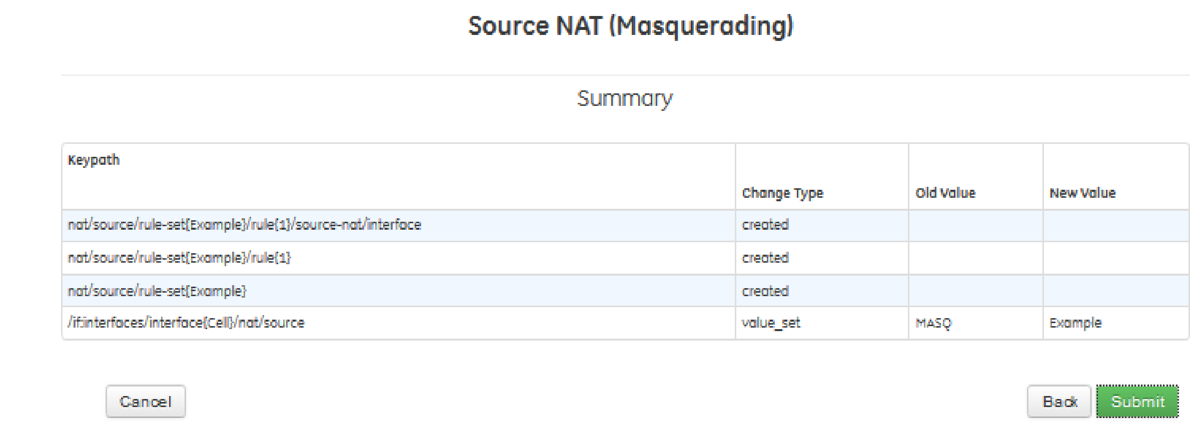


Figure 3-176. Source NAT Wizard Summary Page

A summary page appears that displays the changed items in the configuration's data model, and the types of changes that occurred. To save and apply the changes, click **Submit.**

Using the Web UI

The following process creates the same Source NAT rule set as the example above, using the web UI instead of the Source NAT Wizard. Before using source NAT, the firewall service must be enabled.

Select the **Firewall** system tab. Check the box next to *Enabled* on the ***Basic Config*** tab and click **Save** in the upper left corner of the screen.

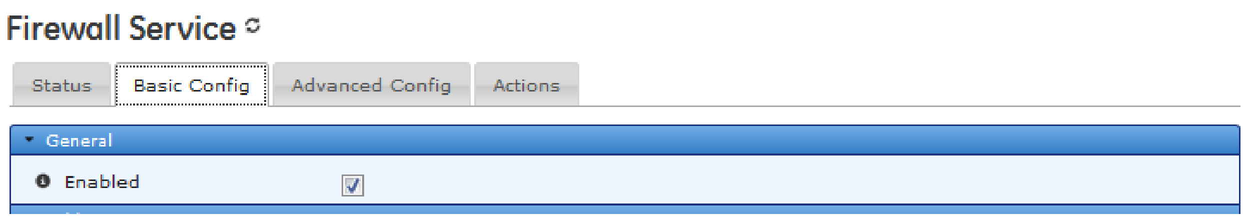


Figure 3-177. Enabling the Firewall service

Click on the **Source NAT** drop-down to open the Source NAT menu.

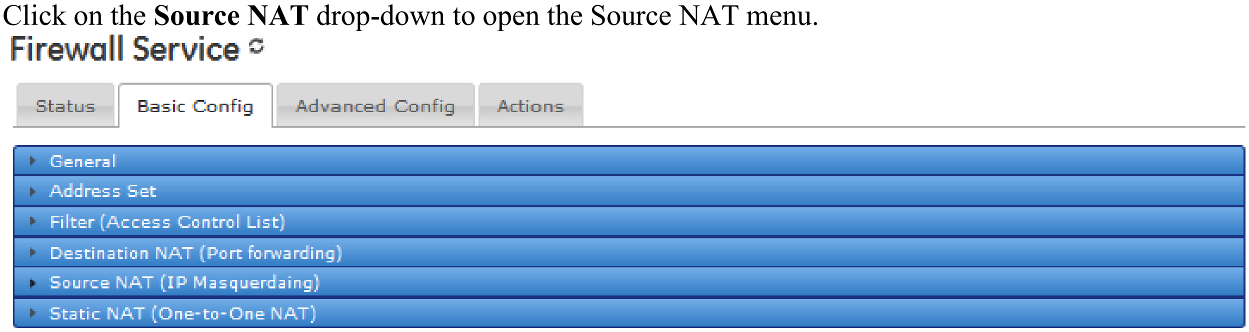


Figure 3-178. NAT menu

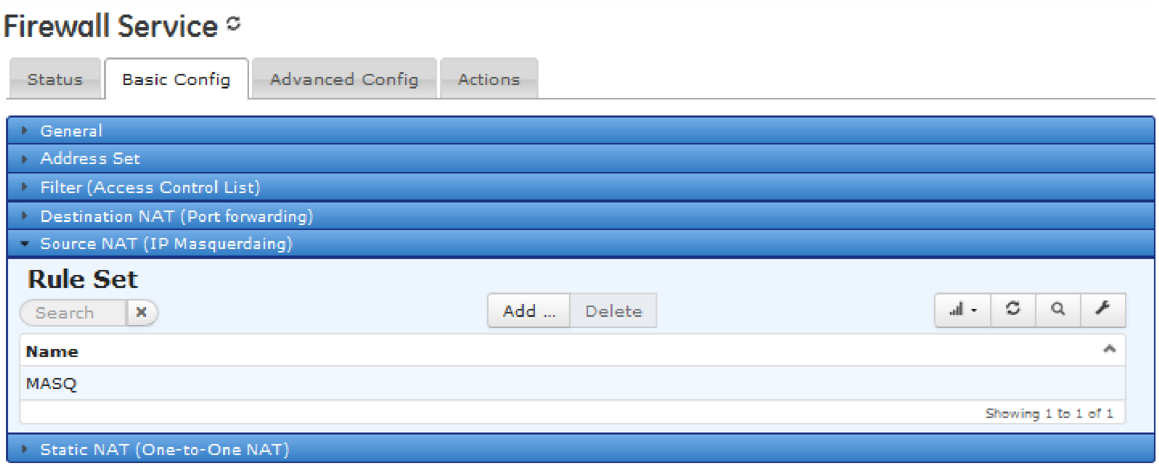


Figure 3-179. Source NAT Menu

The **Source NAT** menu displays all current source NAT rule sets on the device. To edit an existing rule set, simply click on the rule set's name. To delete an existing rule set, highlight it and click the **Delete** button.

To add a new rule set, click the **Add** button. The **Configure Rule Set Details** menu appears.

Figure 3-180. Add New Rule Set menu

First, enter a name for the new rule set and click the **Add** button.

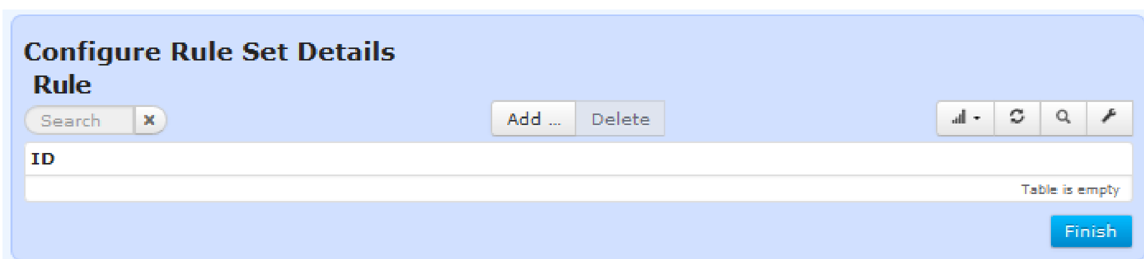


Figure 3-181. Rule Set Display

The menu that appears lists all rules contained within the new rule set. Since this is a new rule set, there are currently none. Click the **Add** button to add a rule. The **Configure Rule Details** menu appears.

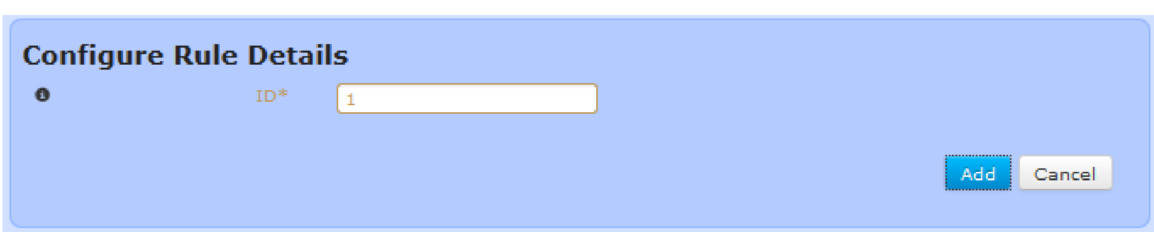


Figure 3-182. Add New Rule menu

Enter a numeric ID for the rule and click the **Add** button. It is important to remember that rules are applied in ascending order. This means that a rule with ID 2, for example, would be processed after a rule of ID 1. Therefore, if the rules in a rule set should be applied in a particular order, care must be taken to set the IDs accordingly. In this example, only one rule is required.

Clicking the **Add** button leads to additional items to configure for new rule.

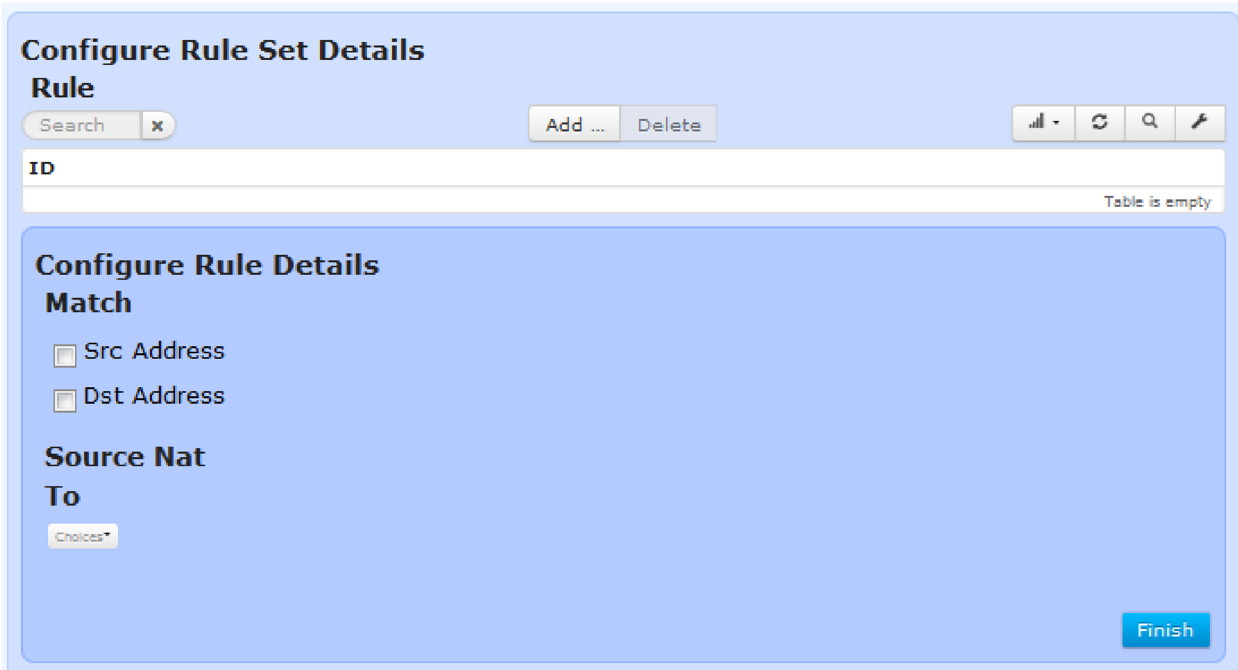


Figure 3-183. Rule menu

The following main sections can be accessed from this screen:

- **Match** – Edit this section if the rule should be applied to a particular source or destination address.
- **Source NAT –** Edit this section if the rule should be applied to a specific interface or address.

Since the rule in this example applies to the cellular interface, configuration will be done on the **Source NAT section.**

Figure 3-184. Source NAT Submenu

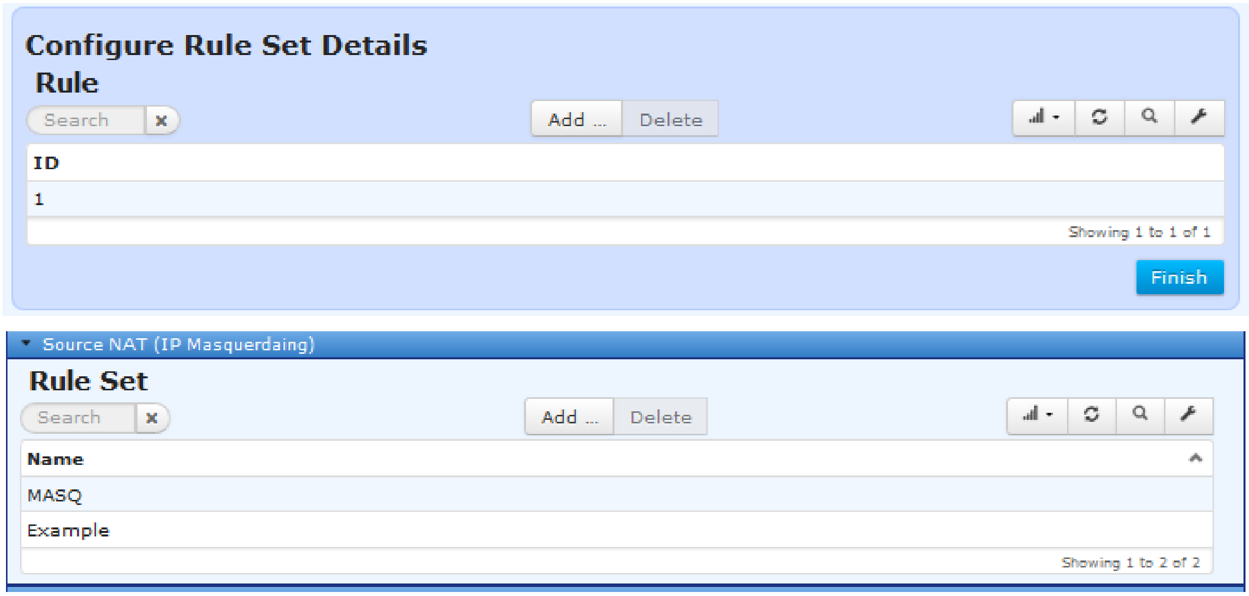
Click the **Choices** dropdown. The following options are available:

- **Interface** - Translate the source address to the address of the interface to which this rule-set has been applied.
- **Address** - Translate the source address to the specified address.

For this example rule, select **Interface.**

Figure 3-185. Source Creation

Click the check box from the left of **Interface** to apply this specifier to the rule. Once finished, click the **Save** button in the upper left corner of the screen. The finished Rule will then populate the table.



Now, the rule set must be applied to the desired interface. Navigate to ***Interfaces*** and click on **Cell** to proceed to the cell interface's menu. From there, navigate to ***Basic Config / NAT***.

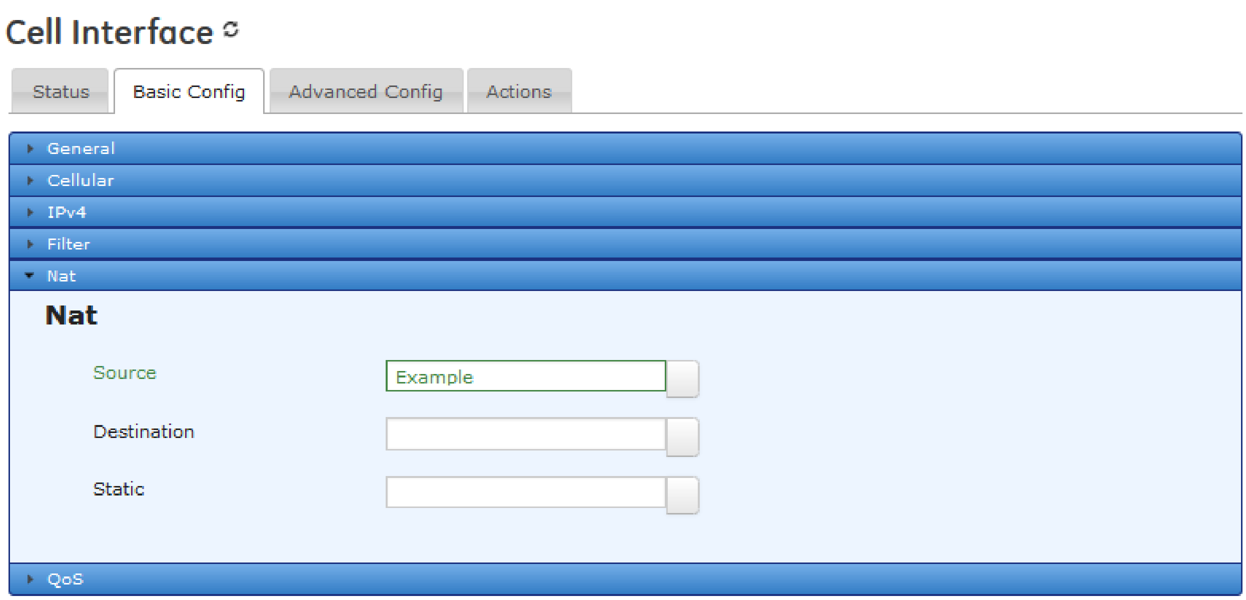


Figure 3-186. Interface's NAT Configuration

The **Source** dropdown box lists all available source NAT rule lists. Select the new rule list and click the **Save** button in the upper left corner of the screen to apply it to the cellular interface.

Using the CLI

To perform the same procedure with the CLI, first change to configuration mode. The steps needed to produce the same source NAT rule set and apply it to the cell interface follow.

1. Enable the firewall service, if it is not already enabled.
   % set services firewall enabled true
2. Create source NAT rule-set named "Example."
   % set services firewall nat source rule-set Example
3. Create a rule for masquerading.
   % set services firewall nat source rule-set Example **rule** 1 **source-nat interface**
4. Apply this source NAT rule-set to the cellular interface.
   % set interfaces Cell **nat source** Example
5. Commit configuration and exit configuration mode.
   % commit

Monitoring

At this time there are no commands to monitor traffic statistics for packets being masqueraded by the firewall. This feature may be added in future revisions of firmware.

3.8.11 Destination NAT (Port Forwarding)

Destination NAT performs translation of destination IP address (and, optionally, destination port) of the traffic ingressing an interface. This is typically used to allow a host on the public network (HOST-B) to access a service running on a host in the private network (HOST-1). This is also called port forwarding.

Figure 3-187 shows the flow of packets being port-forwarded (DNAT'ed) through the Orbit unit. For example, TCP traffic arriving at the cellular interface and getting port forwarded to a private host connected to the local Ethernet interface.

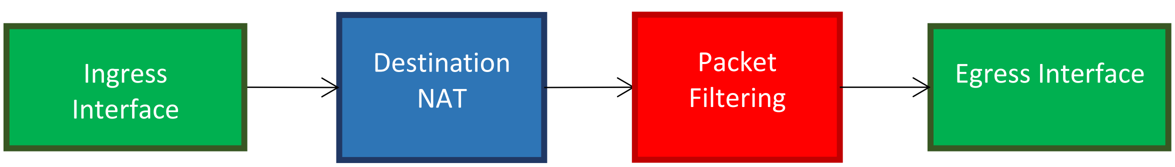


Figure 3-187. Packets Being Port-Forwarded Through Orbit

In the figure below, HOST-B, located in the public network, sends MODBUS traffic on TCP port 5512 to 10.150.1.10. This traffic ingresses the Orbit's cellular interface and must reach the MODBUS server on the private network, HOST-1, at 192.168.1.1:512. A destination NAT rule set must be applied to the cellular interface so that MODBUS traffic sent by HOST-B to 10.150.1.10:5512 is forwarded to 192.168.1.1:512

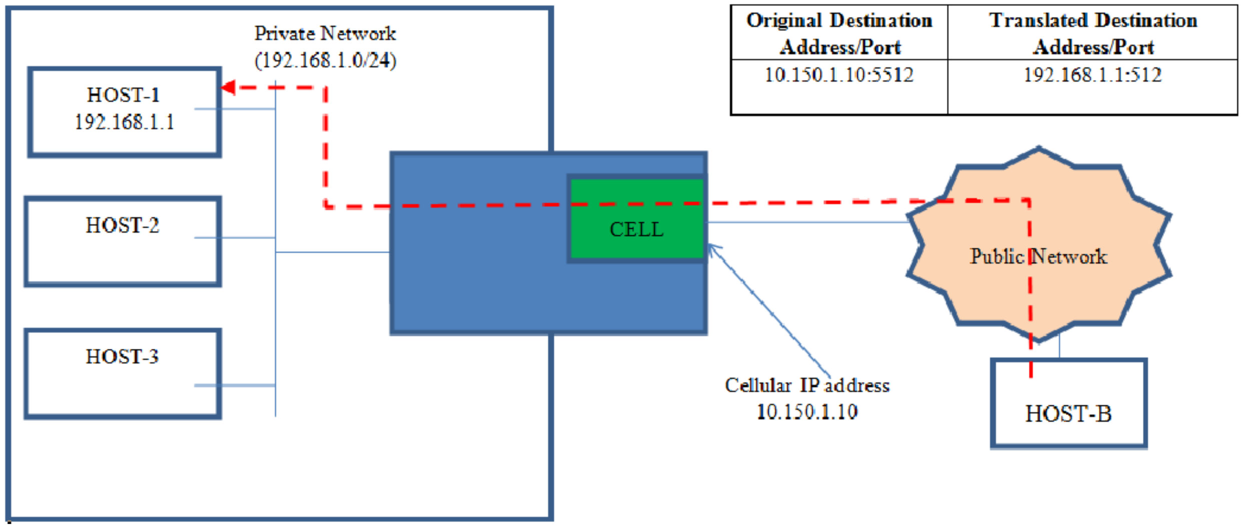


Figure 3-188. Destination NAT Translation of IP Address

Configuring

Destination NAT configuration on Orbit involves following high level steps:

1. Create a destination NAT rule-set.
2. Add one or more rules to perform destination NAT for specific incoming traffic on the public interface.
3. Apply the destination NAT rule-set to the public interface.

The following example describes the step-by-step configuration of an example destination NAT rule-set to perform port forwarding for example shown in Figure 3-188above.

Using the Destination NAT Wizard

Example

The Destination NAT Wizard is the simplest way to add a destination NAT rule-set. First, navigate to **Wizards** on the navigation pane and click **Port Forwarding (Destination NAT)**.

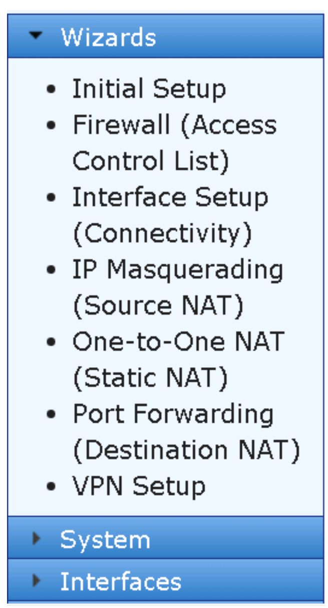


Figure 3-189. Configuration Wizards Navigation Pane

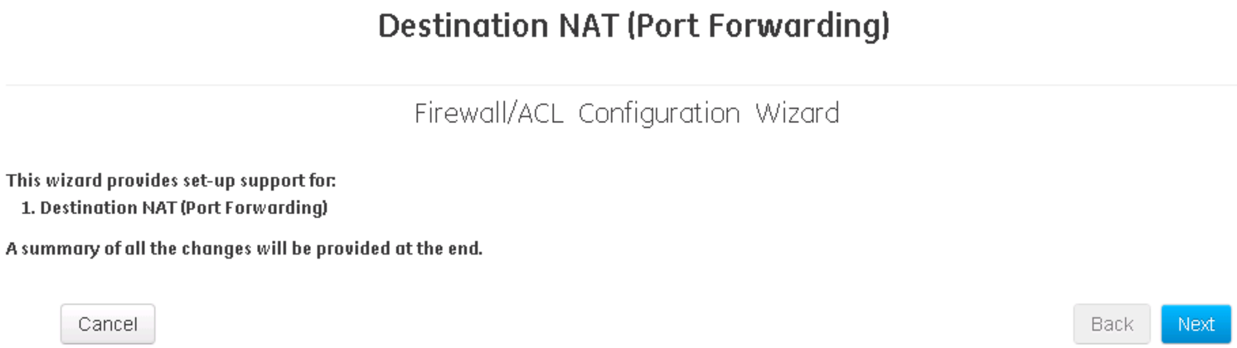
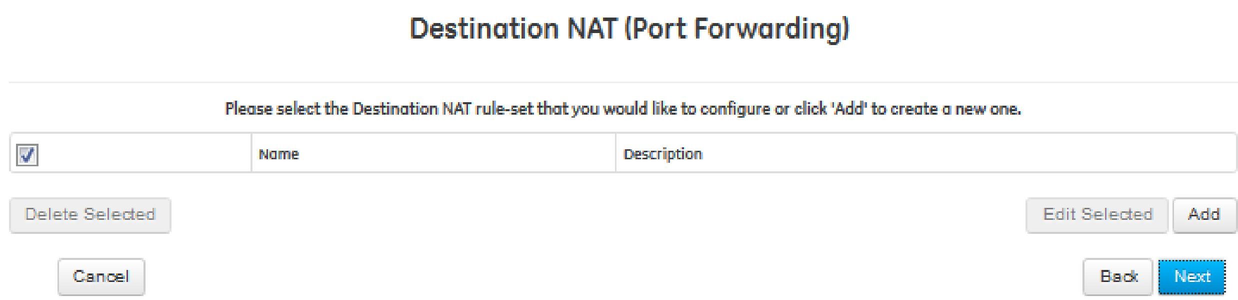


Figure 3-190. Port Forwarding Wizard Introductory Page

The wizard's introduction page appears. Click **Next** to continue.



Click **Add** to create a new rule-set and enter name for the new rule set. Spaces are not allowed; use the underscore character instead. Click **OK** to continue.

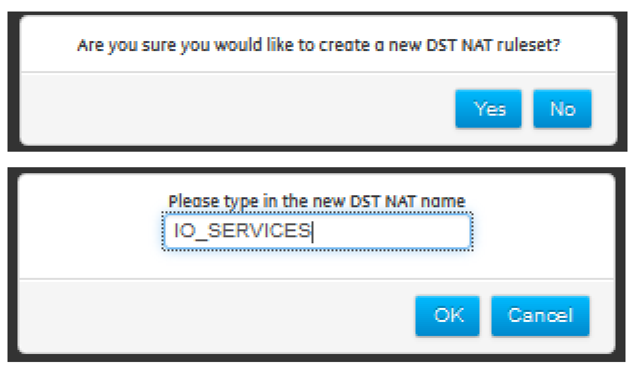


Figure 3-191. Entering a new destination NAT rule set name

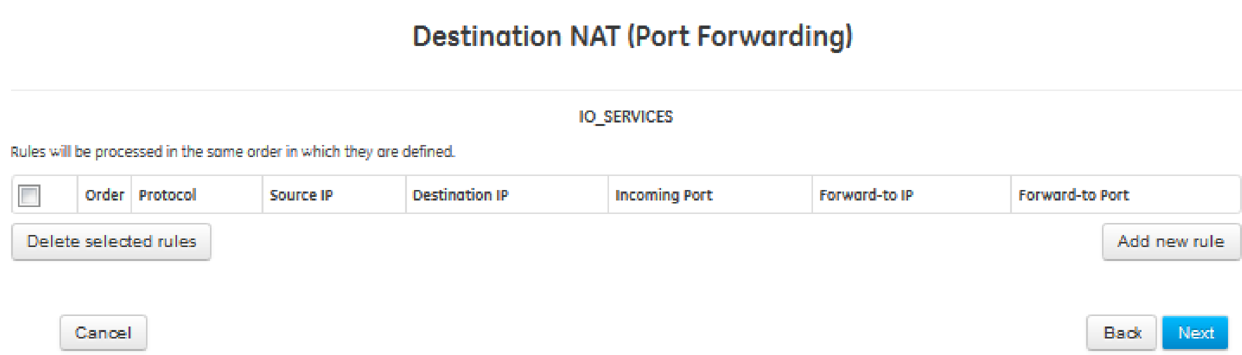


Figure 3-192. Destination NAT rules list for the new rule-set

The **Destination NAT** screen lists all rules contained within the new rule set. Since this is a new rule set, there are currently none. Click **Add New Rule** to add one. The rule creation menu appears.

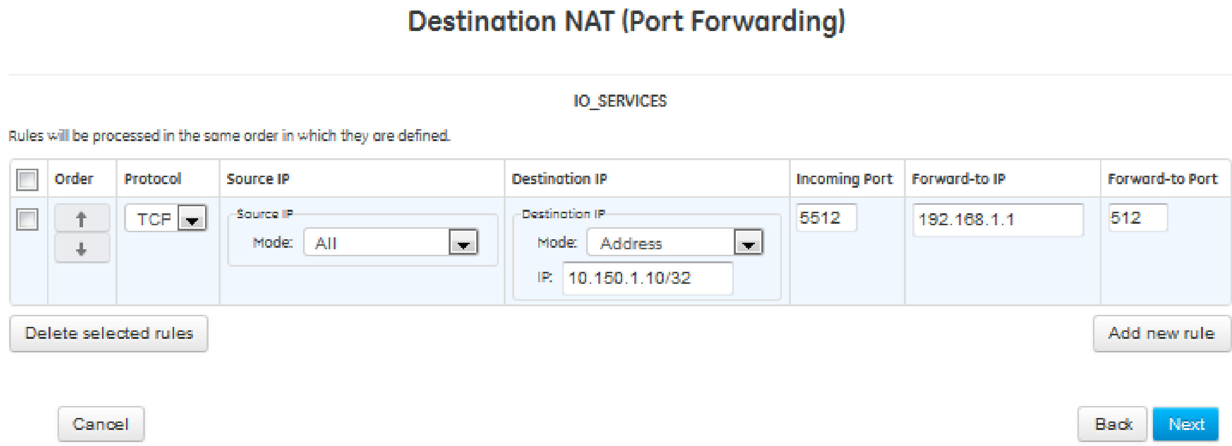


Figure 3-193. Creating a new destination NAT rule

The following options are available within the rule creation menu.

- **Order –** Click the arrows to sort rules in order of priority. Rules with higher priority are applied before rules with lower priority; rule sets containing more than one rule should be sorted accordingly.
- **Protocol –** *Options: All, SCTP, TCP, UDP, ICMP, ESP.* Specifies the IP protocol of incoming traffic that the rule should be applied to. (In the example above, this is *TCP.*)
- **Source IP –** Apply rule to traffic that originates at a specific address or addresses.
- **Mode –** Options:
  - All – Apply rule regardless of source address. (The example above uses this configuration.)
  - Address - Apply rule to a specific source address and prefix.
  - Address Range – Apply rule to a range of source addresses.
  - Address Set – Apply rule to a non-contiguous set of source addresses.
  - Not Address - Apply rule to traffic that does *not* originate from a specific address and prefix.
  - Not Address Range – Apply rule to traffic that does *not* originate from a specific source address range.
  - Not Address Set – Apply rule to traffic that does *not* originate from a non-contiguous set of source addresses.
- **Destination IP –** Apply rule to traffic that ingresses the unit at a specific address or addresses.
- **Mode –** Options:
  - All – Apply rule regardless of destination address.
  - Address - Apply rule to a specific destination address and prefix.(In the example above, this is *10.150.1.1/32.*)
  - Address Range – Apply rule to a range of destination addresses.
  - Address Set – Apply rule to a non-contiguous set of destination addresses.
  - Not Address - Apply rule to traffic that does *not* ingress at a specific address and prefix.
  - Not Address Range – Apply rule to traffic that does *not* ingress at a specific destination address range.
  - Not Address Set – Apply rule to traffic that does *not* ingress at a non-contiguous set of destination addresses.
- **Incoming Port** – Apply rule to a pre-translated ingress port. In the example above, this is *5512.*

- **Forward to IP** – The IP address to which traffic matching this rule should be forwarded. In the example above, this is *192.168.1.1*.
- **Forward to Port –** The port to which traffic matching this rule should be forwarded. In the example above, this is *512*.

The example above can be configured with a single rule. Once all selections are complete, click **Next** to continue.

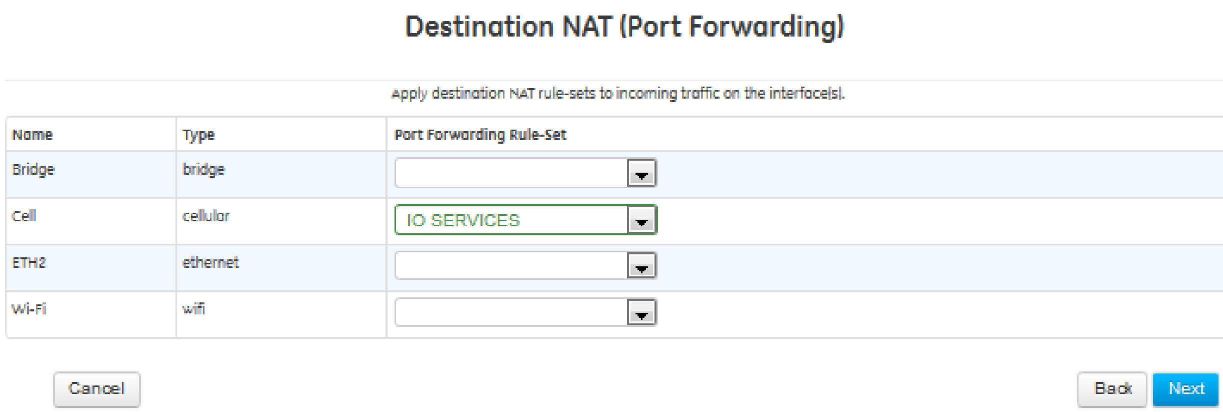
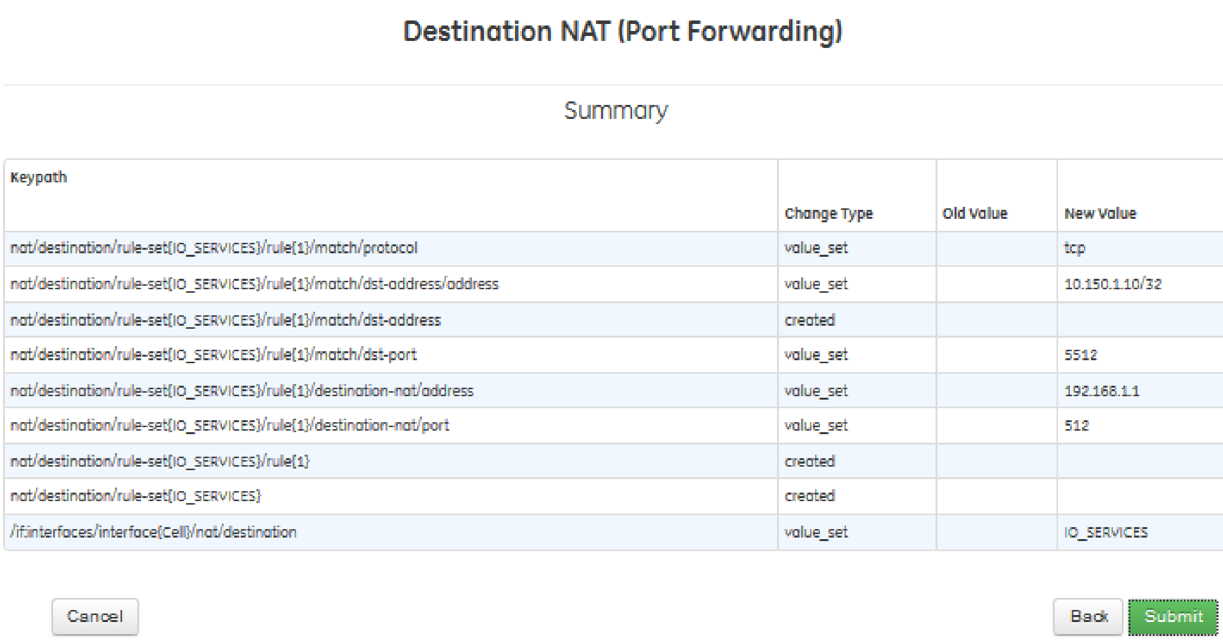


Figure 3-194. Interface Selection menu

The Interface Selection menu allows the created rule set to be applied to one or more interfaces. To do so, click the dropdown box next to the desired interface and select the rule set name. In the example above, the new rule set should be applied to the cellular interface. Click **Next** to continue.



Destination NAT (Port Forwarding)

Summary

Keypath	Change Type	Old Value	New Value
nat/destination/rule-set{IO_SERVICES}/rule{1}/match/protocol	value_set		tcp
nat/destination/rule-set{IO_SERVICES}/rule{1}/match/dst-address/address	value_set		10.150.1.10/32
nat/destination/rule-set{IO_SERVICES}/rule{1}/match/dst-address	created		
nat/destination/rule-set{IO_SERVICES}/rule{1}/match/dst-port	value_set		5512
nat/destination/rule-set{IO_SERVICES}/rule{1}/destination-nat/address	value_set		192.168.1.1
nat/destination/rule-set{IO_SERVICES}/rule{1}/destination-nat/port	value_set		512
nat/destination/rule-set{IO_SERVICES}/rule{1}	created		
nat/destination/rule-set{IO_SERVICES}	created		
/if:interfaces/interface{Cell}/nat/destination	value_set		IO_SERVICES

Cancel Back Submit

Figure 3-195. Destination NAT rule summary page

A summary page appears that displays the items in the configuration's data model that were changed, and type of changes that occurred. To save and apply the changes, click **Submit.**

Using the Web UI

To view the list of destination NAT rule sets that exist on the device at any time, navigate to ***Firewall ---> Basic Config / Destination NAT***

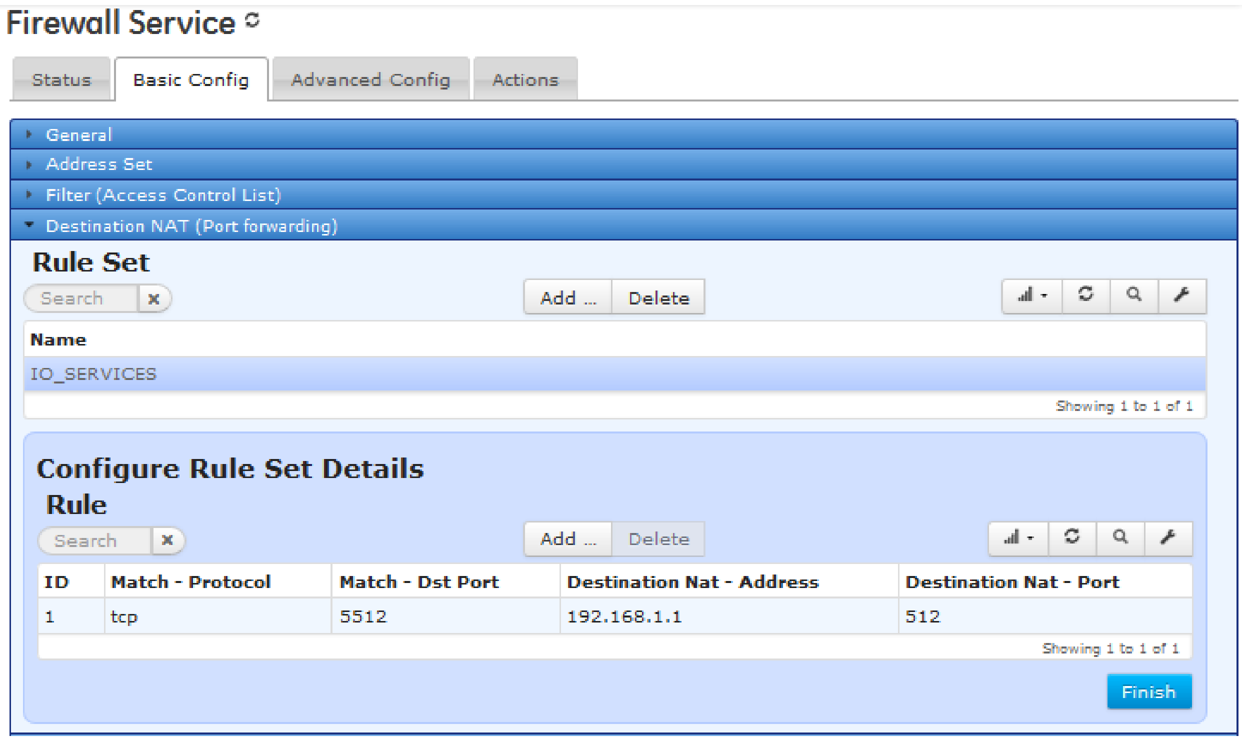


Figure 3-196. List of destination NAT rule sets

An existing rule set may be applied or removed from a rule set by navigating to ***Interfaces***. Click the interface name and view the ***Basic Config / NAT*** menu.

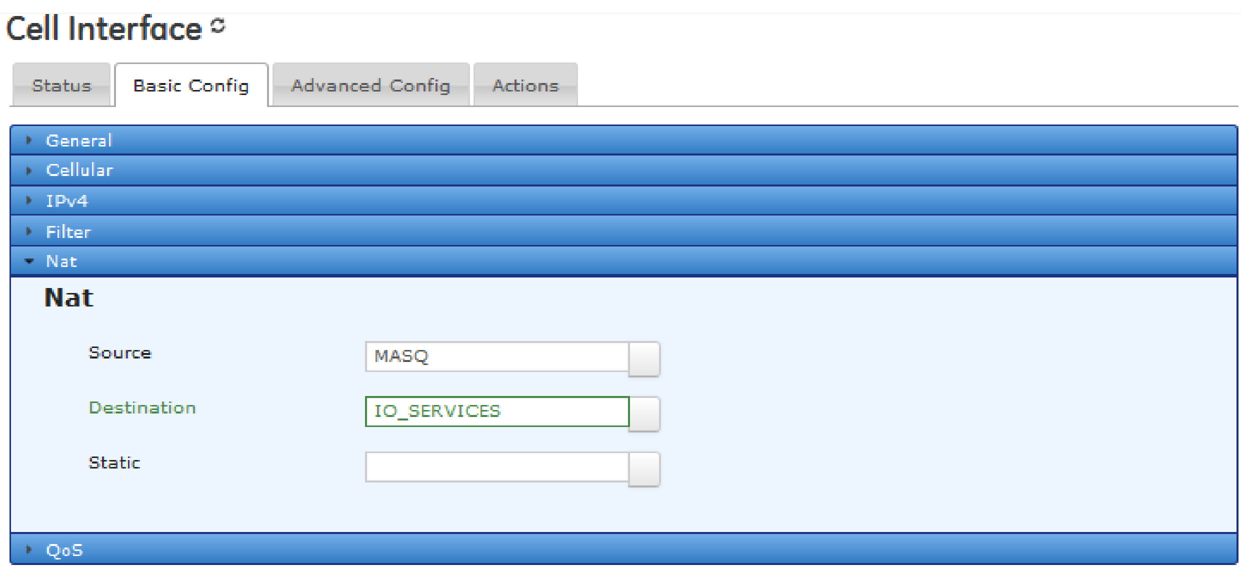


Figure 3-197. The cellular interface's NAT menu

To add or change a Destination NAT rule set, click the button next to **Destination NAT**, select the desired rule set and click **OK**. Finally, click the **Save** button in the upper left corner of the screen to save the changes.

Using the CLI

To perform the same procedure with the CLI, first change to configuration mode. The steps needed to produce the same destination NAT rule set and apply it to the cell interface follow.

1. Enable the firewall service, if it is not already enabled.

   % set services firewall enabled true

2. Create a source NAT rule-set named IO_SERVICES.

   % set services firewall nat destination rule-set IO_SERVICES

3. Create a rule to port forward Modbus TCP traffic that enters the cellular interface on port 5512 to port 512 on the private HOST-1.

   % set services firewall nat destination rule-set IO_SERVICES **rule** 1 **match protocol** tcp

   % set services firewall nat destination rule-set IO_SERVICES **rule** 1 **match dst-address address** 10.150.1.10/32

   % set services firewall nat destination rule-set IO_SERVICES **rule** 1 **match dst-port** 5512

   % set services firewall nat destination rule-set IO_SERVICES **rule** 1 **destination-nat address** 192.168.1.1

   % set services firewall nat destination rule-set IO_SERVICES **rule** 1 **destination-nat port** 512

4. Apply this destination NAT rule-set to the cellular interface.

   % set interfaces Cell **nat destination** IO_SERVICES

5. Commit the configuration and exit configuration mode.

   % commit

Monitoring

At this time there are no commands to monitor traffic statistics for packets masqueraded by the firewall. This feature may be added in future revisions of firmware.

3.8.12 Static NAT

Understanding

Static NAT performs translation of a single public (external network) IP address, or entire subnet, to a private (internal network) IP address or subnet. This can be used to make a private host on an internal network accessible to hosts on the public/external network. This can also be used connect two networks with overlapping address ranges. In particular, this is useful when connecting multiple remote sites with same local addressing (e.g. 192.168.1.0/24) to the back-office network (e.g. 172.16.10/24) using IPsec VPN.

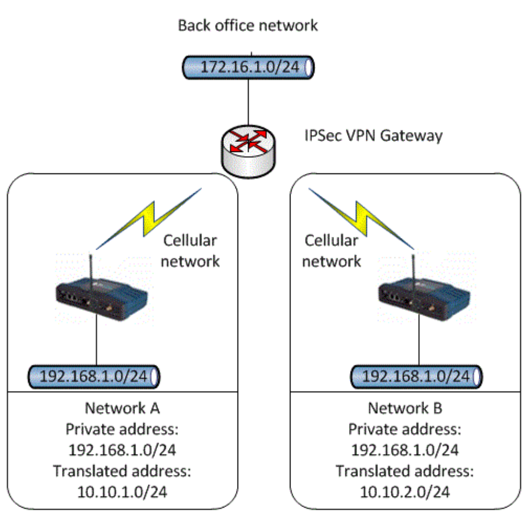


Figure 3-198. Static NAT Example

The figure above shows a network that uses static NAT to prevent routing issues. Two internal subnets maintain IPsec connections over their respective Orbits' cellular network connection to a VPN gateway on a back-office network (172.16.1.0/24). Both subnets, which are located in separate sites, have the same IP address schemes (192.168.1.0/24). Two networks with the same IP addresses would result in routing issues, so each Orbit is configured with static NAT so that the local internal subnet (192.168.1.0/24) translates to a different external IP address block (local tunnel subnet) for site A and B.

Back office IPsec Configuration

Site-A IPsec Connection:
Local Tunnel Network = 172.16.1.0/24
Remote Tunnel Network = 10.10.1.0/24

Site-B IPsec Connection:
Local Tunnel Network = 172.16.1.0/24
Remote Tunnel Network = 10.10.2.0/24

Site-A IPsec Configuration:
Local Tunnel Network = 10.10.1.0/24
Remote Tunnel Network = 172.16.1.0/24
Static NAT: 10.10.1.0/24 -> 192.168.1.0/24

Site-B IPsec Configuration:
Local Network = 10.10.2.0/24
Remote Network = 172.16.1.0/24
Static NAT: 10.10.1.0/24 (local tunnel network is the external network) -> 192.168.1.0/24 (internal network)

Using the above configuration, a host in back office network shall use 10.10.1.2 external address to access an internal host 192.168.1.2 in site A and use 10.10.2.2 external address to access an internal host 192.168.1.2 in site B.

Configuration

Static NAT configuration on Orbit involves following high level steps:

1. Create a static NAT rule-set.
2. Add rule to perform static NAT on the public interface or IPsec connection.

Example

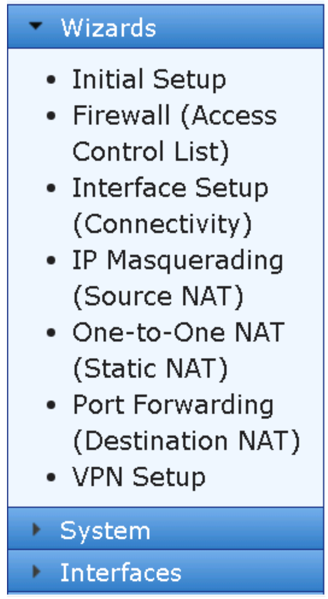
Using the Static NAT Wizard

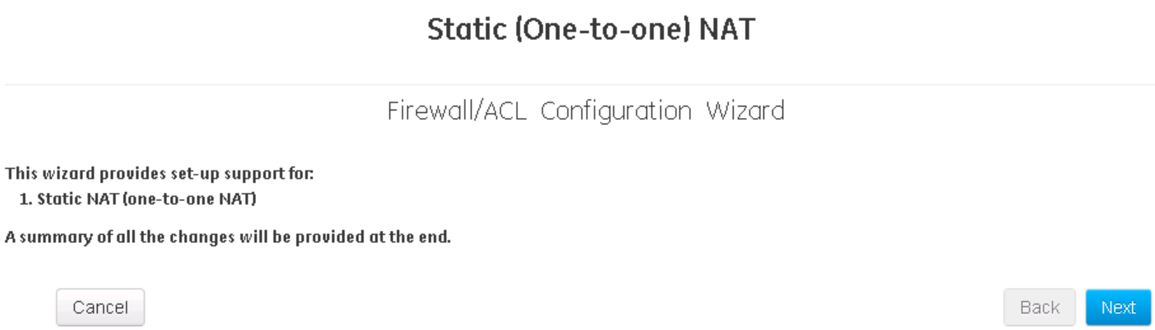
The following example demonstrates step-by-step static NAT configuration for Network A shown in Figure 3-198.

During this example, assume the following:

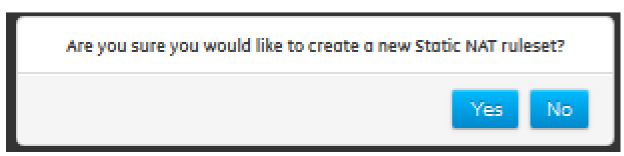
3. An IPsec connection named **Network_A_IPsec_Connection** is already created and configured on the Orbit in Network A. Refer to Section 3.8.13VPN - IPSEC
4. for more information on creating an IPsec connection.
5. Network B has already been appropriately configured for static NAT. Only Network A’s configuration will be shown in this example.

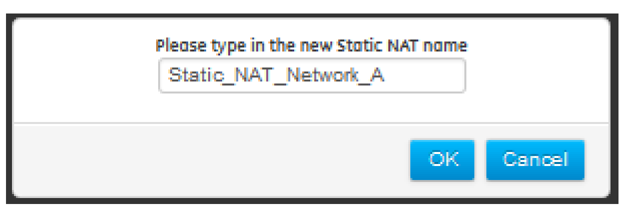
The **Static NAT Wizard** is the simplest way to configure static NAT on the unit. First, navigate to **Wizards** on the navigation pane and click **One-to-One NAT (Static NAT)**.





Click **Next** to continue. Click on the **Add** button. Confirm to create a new rule and then enter a name for the static NAT rule list. Click **Ok** to continue.





The next menu shows all rules contained within the newly named rule set. You may edit existing rules, delete them, or add new ones. Since the rule set is new, it contains no rules at first. Click **Add New Rule** to add one. The rule creation menu appears.

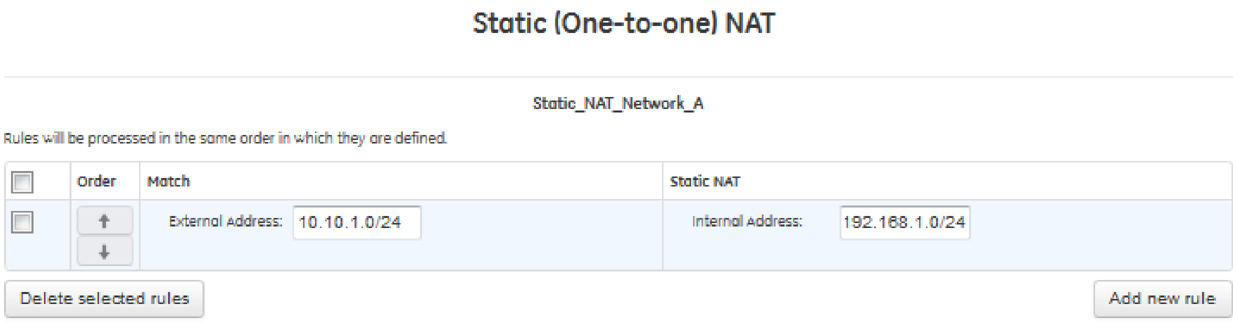


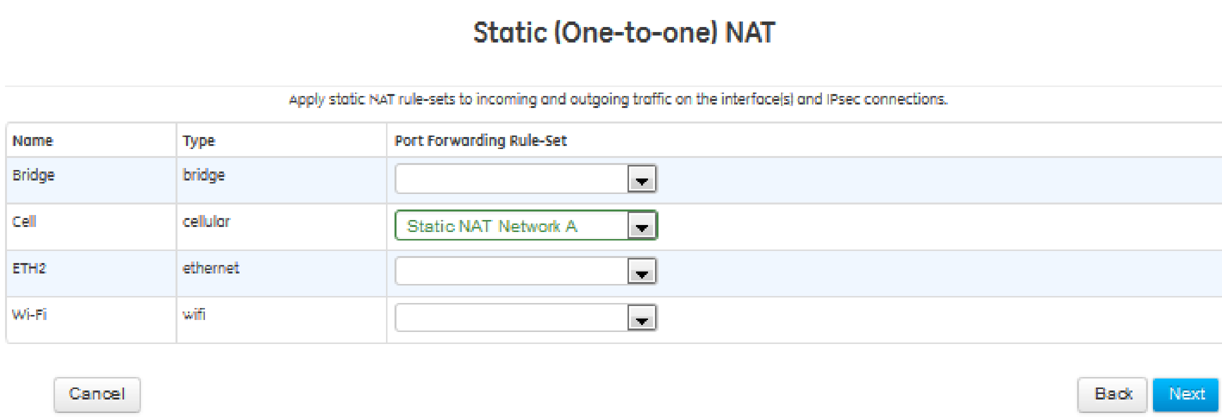
Figure 3-199 Adding a static NAT rule with the Static NAT Wizard

The following options are available within the rule creation menu.

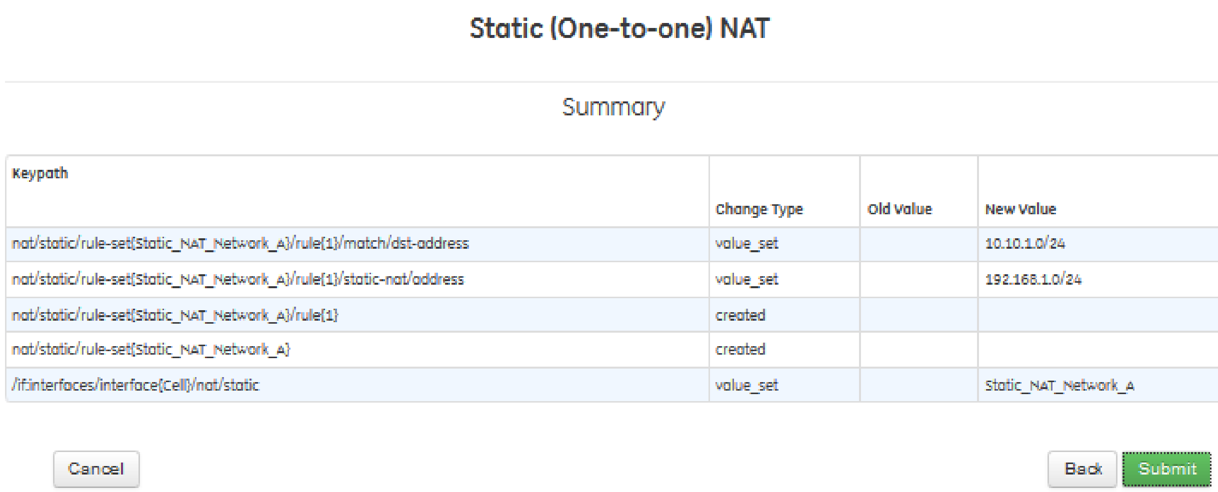
- **Order –** Click the arrows to sort rules in order of priority. Rules with higher priority are applied before rules with lower priority; rule sets containing more than one rule should be sorted accordingly.
- **External Address** - The external address is the address that is translated to an internal address. (This is the rule{1}/match/dst-address in the CLI).
- **Internal Address** - The internal address is the address that is translated to the external address. This is the rule{1}/static-nat/address in the CLI).

In Network A above, this is 192.168.1.0/24.

Once the rule is complete, click **Next** to continue. The **Interface Selection** screen appears.



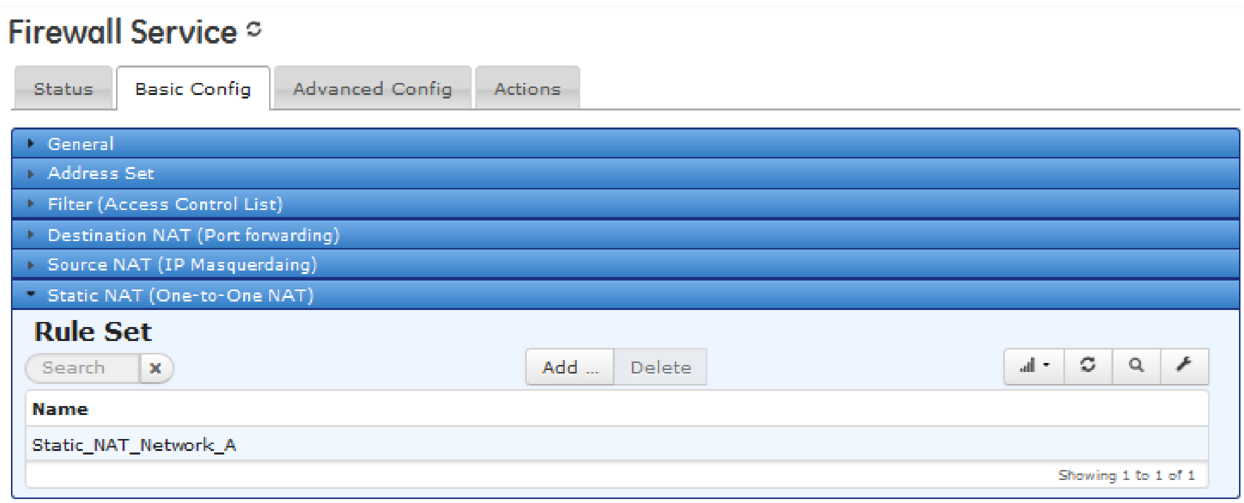
The **Interface Selection** menu allows you to apply a static NAT rule list to an interface or IPsec connection on the Orbit. Select the name of the static NAT rule list from the dropdown box to the right of the interface or IPsec connection and click **Next** to continue.



Keypath	Change Type	Old Value	New Value
nat/static/rule-set{Static_NAT_Network_A}/rule{1}/match/dst-address	value_set		10.10.1.0/24
nat/static/rule-set{Static_NAT_Network_A}/rule{1}/static-nat/address	value_set		192.168.1.0/24
nat/static/rule-set{Static_NAT_Network_A}/rule{1}	created		
nat/static/rule-set{Static_NAT_Network_A}	created		
/if:interfaces/interface{Cell}/nat/static	value_set		Static_NAT_Network_A

A summary page appears that displays the items in the configuration's data model that were changed, and type of changes that occurred. To save and apply the changes, click **Submit.**

To view the list of destination NAT rule sets that exist on the device at any time, navigate to ***Firewall ---> Basic Config / Static NAT.***



Using the CLI

To perform the same procedure with the CLI, first change to configuration mode. The steps needed to produce the same destination NAT rule set and apply it to the cell interface follow.

1. Enable firewall service, if it is not already enabled.

   % set services firewall enabled true

2. Create a static NAT rule set. The rule set name used below is Static_NAT_Network_A.

   % set services firewall nat static rule-set Static_NAT_Network_A

3. Create rule for translating the original "static-nat address" to the translated "match dst-address."

   % set services firewall nat static rule-set Static_NAT_Network_A **rule** 1 **match dst-address** 10.10.1.0/24

   % set services firewall nat static rule-set Static_NAT_Network_A **rule** 1 **static-nat address** 192.168.1.0/24

4. To apply the rule-set to an existing IPsec connection (here named IPSEC_CONN), use the following command.

   % set services vpn ipsec connection IPSEC_CONN **nat static** Static_NAT_Network_A

5. Commit configuration and exit configuration mode.

% commit

3.8.13 VPN - IPSEC

Orbit enables Virtual Private Network (VPN) setups using either IPsec or OpenVPN.   This section describes IPsec.

Understanding

The following types of IPsecVirtual Private Network (VPN) are supported:

1. **Site-to-Site Policy-Based IPsec L3VPN** – This is enables routing of traffic to/from single local LAN of Orbit from/to single remote LAN on the other side of the Remote IPsec router through an IPsec tunnel. Only unicast IP traffic matching the local and remote subnets can be sent over this tunnel. If more than a single pair of local or remote subnets need to exchange data then each pair requires its own tunnel. This is called a policy based VPN since the traffic selector/policy i.e. the local and remote IP subnets is included in the IPsec configuration.

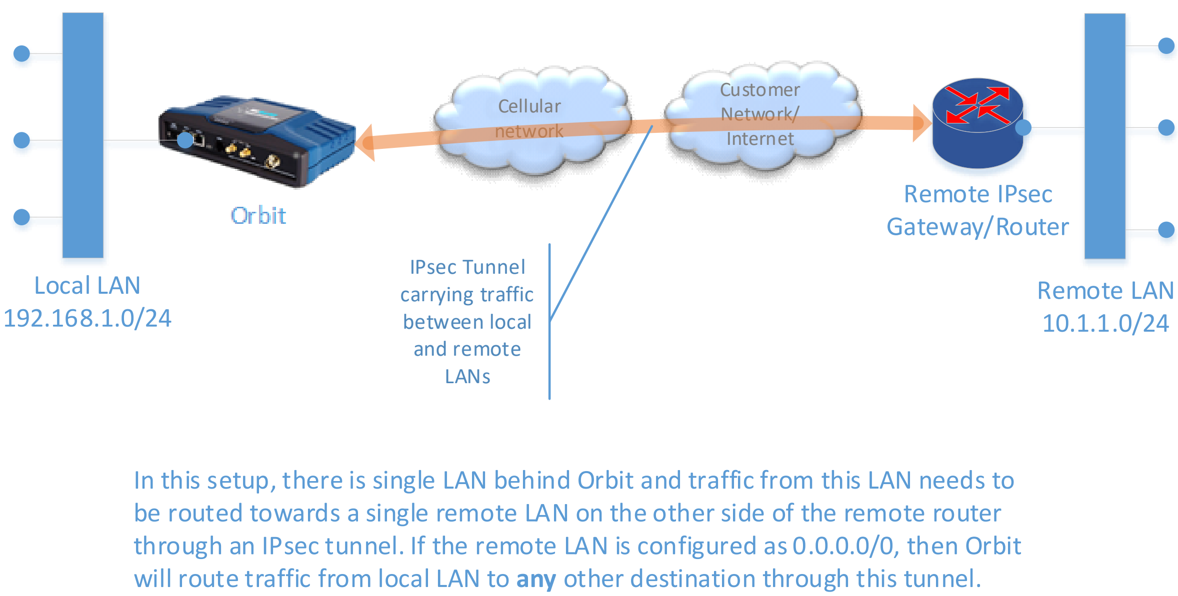
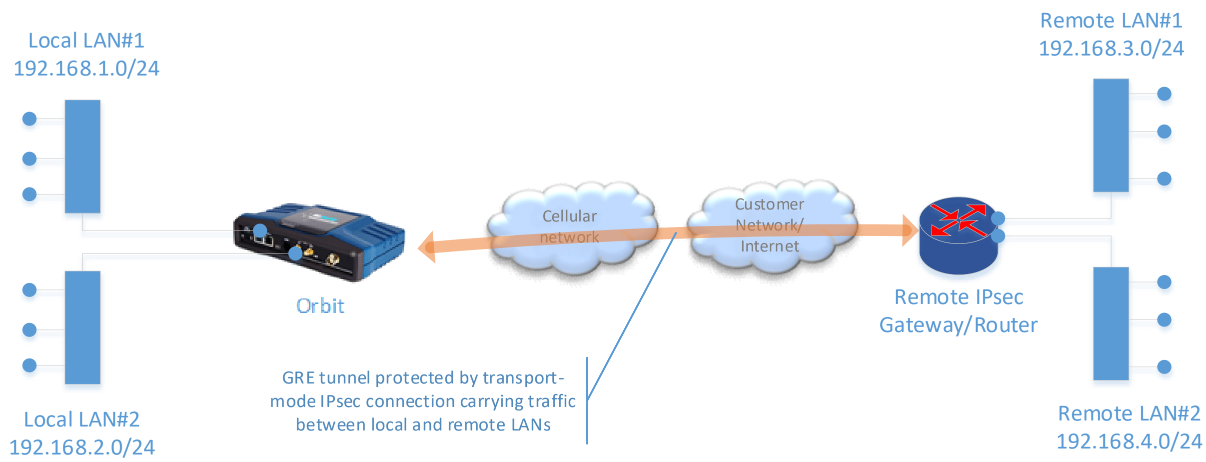


Figure 3-200. Site-to-Site Policy-Based IPsec L3VPN

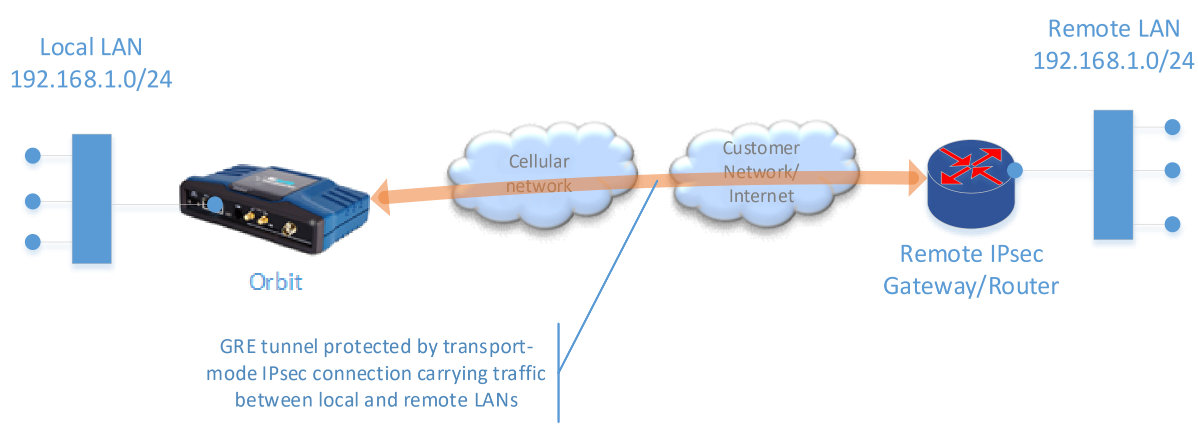
2. **Site-to-Site GRE/IPsec L3VPN** – This enables **routing** of traffic to/from one or more local LANs of Orbit from/to one or more remote LANs on the other side of the Remote IPsec router through a single GRE tunnel protected by transport mode IPsec connection.



In this setup, there are one or more LANs behind Orbit and traffic from these LANs needs to be **routed** towards a one or more remote LANs on the other side of the remote router through a GRE tunnel protected by IPsec transport mode connection. The routes are added for remote LAN networks on Orbit either statically (via manual configuration) or dynamically (by running routing protocols like RIP/OSPF/BGP over GRE tunnel).

Figure 3-201. Site-to-Site GRE/IPsec L3VPN

3. **Site-to-Site GRE/IPsec L2VPN** – This enables **bridging** of traffic to/from one or more local LANs of Orbit from/to one or more remote LANs on the other side of the Remote IPsec router through a single GRE tunnel protected by transport mode IPsec connection. Orbit also supports VLAN trunking over GRE tunnel for a case where there is more than one LAN behind Orbit and remote router.



In this setup, there is single LAN behind Orbit and traffic from this LAN needs to be **bridged** with single remote LAN on the other side of the remote router through a GRE tunnel protected by IPsec transport mode connection. In this mode, the GRE tunnel is in Ethernet-over-GRE mode and simulates a point-to-point layer-2 VPN enabling MAC visibility and learning between the two sites. Orbit also supports VLAN trunking over the GRE tunnel in a case there is more than one LAN behind Orbit and Remote router.

Figure 3-202. Site-to-Site GRE/IPsec L2VPN

4. **Dynamic Multipoint/Mesh VPN (DMVPN)** - DMVPN combines multipoint GRE (mGRE) Tunnels, IPSec encryption and NHRP (Next Hop Resolution Protocol) functionality to enable easier configuration of hub-to-spoke VPN deployments. In addition, it enables formation of on-demand dynamic tunnels between spokes for a full or partial mesh VPN network. The routes are added for remote LAN networks on Orbit either statically (via manual configuration) or dynamically (by running routing protocols like RIP/OSPF/BGP over multipoint GRE tunnel).

   In a hub-n-spoke deployment, where there is one hub router in central office and large number of spoke router at remote sites, if site-to-site VPN setup is used then each spoke requires its own tunnel configuration on the hub router. This can make hub configuration unwieldy. Also, every time a new spoke site is added to the deployment, the hub configuration needs to be updated. This can become cumbersome from management perspective. DMVPN uses single multipoint GRE tunnel interface on the hub which needs to be configured only once initially and is used to terminate all the spoke tunnels. Addition of new spoke site does not require update of hub configuration if dynamic routing protocols are used to add routes towards remote LANs at the spoke site. Although, DMVPN technology is based on open standards, it was created by Cisco and hence is primarily only supported by Cisco routers designed for use as IPsec hub routers.

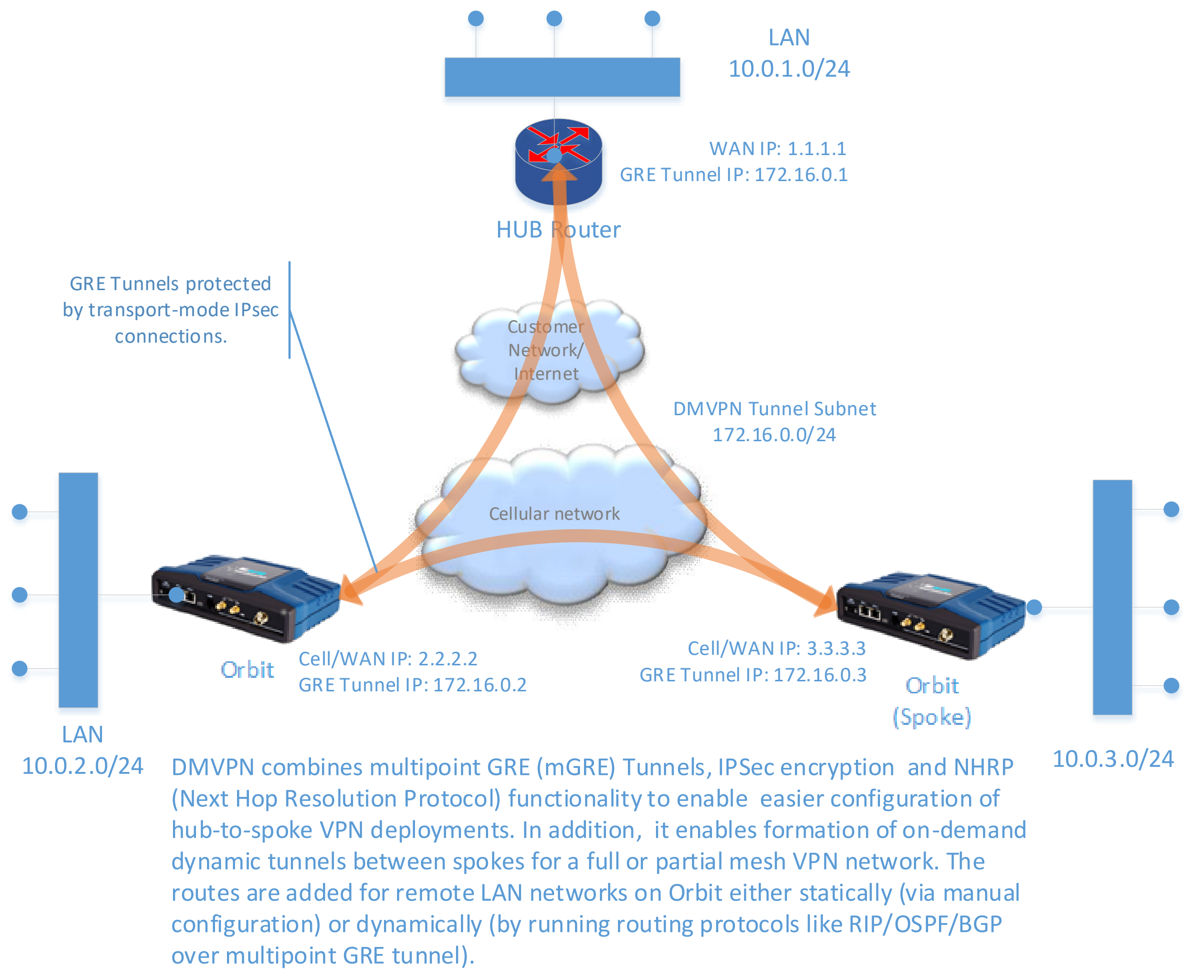


Figure 3-203. Dynamic Multipoint/Mesh VPN (DMVPN)

5. **FlexVPN** – Cisco FlexVPN is a unified solution for site-to-site policy-based IPsec Tunnels as well as large scale route-based Hub-n-Spoke GRE/IPsec tunnels. Unlike DMVPN, NHRP is NOT used by the spokes to register with the HUB. Instead, IKEv2 is used to setup IPsec transport mode security association as well as exchange routes that get automatically added over the associated GRE tunnel interface.

   Orbit interoperability with Cisco FlexVPN HUB router :

   1. **Site-to-Site IPsec Tunnel**: Orbit can tunnel IPv4 (IPv6) traffic over IPv4 (IPv6) transport/underlay with FlexVPN Hub router using standard site-to-site IPsec tunnel. The local and remote subnets must be explicitly defined in Orbit configuration. The Cisco FlexVPN HUB router simply accepts these (reflects them back).

   2. **Hub-n-Spoke IPsec/GRE Tunnel**: Orbit can tunnel IPv4 traffic over IPv4 transport/underlay with Cisco FlexVPN HUB router using GRE tunnel protected by IPsec SA. Orbit establishes the IPsec transport mode SA (with GRE protocol traffic selector) with the HUB router, which sends the assigned GRE tunnel IP address in INTERNAL_IP4_ADDRESS/NETMASK attribute and one or more of its local subnets in thein INTERNAL_IP4_SUBNET or INTERNAL_IP6_SUBNET attributes (as IKEv2 configuration payloads) and the Orbit adds a route to the HUB subnets over the GRE tunnel interface. Orbit sends its assigned tunnel address to the HUB, so that the HUB can add route to Orbit's GRE Tunnel IP over the virtual-access tunnel interface instantiated from the virtual-template.

      A FlexVPN configuration example is provided in Configuration section further below.

IPSec Overview

IPsec, Internet Protocol Security, is a set of protocols defined by the IETF, Internet Engineering Task Force, to provide IP security at the network layer.

An IPsec based VPN is made up by two parts:

- Internet Key Exchange protocol (IKE)
- IPsec protocols (ESP, AH)

The first part, IKE, is the initial negotiation phase, where the Orbit device and VPN gateway agree on which methods will be used to provide security for the underlying IP traffic. There are two IKE protocol versions: IKE-v1 and IKE-v2. These are not compatible with each other. The IKE-v2 is more efficient and therefore should be preferred for new deployments. The Orbit supports IKE-v1 and IKE-v2.

The other part is the actual IP data being transferred, using the encryption and authentication methods agreed upon in the IKE negotiation. This is accomplished by using IPsec protocols like Encapsulating Security Payload (ESP) or Authentication Header (AH). Orbit only supports ESP protocol as it provides both encryption and authentication of the data. The AH protocol provides only data authentication.

The process of IPsec VPN connection establishment consists of following phases:

- IKE Phase-1 (IKE security negotiation)
  - IKE authenticates IPSec peers and negotiates IKE Security Association (SAs) during this phase, setting up a secure channel for negotiating IPSec SAs in phase 2
- IKE Phase-2 (IPsec Security Association)
  - IKE negotiates IPSec SA parameters and sets up matching IPSec SAs in the peers
- Data Transfer

- Data is transferred between IPSec peers based on the IPSec parameters and keys stored in the SA database

Both the IKE and the IPsec connections have limited lifetimes. These lifetimes prevent a connection from being used too long, which is desirable from a cryptanalysis perspective.

The IPsec lifetime is generally shorter than the IKE lifetime. This allows for the IPsec connection to be re-keyed simply by performing another phase-2 negotiation.

Configuration

Site-to-Site IPsec VPN Configuration

The Figure 3-204 below shows a site-to-site policy-based IPsec VPN setup to securely connect remote private network (LAN or WiFi) with the customer's backoffice/data center private network. This enables IP traffic from/to devices connected to either LAN, WiFi or Serial port of the Orbit to securely flow to/from back-office applications via a secure tunnel through a public cellular network. The tunneled application traffic is authenticated and encrypted to protect from eavesdropping, tampering and replay attacks.

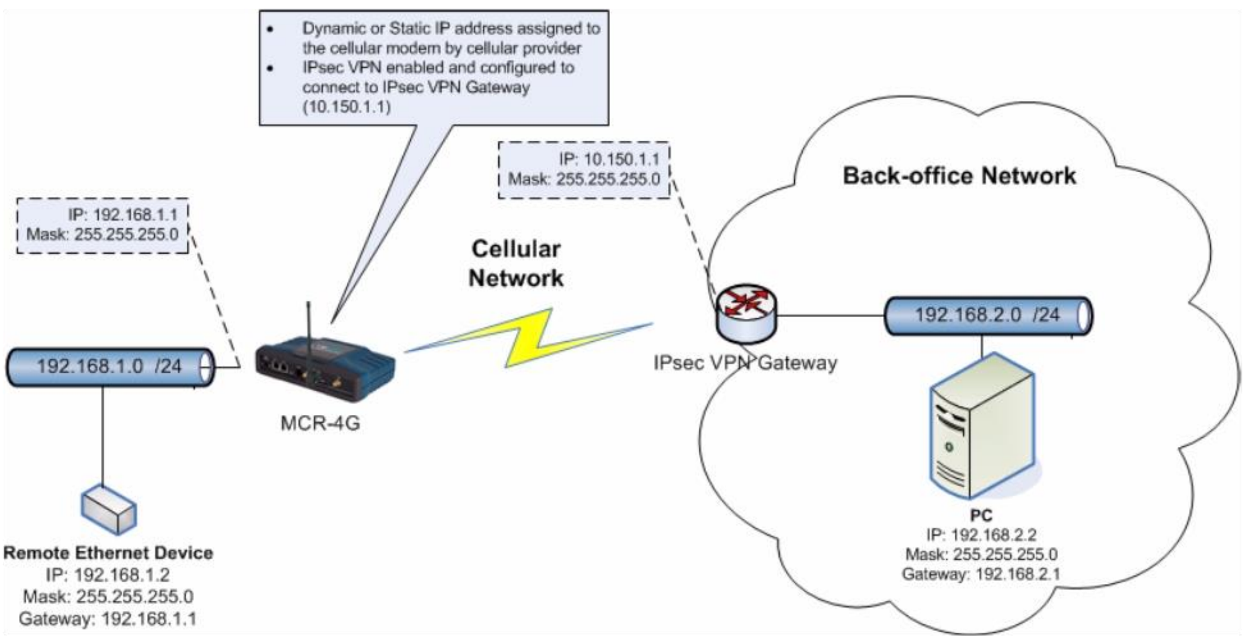


Figure 3-204. VPN Setup Example

The remote Ethernet device is connected to the Orbit via Ethernet on 192.168.1.0/24 network. The device establishes an IPsec tunnel with IPsec VPN gateway, thereby securely connecting remote private network (192.168.1.0/24) with back-office private network (192.168.2.0/24). This allows PC (192.168.2.2) to communicate with remote Ethernet device (192.168.1.2) using any TCP/UDP/IP based protocol and vice versa.

Following are the high level configuration steps involved in IPsec configuration:

1. Configure an IKE policy specifying an authentication method, cipher suites to be included the proposal during IKE phase-1 and the credentials to be used for authentication, e.g.; certificates or pre-shared keys.

2. Configure an IKE peer specifying the peer endpoint address and IKE policy to be used for IKE phase-1 negotiation. The “role” specifies whether Orbit initiates the connection (initiator) or it waits for the connection from the peer (responder). This should usually be set to “initiator”.
3. Configure an IPsec policy specifying ESP cipher suites to be included in the proposal during IKE phase-2.
4. Configure an IPsec connection specifying IKE peer, IPsec policy and local and remote private IP subnets.

NOTE The above configuration parameters should match with the corresponding parameters set in the peer. Otherwise, the IPsec tunnel will not succeed. Typical configuration mistakes include incorrect security credentials (psk or certificates/keys), mismatched cipher suite configuration and mismatched local and remote subnet configuration.

Example

The following example describes the step-by-step VPN configuration for the example network shown in figure above. We'll assume that certificates are being used as security credentials and have already been loaded in the Orbit either manually or via SCEP.

Configuration of the example above is possible via the Web UI's VPN Setup Wizard, or the CLI. Both procedures are shown below.

Using the VPN Setup Wizard

If the VPN uses certificated-based authentication, then the certificates must be installed prior to running the VPN Setup Wizard. (See section 3.9.1 Certificate Management and 802.1X Authentication.) Furthermore, the date and time must be set correctly on the unit or authentication will fail (See section 3.7.1—Date, Time and NTP on Page 220).

In this example, we assume that the pre-shared key based authentication is used.

The **VPN Setup Wizard** is the simplest way to configure a VPN connection on the unit. First navigate to ***Wizards*** and click on **VPN Setup** from the navigation side-bar.

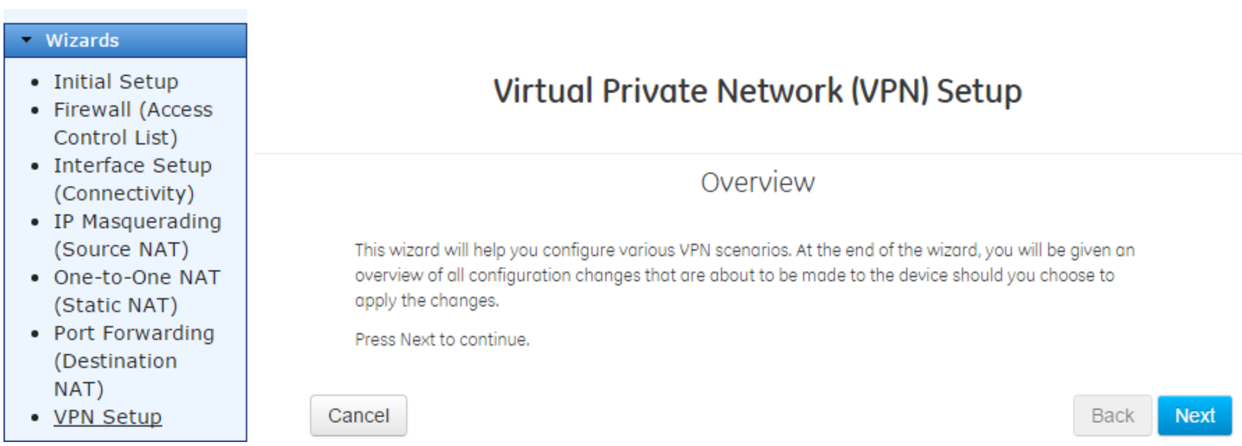


Figure 3-205. VPN Wizard Selection and Start Screen

Click **Next** to continue. The next screen provides a list of VPN setups that one can choose from for a particular use case. For this example, we’ll select “Configure Site-to-Site IPsec VPN”.

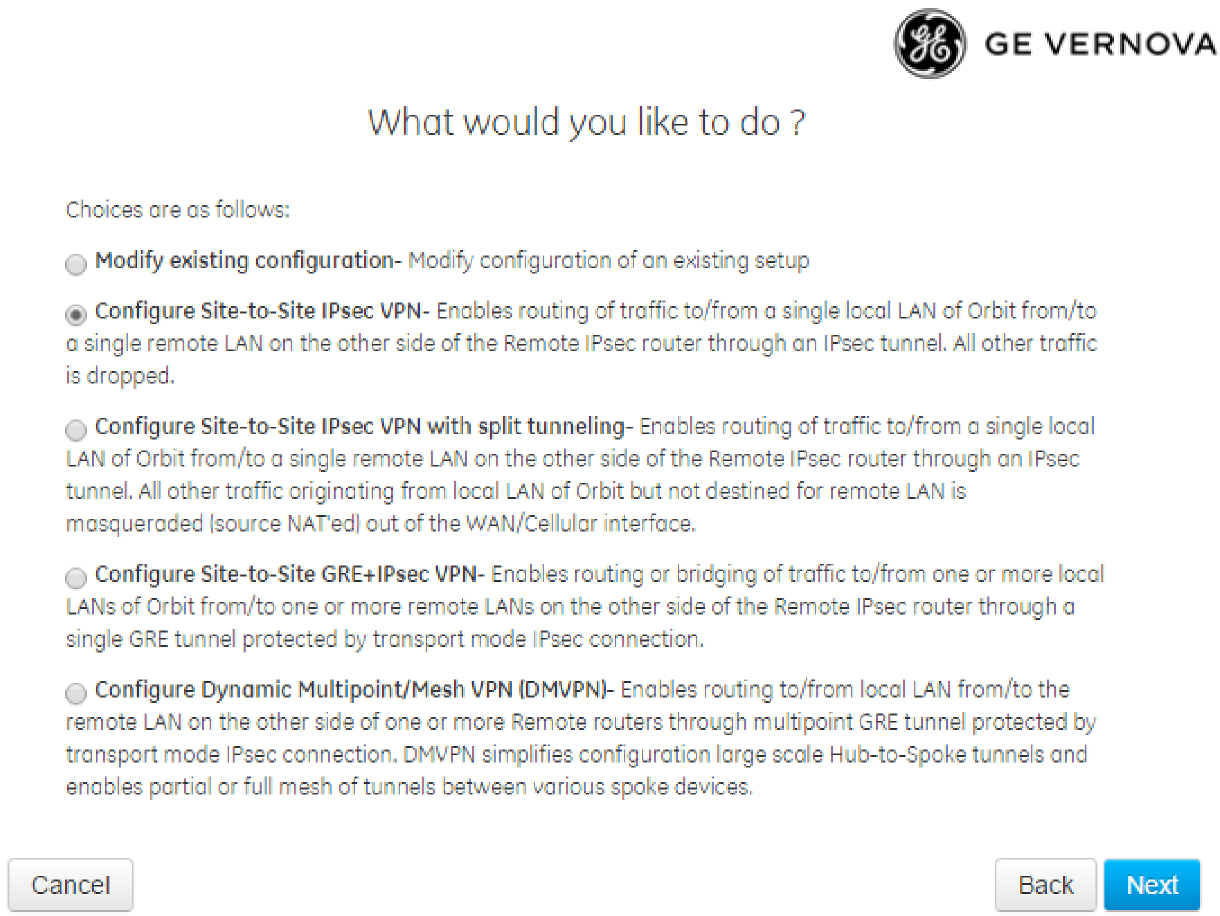


Figure 3-206. VPN Setup Selection Screen

Click **Next** to continue. The next screen shows an example network diagram for the selected setup.

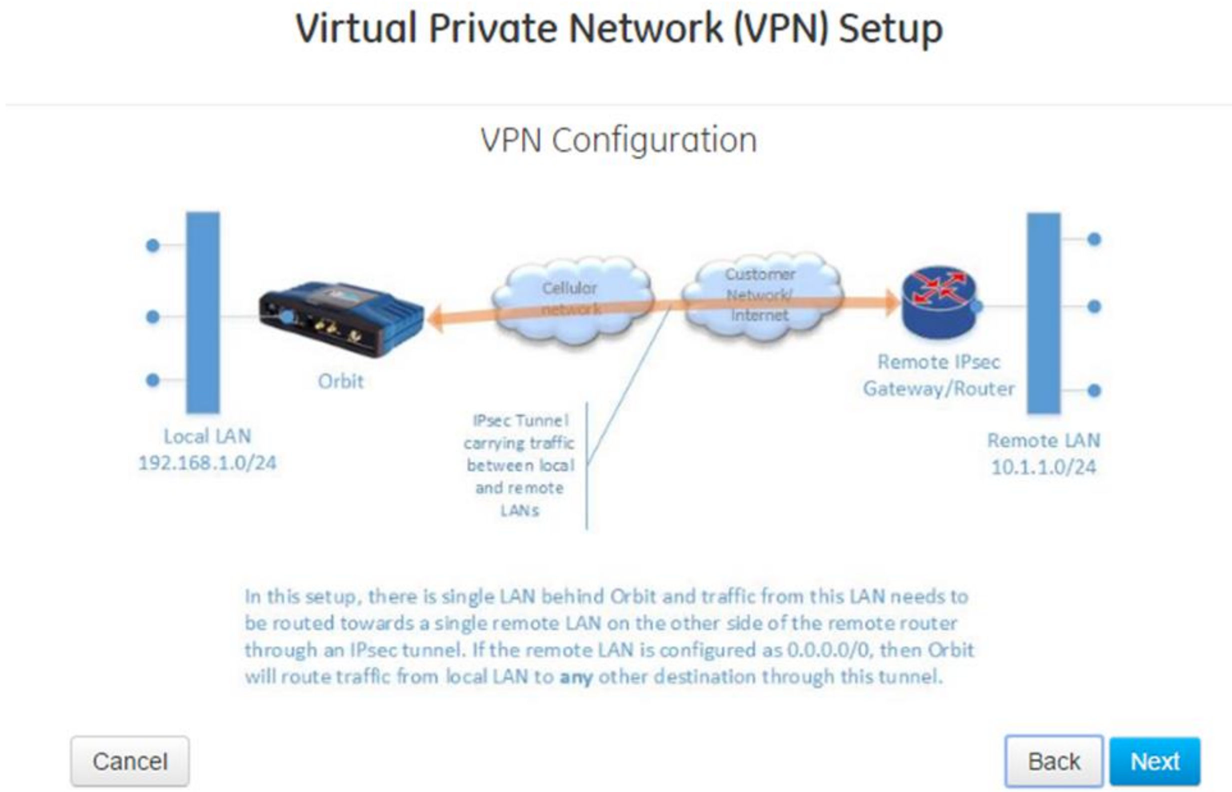


Figure 3-207. VPN Setup Network Diagram

Click **Next** to continue. The next screen requires one to specify a name for this VPN connection.

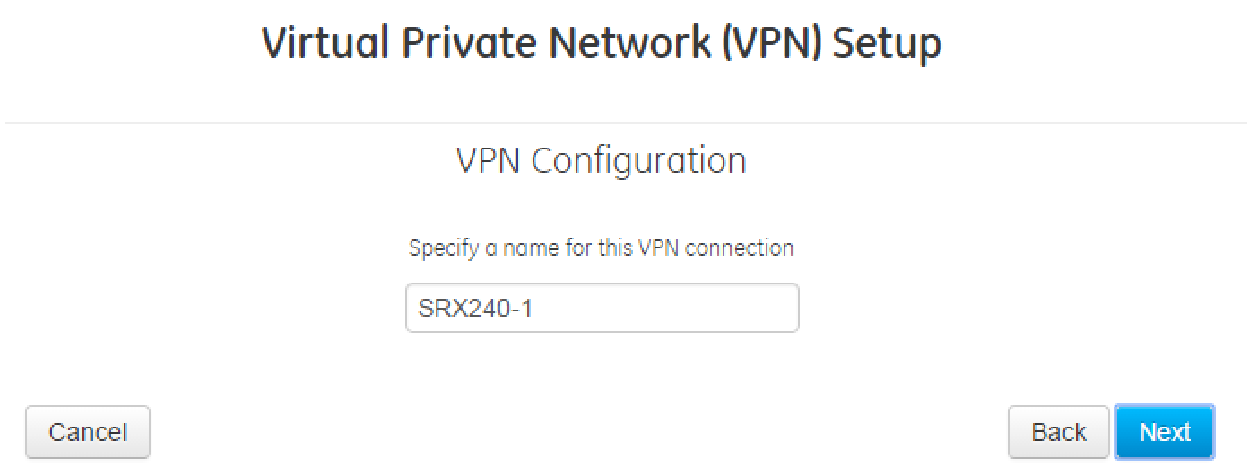
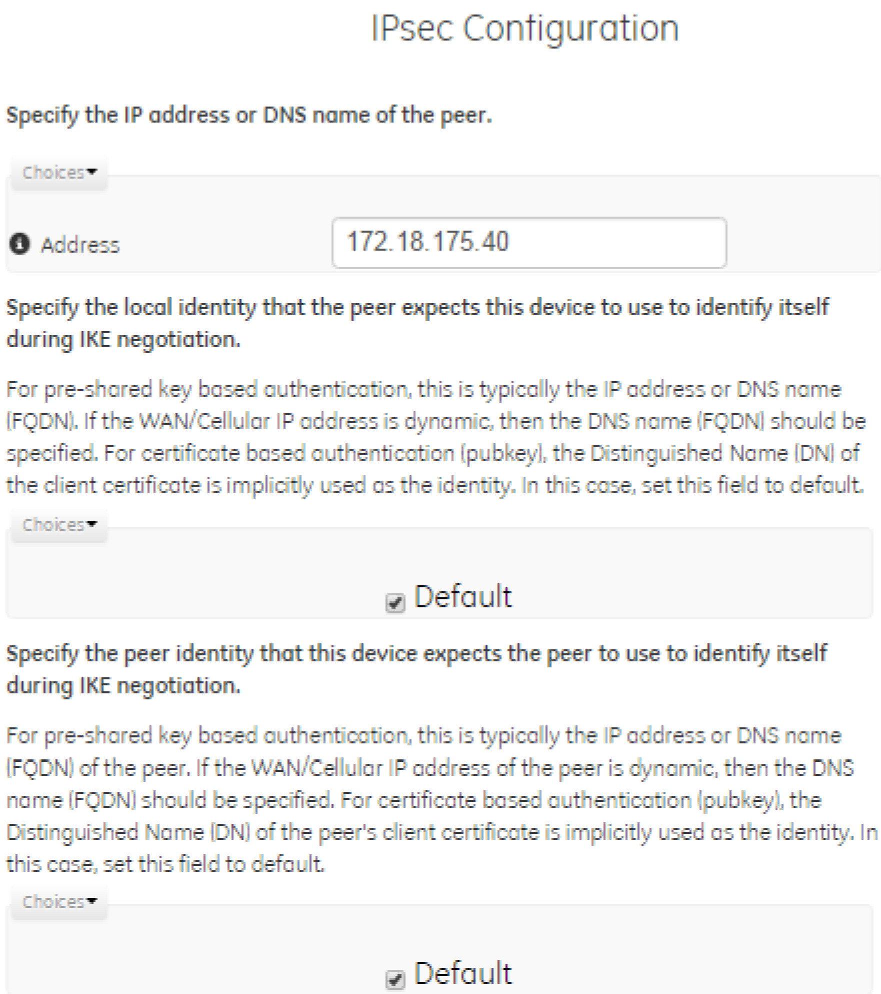


Figure 3-208. VPN – Specifying Name

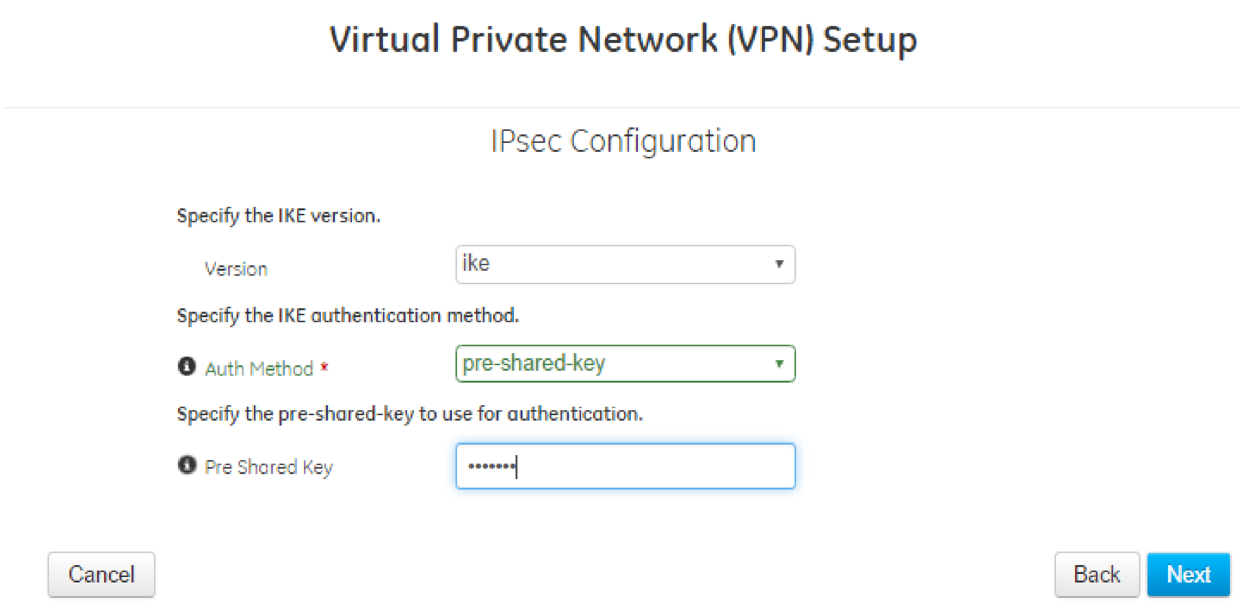
Click **Next** to continue. The next screen requires one to specify the IKE peer endpoint, local IKE identity and peer IKE identity.



- **Local Endpoint –** *any (default), address, FQDN.* This is an optional setting and hence not available for configuration via the VPN wizard. This can be configured from *Services->VPN service->Basic Config* menu.
  - **Any –** Local address is chosen automatically during negotiation.
  - **Address –** Force local address for this connection to a specified IP address.
  - **FQDN –** Force local address for this connection to an IP address resolved by the specified fully qualified domain name (FQDN).
- **Local Identity –** *Default, address, FQDN, user-FQDN, DN.*
  - **Default –** Defaults to local IP address when using pre-shared key based authentication and to the DN of the local certificate when using certificated-based authentication.
  - **Address –** Use the specified IP address as the local IKE identity.
  - **FQDN –** Use the specified fully qualified domain name (FQDN) as the local IKE identity
  - **User-FQDN –** Use user-fully qualified domain name (user-FQDN) as the local IKE identity.
  - **DN –** Use the specified distinguished name as the local IKE identity.
- **Peer Endpoint –** *Address, FQDN.* Required setting.
  - **Address –** Specify the IP address of the IKE peer.
  - **FQDN –** Specify the fully qualified domain name (FQDN) of the IKE peer.
- **Peer Identity –** *Default, address, FQDN, user-FQDN, DN.*

- **Default –** Defaults to peer IP address when using pre-shared key based authentication and to the DN of the peer certificate when using certificated-based authentication.
- **Address –** Use specified IP address as the IKE identity - required.
- **FQDN –** Use specified fully qualified domain name (FQDN) as the peer IKE identity
- **User-FQDN –** Use specified user-fully qualified domain name (user-FQDN) as the peer IKE identity.
- **DN –** Use the specified distinguished name as the peer IKE identity.

Click **Next** to continue. The next screen requires you to specify the IKE version and authentication parameters.



- **Version –** IKE, IKE v1, IKE v2.
  - **IKE –** If the Orbit is the initiator, it uses IKE v2. If the Orbit is the responder, it accepts either IKE v1 or IKE v2, according to the policy proposed by the initiator.
  - **IKE v1 –** As an initiator or responder, the Orbit uses only IKE v1.
  - **IKE v2 –** As an initiator or responder, the Orbit uses only IKE v2.
- **Auth Method –** *Public key, EAP-TTLS, Pre-shared key.*
  - **Public key –** Use RSA/ECDSA public key based authentication.

NOTE The certificates must be installed on Orbit prior to VPN setup.

  - **Pre-shared key** – In lieu of certificates, the EAP-TTLS uses a pre-shared key for authentication.
  - **EAP-TTLS** – Use EAP-TTLS (Extensible Authentication Protocol Tunneled Transport Layer Security) based authentication. This is used for integrity and measurement (IMA) connections. See APPENDIX B – Integrity Measurement Authority (IMA).

The following options are available only when the authentication method chosen is **Public key** or **EAP-TTLS.** For more information on certificates, Certificate Management and 802.1X Authentication.

- **Cert Type** – *RSA, ECDSA.*
- **Cert ID** – Select the client certificate to be used in authentication. This dropdown shows all client certificates that have been installed on the Orbit. Certificates must be pre-installed prior to running the VPN Setup Wizard.

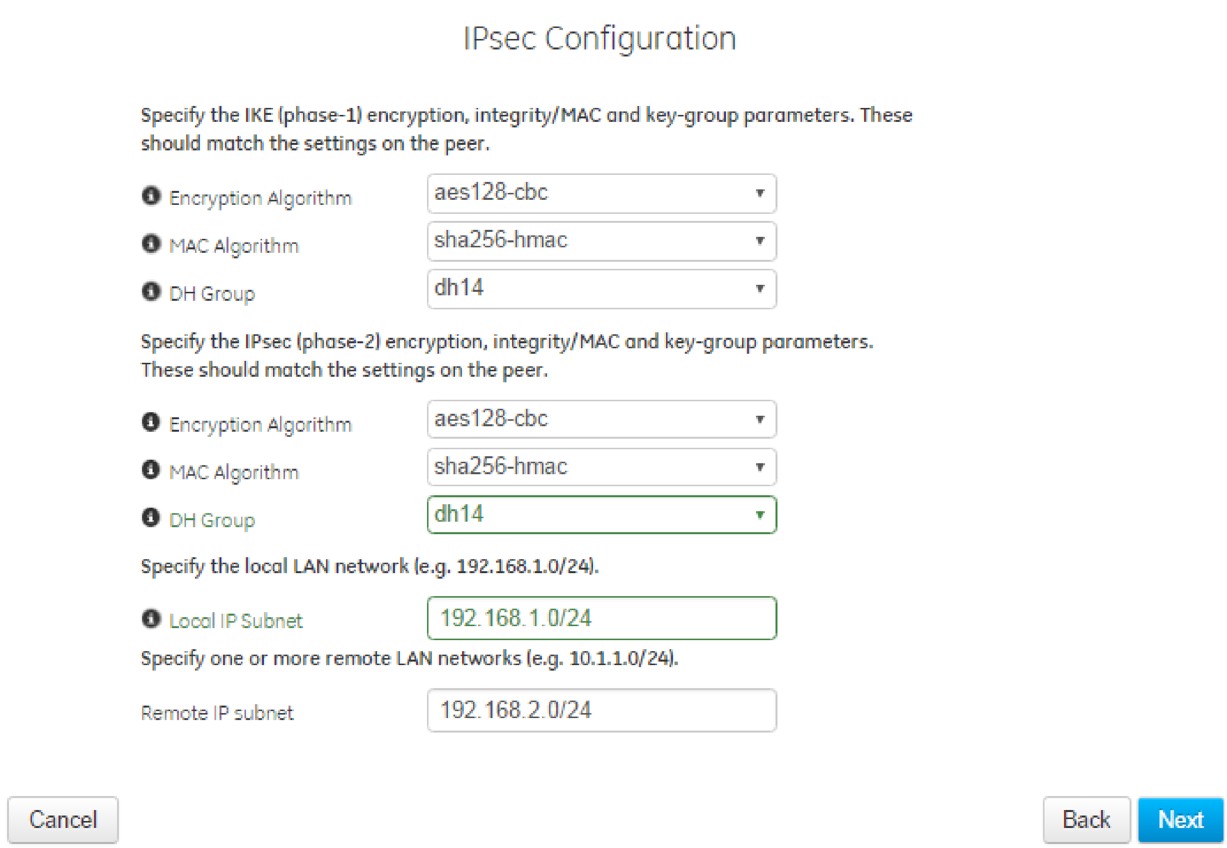
- **Key ID** – Select the private key to be used in authentication. This dropdown shows all private keys that exist on the Orbit. Keys must be pre-installed prior to running the VPN Setup Wizard.
- **CA Cert ID –** Select the Certificate Authority's certificate to be used in authentication. This dropdown shows all CA certificates that exist on the Orbit. Certificates must be pre-installed prior to running the VPN Setup Wizard.

The following options are available only when the authentication method chosen is **Pre-shared key.**

- **Pre-shared Key –** The pre-shared key itself.

NOTE In FIPS mode, pre-shared-key must be greater than 14 characters (112 bits) long.

Click **Next** to continue. The next screen requires configuration of IKE phase-1 and IPsec (phase-2) ciphersuite (encryption algorithm, integrity (MAC) algorithm, DH group). Also, local IP subnet and remote IP subnet needs to be configured.



Cipher suites used for phase-1 and phase-2 must match corresponding configuration on the peer.

- **Encryption algorithm** – 3des, Aes 128 Cbc, Aes 192 Cbc, Aes 256 Cbc, Aes 128 Ctr, Aes 192 Ctr, Aes 256 Ctr, Aes 128 Ccm 8, Aes 192 Ccm 8, Aes 256 Ccm8, Aes 128 Ccm 12, Aes 192 Ccm 12, Aes 256 Ccm12, Aes 128 Ccm 16, Aes 192 Ccm 16, Aes 256 Ccm16, Aes 128 Gcm 8, Aes 192 Gcm 8, Aes 256 Gcm8, Aes 128 Gcm 12, Aes 192 Gcm 12, Aes 256 Gcm12, Aes 128 Gcm 16, Aes 192 Gcm 16, Aes 256 Gcm16.

NOTE Orbit supports 3DES (Triple Digital Encryption Standard), and 128-bit, 192-bit, and 256-bit AES (Advanced Encryption Standard) encryption. When using AES encryption, CBC (Cipher Block Chaining), CTR(Counter), CCM 8, CCM 12, and CCM 16 (Counter with CBC-MAC), and GCM 8, GCM 12, and GCM 16 (Galois/Counter Mode) modes of operation are available.

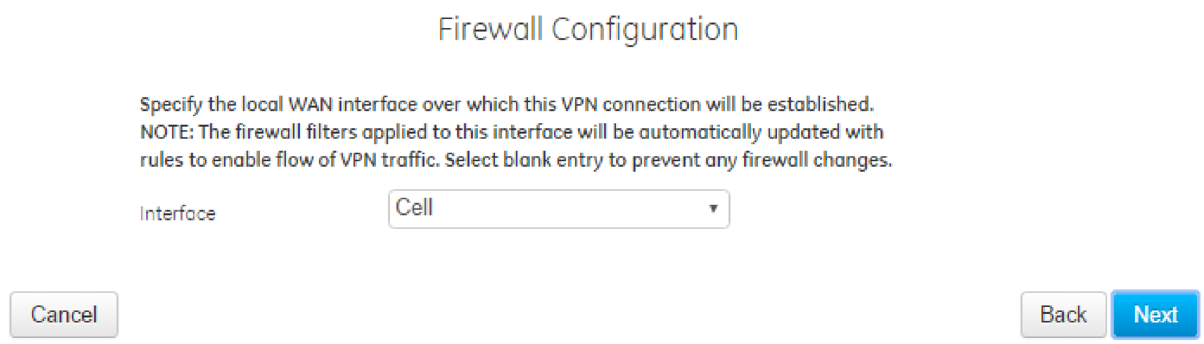
- **MAC algorithm –** *SHA-1 HMAC, SHA-256 HMAC, SHA-384 HMAC, SHA-512 HMAC.*
  Orbit supports HMAC (Hash-based Message Authentication Code), using either SHA-1(Secure Hash Algorithm), or 256-, 384-, or 512-bit SHA-2.
- **DH Group –** *DH-1, DH-2, DH-5, DH-14, DH-15*
  The DH Group setting determines the strength of the key in the Diffie-Hellman key exchange. Higher groups include more bits and are thus more secure but require more time to complete the key exchange. For phase-2 ciphersuite configuration, DH group is optional. It needs to be configured only if perfect forward secrecy (PFS) is desired.

NOTE In FIPS mode, only DH groups 14 and 15 are allowed.

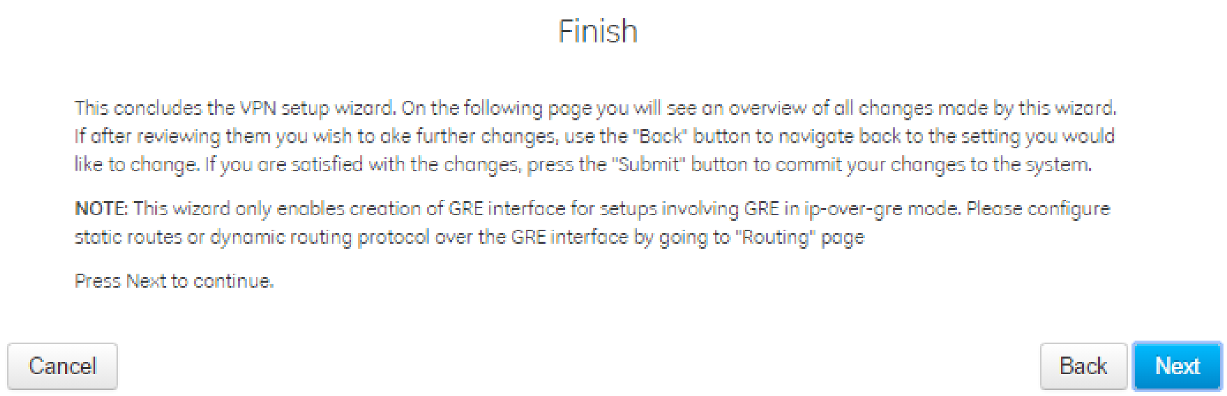
The local and remote subnets should also match those configured on the peer.

- **Local IP Subnet** – The local IP subnet behind Orbit.
- **Remote IP Subnet** – The remote IP subnet behind the peer IPsec VPN router.

Click **Next** to continue. The next screen requires one to select the interface over which this connection will be established. This is almost always the Cell interface.



Click **Next** to continue. The next screen provides some general information.



Click **Next** to continue. The next screen lists all the changes that have been made by this wizard. Click **Submit** to commit these changes on Orbit.

Configuration Summary

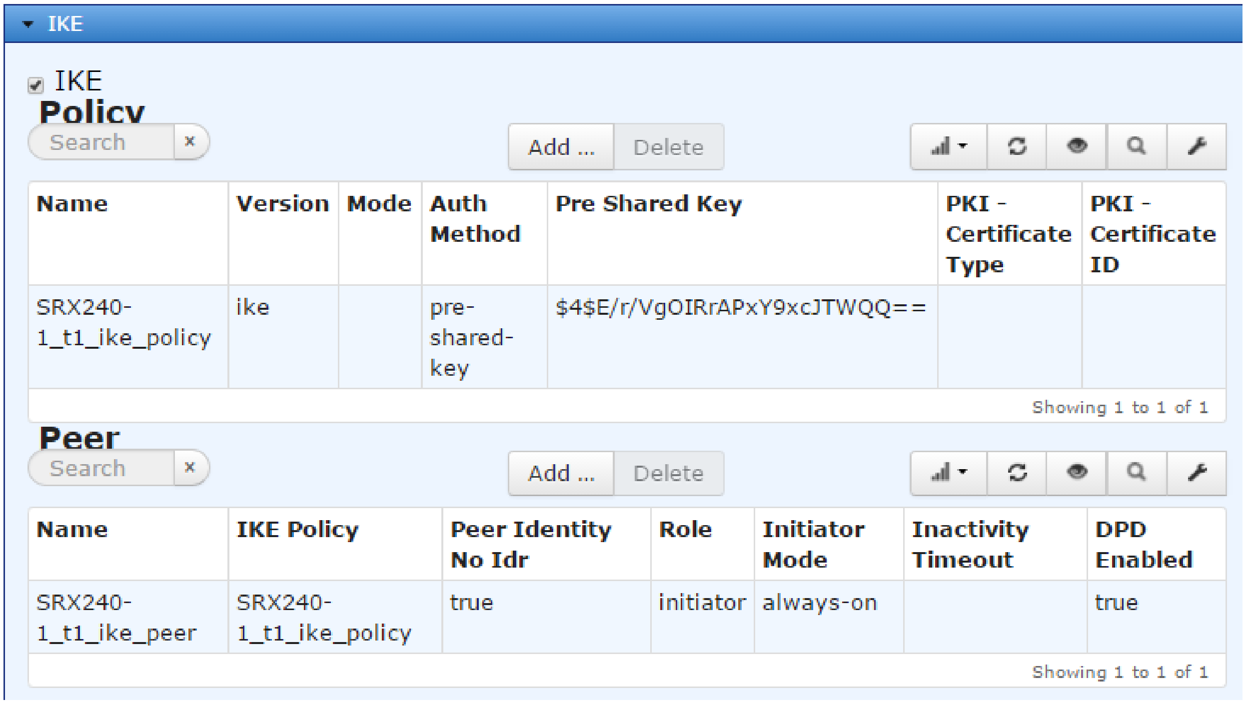
Keypath	Change Type	Old Value	New Value
/serv:services/vpn/ike/policy{SRX240-1_t1_ike_policy}/auth-method	value_set		pre-shared-key
/serv:services/vpn/ike/policy{SRX240-1_t1_ike_policy}/pre-shared-key	value_set		4E/r/VgOIRrAPxY9xcJTWQQ==
/serv:services/vpn/ike/policy{SRX240-1_t1_ike_policy}/ciphersuite{CS1}	created		
/serv:services/vpn/ike/policy{SRX240-1_t1_ike_policy}	created		
/serv:services/vpn/ike/peer{SRX240-1_t1_ike_peer}/peer-endpoint/address	value_set		172.18.175.40
/serv:services/vpn/ike/peer{SRX240-1_t1_ike_peer}/role	value_set		initiator
/serv:services/vpn/ike/peer{SRX240-1_t1_ike_peer}/peer-identity/default	created		
/serv:services/vpn/ike/peer{SRX240-1_t1_ike_peer}/ike-policy	value_set		SRX240-1_t1_ike_policy
/serv:services/vpn/ike/peer{SRX240-1_t1_ike_peer}/local-identity/default	created		
/serv:services/vpn/ike/peer{SRX240-1_t1_ike_peer}	created		
/serv:services/vpn/ipsec/policy{SRX240-1_t1_ipsec_policy}/ciphersuite{CS1}/dh-group	value_set		dh14
/serv:services/vpn/ipsec/policy{SRX240-1_t1_ipsec_policy}/ciphersuite{CS1}	created		
/serv:services/vpn/ipsec/policy{SRX240-1_t1_ipsec_policy}	created		
/serv:services/vpn/ipsec/connection{SRX240-1_t1}/local-ip-subnet	value_set		192.168.1.0/24
/serv:services/vpn/ipsec/connection{SRX240-1_t1}/ipsec-policy	value_set		SRX240-1_t1_ipsec_policy
/serv:services/vpn/ipsec/connection{SRX240-1_t1}/remote-ip-subnets	value_set		192.168.2.0/24
/serv:services/vpn/ipsec/connection{SRX240-1_t1}/ike-peer	value_set		SRX240-1_t1_ike_peer
/serv:services/vpn/ipsec/connection{SRX240-1_t1}/filter/input	value_set		IN_TRUSTED
/serv:services/vpn/ipsec/connection{SRX240-1_t1}/filter/output	value_set		OUT_TRUSTED
/serv:services/vpn/ipsec/connection{SRX240-1_t1}	created		

Cancel Back Submit

Any VPN connection setup through the wizard can be modified/deleted using the wizard as well by choosing the "Modify Existing Configuration" option at the start of the wizard. The VPN wizard is designed to simplify configuration of common VPN use cases. However, in case one needs to configure some advanced setup or manipulate parameters that are not available for configuration in the wizard, one can navigate to ***Services->VPN*** to get full access to VPN service configuration:

Figure 3-209. VPN – Service Configuration

The IKE panel includes configuration for IKE policy and peer settings. When VPN wizard is used for configuration, it automatically configures the IKE policy (<name>_<type>_ike_policy), IKE peer (<name>_<type>_ike_peer) based on specified VPN name.



Name	Version	Mode	Auth Method	Pre Shared Key	PKI - Certificate Type	PKI - Certificate ID
SRX240-1_t1_ike_policy	ike		pre-shared-key	4E/r/VgOIRrAPxY9xcJTWQQ==		

Name	IKE Policy	Peer Identity No Idr	Role	Initiator Mode	Inactivity Timeout	DPD Enabled
SRX240-1_t1_ike_peer	SRX240-1_t1_ike_policy	true	initiator	always-on		true

Figure 3-210. VPN - IKE Policy and IKE Peer menus

Following additional parameters are available for configuration in IKE policy and peer entries:

- **Role** – *Responder, Initiator.*
  - **Responder –** Orbit waits for a connection from the peer.
  - **Initiator –** Orbit initiates the connection. This is the typical setup.
- **Initiator Mode** – (when role is *initiator*)
  - **Always On -** Orbit attempts to keep the tunnel always up
  - **On Demand** – Orbit sets up the tunnel only when the traffic matching the IPsec connection is detected.
- **Life Time –** *15-1440.* The time interval, in minutes, after which the IKE security association expires.
- **DPD Enabled** – *Enable, Disable.* Enabling dead peer detection (DPD) clears an established VPN connection when a dead peer is detected and tries to establish a new one.
- **DPD Interval** – *30-3600.* Specifies the number of seconds to wait before declaring a peer “dead.” This should be set to no less than 300 seconds to reduce excess network traffic.

The IPsec panel includes configuration for IPsec policy and connection settings. When VPN wizard is used for configuration, it automatically configures the IPsec policy (<name>_<type>_ipsec_policy), IPsec connection (<name>_<type>) based on specified VPN name.

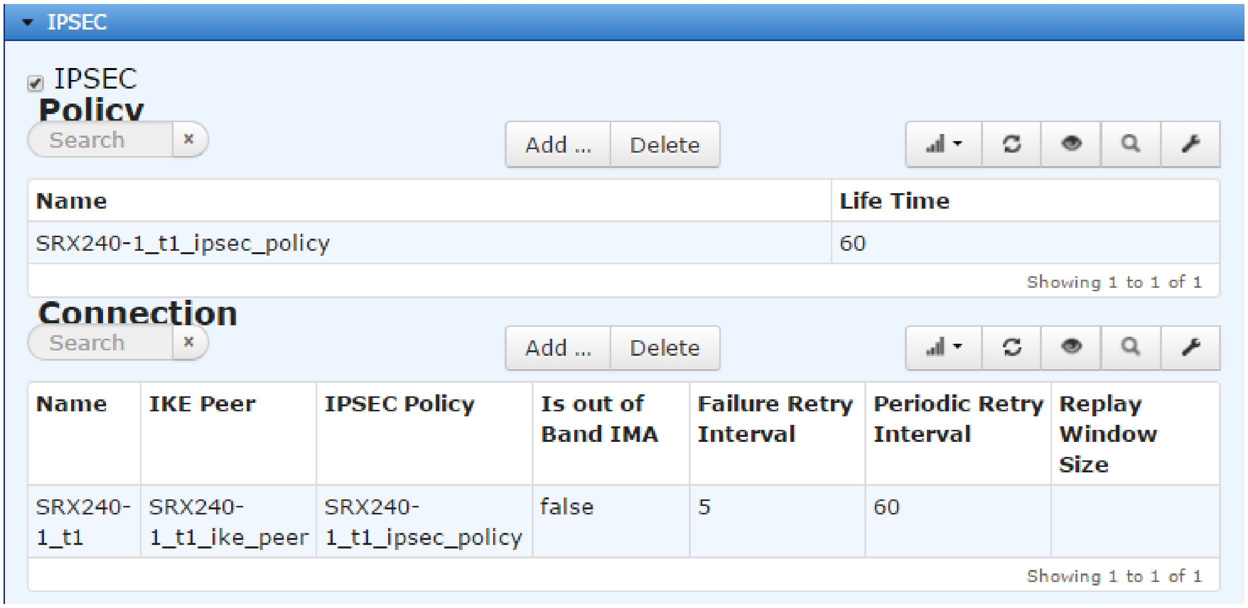


Figure 3-211. VPN - IPsec Policy and Connection menus

Following additional parameters are available for configuration in IPsec policy and connection entries:

- **Connection Type –** *net-to-net or host-to-host.* The net-to-net type signifies IPsec tunnel mode. The host-to-host type signifies the IPsec transport mode.
- **Life Time –** *15-1440.* The time interval, in minutes, after which the IPsec security association expires.
- **Failure Retry Interval –** *1-255.* The number of minutes to wait after repeated failed VPN connections before retrying.
- **Periodic Retry Interval –** *15-255.* The periodic attestation time, in minutes. Used only in IMA connections. See APPENDIX B – Integrity Measurement Authority (IMA).
- **Inbound Firewall Filter** – Apply an existing packet filter to the incoming traffic on this connection. See section 3.8.9 Access Control List (Packet Filtering / Firewall) for more information. An inbound filter to the connection must be applied, or no traffic will pass. If a filter hasn't been created specifically for the VPN connection, use the preconfigured filter *IN_TRUSTED*, which allows all inbound traffic.
- **Outbound Firewall Filter –** Apply an existing packet filter to the outgoing traffic on this connection. See section 3.8.9 Access Control List (Packet Filtering / Firewall) for more information. An outbound filter to the connection must be applied, or no traffic will pass. If a filter hasn't been specifically created for the VPN connection, use the preconfigured filter *OUT_TRUSTED*, which allows all outbound traffic.
- **Static NAT –** Apply an existing static Network Address Translation (NAT) rule set to the connection. See 3.8.12 Static NAT for more information

NOTE The VPN connections that are configured using the VPN service menu cannot be modified using the VPN wizard.

Using the CLI

The CLI can also be used to configure VPN.

The following example describes the step-by-step VPN configuration for the example network shown in Figure 3-204.

1. Enable VPN service

   % set services vpn enabled true

2. Configure IKE policy with auth-method 'pre-shared-key" with password 'test123'.

   % set services vpn policy IKE-POLICY-1 auth-method pre-shared-key

   % set services vpn policy IKE-POLICY-1 pre-shared-key test123

3. Configure the following cipher suite to be included as proposal for IKE phase-1 negotiation:

   a. Encryption Algorithm = AES 128 Bit in CBC mode

   b. Message Authentication Algorithm = HMAC using SHA256 digest

   c. Diffie-Hellman Group = DH-14 (group 14 modp2048)

   % set services vpn ike policy IKE-POLICY-1 **ciphersuite CS1 encryption-algo** aes-128-cbc

   % set services vpn ike policy IKE-POLICY-1 **ciphersuite CS1 mac-algo** sha256-hmac

   % set services vpn ike policy IKE-POLICY-1 **ciphersuite CS1 dh-group** dh-14

NOTE More than one cipher suite can be included in the proposal.

4. Create IKE peer with address 172.18.175.40 and dead peer detection enabled and interval set to 5 minutes.

The dead peer detection (DPD) is enabled by default. When enabled, it sends R_U_THERE/INFORMATIONAL messages to the peer if there no other data sent within DPD interval. This allows Orbit to detect dead peers and clear the connection. The DPD interval should be set to no less than 300 seconds (5 minutes) to reduce the periodic traffic in the network.

   % set services vpn ike peer VPN-GW **ike-policy** IKE-POLICY-1

   % set services vpn ike peer VPN-GW **local-identity** default

   % set services vpn ike peer VPN-GW **peer-endpoint address** 172.18.175.40

   % set services vpn ike peer VPN-GW **peer-identity** default

   % set services vpn ike peer VPN-GW **role** initiator

   % set services vpn ike peer VPN-GW **dpd-interval** 300

5. Create an IPsec policy and configure the following ciphersuite to be included as proposal for IKE phase-2 negotiation:

   - Encryption Algorithm = AES 128 Bit in CBC mode
   - Message Authentication Algorithm = HMAC using SHA256 digest
   - Diffie-Hellman Group = DH-14 (group-14 (modp 2048)).

   % set services vpn ipsec policy IPSEC-POLICY-1 **ciphersuite** CS1 **encryption-algo** aes-128-cbc

   % set services vpn ipsec policy IPSEC-POLICY-1 **ciphersuite** CS1 **mac-algo** sha256-hmac

   % set services vpn ipsec policy IPSEC-POLICY-1 **ciphersuite** CS1 **dh-group** dh-14

NOTE More than one cipher suite can be included in the proposal.

6. Create IPsec connection

   % set services vpn ipsec connection VPN-GWY-CONN **ike-peer** VPN-GWY

   % set services vpn ipsec connection VPN-GWY-CONN **ipsec-policy** IPSEC-POLICY-1

   % set services vpn ipsec connection VPN-GWY-CONN **local-ip-subnet** 192.168.1.0/24

   % set services vpn ipsec connection VPN-GWY-CONN **remote-ip-subnet** 192.168.2.0/24

   % set services vpn ipsec connection VPN-GWY-CONN **filter input** IN_TRUSTED

   % set services vpn ipsec connection VPN-GWY-CONN **filter output** OUT_TRUSTED

   % set services vpn ipsec connection VPN-GWY-CONN **failure-retry-interval 1**

The following table describes the VPN connection attempt retries and time interval between them. After giving up as listed below, the unit waits for “failure-retry-interval” and repeats the connection attempt sequence.

Table 3-28. VPN Connection Retry

Attempt#	Relative Timeout Between Attempts (secs)	Absolute Timeout From First Attempt (secs)
1	0	0
2 (1st retry)	4	4
3 (2nd retry)	7	11
4 (3rd retry)	13	24
5 (4th retry)	23	47
6 (5th retry)	42	89
Give up	76	165
Wait for “failure-retry-interval”, then repeat above sequence		

During initial configuration set failure-retry-interval to lowest value of 1 min, to have Orbit attempt connection more quickly. This allows debugging of any connection-related issue by watching logs on peer side etc. Be sure to change this value to 5 minutes or higher to prevent excessive attempts and traffic.

Commit configuration to save the changes.

% commit

Following shows IKE policy configuration for public-key encryption based authentication method:

1. Create IKE policy with auth-method “public-key encryption”.

   % set services vpn ike policy IKE-POLICY-1 auth-method pub-key

2. Configure Public Key Infrastructure (PKI) security credentials.
   d. Certificate type as “rsa” if RSA public key encryption based certificates are being used.
   e. Client certificate ID – This is the ID that was assigned to the client certificate obtained via SCEP or loaded manually (assumed to be ID-1).
   f. Client private key ID – This is the ID that was assigned to the client private key generated during SCEP procedure or loaded manually (assumed to be ID-1).
   g. Certificate Authority (CA) certificate ID – This is the ID that was assigned to the CA certificate obtained via SCEP or loaded manually (assumed to be CA-1).

   % set services vpn ike policy IKE-POLICY-1 **pki cert-type** rsa
   % set services vpn ike policy IKE-POLICY-1 **pki cert-id** ID-1
   % set services vpn ike policy IKE-POLICY-1 **pki key-id** ID-1
   % set services vpn ike policy IKE-POLICY-1 **pki ca-cert-id** CA-1

Firewall Configuration

The VPN wizard automatically configures the firewall to allow incoming and outgoing IKE/IPsec traffic over the Cell/WAN interface. However, when VPN is configured manually via ***Services->VPN->Basic Config*** menu or via CLI, the firewall needs to be manually configured as well:

1. Add following rules to IN_UNTRUSTED filter that is applied to the Cell interface in the incoming direction:

% set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp

% set services firewall filter IN_UNTRUSTED rule 1 actions

% set services firewall filter IN_UNTRUSTED rule 1 actions action accept

% set services firewall filter IN_UNTRUSTED rule 2 match protocol udp

% set services firewall filter IN_UNTRUSTED rule 2 match src-port

% set services firewall filter IN_UNTRUSTED rule 2 match src-port services [dns]

% set services firewall filter IN_UNTRUSTED rule 10 match protocol udp

% set services firewall filter IN_UNTRUSTED rule 10 match dst-port services [ike ntp]

% set services firewall filter IN_UNTRUSTED rule 10 actions action accept

% set services firewall filter IN_UNTRUSTED rule 11 match protocol esp

% set services firewall filter IN_UNTRUSTED rule 11 actions action accept

% set services firewall filter IN_UNTRUSTED rule 12 match protocol all

% set services firewall filter IN_UNTRUSTED rule 12 actions action drop

2. Add following rules to OUT_UNTRUSTED filter that is applied to the Cell interface in the outgoing direction:

   % set services firewall address-set CELL-IP

   % set services firewall filter OUT_UNTRUSTED rule 1 match src-address address-set CELL-IP

   % set services firewall filter OUT_UNTRUSTED rule 1 match src-address add-interface-address true

   % set services firewall filter OUT_UNTRUSTED rule 1 actions action accept

   % set services firewall filter OUT_UNTRUSTED rule 2 match protocol all

   % set services firewall filter OUT_UNTRUSTED rule 2 actions action drop

3. Delete the source NAT/IP masquerading from Cell interface:

   % delete interfaces interface Cell nat source MASQ

4. Commit the changes:

   % commit

NOTE See section 3.8.22 Network Link failover/failback for GRE/IPsec VPN configuration examples. See section 12.0 APPENDIX G for more VPN configuration examples like DMVPN etc.

Conditional Operation

The Site-to-Site IPsec VPN connections in the initiator mode can be configured to operate conditionally based on state of a network monitor operation. Following configuration will make IPsec connection named IPSEC-1 to be established only if the PROBE-1 network monitor operation state is true (UP). Otherwise, the IPsec connection will be disconnected.

% set services vpn ipsec connection IPSEC-1 conditional-operation operation PROBE-1

One of the use cases where this functionality is used is in redundant AP setup, where only the primary AP is supposed to setup IPsec VPN connection with an upstream hub router when it is in a “master” state and is supposed to tear down the connection when it becomes a “backup” to a secondary AP.

FlexVPN Configuration

FlexVPN interoperability was described earlier. Below is an example FlexVPN GRE tunnel configuration on the Orbit router and corresponding Cisco FlexVPN HUB router configuration.

```
%set services vpn enabled true
%set services vpn ike
%set services vpn ike policy IKE-POLICY-1 version ikev2
%set services vpn ike policy IKE-POLICY-1 auth-method pre-shared-key
%set services vpn ike policy IKE-POLICY-1 pre-shared-key
$8$9vpkZBPRB6/FL0z6SSvO5SDjf2Shh+dt3xBz+BNidpQ=
%set services vpn ike policy IKE-POLICY-1 ciphersuite CS1 encryption-algo aes256-cbc
%set services vpn ike policy IKE-POLICY-1 ciphersuite CS1 mac-algo sha512-hmac
%set services vpn ike policy IKE-POLICY-1 ciphersuite CS1 dh-group dh5
%set services vpn ike peer FLEXVPN-HUB ike-policy IKE-POLICY-1
%set services vpn ike peer FLEXVPN-HUB peer-endpoint address 172.18.175.51
%set services vpn ike peer FLEXVPN-HUB role initiator

%set services vpn ipsec
%set services vpn ipsec policy IPSEC-POLICY-1 ciphersuite CS1 encryption-algo aes256-cbc
%set services vpn ipsec policy IPSEC-POLICY-1 ciphersuite CS1 mac-algo sha512-hmac
%set services vpn ipsec connection FLEXVPN-HUB ike-peer FLEXVPN-HUB
%set services vpn ipsec connection FLEXVPN-HUB ipsec-policy IPSEC-POLICY-1
%set services vpn ipsec connection FLEXVPN-HUB host-to-host
%set services vpn ipsec connection FLEXVPN-HUB host-to-host flexvpn true
%set services vpn ipsec connection FLEXVPN-HUB failure-retry-interval 1
%set services vpn ipsec connection FLEXVPN-HUB filter input IN_TRUSTED
%set services vpn ipsec connection FLEXVPN-HUB filter output OUT_TRUSTED

%set interfaces interface GRE1 gre-config
%set interfaces interface GRE1 gre-config mode ip-over-gre
%set interfaces interface GRE1 gre-config src-address 0.0.0.0
%set interfaces interface GRE1 gre-config dst-address 172.18.175.51
%set interfaces interface GRE1 gre-config ipsec-connection FLEXVPN-HUB
%set interfaces interface GRE1 filter input IN_TRUSTED
%set interfaces interface GRE1 filter output OUT_TRUSTED
%set interfaces interface GRE1 ipv4
```

The GRE1 interface can be used like how it is used in DMVPN setup to tunnel any IPv4 traffic to/from the HUB through this tunnel interface. The snippet below shows configuration for running RIPv2 protocol on the GRE1 interface and exporting local Loopback IPv4 to the HUB:

```
%set interfaces interface LO1 type loopback
%set interfaces interface LO1 ipv4 address 10.1.1.22 prefix-length 32
%set routing router-id 10.15.67.22
%set routing route-filter LO1 rule 1 match outgoing-interface LO1
%set routing route-filter LO1 rule 1 actions action accept
%set routing rip enabled true
%set routing rip export-filter LO1
%set routing rip interface GRE1
```

Cisco FlexVPN HUB router configuration:

```
crypto ikev2 authorization policy FLEXVPN_SPOKES_CELL
pool FLEXVPN_POOL_1
 netmask 255.255.240.0
 route set interface
!

crypto ikev2 proposal IKEV2-PROPOSAL-1
 encryption aes-cbc-128
 integrity sha256
 group 14

crypto ikev2 proposal IKEV2-PROPOSAL-2
 encryption aes-cbc-256
 integrity sha256

 group 14
!

crypto ikev2 policy IKEV2-POLICY
 match fvrf any
 proposal IKEV2-PROPOSAL-1
 proposal IKEV2-PROPOSAL-2
!
```

```
crypto ikev2 keyring IKEV2-KEYS
 peer ORBIT-V4
  address 0.0.0.0 0.0.0.0
  pre-shared-key local test123456
  pre-shared-key remote test123456
!

crypto ikev2 profile FLEXVPN_IKEV2_PROFILE_PSK
 match identity remote address 192.168.3.22 255.255.255.255
 authentication remote pre-share
 authentication local pre-share
 keyring local IKEV2-KEYS
 dpd 30 5 on-demand
 aaa authorization group psk list default FLEXVPN_SPOKES_CELL
 virtual-template 1
!

crypto ipsec transform-set FLEXVPN_TRANSFORM esp-aes 256 esp-sha512-hmac
 mode transport
!

crypto ipsec profile FLEXVPN_IPSEC_PROFILE
 set transform-set FLEXVPN_TRANSFORM
 set ikev2-profile FLEXVPN_IKEV2_PROFILE_PSK
!

interface Loopback1
 description FlexVPN Tunnel source
 ip address 10.243.0.1 255.255.255.224
 ip rip advertise 5
 no ipv6 redirects
 no ipv6 unreachables
!

interface Loopback2
 description Network behind Tunnel
```

```
 ip address 10.1.1.1 255.255.255.0
 ip rip advertise 5
 ipv6 address 2001:10:1::1/128
 no ipv6 redirects
 no ipv6 unreachables
!

interface GigabitEthernet0/0/1
 ip address 172.18.175.51 255.255.255.0
 negotiation auto
!

interface Virtual-Template1 type tunnel
 ip unnumbered Loopback1
 ipv6 unnumbered Loopback1
 ipv6 enable
 ipv6 mtu 1300
 tunnel source GigabitEthernet0/0/1
 tunnel protection ipsec profile FLEXVPN_IPSEC_PROFILE
!

router rip
 version 2
 network 10.0.0.0
 default-information originate
 no auto-summary
!

ip local pool FLEXVPN_POOL_1 10.243.0.2 10.243.31.255
```

Monitoring

Using the Web UI

To view the VPN status, navigate to ***Services->VPN-> Status***.

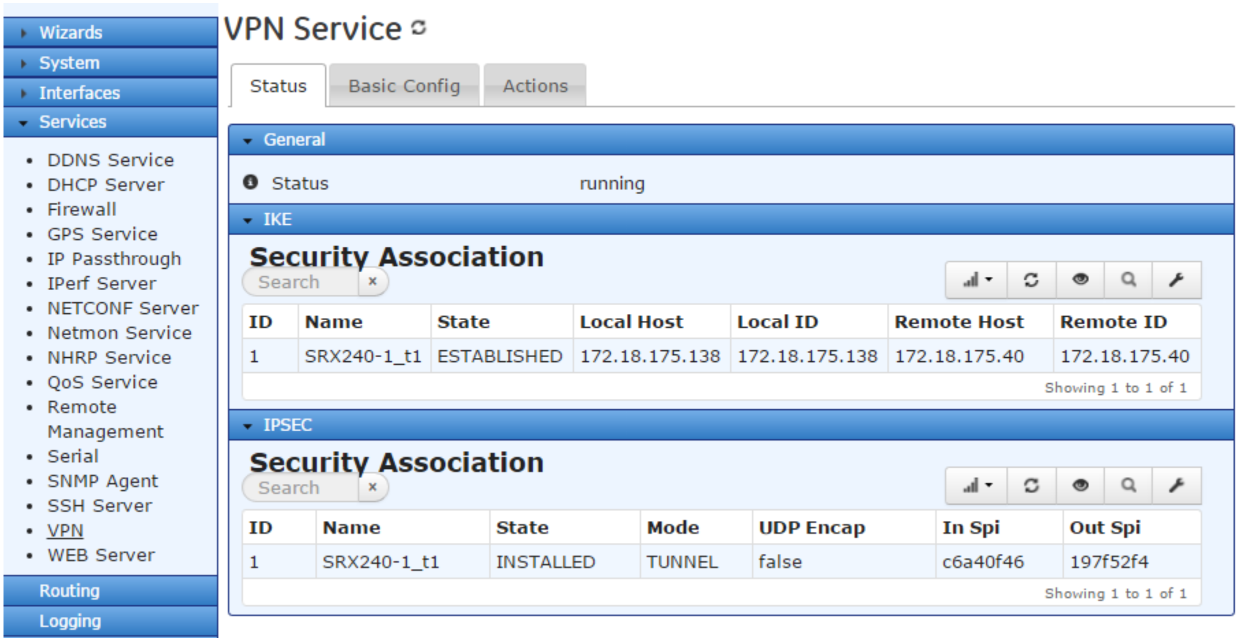


Figure 3-212. VPN - Status

Under IKE panel, click on the IKE security association row to view the detailed status.

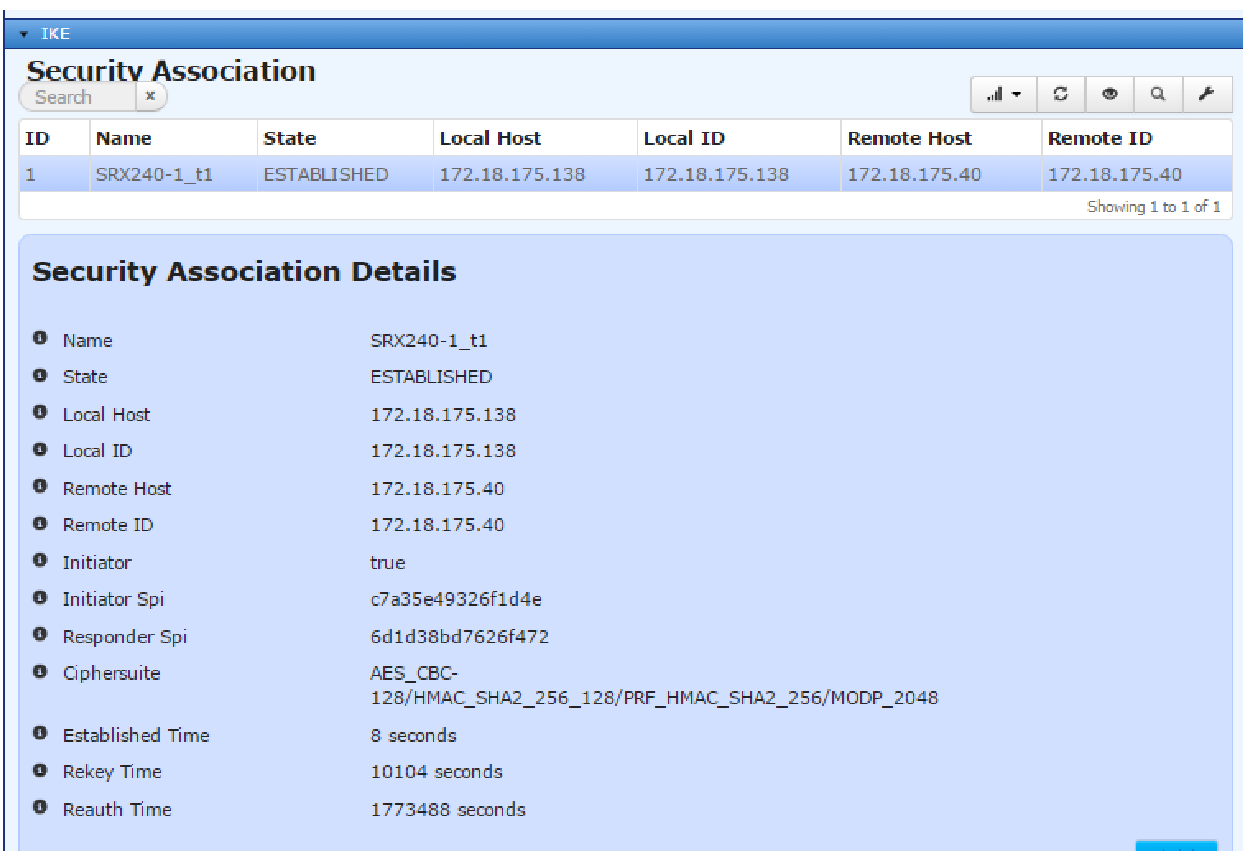


Figure 3-213. VPN – IKE Security Association Detailed Status

Under IPsec panel, click on the IPsec security association row to view the detailed status.

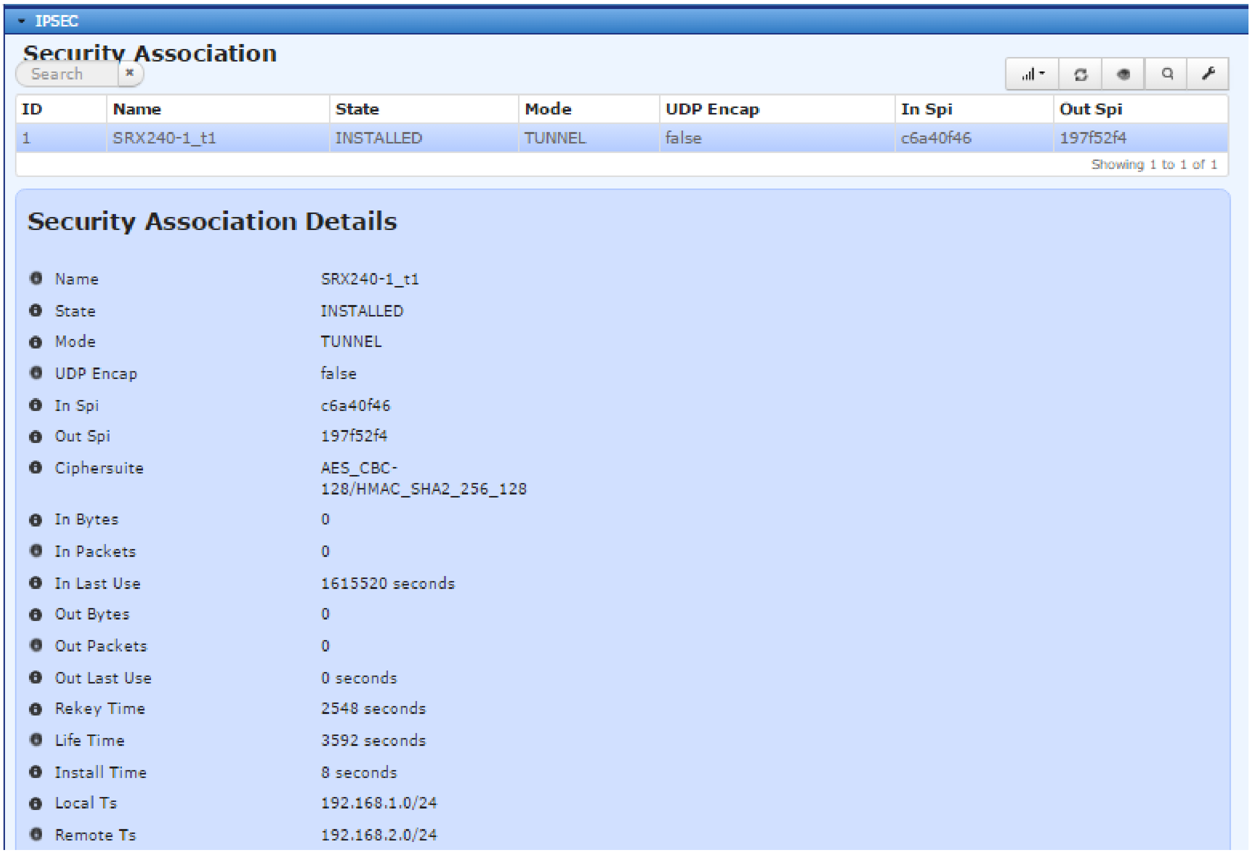


Figure 3-214. VPN - IPsec Security Association Detailed Status

Using the CLI

Ensure the CLI is in operational mode.

>show services vpn

```
services vpn ike security-associations security-association 11
 name            SRX240-1_t1
 state           ESTABLISHED
 local-host       172.18.175.138
 local-id         172.18.175.138
 remote-host      172.18.175.40
 remote-id        172.18.175.40
 initiator        true
 initiator-spi    b19beb547030c7c3
 responder-spi    259b6cf8efb75dcc
 ciphersuite      AES_CBC-128/HMAC_SHA2_256_128/PRF_HMAC_SHA2_256/MODP_2048
 established-time 5590
 rekey-time       4584
 reauth-time      1773488
services vpn ipsec security-associations security-association 40
 name        SRX240-1_t1
 state       INSTALLED
 mode        TUNNEL
 udp-encap   false
 in-spi      ccc45708
 out-spi     127c75e1
 ciphersuite AES_CBC-128/HMAC_SHA2_256_128/MODP_2048
 in-bytes    0
 in-packets  0
 in-last-use 1615520
```

```
out-bytes    0
out-packets  0
out-last-use 0
rekey-time   1195
life-time    2202
install-time 1399
local-ts     192.168.1.0/24
remote-ts    192.168.2.0/24
```

Ping the back-office PC from the local device to make sure the traffic is passing between device and PC.

```
> ping 192.168.2.1
PING 192.168.1.2 (192.168.2.1) 56(84) bytes of data.
64 bytes from 192.168.2.1: icmp_req=1 ttl=63 time=389 ms
64 bytes from 192.168.2.1: icmp_req=2 ttl=63 time=161 ms

--- 192.168.2.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 550ms
rtt min/avg/max/mdev = 161/275/389/114 ms
```

Troubleshooting

The following are common reasons for VPN connection failure:

1. Invalid certificate or keys loaded on the device
2. Time not synchronized on the device. Note that after cell connection is established, device can take few minutes to sync time from NTP server. VPN connection will not succeed until time is synchronized.
3. Mismatch in cipher suites configured for IKE policy on device and peer VPN gateway.
4. Mismatch in cipher suites configured for IPsec policy on device and peer VPN gateway.
5. Mismatch in remote and local IP subnets configured for IPsec connection on device and peer VPN gateway. Note the following:

- For device
  - remote ip subnet = back-office subnet
  - local ip subnet = local LAN or WIFI subnet on device
- For VPN gateway
  - remote ip subnet = device's local LAN or WIFI subnet
  - local ip subnet = back-office subnet on device

3.8.14 VPN – OpenVPN

Orbit supports Virtual Private Network (VPN) setups using either IPsec or OpenVPN.   This section describes OpenVPN.

Understanding

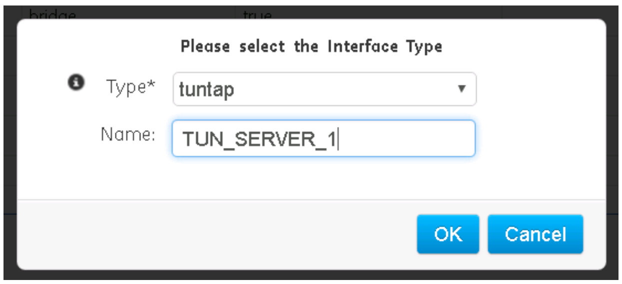
OpenVPN provides a secure tunnel connection and is generally easier to configure than IPsec. Orbit's implementation of OpenVPN provides support for one Server instance and up to two Client instances. The server implementation accepts connections from up to two external OpenVPN clients. Both Client and Server instances can be enabled on a single Orbit device. The implementation uses pre-shared keys and communicates using a TUN virtual network device. Communication is limited to IPv4.

Using the Web UI

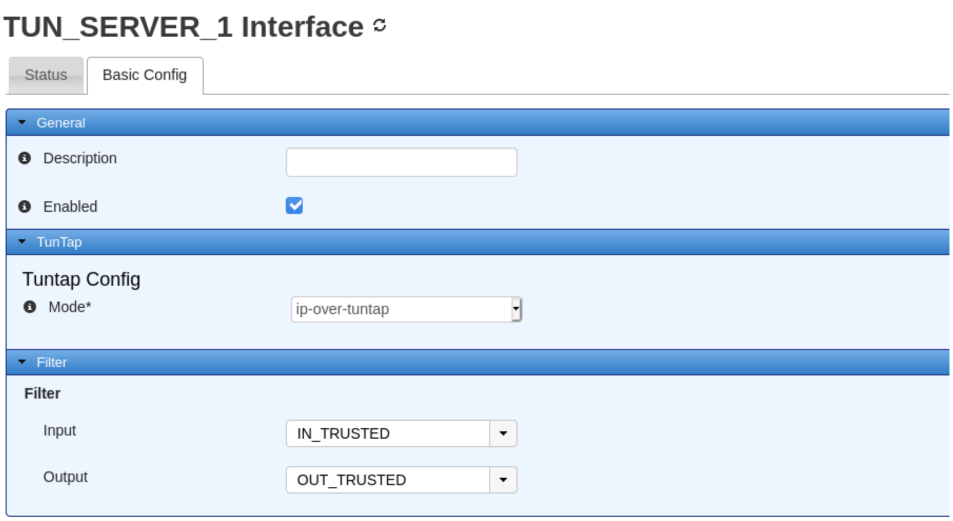
All OpenVPN connections require creation of TUN virtual device.

Configure the TUN tunnel

1. Configure TUN tun/tap interface with a descriptive name (e.g., TUN_SERVER for server and TUN_CLIENT for clients)
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click ‘Add’ to create new interface named ‘TUN_SERVER_1’:



2. Configure TUN tun/tap interface as ip-over-tuntap, and set up access filters.
   - Navigate to ***Interfaces / TUN_SERVER_1*** and click to modify settings

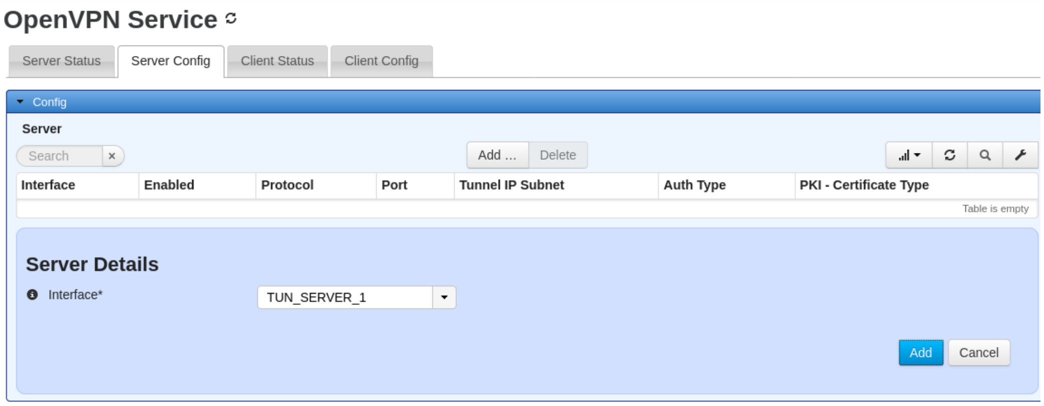


TUN/TAP Interface Parameter definition:

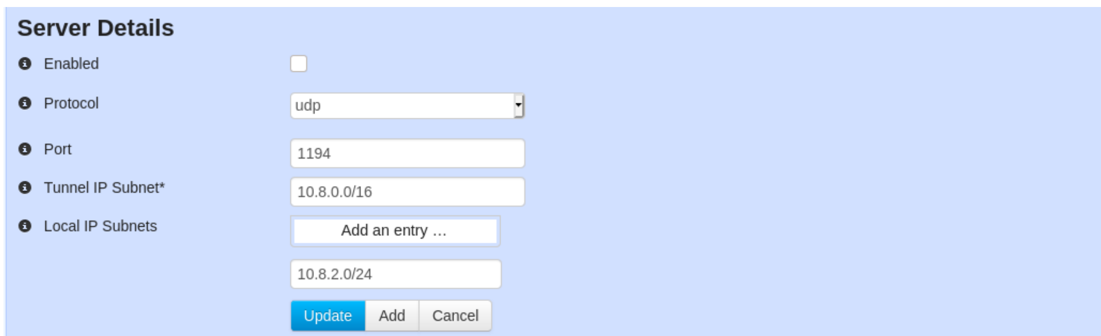
- **Description** – The name of the interface. Up to 48 characters.
- **Mode** – The only config choice is ip-over-tuntap (TUN); Orbit does not support ethernet-over-tuntap (TAP)
- **Input, Output filters** – these specify access control lists as defined in Table 3-27

Configure a VPN server

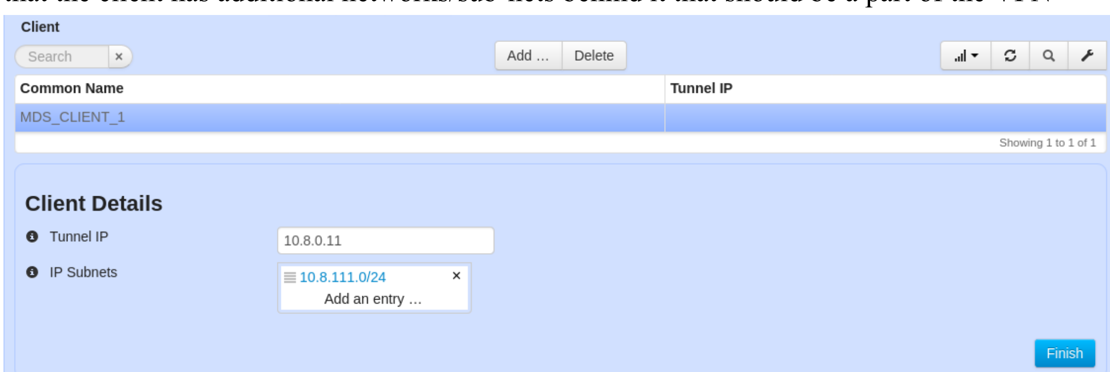
1. Add the VPN server
   - Navigate to ***Services / OpenVPN*** and click add



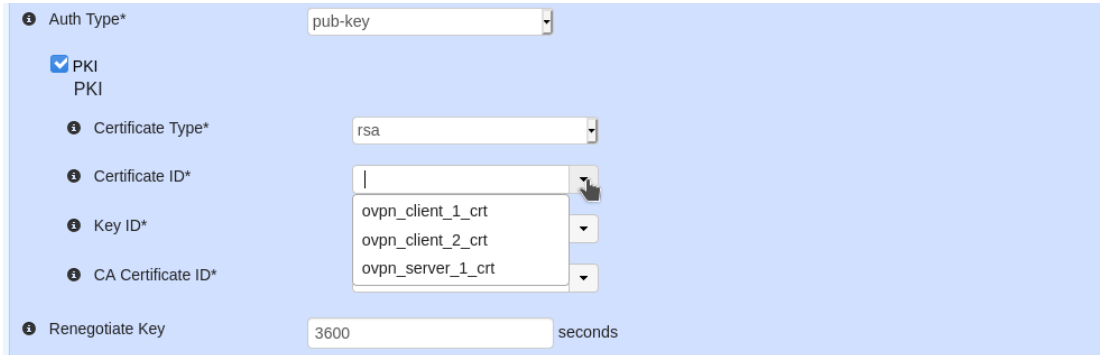
2. Specify the general server details:
   - Includes protocol, port, and tunnel IP address



3. Add any reserved client details for the server:
   - This is needed if you want to reserve a virtual IP address for a client or if you want to indicate that the client has additional networks/sub-nets behind it that should be a part of the VPN



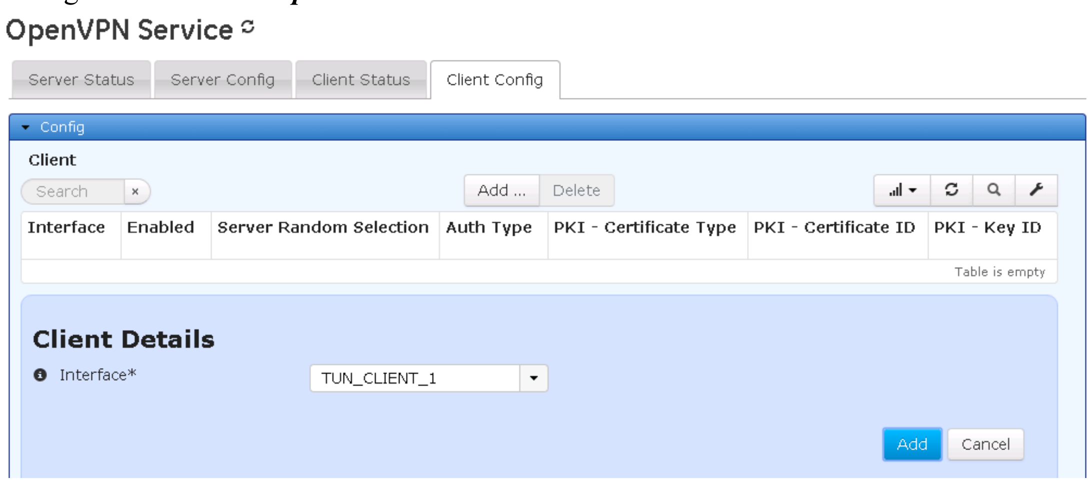
4. Specify the public key infrastructure settings
   - NOTE: certificates and keys must be added using the certification management facility *prior* to the creation of an OpenVPN server instance.



5. Specify the ciphersuite and encryption parameters
   - Use settings that appropriate and supported for standard OpenVPN connections.

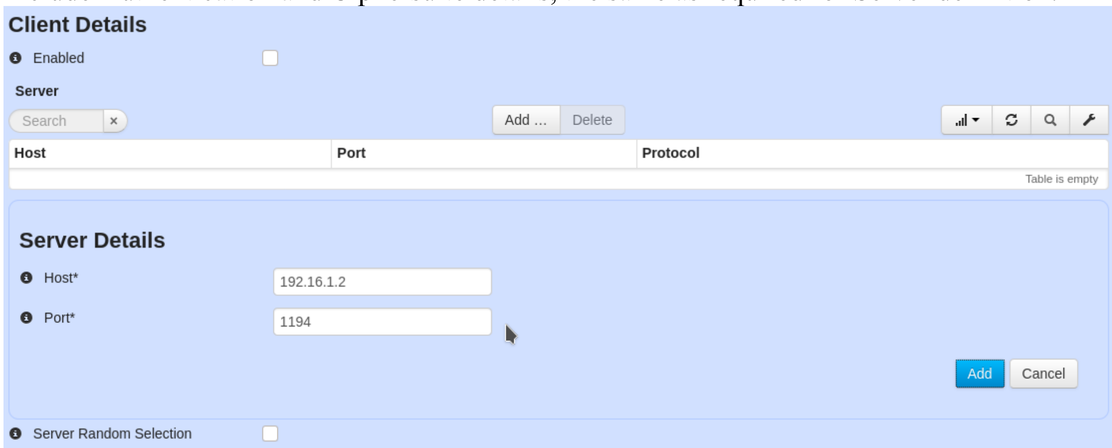
Configure a VPN Client

1. Add the VPN Client
   - Navigate to ***Services / OpenVPN*** and click add



2. Specify the connection details for the client
   - Include host address and port number of the server. Multiple servers can be specified to offer resilience and redundancy. The Server Random Selection option controls how servers are picked.

- Include Authentication and Ciphersuite details, the same as required for Server definition.



General

Definition of parameters involved in configuration include the following:

- **Protocol** – this is the protocol the OpenVPN server should support. The options are either TCP or UDP. [Server side only]
- **Host** – The OpenVPN server that the client should attempt to connect to. [Client side only]
- **Port** – The port that OpenVPN runs on.
- **Tunnel IP Subnet** – this is the primary subnet that the server should set up the virtual private network on. provided. The CIDR prefix for this should be 28 or lower since we are setting up a server with the subnet topology. The first address in the subnet is automatically assigned to the server and remaining address are available in the subnet pool for connecting clients. [Server side only]
- **Local IP Subnets** - this is the primary subnet that the server should set up the virtual private network on. provided. The CIDR prefix for this should be 28 or lower since we are setting up a server with the subnet topology. The first address in the subnet is automatically assigned to the server and remaining address are available in the subnet pool for connecting clients. [Server side only]
- **Renegotiate Key** – Duration between renegotiating the data channel key. [Server side only]
- **Server Random Selection** – if the box is selected the system will randomly select from a list of servers provided. [Client side only]
- **Auth Type** – must be configured as “pub-key” to specify public key encryption.
- **Certificate Type** – must be configured as “rsa” to specify RSA public key encryption based certificates are being used.
- **Certificate ID, Key ID, CA Certificate ID –** Reference to the remotes certificate material loaded through the Certificate Management side menu (section 3.9).
- **Encryption algorithm** – the permitted choices for OpenVPN are limited to, Aes 128 Cbc (DEFAULT), Aes 192 Cbc, Aes 256 Cbc.
- **MAC algorithm** – the permitted choices for OpenVPN are limited to SHA-1 HMAC, SHA-256 HMAC (DEFAULT), SHA-384 HMAC, SHA-512 HMAC.
- **Compression** – Over the air compression
  - lzo - Compresses the tunnel traffic with the LZO algorithm
  - lz4 - Compresses the tunnel traffic with the LZ4 algorithm

- disable - No data compression (DEFAULT)

Using the CLI

The following lists the sequence of CLI commands to create and configure a TUN virtual network device and enable it:

%set interfaces interface *TUN1* type tuntap tuntap-config mode *ip-over-tuntap*
%set interfaces interface *TUN1* filter input *IN_TRUSTED* output *OUT_TRUSTED*
%set interfaces interface *TUN1* enabled *true*

The following lists the sequence of CLI commands to create and configure an OpenVPN Server instance and to enable it:

%set services openvpn server *TUN1*
%set services openvpn server *TUN1* **tunnel-ip-subnet** *10.8.0.0/28*
%set services openvpn server *TUN1* **auth-type** *pub-key*
%set services openvpn server *TUN1* **pki cert-type** *rsa*
%set services openvpn server *TUN1* **pki ca-cert-id** *ovpn_ca_cert*
%set services openvpn server *TUN1* **pki cert-id** *ovpn_server_cert* **key-id** *ovpn_server_key*
%set services openvpn server *TUN1* **enabled** *true*

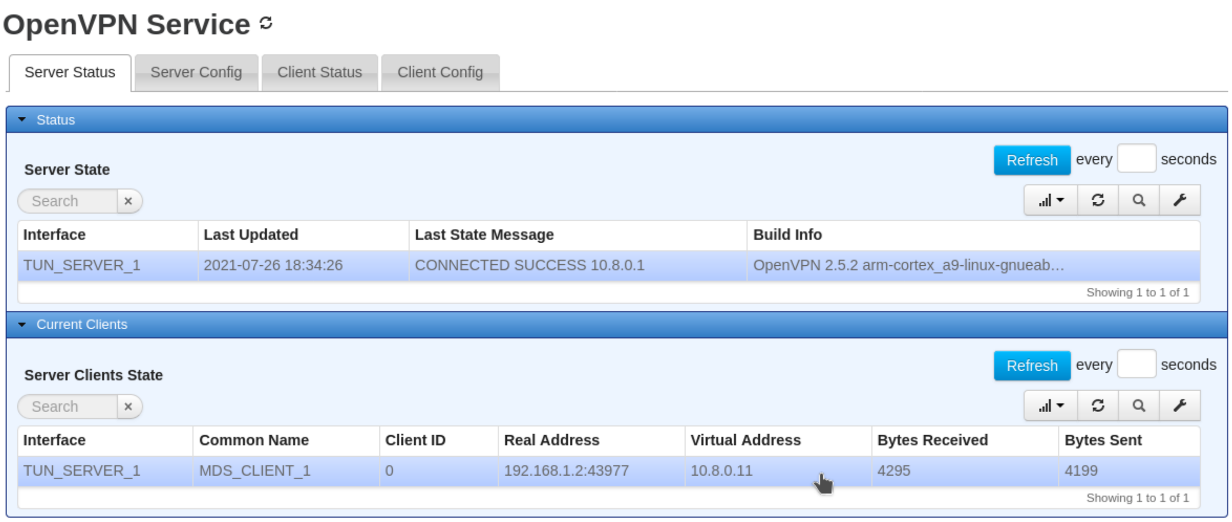
The following lists the sequence of CLI commands to create and configure an OpenVPN Client instance and to enable it:

%set services openvpn client *TUN2*
%set services openvpn client *TUN2* **server 192.168.1.2** *1194*
%set services openvpn client *TUN2* **auth-type** *pub-key*
%set services openvpn client *TUN2* **pki cert-type** *rsa*
%set services openvpn client *TUN2* **pki ca-cert-id** *ovpn_ca_cert*
%set services openvpn client *TUN2* **pki cert-id** *ovpn_client_cert* **key-id** *ovpn_client_key*
%set services openvpn client *TUN2* **enabled true**

Monitoring

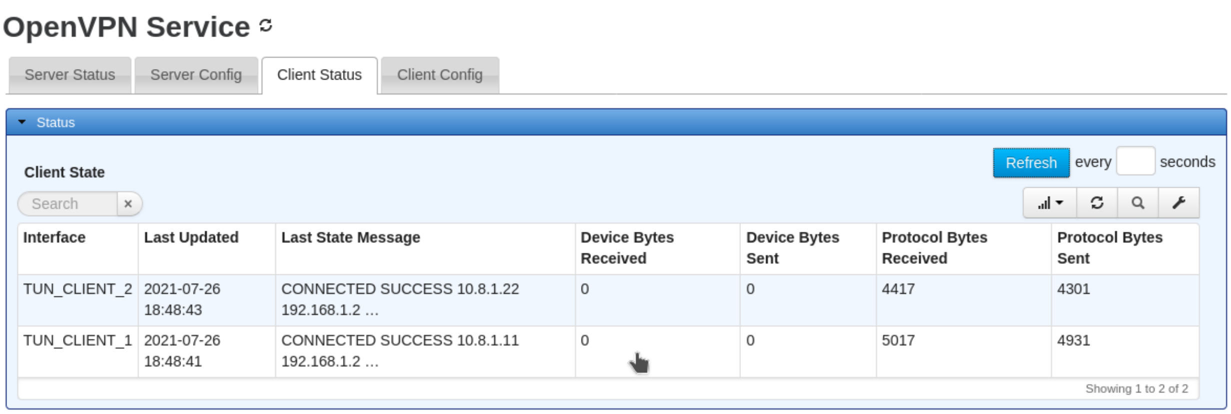
Server

Server status provides general information on the TUN virtual device as well as information on connected clients.



Client

Client status provides summarized information for all connected clients.



3.8.15 DHCP Service

Understanding

The unit can be configured as a DHCP server. When enabled, this service will respond to DHCP requests from any interface.

As a DHCP server, the unit can assign either IPv4 or IPv6 addresses to clients

NOTE In order for the DHCP server to assign addresses from the configured v4 or v6 subnet, at least one of the unit's interfaces (ETH1, ETH2, WiFi or Bridge) must be configured with an IP address from that subnet.

Configuring

Using the Web UI

Navigate to ***DHCP Server ---> Basic Config***.

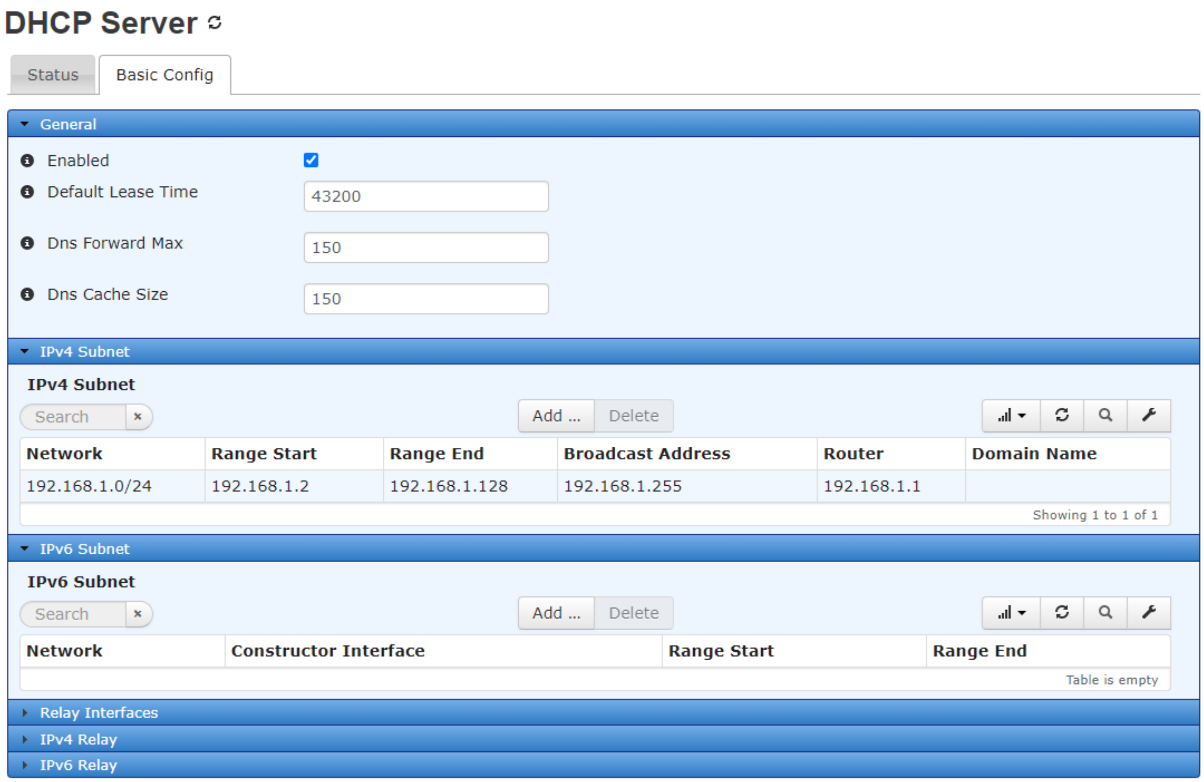


Figure 3-215. DHCP Menu

The **General** drop-down contains the following options.

- **Enabled -** Enables the DHCP service. Check this box to allow the unit to act as a DHCP server.
- **Default Lease Time –** This is the amount of time, in seconds, that a client's lease is valid. This value is only used if the client doesn't include a lease time in its DHCP request. In IPv6 addressing, this is also known as "valid lifetime."
- **Dns Forward Max –** This is the value of the maximum number of concurrent DNS queries that will be supported by the DNS proxy thst is setup by the DHCP service.
- **Dns Cache Size –** This is the value of the maximum number of cached DNS entries that will be kept by the DNS proxy that is setup by the DHCP service.

The **V4 Subnet** and **V6 Subnet** drop-downs show the currently configured DHCP subnets. Click on an entry to edit, add or delete new entries.

IPv4 Subnets

To add an IPv4 subnet, click the **Add** button in the **V4 Subnet** section.

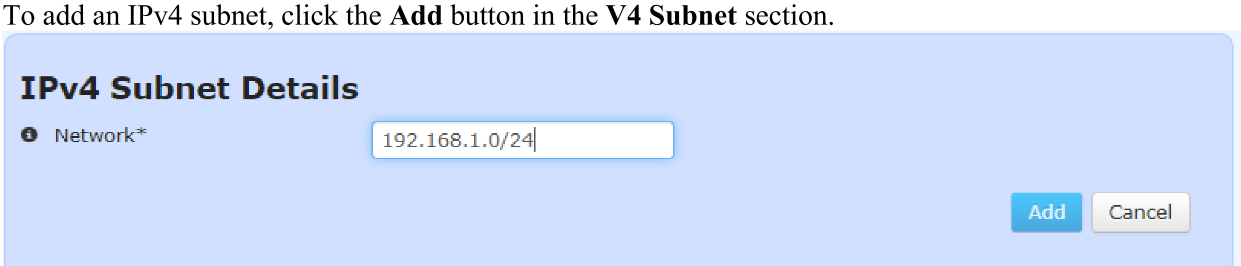


Figure 3-216. Adding a new DHCP IPv4 subnet

Enter the subnet's IPv4 address and prefix and click Add. A menu appears to configure DHCP options for the subnet.

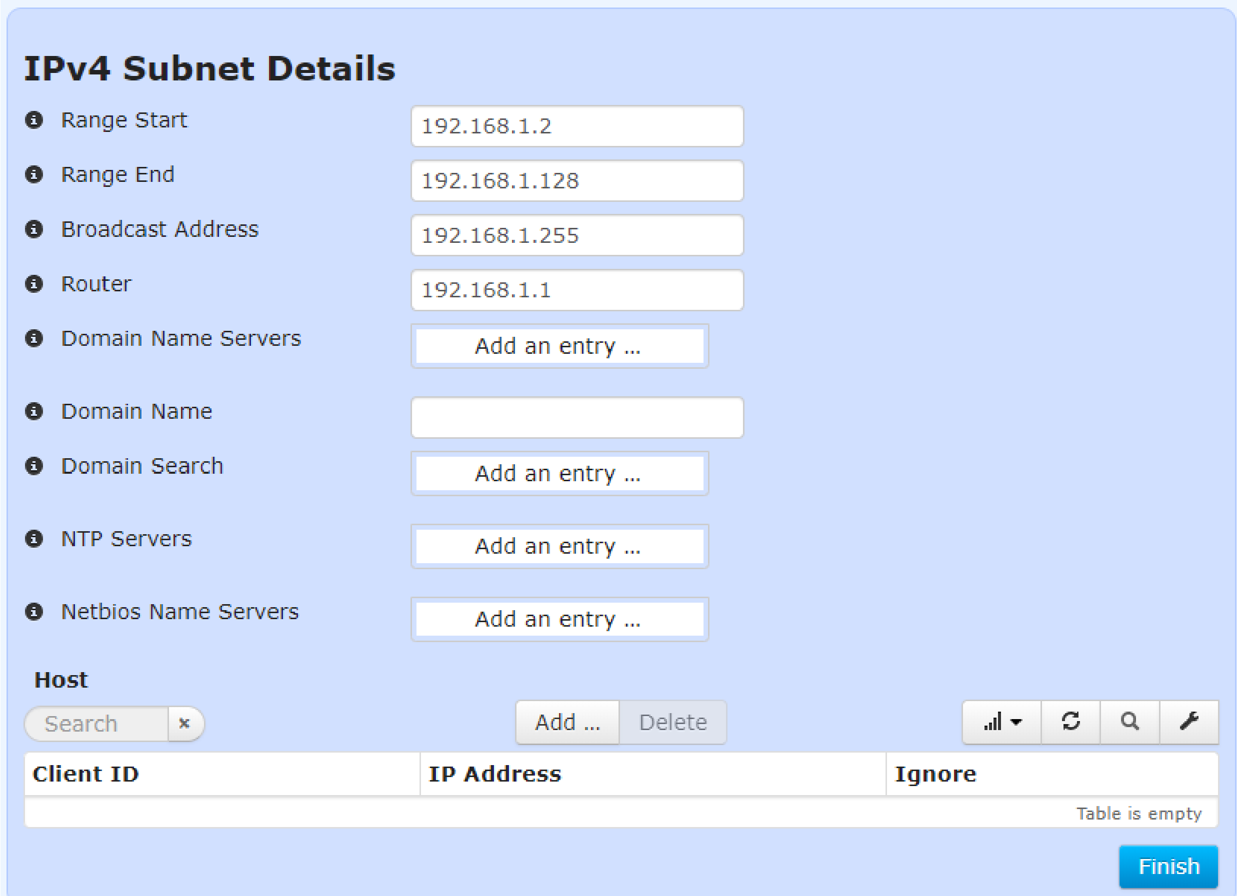


Figure 3-217. Configuration options for an IPv4 subnet

The following configuration options are required.

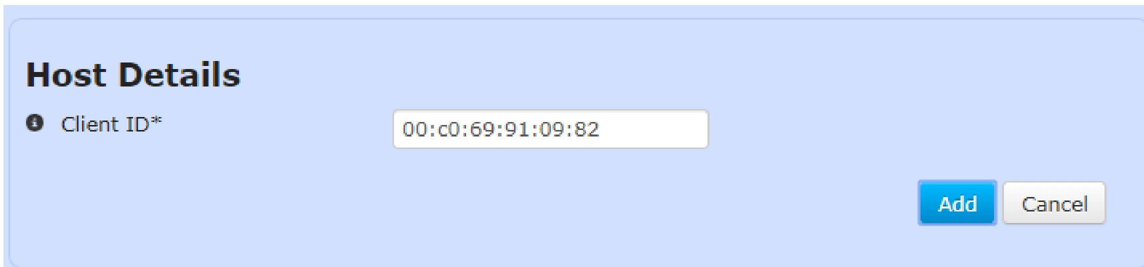
- **Range Start** – The start of the range of IP addresses to be assigned.
- **Range End** – The last of the range of IP addresses to be assigned.

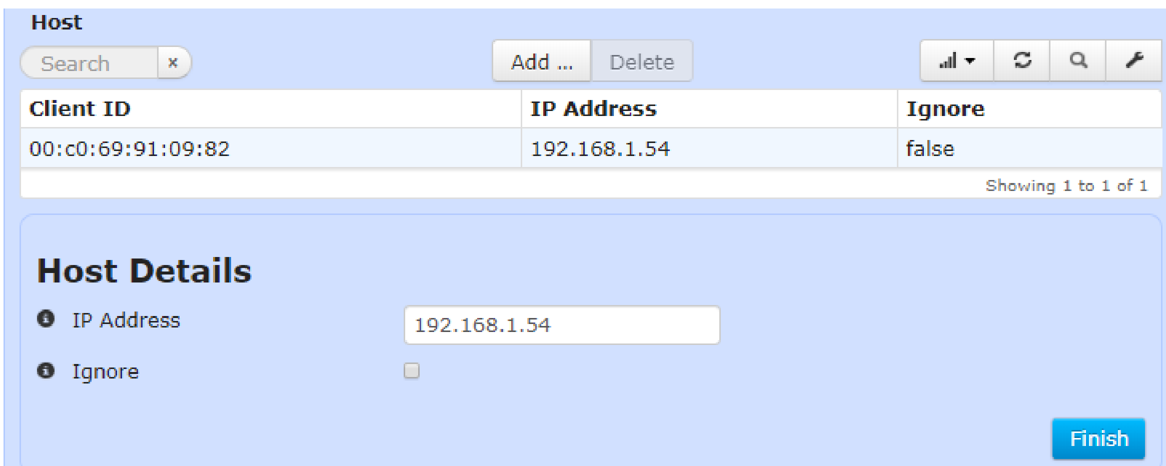
The following configuration options are optional.

- **Broadcast Address** – Address that clients should use for broadcast messages.
- **Router** – The IP address that the clients should use as their default router/gateway. If not specified, the unit's address is provided to the clients as the default router.
- **Domain Name Servers** – A list of IPv4 addresses for DNS servers that clients should use to resolve domain names.
- **Domain Name** – Domain name to pass to clients.
- **Domain Search** – Search list of domain names to pass to the clients.
- **NTP Server** – A list of NTP (Network Time Protocol) servers to pass to clients. Domain names or IP addresses may be used. Entries must be separated by spaces.
- **NetBIOS Name Servers** – A list of NetBIOS name servers to pass to clients. Domain names or IP addresses may be used. Entries should be in order of preference and must be separated by spaces. NetBIOS is also referred to as "WINS."

- **Host-** The list of static host entries, where each entry has following fields:
  - **Client-Id-** "This field is used to identify the client. It can be specified as MAC address of the client XX:XX:XX:XX:XX:XX, where, individual XX octets can be wildcarded by specifying *. It can also be specified as DHCP option 61 client identifier by prefixing the client-identifier with \"id:\", for example, as id:my-device-1 when using \"my-device-1\" string as client-identifier or as id:01:02:03:04 when using 01:02:03:04 colon delimited hexadecimal string as client-identifier..
  - **IP-Address-**IPv4 address to assign to this client.
  - **Ignore -**When enabled, the DHCP server shall not assign a lease to this client**.**

    For example, with following configuration, the client with MAC address of 00:c0:69:91:09:82 will be assigned 192.168.1.200





Once all configuration is complete, click **Save.**

IPv6 Subnets

To add an IPv6 subnet, click **Add** in the **V6 Subnet** submenu, located in the main **DHCP** menu.

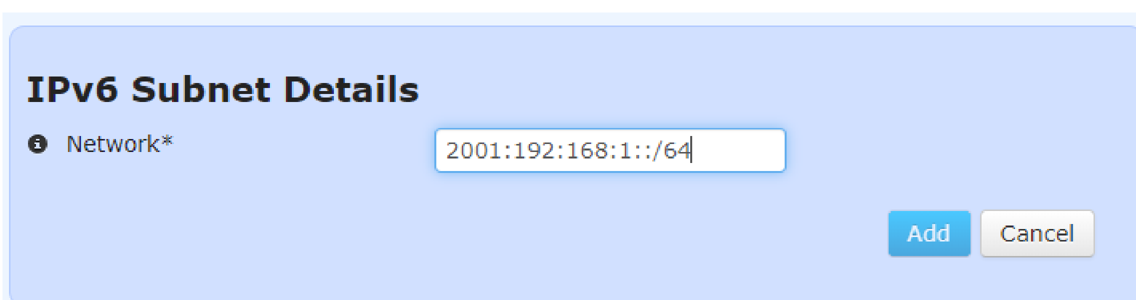


Figure 3-218. Adding a new DHCP IPv6 subnet

Enter the subnet’s IPv6 address and prefix and click **Add.** A menu appears to configure DHCP options for the subnet.

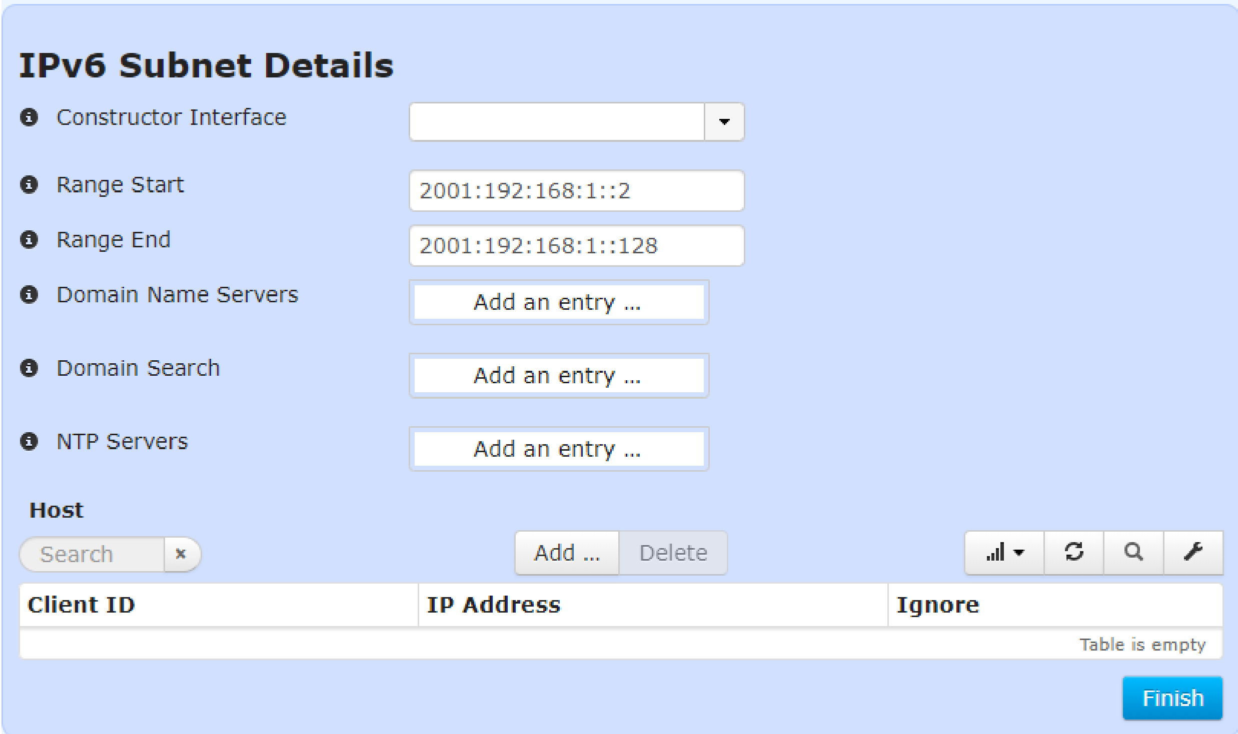


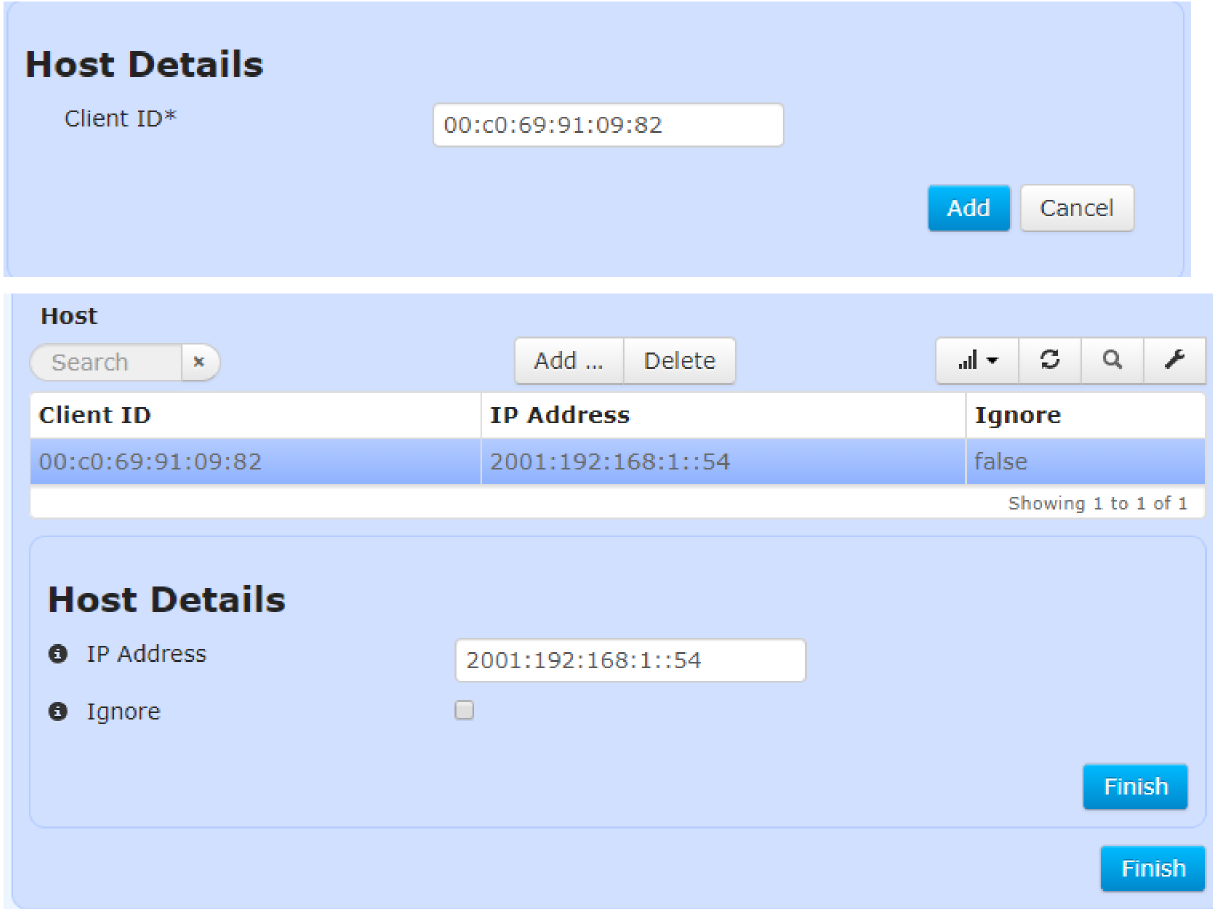
Figure 3-219. Configuration options for an IPv6 subnet

The following configuration items are required:

- **Range Start –** The start of the range of IP addresses to be assigned.
- **Range End –** The last of the range of IP addresses to be assigned.
- **Domain Name Servers –** A list of IPv6 addresses for DNS servers that clients should use to resolve domain names.
- **Domain Search** – Search list of domain names to pass to the clients
- **NTP Servers** - A list of NTP (Network Time Protocol) servers to pass to clients. Domain names or IP addresses may be used.
- **Host-** The list of static host entries, where each entry has following fields:
    - **Client-Id-** "This field is used to identify the client. It can be specified as MAC address of the client XX:XX:XX:XX:XX:XX. When it is specified as MAC address, then static entry is created using DUID-LL formed from the MAC address (00:03:00:01:XX:XX:XX:XX:XX:XX). It can also be specified with explicit DUID by prefixing it with \"id:\", for example, as id:00:03:00:01:XX:XX:XX:XX:XX:XX.

      NOTE: Wildcarded IPv6 DUID is NOT supported."
    - **IP-Address-**IPv6 address to assign to this client.
    - **Ignore -**When enabled, the DHCP server shall not assign a lease to this client**.**

  For example, with following configuration, the client with MAC address of 00:c0:69:91:09:82 will be assigned 2001:192:168:1::54.



Once all configuration is complete, click **Save.**

Using the CLI

The following shows an example of configuring DHCP service on the unit.

```
set services dhcp enabled true

# v4subnet
% set services dhcp v4subnet 192.168.1.0/24 range-start 192.168.1.2
% set services dhcp v4subnet 192.168.1.0/24 range-end 192.168.1.128
% set services dhcp v4subnet 192.168.1.0/24 broadcast-address 192.168.1.255
% set services dhcp v4subnet 192.168.1.0/24 router 192.168.1.1

# static IPv4 entry
% set services dhcp v4subnet 192.168.1.0/24 host 00:c0:69:91:09:82 ip-address 192.168.1.54

# v6subnet
% set services dhcp v6subnet 2001:192:168:1::/64 range-start 2001:192:168:1::2
% set services dhcp v6subnet 2001:192:168:1::/64 range-end 2001:192:168:1::128

# static IPv6 entry
% set services dhcp v6subnet 2001:192:168:1::/64 host 00:c0:69:91:09:82 ip-address 2001:192:168:1::54

% commit
```

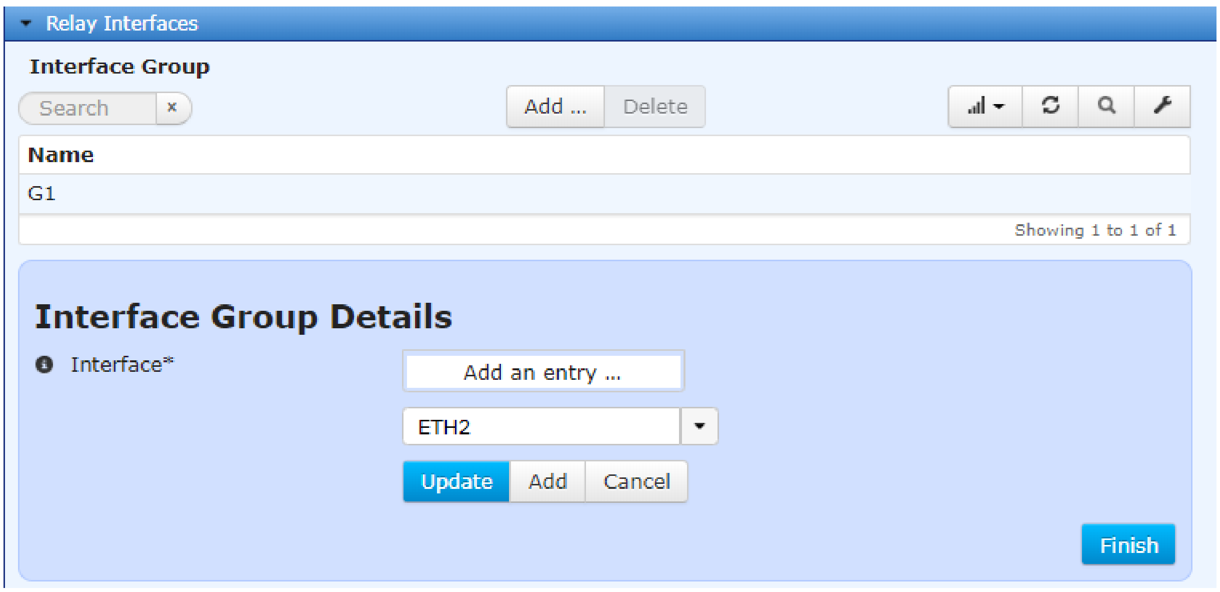
DHCP Relay

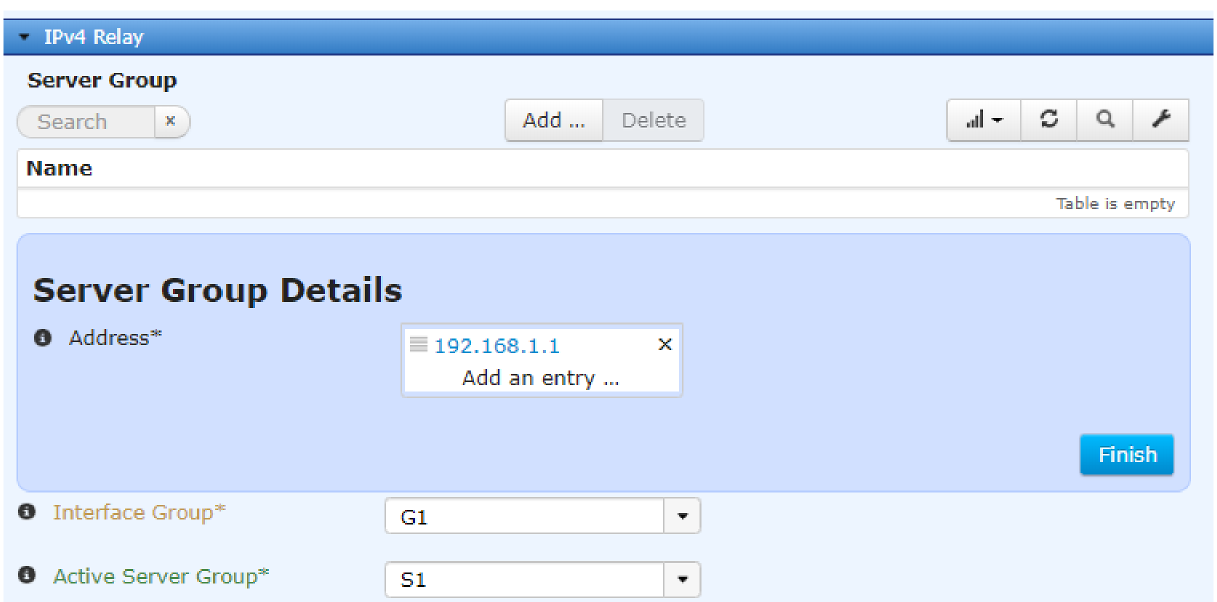
Orbit supports IPv4 and IPv6 DHCP relay functionality, where it can receive DHCP messages from the clients on a group of interfaces and send them (unicast) to a configured DHCP server that is on a different sub-network.

Using the Web UI

The DHCP relay configuration consists of creating an interface group that includes the interfaces directly connected to the network segment on which clients reside and configuring server group that consist of one or more DHCP server IP addresses.

For example, with following configuration, DHCP messages received from clients on ETH2 network segment will be forwarded to DHCP server with IPv4 address 192.168.1.1.





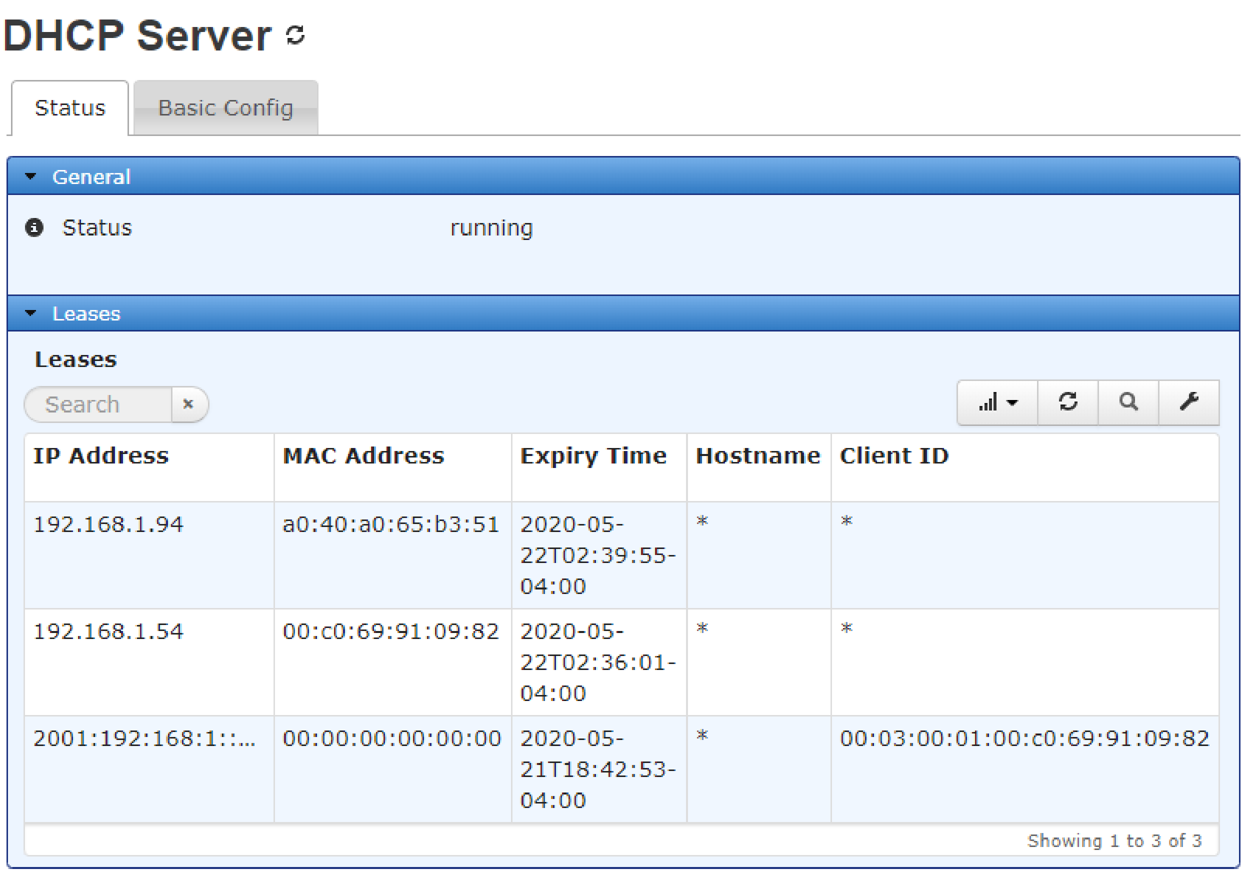
Using the CLI

```
% set services dhcp enabled true
% set services dhcp relay interface-group G1 interface [ ETH2 ]
% set services dhcp relay ipv4 server-group S1 address [ 192.168.1.1 ]
% set services dhcp relay ipv4 interface-group G1
% set services dhcp relay ipv4 active-server-group S1
% commit
```

Monitoring

Using the Web UI

The **Leases** submenu located under the **Status** tab shows the DHCP leases currently assigned by the device.



Using the CLI

From the CLI in operational mode, follow the example below to view the DHCP leases.

```
admin@none 16:42:06> show services dhcp
services dhcp leases 192.168.1.94
 mac-address a0:40:a0:65:b3:51
 expiry-time 2020-05-22T02:39:55-04:00
```

```
 hostname    *
 client-id   *
services dhcp leases 192.168.1.54
 mac-address 00:c0:69:91:09:82
 expiry-time 2020-05-22T02:36:01-04:00
 hostname    *
 client-id   *
services dhcp leases 2001:192:168:1::54
 mac-address 00:00:00:00:00:00
 expiry-time 2020-05-21T18:42:53-04:00
 hostname    *
 client-id   00:03:00:01:00:c0:69:91:09:82
```

3.8.16 Terminal Service

Understanding

Orbit allows the setup of a serial port as a terminal server that passes data to/from the serial port to network interfaces. The serial port must be configured to do this. In most cases, the data from the serial port is treated as a seamless stream; meaning it is not protocol aware and will send data from the serial port to the remote endpoint as soon as the data is received. The exceptions to this are the polled server operations: MODBUS/TCP, polled TCP, and polled UDP. In these cases, 32+ connected clients are supported. Clients are serviced on a per-transaction basis, in the order that the original TCP or UDP frame is received. A transaction begins when the initial data frame is received over TCP or UDP and ends when the serial data received in response is transmitted to the remote client. (A transaction timeout timer is used to prevent stale messages from being sent past their useful life.)

For terminal server operation with COM ports, the serial port requires configuration of baud rate and data format, as well as line type (RS232/RS485) and handshaking as applicable.

The terminal server listens on all local IPv4 addresses. IPv6 network operations are not supported at this time.

NOTE Serial ports in Orbit are broadly defined to include any user addressable interfaces that pass serial bytes. Serial ports include all physical COM ports and the mini-USB. Depending on configuration, serial ports may also include virtualized access to the over-the-air serial data stream of NIC interfaces. Examples include “LnRadio-serial” which provides a backward compatible serial interface to legacy licensed narrowband MDS radios.

Terminal-server network operation can be configured as:

- TCP
  - TCP Client
  - TCP Server
  - TCP Client/Server
  - MODBUS-TCP client
  - MODBUS-TCP server
  - MODBUS-TCP client/server
- UDP

- Point-to-Point
- Point-to-Multipoint
- Multipoint-to-Point
- Multipoint-to-Multipoint
- Polled UDP

When a terminal server on the unit is configured as TCP server, then the unit listens on a TCP port for client connections. The server may be configured in streaming TCP mode, where data is transmitted to/from the serial port as soon as it is received, or in polled TCP mode. In polled TCP mode, 32+ connected clients are supported and data received from client connections is handled on a per-transaction basis, as described above in Understanding. Polled TCP mode is useful for scenarios that require network traffic to be handled on a per-transaction basis, such as MODBUS over TCP.

When a terminal server on the unit is configured as TCP client, then the unit can be further configured to attempt connection to the remote IP address (and port) when data is received on the serial port or to maintain a persistent TCP connection. Once a TCP connection is established, then serial traffic from the COM port can pass to and from the TCP server as long as the TCP connection remains established. More than one remote IP address (and port) can be configured to allow TCP client to failover from primary TCP server to the backup. The TCP client cycles through the configured remotes until a connection is successfully established. Please refer to TCP client configuration for more details on multi-remote operation.

When a terminal server on the unit is configured as a MODBUS/TCP server, then the unit listens on a TCP port for a client connection. Once a TCP connection is established, the unit will convert the incoming MODBUS/TCP frame into either a MODBUS/RTU or MODBUS/ASCII frame for transmitting on the serial port. Serial data received is converted from either MODBUS/RTU or MODBUS/ASCII to MODBUS/TCP for transmission back to the MODBUS/TCP client. 32+ connected clients are supported and data received from client connections is handled on a per-transaction basis, as described above in Understanding.

When a terminal server on the unit is configured as a MODBUS/TCP client, then the unit attempts to connect to a remote IP address. Once a TCP connection is established, the unit will convert MODBUS/RTU or MODBUS/ASCII frames received on the serial port into a MODBUS/TCP frame for transmission to the remote server. Data received from the remote server is converted from MODBUS/TCP to either MODBUS/RTU or MODBUS/ASCII before it is transmitted on the serial port.

When a terminal server on the unit is configured as a UDP endpoint, then traffic from the COM port is sent to the remote host at the specified port in UDP packets. Likewise, traffic sent to the UDP port of the unit is forwarded out the COM port. The UDP packets may be unicast or multicast, depending on the UDP mode. Since UDP is stateless, some packets may not reach their intended destination or may arrive out of order. The protocol contained in the UDP messages must handle these scenarios.

The terminal server can be configured as a polled UDP endpoint for scenarios that require network traffic to be handled on a per-transaction basis, such as MODBUS over UDP. The terminal server supports 32+ active transactions, as described above in Understanding. Since UDP is stateless, some packets may not reach their intended destination or may arrive out of order. The protocol contained in the UDP messages must handle these scenarios.

Table 3-29. TCP Terminal Server Settings

	Maximum connected clients	Data is transmitted
Streaming TCP	1	Upon receipt
Polled TCP	32+	On a per-transaction basis, based on the order the initial frame was received

Table 3-30. UDP Terminal Server Settings

	UDP RX	UDP TX
Point-to-Point	Local Address/Port	Peer Unicast Address/Port
Point-to-Multipoint	Local Address/Port	Multicast Group Address/Port
Multipoint-to-Point	Multicast Group Address/Port	Peer Unicast Address/Port
Multipoint-to-Multipoint	Multicast Group Address/Port	Multicast Group Address/Port
Polled UDP	Local Address/Port	Peer Unicast Address/Port

NOTE Once a terminal-server is enabled on a COM port, the port stays in data mode and the CLI will not be available on that port. To break out of data mode, the escape sequence +++ can be entered on the PC's keyboard. The baud rate and format must match on the PC and on the unit for the escape sequence to be detected. Once the sequence is detected, the login prompt is presented as long as the port is enabled for console access.

Basic Setup of UDP Terminal Server

Configuring

The following shows how to enable a UDP terminal server on COM1. Navigate to ***Serial ---> Basic Config / Terminal Server***

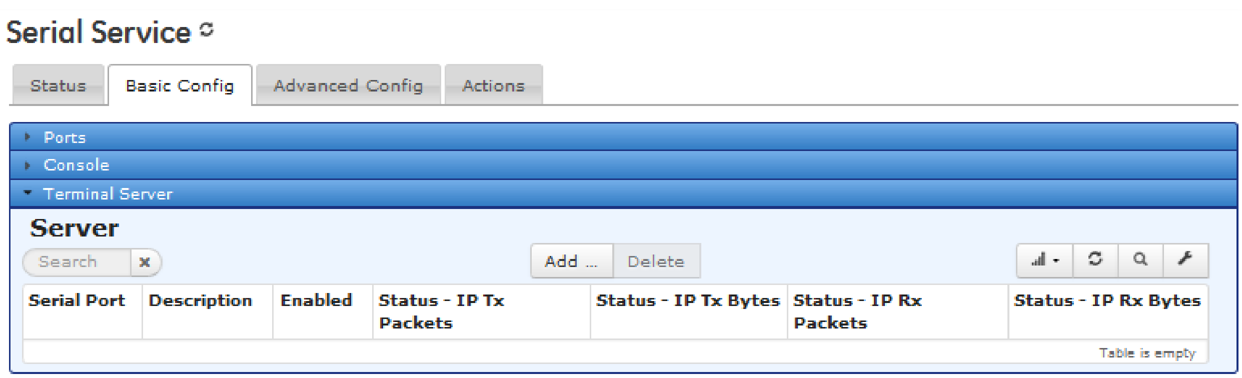


Figure 3-220. Terminal Server Start Screen

Click on **Add** and select the serial port for use by typing in COM1 or select after clicking on the button to the right of the field. Then, after selecting the COM port, click the **Add** button.

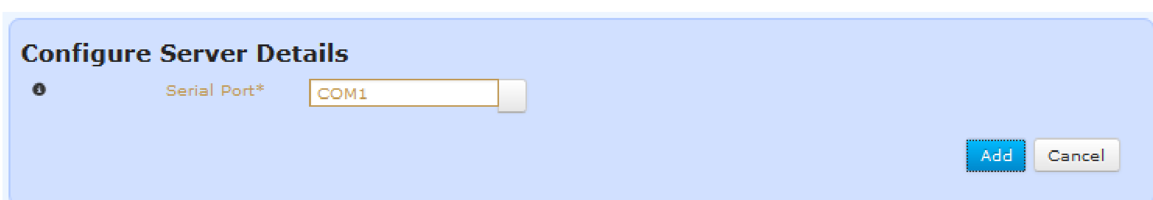


Figure 3-221. Terminal Add Screen

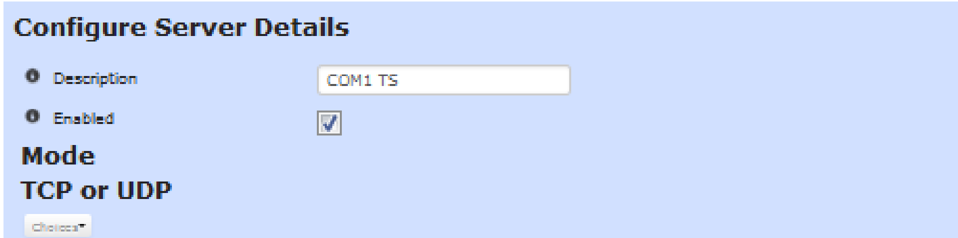


Figure 3-222. Terminal Server Setup Screen

- **Description** – A user-defined string describing the terminal server.**-** blank by default
- **Enabled** -– Check box to allow for enabling/disabling the server
- **Mode -** Further detailed configuration information
  - Click **Choices**
  - Click **Udp**
  - Click **Udp** check box

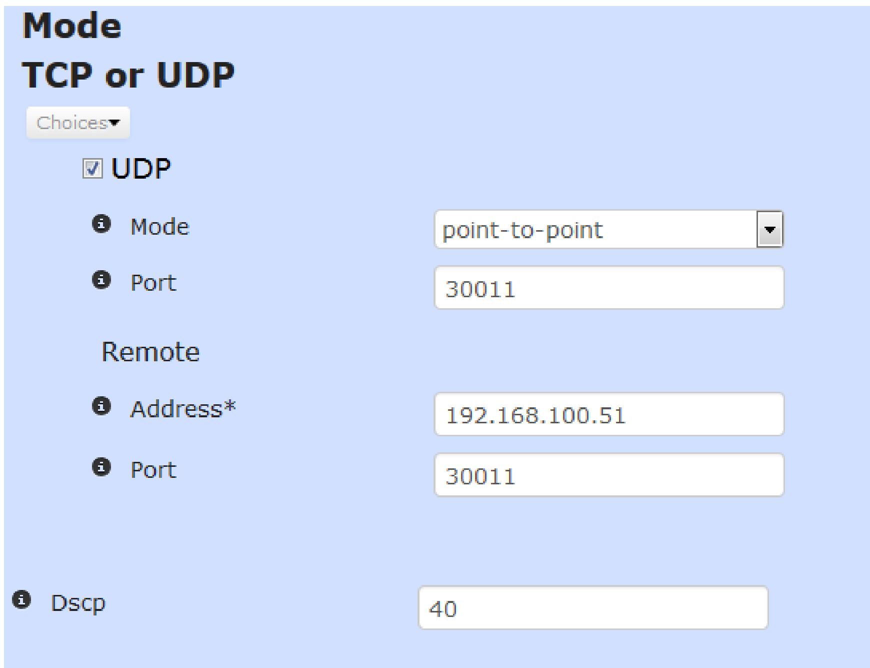


Figure 3-223. UDP Terminal Server Configuration Screen

UDP

- **Mode** – Mode of terminal server
  - Point to Point (DEFAULT)
  - Point to Multipoint
  - Multipoint to Point
  - Multipoint to Multipoint
  - Polled UDP

Remote

- **Address** – The IPv4/IPv6 address
- **Port** – The UDP port used when sending serial data to the remote address (30011 - DEFAULT)

- **DSCP** – The Differentiated Services Code Point to set in the IPv4 header of outgoing packets (40 – DEFAULT)

When selecting one of the Multicast options:

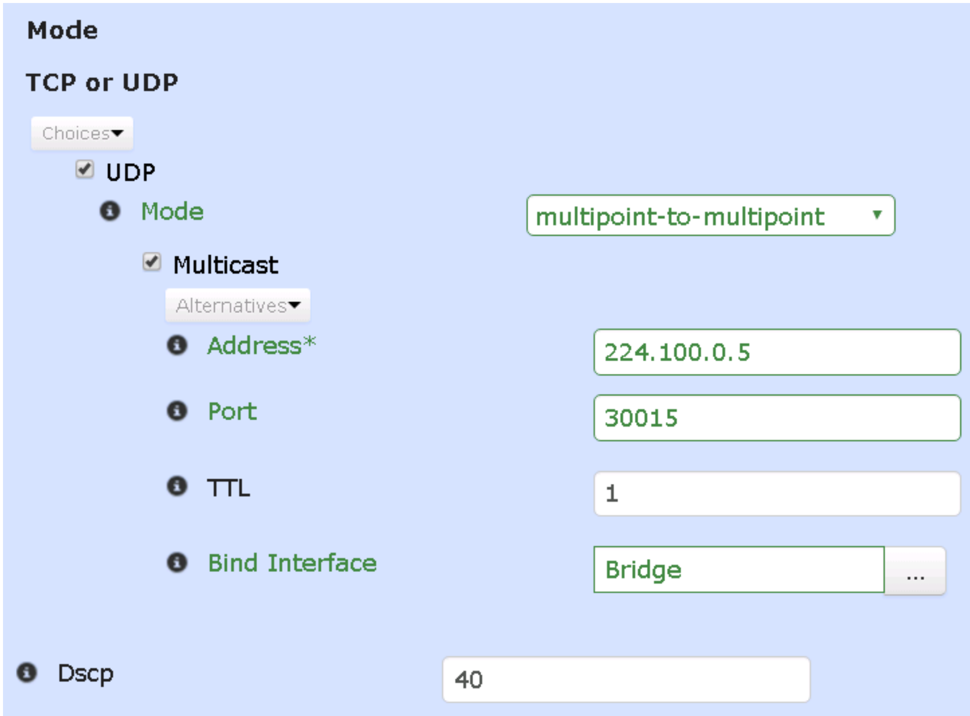


Figure 3-224. UDP Terminal Server Multicast Settings Screen

Multicast

- **Address** – The multicast IPv4 address in the form of 224.0.0.1
- **Alternatives:** Specifies multicast group IP version (IPv4 multicast group address – Default)
- **Port** – The local port of the server 0-65535 (30011 - DEFAULT)
- **TTL -** The multicast TTL threshold used to restrict delivery of multicast frame as they pass through routers to a specified number of hops.
    - Setting TTL to a value of 0 restricts the frame to the same host.
    - Setting TTL to a value of 1 restricts the frame to the same subnet.
    - Setting TTL to a value of 32 restricts the frame to the same site.
    - Setting TTL to a value of 64 restricts the frame to the same region.
    - Setting TTL to a value of 128 restricts the frame to the same continent.
    - Setting TTL to a value of 255 unrestricts the frame.
- **Bind Interface** – The bind interface specifies the interface that multicast traffic will be sent out on. (This provides a simplified method of configuration, avoiding the need to setup static routes)
- **DSCP** – The Differentiated Services Code Point to add to the IP header of outgoing packets (40 – DEFAULT)

The polled UDP settings are similar to point-to-point, with one additional configuration option.

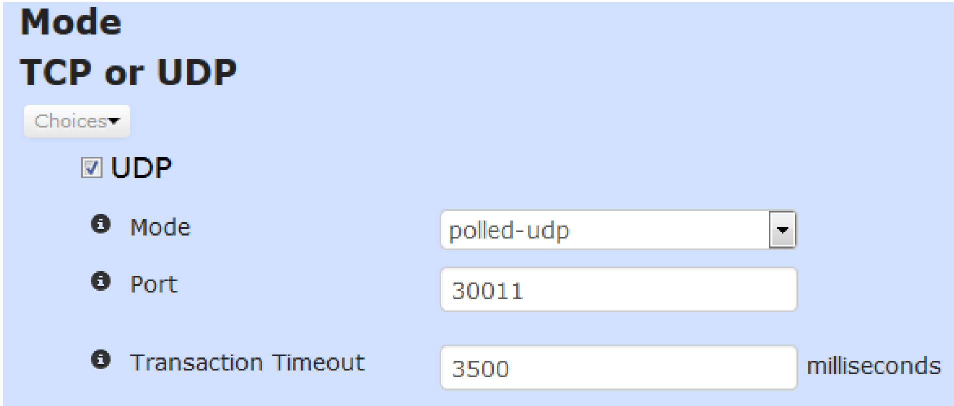


Figure 3-225. Polled UDP Settings Screen

- **Transaction timeout** – The period, in milliseconds, of inactivity on the serial port before an inactive transaction is dropped. A transaction begins when data is received via UDP and ends when serial data received in response is transmitted to the remote endpoint. (3500 – DEFAULT)

Basic Setup of a TCP Terminal Server

Start the same initial settings as were done for UDP setup.

- Click **Choices**
- Click **TCP Server**
- Click **TCP Server** check box

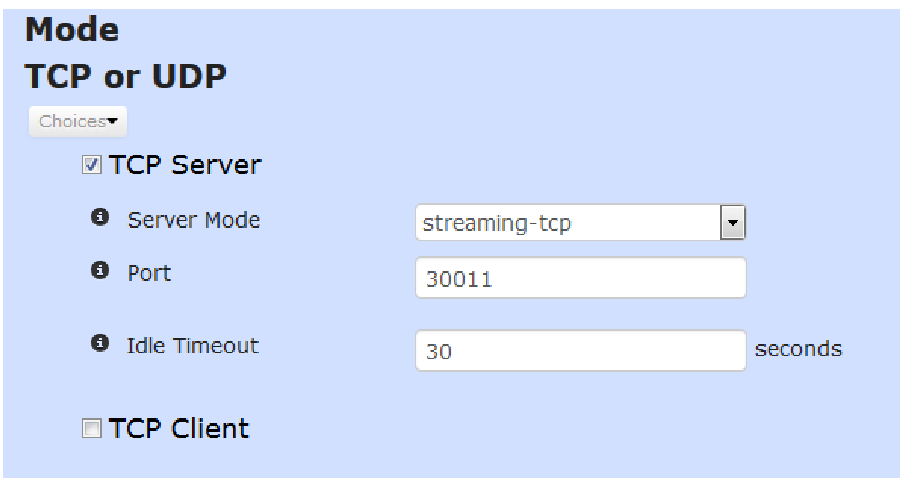


Figure 3-226. TCP Terminal Server Settings Screen

TCP Server

- **Server Mode**
  - **streaming-tcp**: A single client connection is supported. Data is transmitted to/from the serial port as soon as it is received.
  - **polled-tcp**: >= 32 connected clients are supported. Data received from client connections is handled on a per-transaction basis, in the order that the initial TCP frame was received. A transaction begins when the initial data frame is received over TCP and ends when the serial data received in response is transmitted to the remote client.

- **multipoint-tcp**: >= 32 connected clients are supported. Any serial data received is passed to all TCP clients. Data received from any IP connection is sent to the serial port. This mode is analogous to UDP multicast. The primary use case would be a serial poller with TCP clients.

- **Port** – The local port of the server 0-65535 (30011 - DEFAULT)
- **Idle Timeout -** The time interval (in secs) after which a tcp connection is disconnected if there is no data activity to/from the client. Note: a value of "0" is reserved to mean "persistent connection". (30 sec DEFAULT)

Other TCP server settings vary based on the server mode selected.

The following setting applies only when the server operates in Steaming TCP mode.

- **Connection Policy –** This specifies the behavior when a new TCP connection is attempted and there is already an existing session in progress.
  - **drop-existing**: This specifies to drop the existing connection (if the idle timeout is 0)
  - **drop-new**: This specifies to drop the new attempted connection. (DEFAULT)

The following setting applies only when the server operates in Polled TCP mode.

- **Transaction Timeout -** The period, in milliseconds (50-65535), of inactivity on the serial port before an inactive transaction is dropped. If this expires the poll is considered lost. A transaction begins when data is received via TCP and ends when serial data received in response is transmitted to the remote endpoint. (3500 – DEFAULT)
- **Queue Timeout** - The period, in milliseconds (0, or 50-65535) after which a packet in queue is considered stale and should be dropped. Setting the value to 0 disables the timeout.

NOTE The Host polling system should ensure that any retry timers are set to a value greater than the sum of **Transaction Timeout** and **Queue Timeout**.

- **Reply Type** – This specifies what type of response should be expected to indicate end of transaction.
  - **single-packet**: a single packet defined by vmin/vtim represents end of transaction
  - **multi-packet**: a transaction response may consist of multiple packets. The transaction is delimited by expiration of the "Response Idle Timeout"
- **Response Idle Timeout** – (*only applicable when reply type is "multi-packet")* This specifies the period in milliseconds (10-5000) to wait for a new packet after receipt of previous packet before considering the response complete
- **Drop Unsolicited Serial Traffic –** If the checkbox is selected the server will drop unsolicited traffic. If not selected, the server will pass unsolicited traffic to the serial port. Leave this box unchecked to support "report by exception" from connected devices.

TCP Client

Single Remote

In this example below, the TCP Client is configured with one remote with IPv4 address 192.168.1.2 and TCP port of 30011.

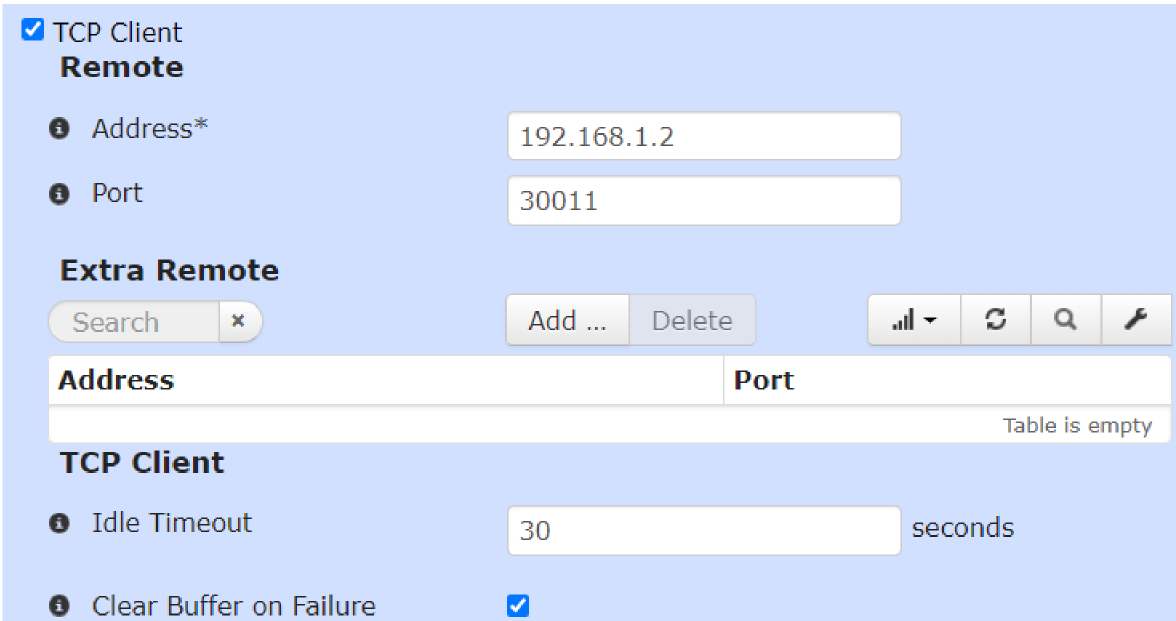


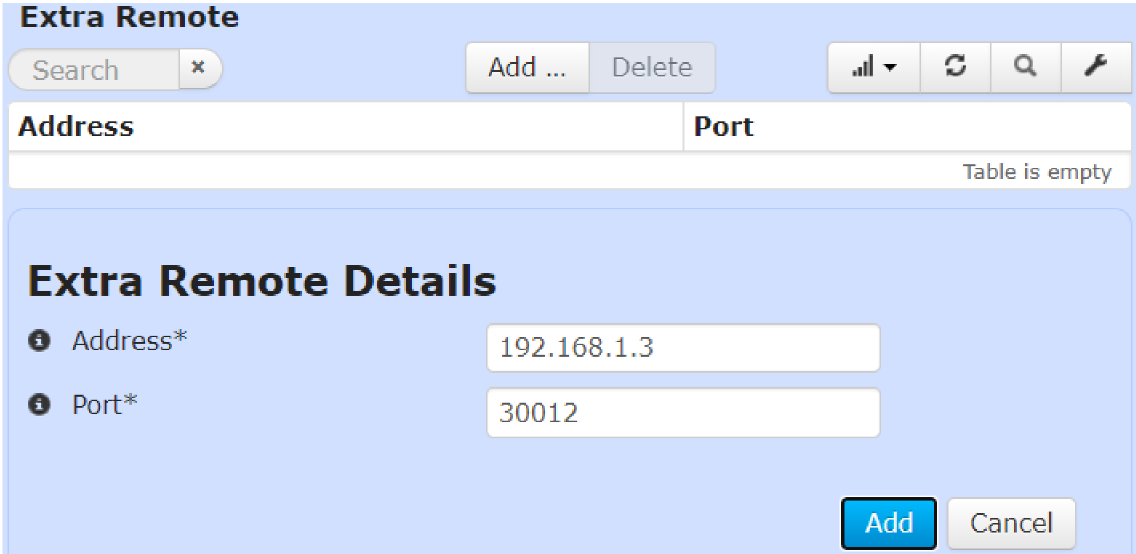
Figure 3-227. TCP Terminal Client Settings Screen

Remote

- **Address** – The IPv4 address used when sending serial data.
- **Port** – The local port of the server 0-65535 (30011 - DEFAULT)
- **Idle Timeout -** The time interval (in secs) after which a tcp connection is disconnected if there is no data activity to/from the client. Note: a value of "0" is reserved to mean "persistent connection". (30 sec DEFAULT)
- **Clear Buffer On Failure –** When disabled, the received serial data is buffered while the TCP connection is being established and all buffered data is delivered on successful connection. When enabled, the buffering is disabled. (DEFAULT = Enabled)

Multiple Remotes

One or more extra remotes can be configured to enable failover between primary and backup remote TCP server destinations. In the example below, second remote is configured with IPv4 address 192.168.1.3 and port 30012.



Following describes the TCP client operation with multiple remotes:

- After it is enabled or after a configuration change, the tcp-client first attempts connection to the primary remote.
- If idle timeout is non-zero, the tcp client attempts connection only on receiving data from serial port.
- If idle timeout is non-zero, in case of failure to connect to primary remote, tcp client clears receive buffer and updates state to attempt connection to the next remote in the extra remotes list (or back to the primary remote once it has cycled through all the extra remotes) when data is received from the serial port.
- If idle timeout is non-zero, the tcp client releases connection in case there is no data transmission for idle timeout seconds.
- If idle timeout is non-zero, the tcp client first attempts connection to the remote with which it previously had a successful connection.
- If idle timeout is zero, the tcp client attempts and maintains a persistent connection to one of the remotes (whichever ends up getting connected).
- If idle timeout is zero, in case of failure to connect to primary remote, tcp client waits for 5 seconds and then attempts connection to first remote in the extra remotes list and, so on in a round robin fashion, until successful.

TCP Client / Server

If **TCP Client / Server** is selected, options for both TCP Client and TCP Server are available.

Basic Setup of Modbus Terminal Server

Start with the same initial settings as were done for UDP setup.

- Click **Choices**
- Click **Modbus TCP**
- Click **Modbus TCP** check box

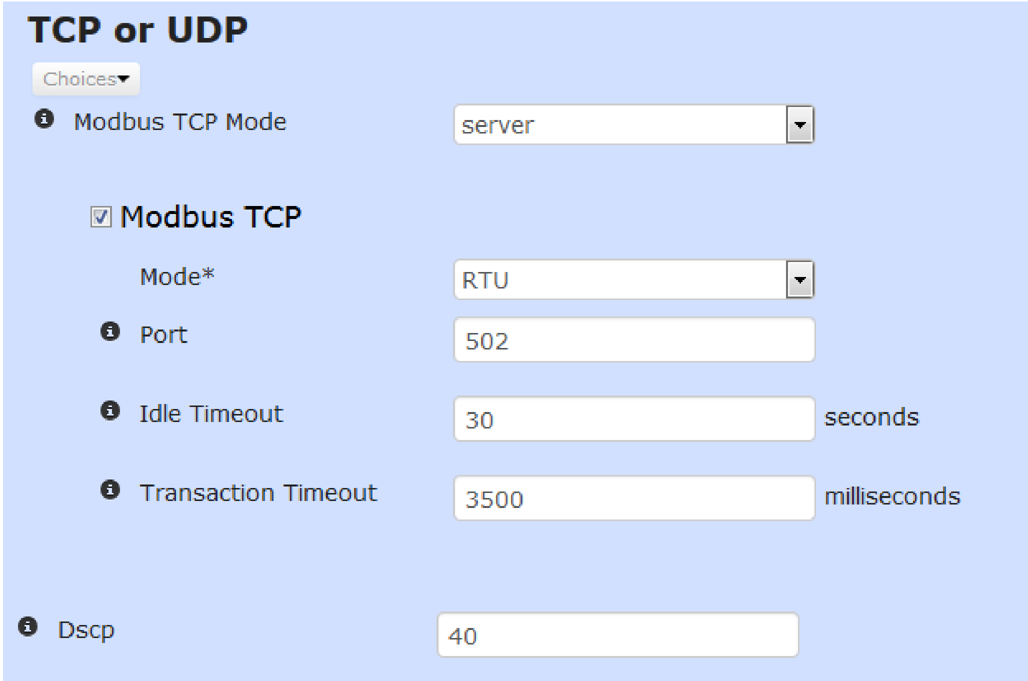


Figure 3-228. Terminal Server Modbus TCP Settings Screen

Modbus TCP

- **Mode** – Mode for the Modbus server
  - **RTU** – Convert from Modbus/TCP to Modbus/RTU
  - **ASCII** -– Convert from Modbus/TCP to Modbus/ASCII
- **Port** – The local port of the server 0-65535 (502 - DEFAULT)
- **Idle Timeout -** The time interval (in secs) after which a tcp connection is disconnected if there is no data activity to/from the client. Note: a value of "0" is reserved to mean "persistent connection". (30 sec DEFAULT)
- **Transaction Timeout -** The period, in milliseconds, of inactivity on the serial port before an inactive transaction is dropped. A transaction begins when data is received via TCP and ends when serial data received in response is transmitted to the remote endpoint. (3500 – DEFAULT)

UDP Multicast (Point to Multipoint) Server Setup Example

When the Terminal Server is configured to operate in either the Point-to-Multipoint or Multipoint-to-Multipoint UDP mode, a static route must be created to direct how the unit handles the transmission of the multicast UDP packets. This static route must define the "Outgoing Interface" for the Orbit to use to get to a Destination Prefix of the full multicast subnet of "224.0.0.0/4".

It is also recommended that a multicast static route be configured on each multipoint unit.

NOTE If a unit participates in multiple multicast groups, and each of these groups are accessible via different interfaces, then a separate static route must be created for each group and interface combination (i.e. 224.0.0.3/32 via ETH1 and 224.0.0.4/32 via ETH2), instead of the full multicast subnet.

Summary of Configuration Steps (be sure to follow these steps in order):

1. Configure an IPv4 Static-Route for the Multicast Subnet.(Static Neighbor Entries)
   - Configure Destination Prefix (dest-prefix)
   - Configure Outgoing Interface (outgoing-interface)

2. Configure Orbit Serial Terminal Server
   - Configure which Serial Port to use as Terminal Server
   - Configure UDP as Protocol
   - Configure UDP Mode to use **Point-to-Multipoint**
   - Configure remaining Terminal Server parameters, i.e. Local listening port, Remote port, Remote IP, Multicast port, Multicast IP
3. Save/Commit Configuration

Step by step walkthrough - Web Based Configuration:

4. On the left hand side of the Web GUI, click Routing.
5. Navigate to Routing ---> Basic Config / IPv4
6. Click on +Add
7. Type a numeric ID (220) which will be used to identify this route and click "Add"
8. Enter the following: 224.0.0.0/4 - This destination prefix will cover the entire Multicast Subnet and send all Multicast data out of the Bridge interface.

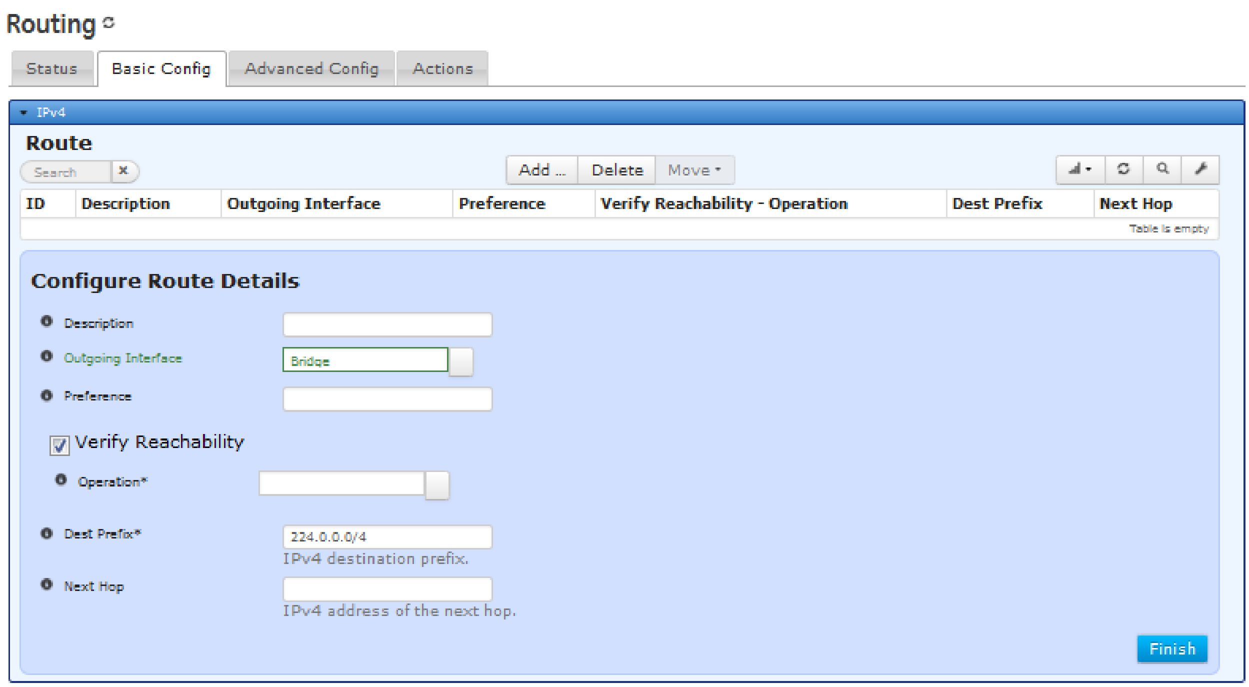


Figure 3-229. Example: Static Route Settings

9. Save the configuration.
10. View the finished IPv4 Route table to view that the route is present:

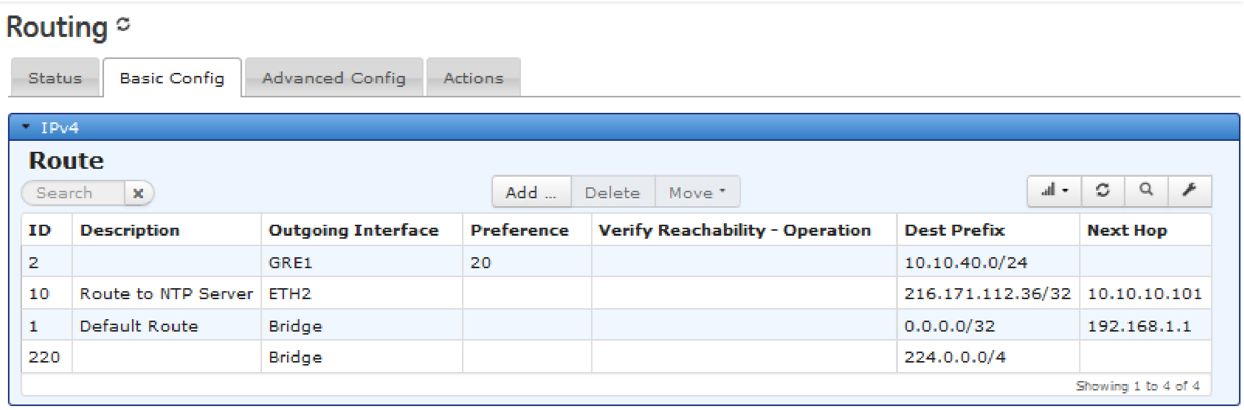


Figure 3-230. Example: Route Page

NOTE Step #8 & #9 are ONLY if the user has a Terminal Server already configured in their system. Otherwise proceed to Step #10

11. Navigate to Serial ---> Basic Config / Terminal Server
12. Disable and re-enable the Terminal Server.
    - Click to select the Serial Port,
    - Un-check the Enabled box
    - Save
13. Re-check the Enabled box and then Save.
14. Repeat this on each Multipoint unit.
15. Click on **Add** then select the COM port to use as a Terminal Server and then **OK**.
16. Configure the COM port;
    - Click **Choices**
    - Click **Udp**
    - Click **Udp** check box
17. Configure the UDP Mode that best fits the system, configure any local ports, remote ports/IPs, and Multicast ports/IPs.

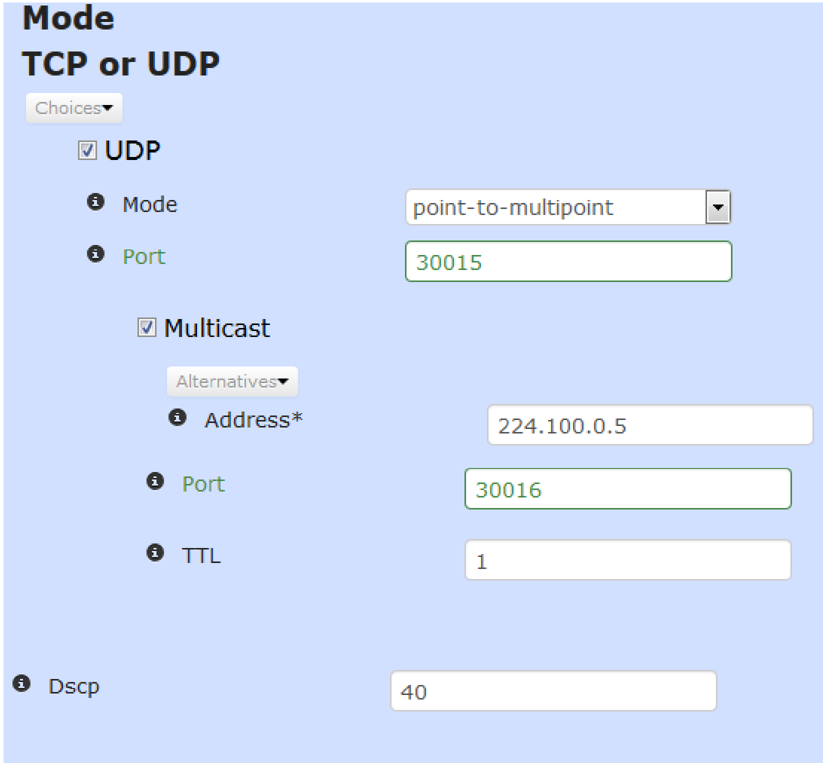


Figure 3-231. Example: UDP TS Configuration

18. Save the configuration.

Command Line Interface (CLI):

NOTE Change plain *text/italics* as appropriate to set up the system

Configure the following:

% set routing static-routes ipv4 route 220 **dest-prefix** 224.0.0.0/4 **outgoing-interface** Bridge

% set services serial terminal-server server YOURPORT **mode udp mode point-to-multipoint port** 30015 **multicast port** 30016 **address** 224.100.0.5

% commit

Configuring via the CLI

The following shows how to configure and enable a UDP terminal server on COM1:

% set services serial terminal-server server COM1 **mode udp port** 10000 **remote address** 192.168.1.12 **port** 10000

% commit

The following shows how to enable a TCP server on COM1:

% set services serial terminal-server server COM1 **mode tcp-server port** 30011 **idle-timeout** 30

% commit

The following shows how to enable a TCP client on COM1:

% set services serial terminal-server server COM1 mode tcp-client remote address 192.168.1.2

% set services serial terminal-server server COM1 mode tcp-client remote port 30011

% set services serial terminal-server server COM1 mode tcp-client idle-timeout 30

% commit

The following shows how to configure an extra remote for failover scenario:

```
% set services serial terminal-server server COM1 mode tcp-client extra-remote 192.168.1.3
30012

% commit
```

Monitoring

Each Terminal server has the same statistic information. Navigate to terminal server and select the server. For example for a COM1 server - navigate to ***Serial ---> Basic Config / Terminal Server*** and then click on **COM1**. The Terminal Service **Status** will be located at the end of the Server Details.

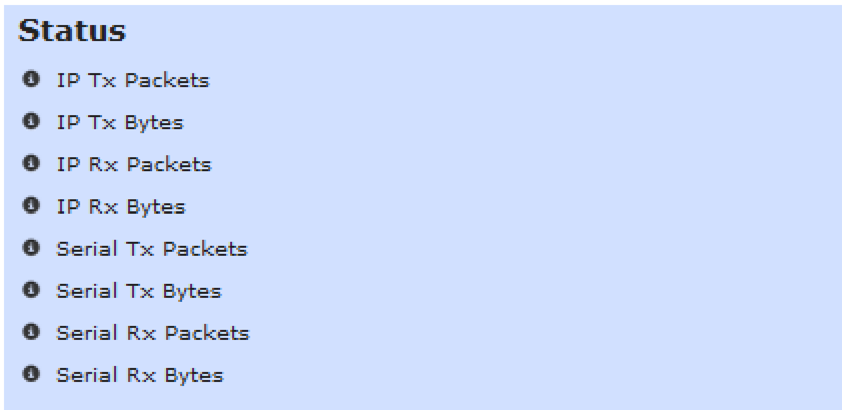


Figure 3-232. Terminal Server on COM1 Status Information

- **IP Tx Packets -** The number of IP packets transmitted
- **IP Tx Bytes -** The number of IP bytes transmitted
- **IP Rx Packets -** The number of IP packets received
- **IP Rx Bytes -** The number of IP bytes received
- **Serial Tx Packets -** The number of serial packets transmitted
- **Serial Tx Bytes -** The number of serial bytes transmitted
- **Serial Rx Packets -** The number of serial packets received
- **Serial Rx Bytes -** The number of serial bytes received

From the CLI - ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
> show services serial
                                                   SERIAL   SERIAL  SERIAL     SERIAL
SERIAL  IP TX      IP TX   IP RX      IP RX   TX       TX      RX          RX
PORT    PACKETS   BYTES   PACKETS   BYTES   PACKETS BYTES   PACKETS  BYTES
------------------------------------------------------------------------------------------
COM2    0          0       0          0       0        0       0          0
```

Serial Port Settings for Polled TCP Server and Polled UDP Modes

Some protocols, such as DNP3, can generate packets larger than 255 bytes, which is Orbit's default **Vmin** value for serial ports. To ensure that large packets are not truncated when they arrive via serial port, set **Vmin** equal to or larger than the largest expected packet.

For example, a polled TCP server that expects to receive 300-byte packets on COM1 should set COM1's **Vmin** setting equal to or larger than 300.

Figure 3-201 below shows the configuration settings available for a serial port. Please refer to section 3.5.1, ***Serial Interface***, for information on configuring the serial port.

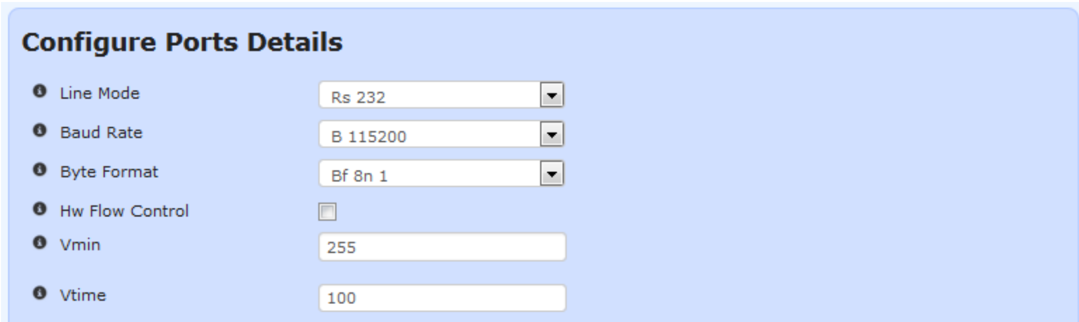


Figure 3-201. Serial Port Configuration Screen

3.8.17 Remote Management Interfaces

Understanding

The Orbit supports remote device management via SSH, HTTP/HTTPS, SNMP and NETCONF. Each of these services can configured to only listen to specified IP addresses configured on the system. Used in conjunction with Access Control List (Packet Filtering / Firewall) rules, this may be useful if there are multiple networks being routed between and it is not desirable to expose management interfaces via one or more of the networks.

For example, consider the case shown in Figure 3-233. An Orbit, located at a remote site, maintains a connection to the backhaul network on its ETH1 connection, and also serves as a WiFi access point. The contract technicians who visit the remote site need to be able to use the WiFi connection so that they can access the corporate intranet through the Orbit, but the system administrators have determined that they should not be able to manage the Orbit or change its configuration. Therefore, device management is allowed solely on ETH1's IP address.

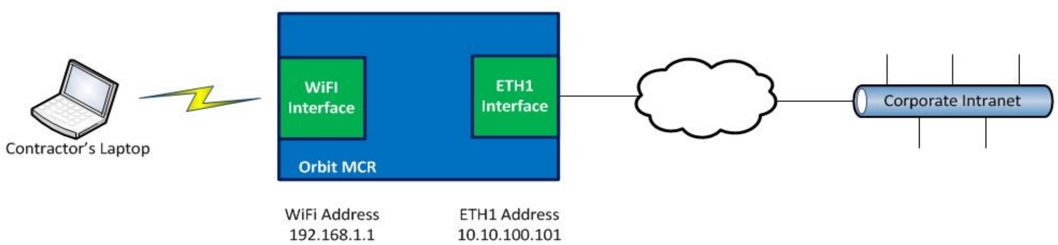


Figure 3-233. Device Management Example Network.

A contractor's laptop should be able to access the corporate intranet through the WiFi connection, while remaining unable to manage the Orbit.

Configuration

Web UI - HTTP/HTTPS Configure

To limit services to a specific statically assigned IP address, navigate to ***Web Server ---> Basic Config*** menu.

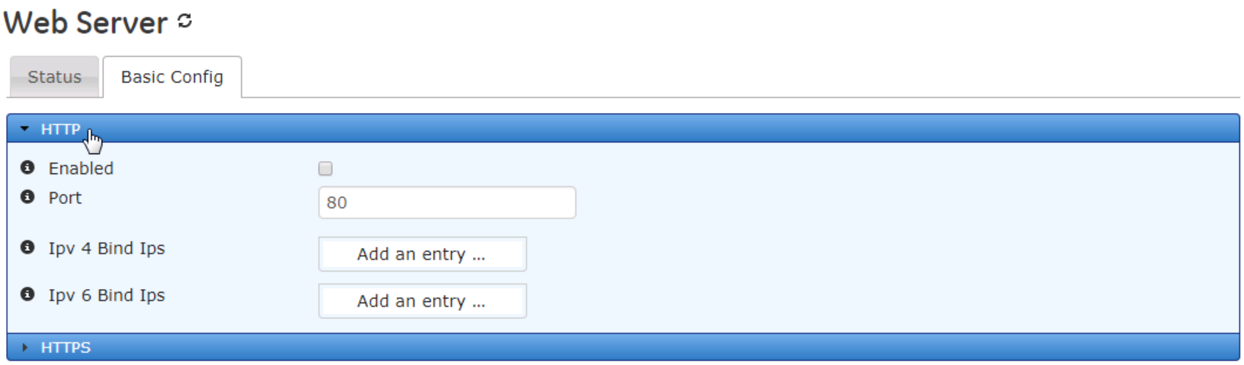


Figure 3-234. HTTP Basic Configuration

HTTP

- **Enabled -** Enable (Default) or Disabled Service.
- **Port -** The port to listen to HTTP connections on Valid values: 0—65535 -Default: 80
- **IPv4 Bind IPs** - Restrict the server to only listen for connections on the specified IPv4 addresses. If not present, or empty, the server will listen on all IPv4 addresses.
- **IPv6 Bind IPs** - Restrict the server to only listen for connections on the specified IPv6 addresses. If not present, or empty, the server will listen on all IPv6 addresses.

NOTE In FIPS mode, only HTTPS is allowed. HTTP cannot be enabled.

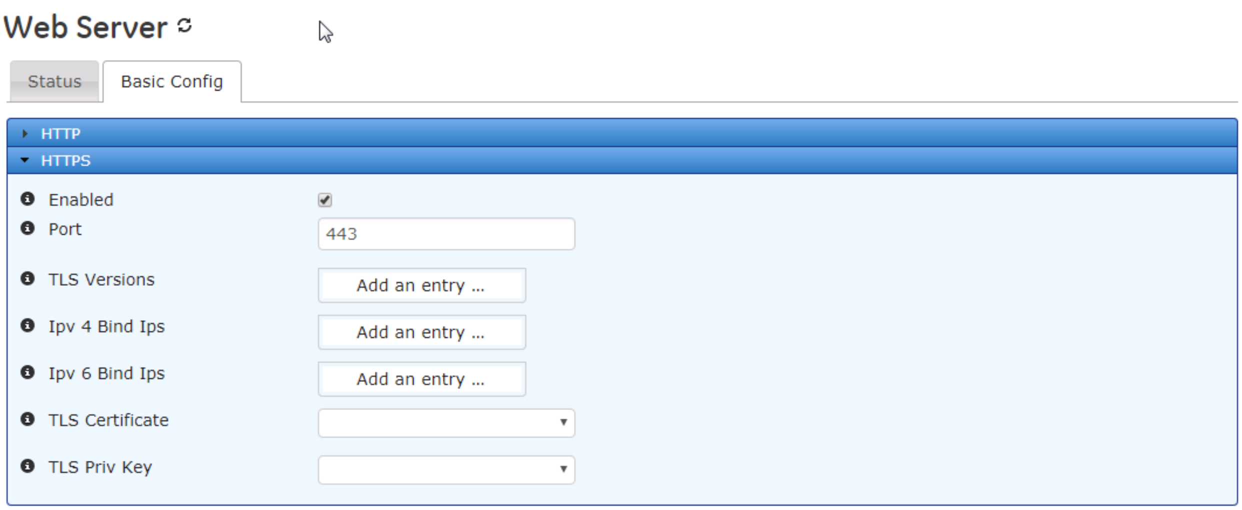


Figure 3-235. Web HTTPS Basic Configuration

HTTPS

- **Enabled -** Enable (Default) or Disabled Service.
- **Port -** The port to listen to HTTPS connections on Valid values: 0—65535 -Default: 443
- **TLS Versions -** Restrict the server to only operate using the specified version of TLS. If not present, or empty, the server will operate on any of the TLS versions from TLS 1.0 to TLS 1.2.
- **TLS Cipher Suites -** Restrict the server to only operate using the specified TLS cipher suites. If not present, or empty, the server will use all available values. In FIPS mode, the ECDHE cipher suites values are not valid. The order of the values will be retained and used in the TLS handshake.
- **IPv4 Bind IPs** - Restrict the server to only listen for connections on the specified IPv4 addresses. If not present, or empty, the server will listen on all IPv4 addresses.

- **IPv6 Bind IPs** - Restrict the server to only listen for connections on the specified IPv6 addresses. If not present, or empty, the server will listen on all IPv6 addresses.
- **TLS Certificate** - The certificate to use for the HTTPS server. If empty or not present, a self-signed certificate/key pair will be used.
- **TLS Private Key** - The private key which matches the specified TLS-certificate. If empty or not present, a self-signed certificate/key pair will be used.

Click **Add an Entry** next to **TLS Versions** in the HTTPS submenu to access a dropdown box containing all of the available TLS versions. Select the TLS versions for the webserver to use and click **Add**.

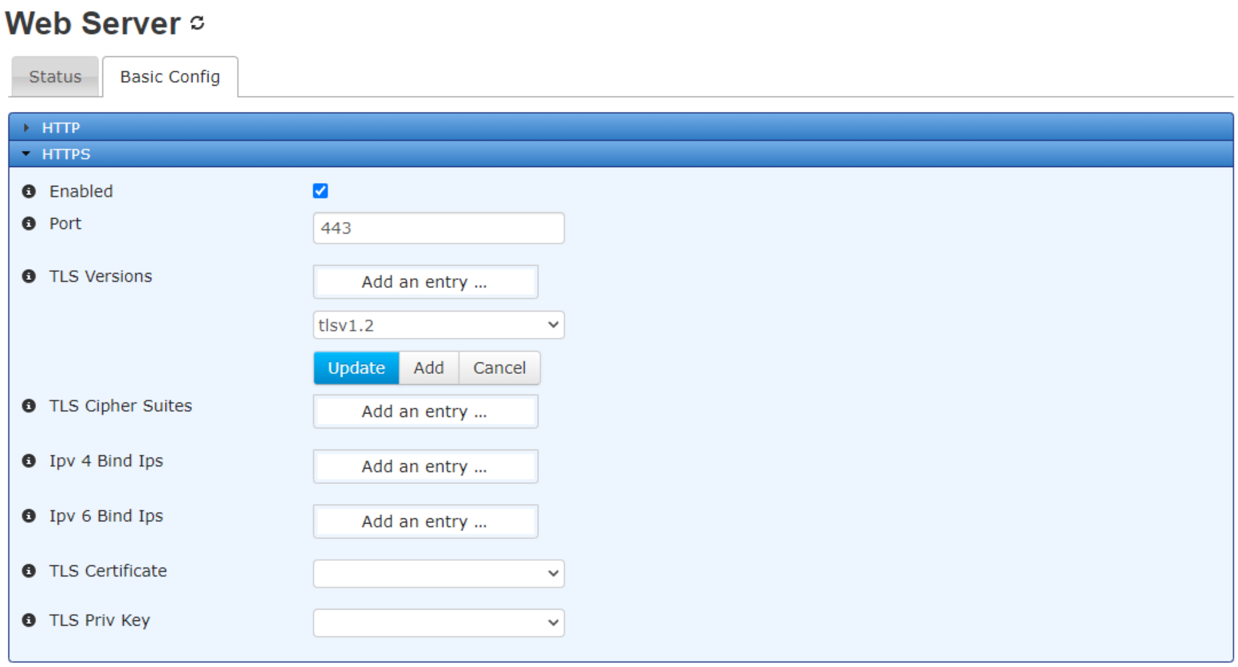


Figure 3-236. HTTPS TLS Versions

Click the x next to any of the existing **TLS Cipher Suites** values in the HTTPS submenu to remove it, or click **Add an Entry** to access a dropdown box containing all of the available TLS Cipher Suites. Select the TLS Cipher Suites for the webserver to use and click **Add**. You can drag the current TLS Cipher Suites values to change the order you would like to have the webserver use in the TLS handshake.

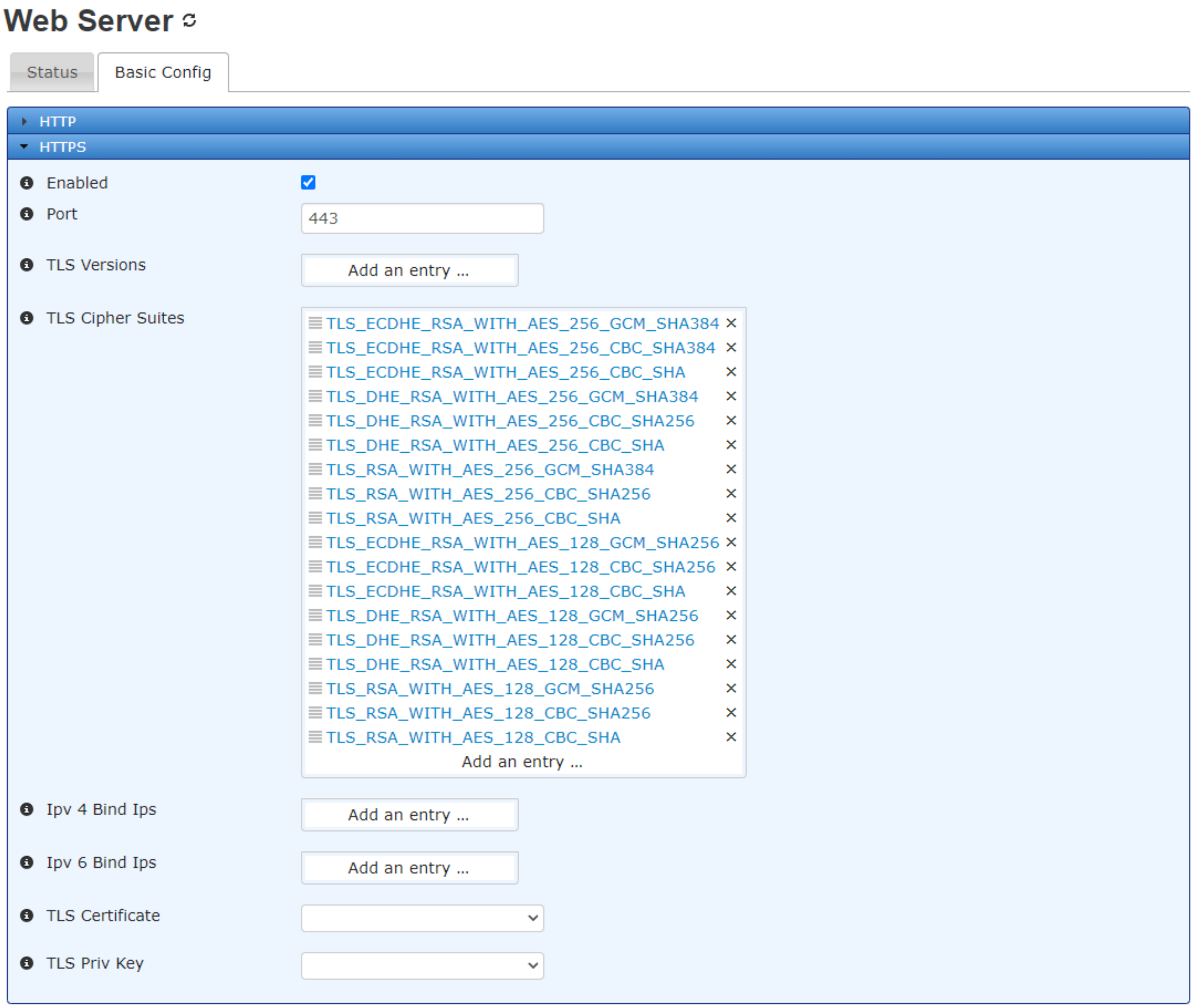


Figure 3-237. HTTPS TLS Cipher Suites

Click **Add an Entry** next to **IPv4 Bind IPs** or **IPv6 Bind IPs** in each submenu to access a dropdown box containing all IP addresses on the device. Select the IP address belonging to the appropriate interface and click **Add.**

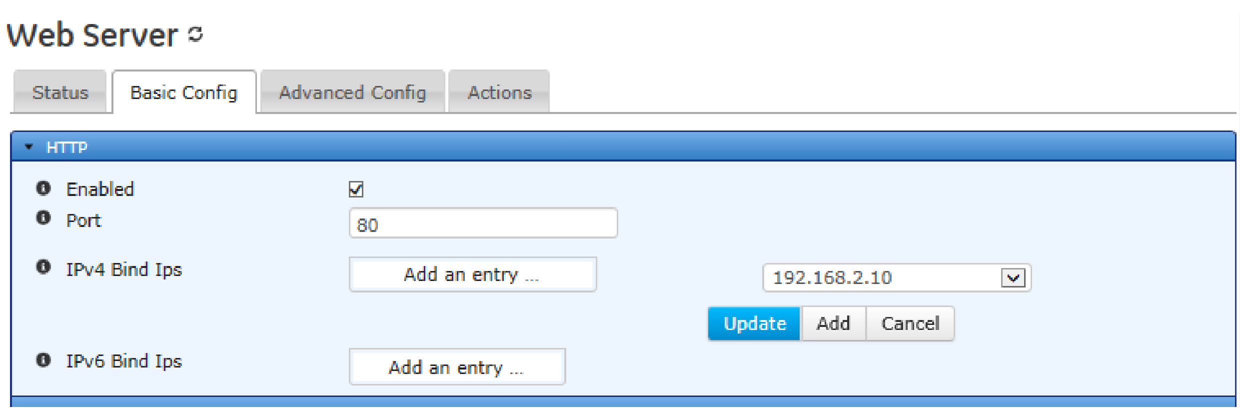


Figure 3-238. HTTP Restricted IP

Once configuration is complete, click **Save**.

Web UI - SNMP Configure

To configure SNMP to listen only to a specific address, navigate to ***SNMP Agent ---> Basic Config***.

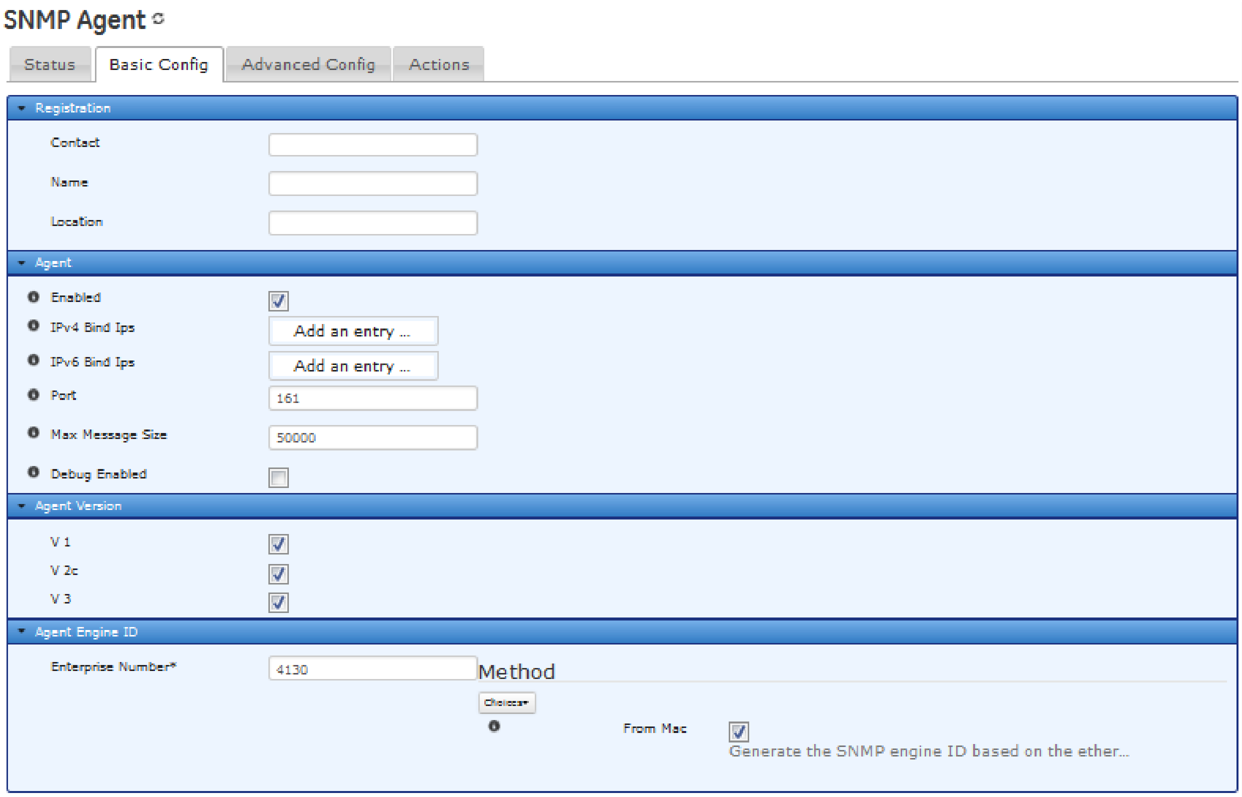


Figure 3-239. Accessing the SNMP menu

Click **Add an Entry** next to **IPv4 Bind IPs** or **IPv6 Bind IPs** in the **Agent** submenu to access a dropdown box containing all IP addresses on the device. Select the IP address belonging to the appropriate interface and click **Add.** Once configuration is complete, click **Save**.

Web UI - SSH Configure

To configure SSH to listen only to a specific address, navigate to ***SSH Server ---> Basic Config***.

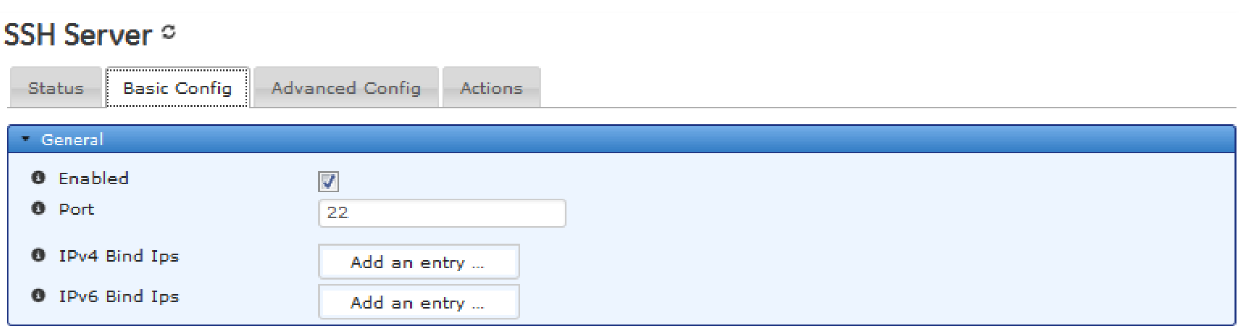


Figure 3-240. SSH Menu

- **Enabled** - Whether or not to run the netconf server. Default = true
- **Port** - The port to listen to netconf connections on. Default=830
- **IPv4 Bind IPs** - Restrict the server to only listen for connections on the specified IPv4 addresses. If not present, or empty, the server will listen on all IPv4 addresses.
- **IPv6 Bind IPs** - Restrict the server to only listen for connections on the specified IPv6 addresses. If not present, or empty, the server will listen on all IPv6 addresses.

Click **Add an Entry** next to **IPv4 Bind IPs** or **IPv6 Bind IPs** to access a dropdown box containing all IP addresses on the device. Select the IP address belonging to the appropriate interface and click **Add.** Once configuration is complete, click **Save**.

Web UI - NetConf Configure

To configure NETCONF to listen only to a specific address, navigate to ***NETCONF Server ---> Basic Config***

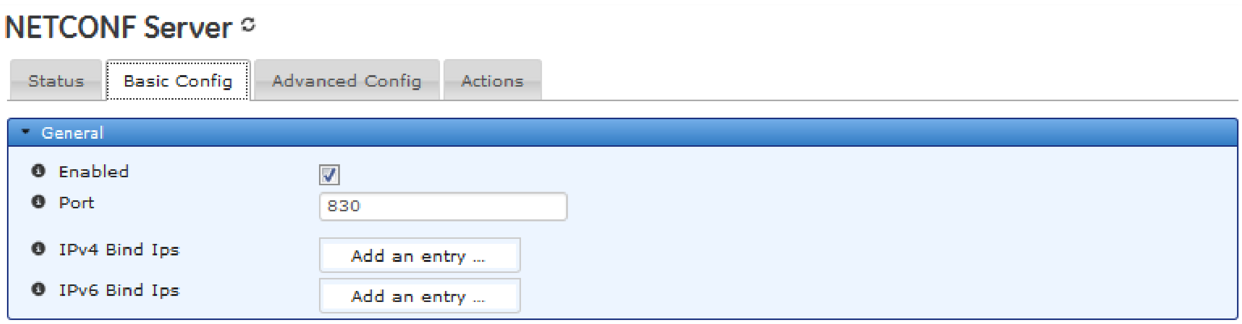


Figure 3-241. NETCONF Menu

- **Enabled** - Whether or not to run the netconf server. Default = true
- **Port** - The port to listen to netconf connections on. Default = 830
- **IPv4 Bind IPs** - Restrict the server to only listen for connections on the specified IPv4 addresses. If not present, or empty, the server will listen on all IPv4 addresses.
- **IPv6 Bind IPs** - Restrict the server to only listen for connections on the specified IPv6 addresses. If not present, or empty, the server will listen on all IPv6 addresses.

Click **Add an Entry** next to **IPv4 Bind IPs** or **IPv6 Bind IPs** to access a dropdown box containing all IP addresses on the device. Select the IP address belonging to the appropriate interface and click **Add.** Once configuration is complete, click **Save**.

CLI Configure

To configure the services to only listen to a specific statically assigned IP address the following commands would be used:

```
% set services web http ipv4-bind-ips [192.168.1.1]
% set services web https ipv4-bind-ips [192.168.1.1]
% set services snmp ipv4-bind-ips [192.168.1.1]
% set services ssh ipv4-bind-ips [192.168.1.1]
% set services netconf ipv4-bind-ips [192.168.1.1]
```

These remote management interfaces can also be bound to IPv6 address by using “ipv6-bind-ips” instead of “ipv4-bind-ips”. If these settings are not configured, the default behavior is to listen on all IP addresses in the system.

Monitoring

Use the CLI command **% show services** to view each service configuration.

```
> show services
NAME                 STATUS
------------------------------------------------------
VPN                  disabled
Serial               running
Firewall             running
DHCP Server          running
SSH Service          running
WEB Service          running
IPerf Server         running
SNMP Service         running
NETCONF Service      running
Quality of Service   running
                                                  SERIAL   SERIAL  SERIAL   SERIAL
SERIAL  IP TX    IP TX  IP RX    IP RX  TX       TX      RX       RX
PORT    PACKETS  BYTES  PACKETS  BYTES  PACKETS  BYTES   PACKETS  BYTES
------------------------------------------------------------------------------------
COM2    0        0      0        0      0        0       0        0
```

3.8.18 Remote Management Service

Understanding

The Remote Management Service provides effective remote management using minimum bandwidth. It is especially useful with connections that use a narrow channel, such as the NX and LN interfaces.

Standard Web UI sessions and individual radio firmware push are prohibitively expensive on low bandwidth channels. Remote management offers a far less bandwidth-intensive means to perform these tasks.

The service includes facilities to initiate a broadcast firmware update from one radio (typically the AP) to other radios in the network, and to broadcast updates to firmware certificates. The service's web proxy client allows you to transparently use the web UI of a local radio to manage a second radio remotely.

As an example, consider the simple network below. A user maintains a network connection to the local radio with IP address, 192.168.1.10. The local radio is part of a narrowband network that includes three remote radios. The user would like to access the remote radio at IP address 192.168.1.65 to check its current configuration. With the web proxy enabled, the unit with address 192.168.1.10 intercepts the intended web connection to the remote unit 192.168.1.65 and establishes a secure proxy connection to that unit. Only the essential data from the remote unit needs to go over-the-air. The local unit handles most of the work, providing significantly faster access time.

The proxy service can be disabled but is normally on by default. Once enabled, no special action is required to access remote units; redirects happen automatically.

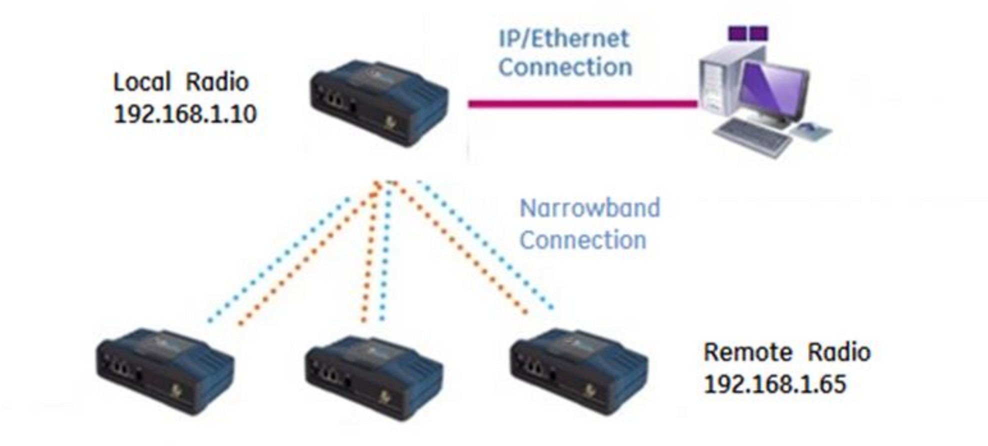


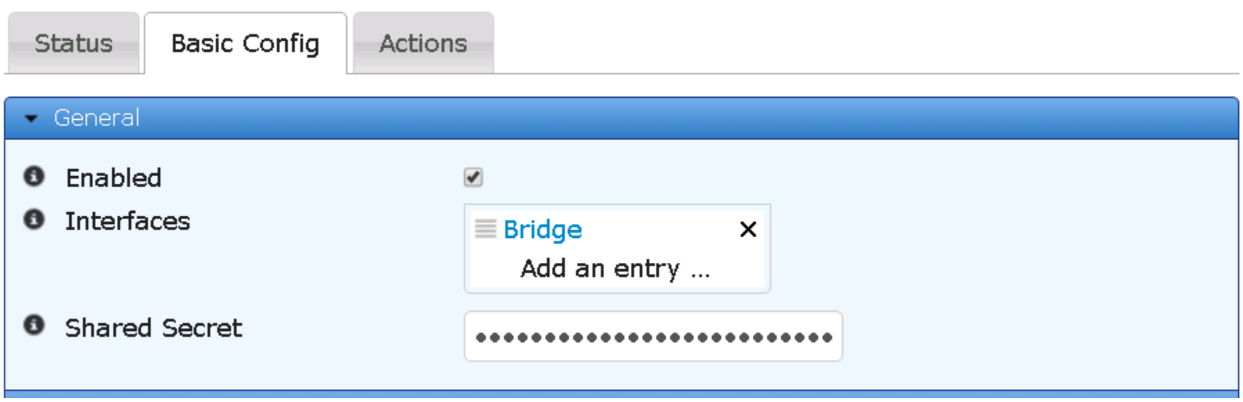
Figure 3-242 Narrowband example network.

Configuration

Using the WebUI

Navigate to ***Services->Remote Management*** and click the **Basic Config** tab.

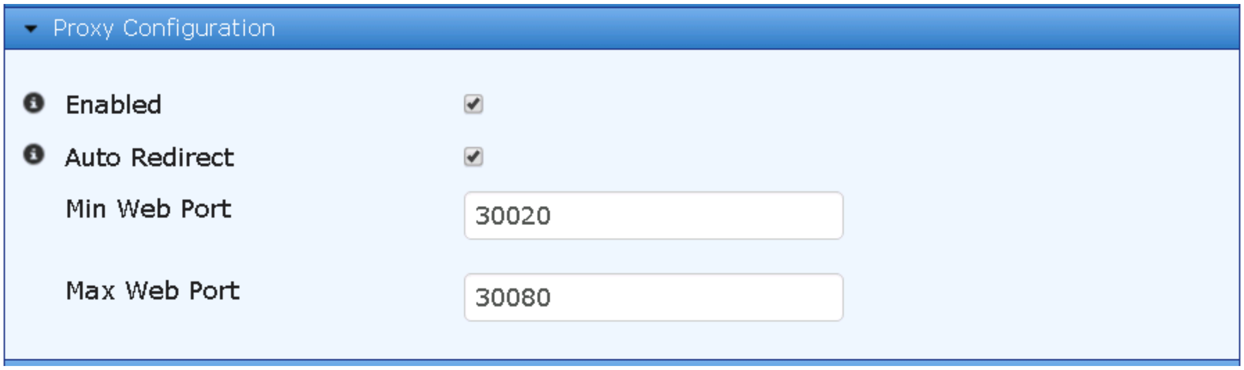
The Basic Config menu is divided into sections for General, Proxy Configuration, and Firmware.



General

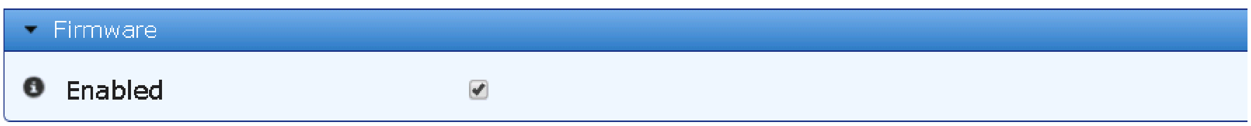
- **Enabled** – Enables the Remote Management Service. Enabled by DEFAULT.
- **Interfaces –** Enter one or more network interfaces on which the Remote Management Service should run. If a desired network interface is present in a bridge, you must enter the bridge's name in this field.
- **Shared Secret –** A shared secret used to allow remote connections to or from the device. It must be the same on both sides of the connection. For greater security, we recommend that you change this password and do not use the default. DEFAULT *rmadmin*

NOTE In FIPS mode, passphrases are not allowed. Only a 128-character hexadecimal value (0-9, a-f, A-F) is permitted.



Proxy Configuration

- **Enabled** – Enables the unit to open a web UI session on a remote Orbit device and allows another unit to make connections to this device. Enabled by DEFAULT.
- **Auto Redirect** – Enables the unit to intercept HTTP connections to a remote unit and attempt a proxy operation. Enabled by DEFAULT.
- **Min Web Port** – Sets the lower bound on the pool of ports used for proxy operations.
- **Max Web Port** – Sets the upper bound on the pool of ports used for proxy operations.



Firmware

- **Enabled** – Enables the unit to either push firmware to other Orbit devices on the network, or receive firmware pushed by other devices. This feature must be enabled on both sending and receiving devices. Enabled by DEFAULT.

NOTE Remote Management operates on the following IP addresses and ports. Ensure that they are not blocked by your firewall settings, or the service will not operate properly.

Firmware Reprogramming

Address	230.4.4.1	UDP Port 1044
Address Range	230.5.5.0 – 230.5.5.255	UDP Port 1044
Address	<Interface Broadcast>	UDP Port 40010

Web Proxy

Address	<local unit’s address>	<TCP ports as specified by Min/Max>

To initiate an over the air reprogramming session (or to remotely reboot a unit) access the Actions menu at ***Services->Remote Management->Actions.***

Cancel Session and Reboot Remote Devices

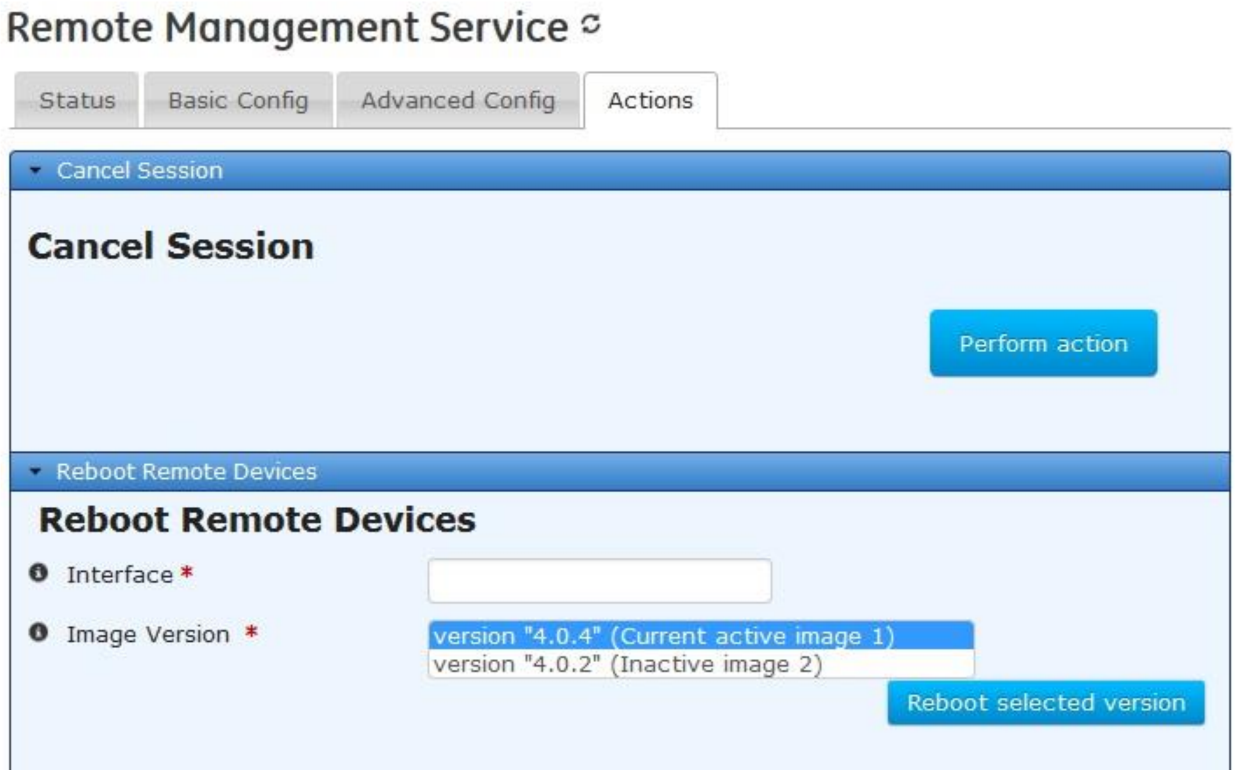


Figure 3-243 Cancel Remote Session and Reboot Remote Devices options

To cancel an active remote reprogramming session, expand the **Cancel Session** menu and click **Perform Action.**

Reboot Remote Devices sends a request across the selected interface for all Orbit units on the network to reboot to the specified image version. The Remote Management Service must be enabled on each remote radio in order for them to receive the request.

- **Interface –** The network interface on which to transmit the reboot request. If a desired network interface is present in a bridge, you must enter the bridge's name in this field.
- **Image Version –** Select either onboard firmware version. Each remote Orbit unit that receives the request will reboot to this version of firmware *if* it is present. If the remote unit does not currently have the specified firmware version, it will ignore the reboot request.

Send Firmware

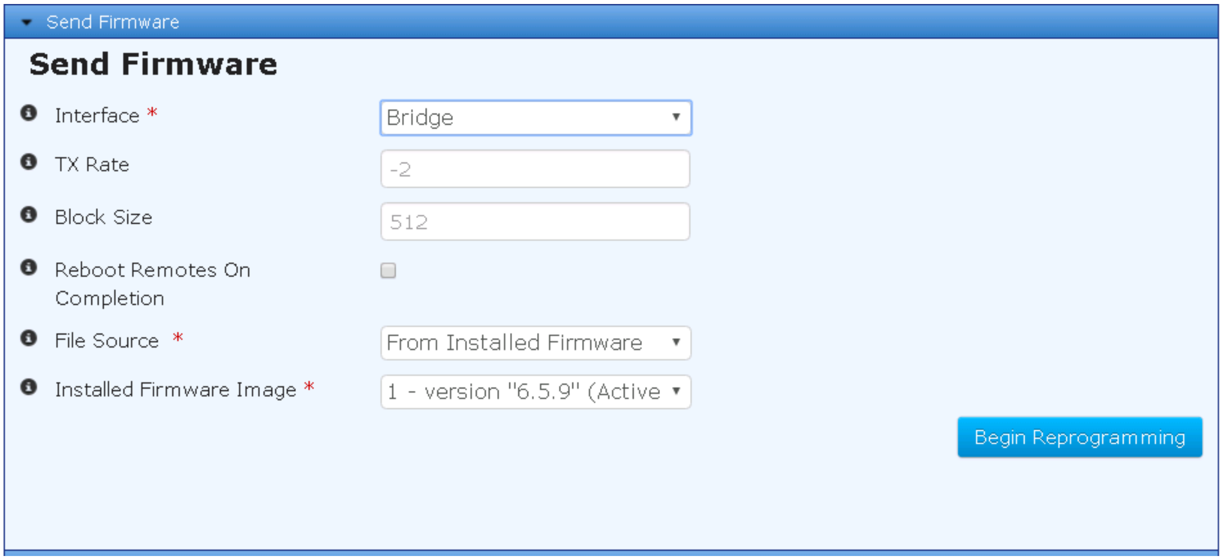


Figure 3-244 Send Firmware menu

Use the **Send Firmware** menu to send a firmware image to Orbit radios on the network. The Remote Management Service must be enabled on each remote radio in order for them to receive the request. Remote reprogramming can be used to push firmware from an access point to all remote radios at once, while limiting the reprogramming operation's use of the channel to prevent interference with data traffic. It is ideally suited for networks that operate on narrow channel sizes, such as Orbit NX915 and LN.

NOTE Broadcast Firmware updates may require header compression to be disabled.

The sending radio makes three attempts to send a firmware image through multicast. Firmware data is sent as a series of blocks. Only blocks that were not received by a remote in the previous cycle are resent. To prevent flooding the network with reprogramming traffic, the firmware push is automatically constrained as a best-effort service, and TX Rate and Block Size parameters are set to their most conservative values.

- **Interface –** The network interface on which to transmit the reboot request. If a desired network interface is present in a bridge, you must enter the bridge's name in this field.
- **TX Rate –** Desired firmware transfer rate, in kbps. You may also enter -1 to transfer data as fast as the network will allow, or -2 to transfer data as fast as may be sustained by the slowest peer. -2 to 1000000, DEFAULT -2.
- **Block Size –** Number of bytes per data block. 512 to 1300, DEFAULT 512.
- **Reboot Remotes on Completion –** Disabled by DEFAULT. If this option is selected, remote units will automatically reboot to the new firmware once they have successfully received and verified the firmware image.
- **File Source –** Select from the following:
    - Local File
    - From HTTP Server
    - From FTP Server
    - From TFTP Server
    - From SFTP Server
    - From Installed Firmware

- Additional options appear based on File Source transfer method selected above.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP and SFTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For HTTP, FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)
- **Installed Firmware Image** – For Installed Firmware, the firmware image to send (1 or 2)

Statistics are available to show reprogramming status. Additionally you can view a remote unit’s event log to determine that it has opened a remote reprogramming session, completed successfully, or finished unsuccessfully. You can also monitor the transfer status by viewing the AP’s event log to see that it has begun or finished a remote transfer session.

Send Firmware Certificate

Send Firmware Certificate can be used to push a firmware certificate from an access point to all remote radios at once, to simplify the operation of changing a firmware certificate.

The same system configuration settings are necessary that are required for sending firmware images.

- **Interface –** The network interface on which to transmit the reboot request. If a desired network interface is present in a bridge, you must enter the bridge’s name in this field.
- **TX Rate –** Desired firmware transfer rate, in kbps. You may also enter -1 to transfer data as fast as the network will allow, or -2 to transfer data as fast as may be sustained by the slowest peer. -2 to 1000000, DEFAULT -2.

- **Block Size –** Number of bytes per data block. 512 to 1300, DEFAULT 512.
- **File Source –** Select from the following:
  - Local File
  - From HTTP Server
  - From FTP Server
  - From TFTP Server
  - From SFTP Server
  - From Installed Firmware Certificate
- Additional options appear based on File Source transfer method selected above.

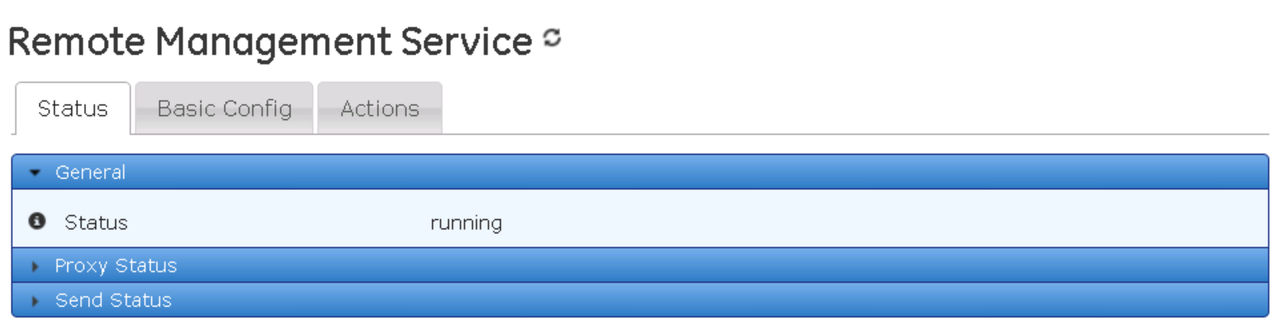
NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **Certificate Identity** – For a local file, HTTP, FTP, TFTP, and SFTP, the name to use when installing the Firmware certificate
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP and SFTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For HTTP, FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)
- **Installed Firmware Certificate** – For Installed Firmware Certificate, the certificate file to use

You can view a remote unit's event log to determine that it has opened a remote transfer session, completed successfully, or finished unsuccessfully. You can also monitor the transfer status by viewing the AP's event log to see that it has begun or finished a remote transfer session.

Status

Navigate to ***Services->Remote Management->Status.***

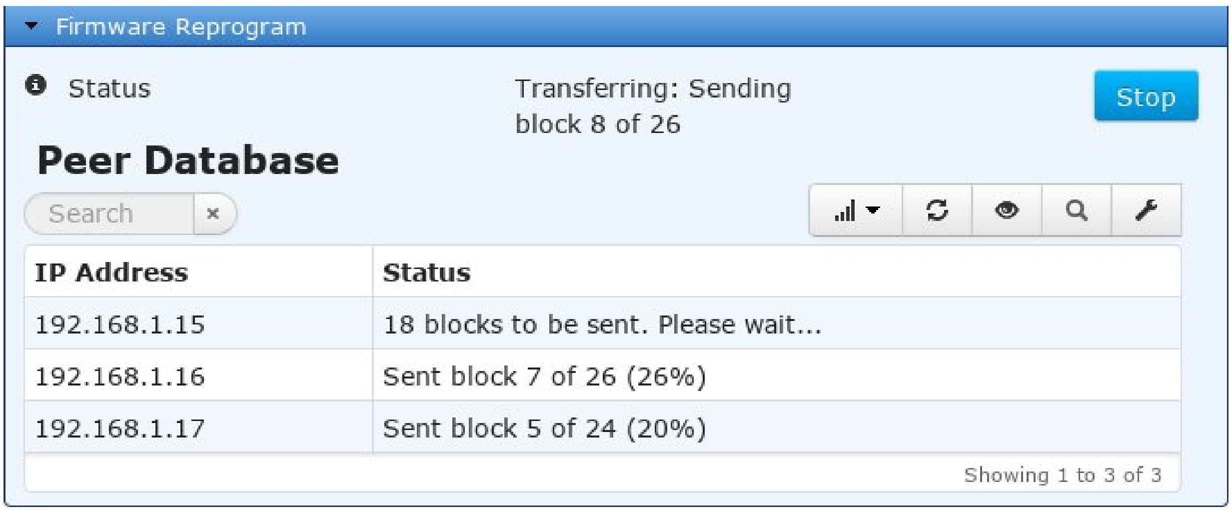


General

- **Status –** Displays whether the service is currently running.

Proxy Status

- **Remotes** - Displays the connected Remote's status



Send Status (*formerly Firmware Reprogram*)

- **Status –** The current state of the firmware or firmware certificate reprogramming process. This applies to both the sending and receiving devices.
- **Peer Database (Sending device only) –** During an active transfer, a table showing the IP address and status of each participating receiving device will be displayed. If there is no active transfer, the status of the last send operation will be shown for each device.

Using the CLI

To configure Remote Management, ensure that the CLI is in configuration mode.

Use the following command to enable the Remote Management service on the Bridge interface, with a shared secret of *rmadmin.*

% set services remote-management enabled *true* **interfaces** *Bridge* **shared-secret** *rmadmin*

Use the following commands to enable the radio to send or receive firmware remotely, as well as manage or be managed through a remote web UI session.

% set services remote-management firmware enabled *true*
% set services remote-management web-proxy auto-redirect *true*
% set services remote-management web-proxy enabled *true*

You may perform remote management actions in either operational or configuration mode. The following command requests remote units to reboot to image version 4.0.4.

% request services remote-management reboot-remote-devices interface *Bridge* **which-image { version** *4.0.4* **}**

The following command requests remote units to reboot to the active image version of the *current* radio. For example, if the local radio's active firmware image is version 4.0.0, remote radios will receive a request to reboot to firmware version 4.0.0.

% request services remote-management reboot-remote-devices interface *Bridge* **which-image {** *active* **}**

The following command initiates a remote reprogramming session of the current radio's active image over the Bridge interface, with a blocksize of 512, at a rate of 500 kbps. Remotes are requested to reboot to the new image upon successful completion.

% request services remote-management send firmware local-image { *active* **} blocksize** *512* **interface** *Bridge* **reboot-remotes-on-completion** *true* **txrate** *500*

The following command initiates a remote transfer session of the current radio's firmware certificate called "GEMDS-FW" over the Bridge interface, with a blocksize of 512, at a rate of 500 kbps.

% request services remote-management send firmware-certificate local-certificate { cert-id *GEMDS-FW* **} blocksize** *512* **interface** *Bridge* **txrate** *500*

Use the following command to cancel the currently active remote reprogramming or management session.

% request services remote-management cancel-session

Monitoring

To view the current Remote Management status, ensure that the CLI is in operational mode.

% show services remote-management-status
services remote-management-status web-proxy-client status disabled
services remote-management status web-proxy-server status operating

3.8.19 Quality of Service (QoS)

Understanding

Quality of service (QoS) allows the Orbit device to classify different types of traffic flows and provide differentiated service (like higher priority etc) to certain flows before they are transmitted out of the network interface. Each interface has a packet queue that holds packets that are going to be transmitted out of the interface while the interface is busy. If the interface is saturated with traffic, the interface will report busy and the packet queue will buffer the packet. Normally the packet the queue sends the packets to the interface in the order it receives them, but QoS allows a different behavior. Depending on the policy applied to the interface, the packets that are in the queue can be sent to the interface in a different order that it was received based on fairness or the priority of the packet.

QoS functionality on Orbit platform consists of two key concepts:

- **Packet classifiers** are used to classify traffic into one or more classes. The packet classifiers can classify traffic based on both layer-2 (Ether Type, source MAC, destination MAC, VLAN ID, VLAN priority) and layer-3/4 (protocol, src IP address, dst IP address, src Port, dst Port, tos/dscp) packet fields.
- **Policies** are used to provide special treatment of these classes according to the policy type. Orbit platform support following types of policies:

Following QoS policies that can be applied to Orbit's non-virtual interfaces (LnRadio, NxRadio etc.) or a class in a class-full policy:

- **Prioritization –** This policy implements a strict priority scheduler that requires classifiers be set up to give traffic different priorities. The prioritization policy will always send highest priority traffic first. Excessive high priority traffic can prevent any lower priority traffic from being sent.
- **Fairness -** This policy attempts to split up the traffic into different groups based on the packets IP addresses and IP protocols. It services these groups in a round robin fashion to ensure one traffic flow does not prevent others from using the link. The fairness policy determines traffic flows on its own and does not need the user to set up classifiers for it. Orbit uses Stochastic Fair Scheduling (SFQ) algorithm for fairness.
- **Shaping** – This policy is used to set minimal and maximal rates for a class of traffic. For example, with business critical traffic like SCADA, traffic shaping can be setup to guarantee that this class of traffic will always have at least 100Kbyte/s of an 800Kbyte/s link, regardless of the amount of other traffic. The remaining unclassified traffic can use the entire 800Kbyte/s link as long as there is no SCADA traffic, but as soon as SCADA traffic resumes, it will be given at least 100Kbyte/s allocation of the bandwidth. Additionally, a maximal rate could be applied to a class of traffic to prevent that class from consuming too much of a link. For example, a video stream could be limited to using 400Kbyte/s of an 800Kbyte/s link to prevent it from interfering with any other traffic or to prevent it from saturating a radio interface.

Following QoS policies are system wide policies (not applied to any specific interface):

- **Modify –** This is a special QoS policy that provides the ability to modify fields in an IP packet before they egress an interface. The modifications that can be performed are setting the ToS or DSCP value in IP packets. The modify policy is particularly useful when the traffic going through GRE or IPsec tunnels (tunneled traffic) needs to be provided differentiated service. This use case often arises when tunneling traffic over Cellular networks. In this scenario, the GRE or IPsec tunnel inherits the ToS/DSCP value of the tunneled traffic (i.e. copies the TOS field to outer header) enabling classifiers to be setup based on inner TOS values thereby providing differentiated service to the inner/tunneled traffic when egressing the cellular interface.

NOTE The modify policy does NOT need to be applied to an interface for it to take effect. Creating the policy with at least one classifier enables the policy and any traffic matching the classifiers will be modified accordingly.

Following diagram the illustrates the use of modify policy to provide differentiated service to tunneled traffic as per 3GPP LTE QoS.

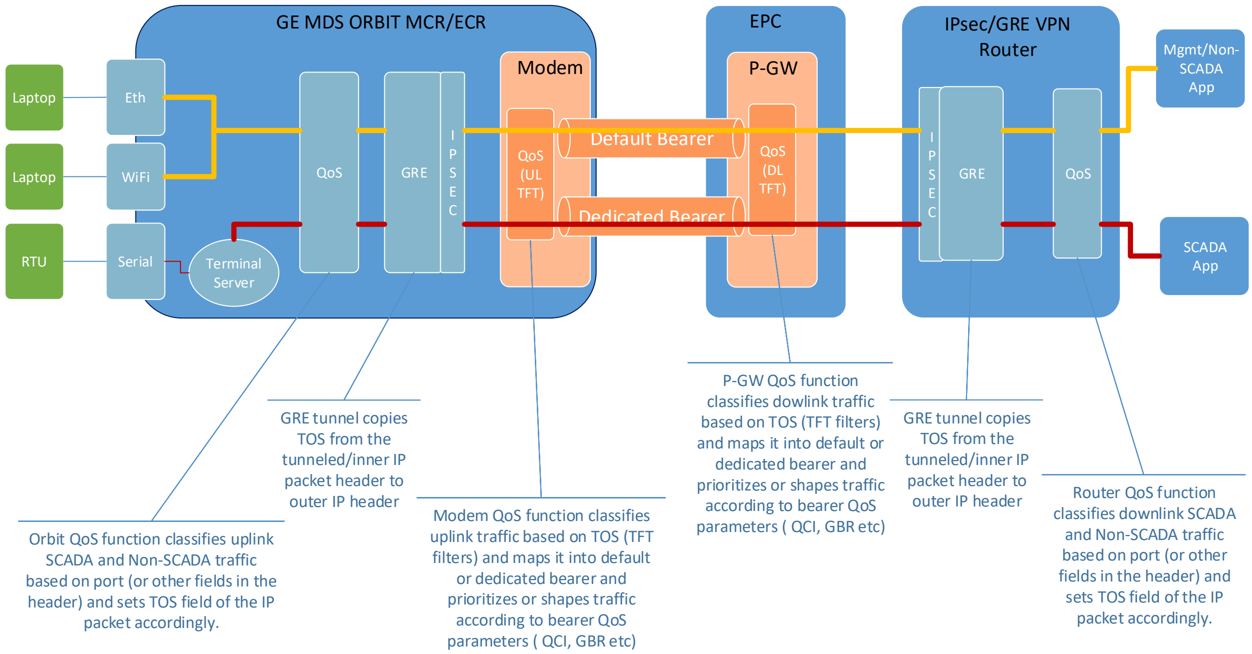


Figure 3-245. Single APN/PDN, Single Default Bearer, One or More Dedicated Bearers

The packet classifiers mark the packets as they travel through the system. This mark is used when the packet gets to the queue, to put it in its proper class. Packets can be classified based on the following parameters:

In the IPv4 headers:

- IP protocol
- Source address
- Source port
- Destination address
- Destination port
- DSCP value
- TOS value

In the Ethernet header:

- Ether-type
- Source address
- Destination address
- VLAN ID
- VLAN priority
- VLAN encapsulated ether-type

The following figures show a simplified relationship between the packet classifiers and the packet queues.

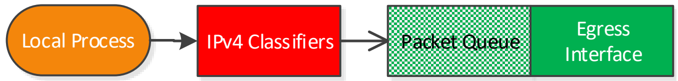


Figure 3-246. Packet classification for locally generated traffic

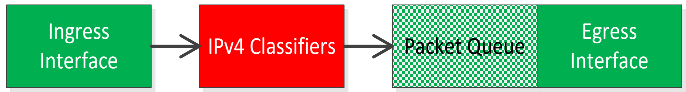


Figure 3-247. Packet classification of routed traffic

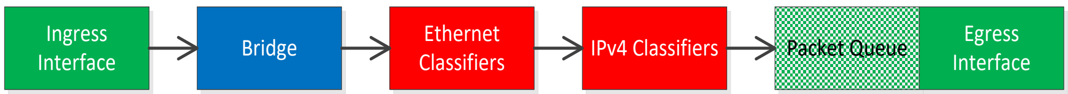


Figure 3-248. Packet classification of bridged traffic

NOTE The Ethernet classifiers are only pertinent to traffic that is bridged through the system

NOTE The QoS policies affect the outgoing traffic flows on an interface only if the interface is saturated. That is, when the offered load exceeds the outgoing link capacity.

For example, QoS configured as:

- GOOSE traffic treated as the highest priority.
- VLAN 101 traffic treated as the next lowest priority.
- All remaining traffic treated as the lowest priority.

In this case, QoS is invoked only when traffic is queued due to exceeding maximum throughput. GOOSE traffic would be given highest priority and be sent over the air first, followed by any VLAN 101 traffic and then all remaining traffic.

Configuring

In the web UI, the QoS service is configured under ***QoS Services ---> Basic Config***.

Using the Web UI

Example: Prioritize traffic with a particular ether-type above all other traffic

This example will create a QoS policy that uses a classifier to prioritize GOOSE messages above all others.

First, navigate to ***QoS Services ---> Basic Config.*** Ensure that QoS is **Enabled**.

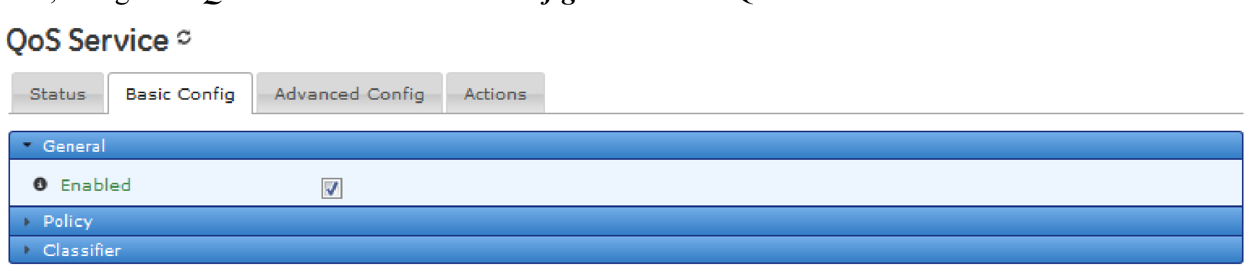


Figure 3-249. Enabling QoS

To create a classifier for GOOSE messages, click **Add** in the Classifier submenu. The **Configure Classifier Details** appears.

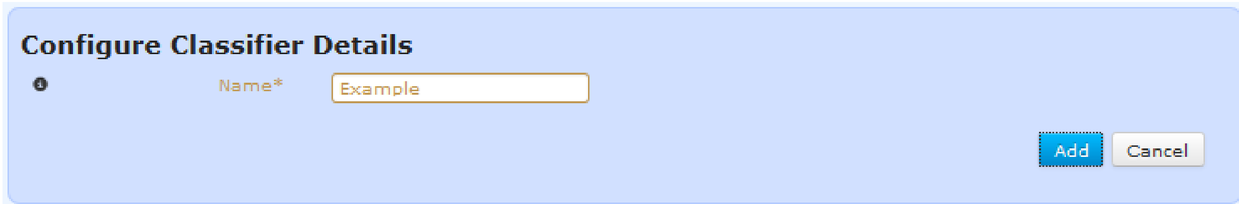


Figure 3-250. Naming a new classifier

Give the new classifier a name and click the **Add** button. A menu bearing the classifier's name appears to configure it.

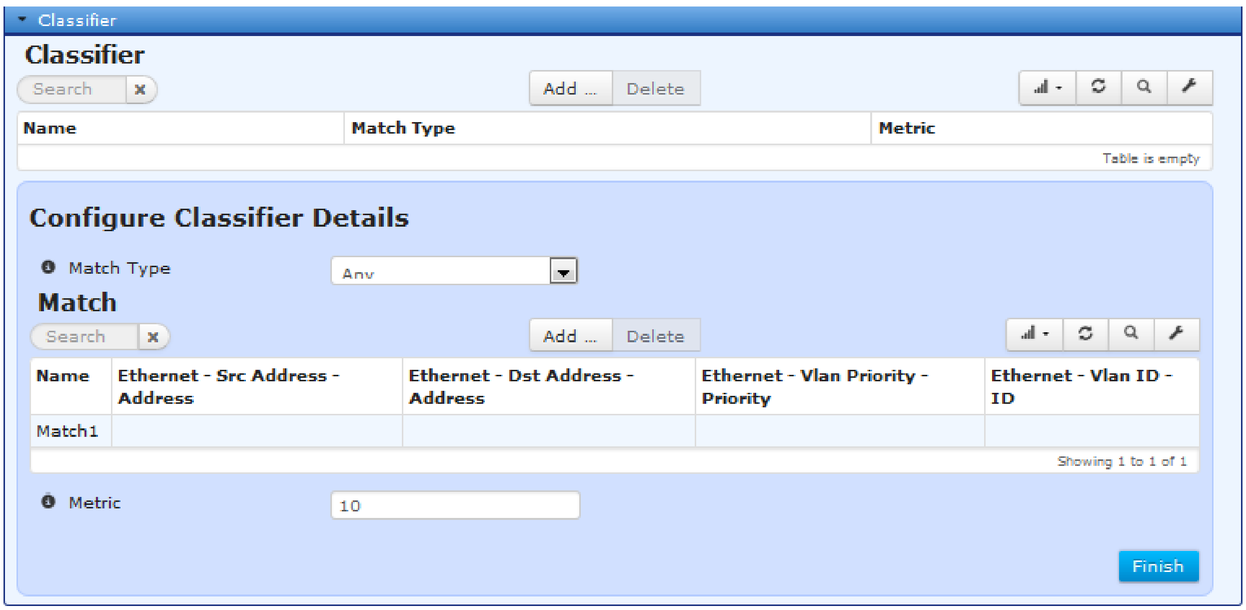


Figure 3-251. QoS classifier configuration

The following options are available on the classifier menu.

- **Match Type** – *All, Any.*
  - **All** – Match *all* match rules if there is more than one match rule in the classifier.
  - **Any** – Match *any* match rule if there is more than one match rule in the classifier.
- **Match** – The list of match rules that govern the classifier.
- **Metric** – *1-20.* Classifiers with a lower metric value are evaluated first. This means that if traffic matches more than one classifier, the classifier with the lowest metric is the one that is applied.

Click the **Add** button under the **Match** submenu to add a match rule.

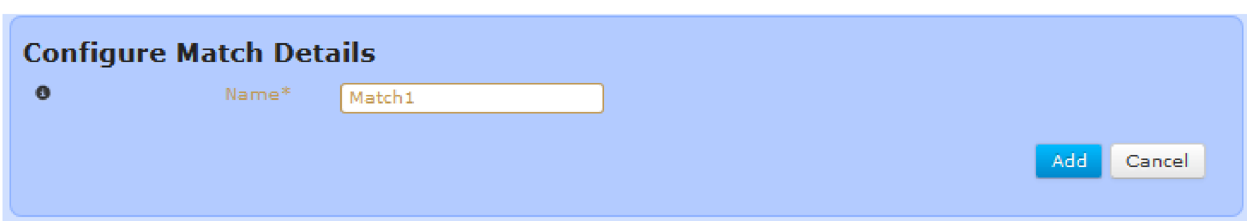


Figure 3-252. Adding a new match rule

First, give the new match rule a name and click the **Add** button.

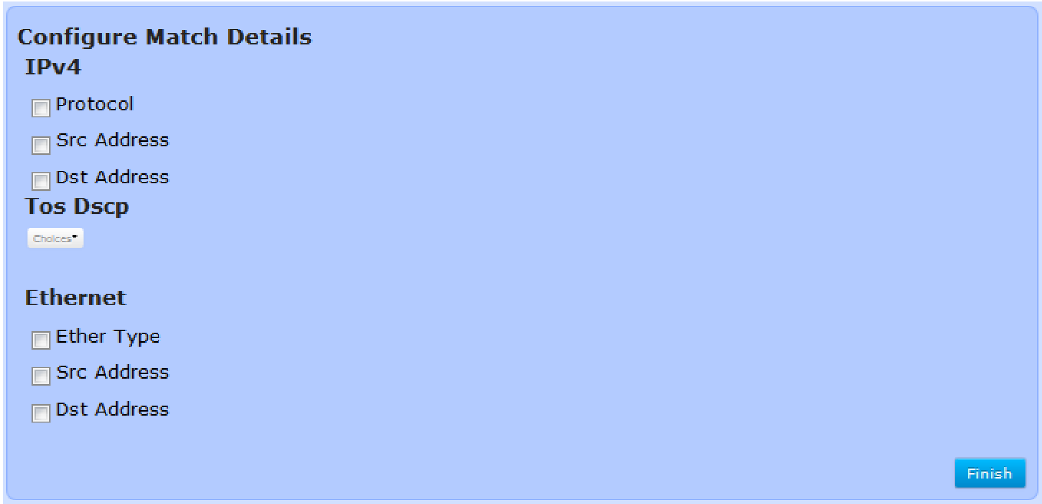


Figure 3-253. Match Menu

A match rule can be created to classify on either IPv4 or Ethernet. In this example, we use ether type to classify GOOSE messages.

To classify based on ether type, click the check box to the left of **Ether Type.**

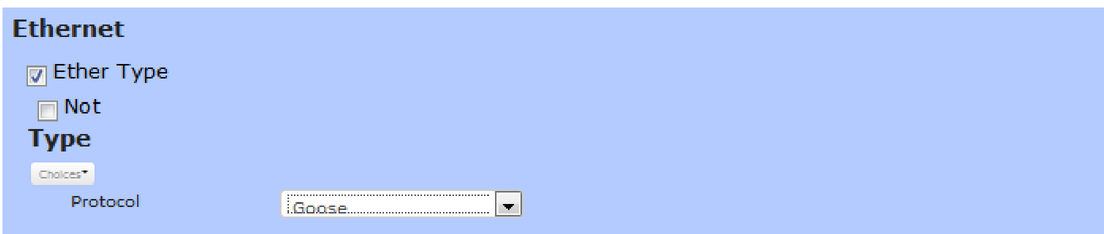


Figure 3-254. Ether type classification menu

The following options are available on the **Ether Type** menu.

- **Not –** This menu is used to create a rule that matches packets that do *not* match a specific ether-type.
- **Type –** Protocol, Custom.
  - **Protocol –** Any, Arp, Goose, Gse, Ieee1588, IPv4, IPv6, Ipx, Mpls-multicast, Mpls-unicast, Pppoe-discovery, Pppoe-session, Profinet, Provider-bridging, Q-in-q, Rarp, Vlan.
  - **Custom –** Enter the ether-type value directly, as either an unsigned 16-bit integer, or an unsigned 16-bit integer in hexadecimal format.

To specify GOOSE messages, click the **Type** dropdown box and select Protocol. Next, select Goose from the **Protocol** drop-down box. **Save** the configuration.

We must now create a QoS policy that applies this classifier. Return to the ***QoS Services ---> Basic Config*** menu and click the **Add** button in the **Policy** submenu.

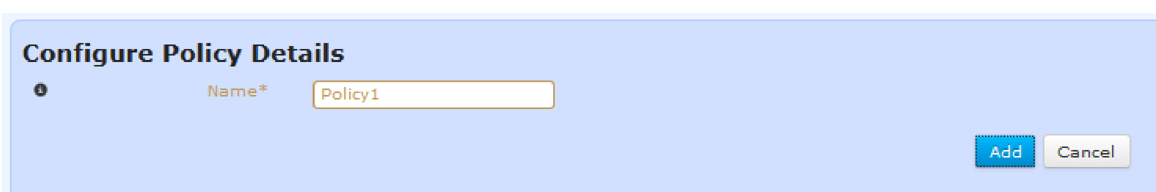


Figure 3-255. Naming a new QoS policy

First, give the new policy a name and click the **Add** button.

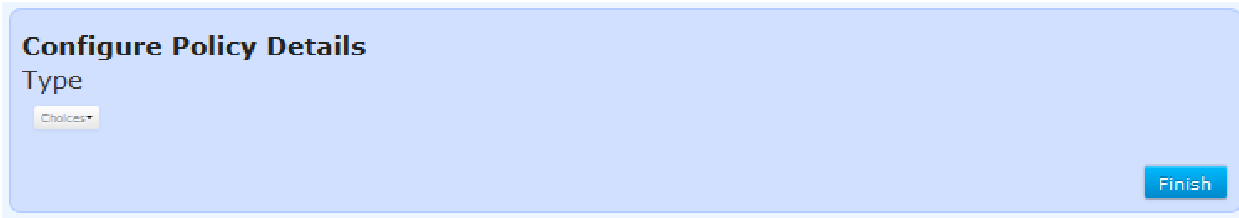


Figure 3-256. Specifying the type of QoS policy

The **Type** dropdown contains the following options.

- **Prioritization** - The policy will implement a priority scheduler. Higher priority packets will always be serviced first. If there is excessive high priority traffic, lower priority packets may be lost.
- **Fairness –** A fairness policy attempts to split up the traffic into different groups, which it services in a round robin fashion to ensure one traffic flow does not prevent others from using the link. A fairness policy determines traffic flows on its own and does not need the user to set up classifiers for it.
- **Shaping-htb –** The shaping-htb policy sets up minimal and maximal data rates for classes of traffic. Classifiers must be set up to identify traffic and the classifiers are used to assign that class of traffic to one of the shaping policies. The shaping policy sets a guaranteed minimum date rate for each class and optionally a maximum data rate that the class cannot exceed.

Since this example prioritizes GOOSE messages above all other traffic, select Prioritization.

Figure 3-257. QoS Prioritization menu

Prioritization is based on priority classes that categorize packets based on QoS classifiers. Each class assigns a priority to packets that match the classifier. Create up to eight priority classes per policy.

The **Default** priority will be applied to all packets that do not match any priority class in the policy. The value can be a number from 1-16, where 1 is the highest priority and 16 is the lowest. For this example, we choose 1.

Click the **Add** button in the class submenu to create a new priority class. The **Configure Class Details** appears.

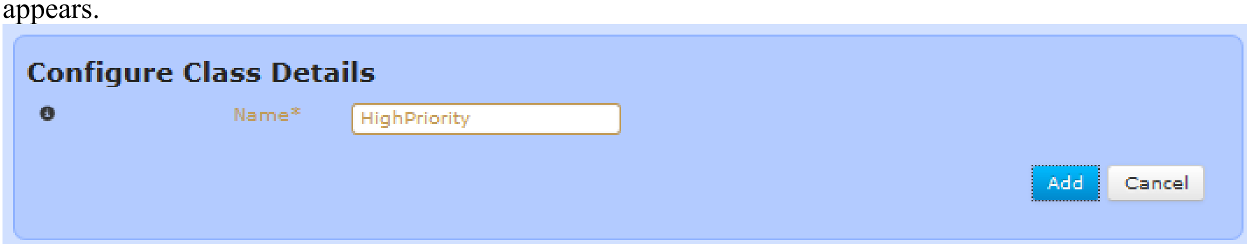


Figure 3-258. Naming a new QoS priority class

Enter a name for the priority class and click **Add.** A menu bearing the policy's name appears.

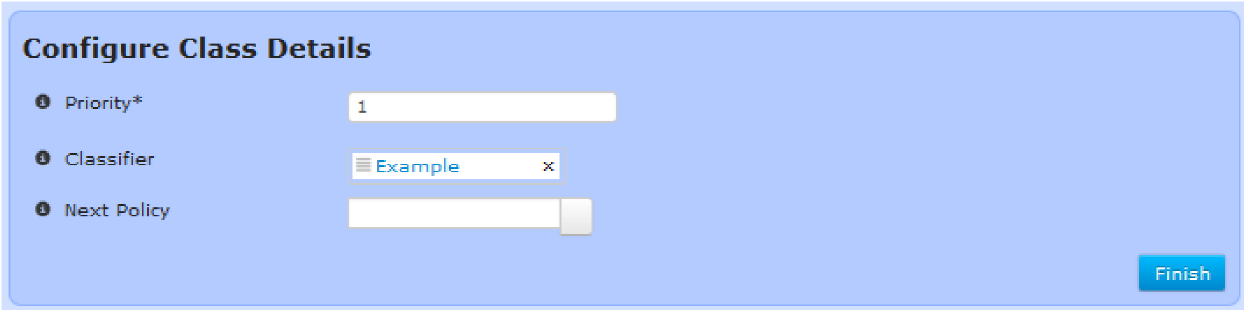


Figure 3-259. Configuring a QoS priority class

The following options are configurable:

- **Priority –** *1-16.* This is the priority to be assigned to packets that match the classifier. 1 is the highest priority and 16 is the lowest.
- **Classifier –** Any existing QoS classifier.
- **Next policy –** If a QoS fairness policy was created, it may be applied it to this priority class. In this case, traffic matching this priority class' classifier will also be governed be a fairness scheme, where traffic sent from a single IP address or protocol will not monopolize the entire link.

Select the name of the classifier that was created for this example from the **Classifier** dropdown box. This incorporates the classifier, which selects all GOOSE messages, into the new priority class. Since this example makes GOOSE messages the highest priority, enter 1 as the priority. Click **Save**. The configured QoS classifiers and policies are listed at ***QoS Services ---> Basic Config***.

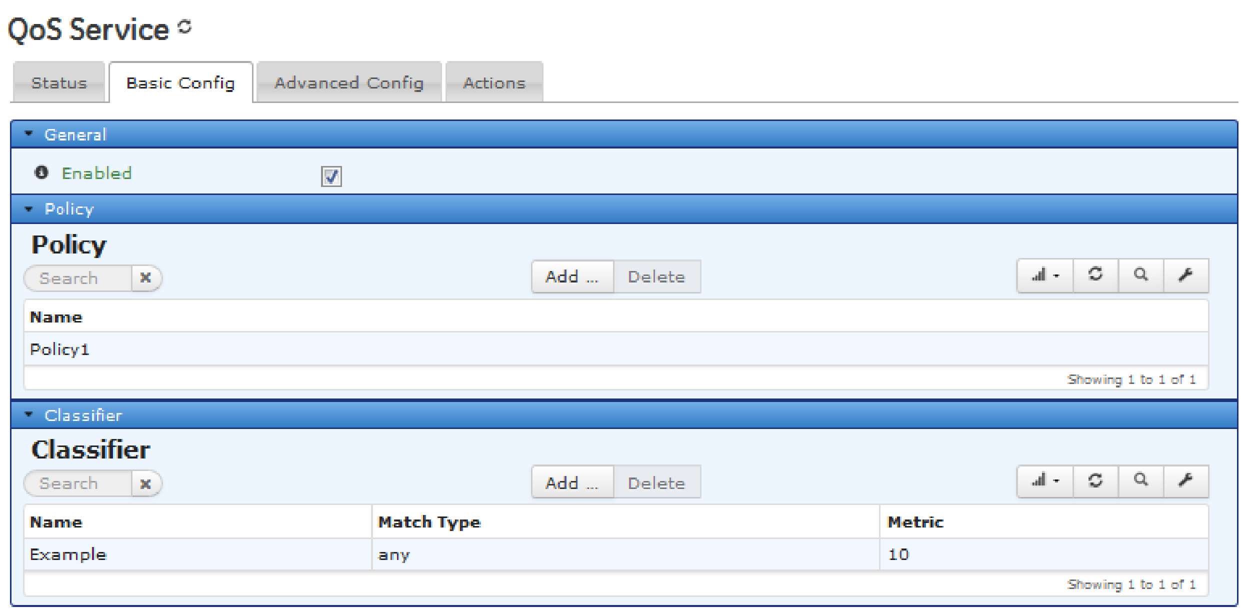


Figure 3-260. QoS menu

This policy has to be applied to an interface before it has any effect. Navigate to ***Interfaces*** and click on the desired interface. Click on the **QoS** dropdown from the ***Basic Config*** tab and select the new QoS policy to apply it to all traffic leaving that interface. Once configuration is complete, click **Save.**

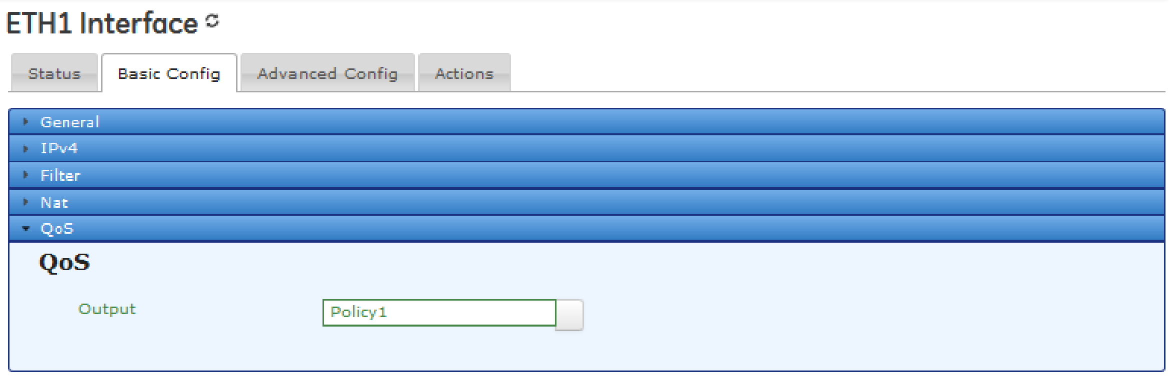


Figure 3-261. Applying a QoS policy to an interface

Using the CLI

Example: Prioritize traffic with a particular ether-type above all other traffic

This example will create a QoS policy that uses a classifier to prioritize GOOSE messages above all others.

First, ensure that QoS is enabled.

```
% set services qos enabled true
```

To set up the classifier:

```
% set services qos classifier GOOSE match M1 ethernet ether-type protocol goose
```

To set up the policy:

```
% set services qos policy Policy1 prioritization default-priority 5
% set services qos policy Policy1 prioritization class HIGH priority 1 classifier GOOSE
% set services qos policy Policy1 prioritization class STANDARD priority 5
```

This will set up a policy that prioritizes all traffic with the ether-type of 0x88b8 above all else. Showing the config should display:

```
% show services qos
enabled true;
policy Policy1 {
    prioritization {
        default-priority     5;
        class HIGH {
            priority         1;
            classifier       [ GOOSE ];
        }
        class STANDARD {
            priority         5;
        }
    }
}
classifier GOOSE {
    match M1 {
        ethernet {
            ether-type {
                protocol     goose;
            }
```

```
        }
    }
}
```

This policy has to be applied to an interface before it has any affect. To apply the policy to an interface:

% set interfaces interface NxRadio **qos output** Policy1

Now all traffic going out of interface NxRadio will prioritize based on Policy1.

Example: Priority Inversion

Suppose all traffic from IP address 1.2.3.4 needs to be prioritized above all else, unless it is SFTP traffic. SFTP traffic from anyone has to be prioritized at the lowest priority. To start with we will set up the classifiers and the policies.

% set services qos classifier SFTP **match** M1 **ipv4 protocol assigned-number tcp**

% set services qos classifier SFTP **match** M1 **ipv4 dst-port services ssh**

% set services qos classifier FROM1234 **match** M1 **ipv4 src-address address** 1.2.3.4/32

% set services qos policy Policy1 **prioritization class** HIGH **priority** 1 **classifier** FROM1234

% set services qos policy Policy1 **prioritization class** BULK **priority** 15 **classifier** SFTP

% set services qos policy Policy1 **prioritization default-priority** 5

This creates a policy with three classes where unclassified traffic will go into the second priority class. The class priority numbers do not imply the number of underling classes, just the order of the classes' priority. The default priority can be the same as a defined class, but if it's not a class is created under the hood with no classifier or next policy.

The problem with this configuration is that because we check for matches in order of priority we will match on the IP address of 1.2.3.4 and apply the mark for the high priority class before we check if it is SFTP. One solution to this is to use the classifiers metric. A classifier with a lower metric is evaluated before classifiers with higher metrics. All classifiers have a default metric of 10. So by giving SFTP classifier a lower metric, it will be considered before the FROM1234 classifier.

% set services qos classifier SFTP **metric** 5

The other way to solve the problem would to be use the not syntax and explicitly prevent the FROM1234 classifier from matching SFTP traffic.

% set services qos classifier FROM1234 **match** M1 **ipv4 protocol not assigned-number tcp**

% set services qos classifier FROM1234 **match** M2 **ipv4 src-address address** 1.2.3.4/32

% set services qos classifier FROM1234 **match** M2 **ipv4 protocol assigned-number tcp**

% set services qos classifier FROM1234 **match** M2 **ipv4 dst-port services ssh not**

This will make the FROM1234 classifier:

```
% show services qos classifier FROM1234
match-type any;
match M1 {
    ipv4 {
        protocol {
            not;
            assigned-number tcp;
        }
        src-address {
            address         1.2.3.4/32;
        }
    }
}
match M2 {
    ipv4 {
```

```
            protocol {
                assigned-number tcp;
            }
            src-address {
                address        1.2.3.4/32;
            }
            dst-port {
                not;
                services [ ssh ];
            }
        }
    }
```

This will make the classifier match everything from 1.2.3.4 that is not TCP and everything from 1.2.3.4 that is TCP and port is not SFTP. The coupling of ports to IP protocols complicates negating ports. Either constricting higher priority rules with the not syntax or inverting the order classification is evaluated with metric will work.

Example: Fairness

Taking the last example if we wanted to extend it so that all traffic from 1.2.3.4 is evaluated fairly, we could apply a next policy to that class.

% set services qos policy FAIR **fairness** sfq

% set services qos policy Policy1 **prioritization class** HIGH **next-policy** FAIR

Now multiple traffic flows from 1.2.3.4 will be treated fairly.

Example: shaping-htb

This example shows how to set up a shaping-htb policy, named *HTB*, with three classes of traffic: *GOOSE, VIDEO*, and *OTHER*. The policy is applied to the NxRadio interface after it's been determined that the max over-the-air egress data rate is 800Kbyte/s for this fielded unit. The GOOSE traffic is given high priority so that it is always handled before the other classes. It is given a committed, minimal, data rate of 100Kbyte/s so that it always has bandwidth to send GOOSE traffic and it can use up to 800Kbyte/s when there is no traffic in the other classes. Note that if no maximum rate is specified it is automatically set to the same rate as the committed rate. VIDEO class is given a committed rate of 200Kbyte/s but cannot exceed 400Kbyte/s even if there is no traffic in the other classes. This is done to ensure that the VIDEO stream will never saturate the link. Lastly, the default class OTHER is for any traffic that is not part of GOOSE or VIDEO classes. It has a committed rate of 500Kbyte/s and can use the entire 800Kbyte/s bandwidth if there is no traffic in the classes.

% set services qos classifier GOOSE **match** M1 **ethernet ether-type protocol vlan**

% set services qos classifier GOOSE **match** M1 **ethernet encap-protocol protocol** goose

% set services qos classifier VIDEO **match** M1 **ipv4 protocol assigned-number tcp**

% set services qos classifier VIDEO **match** M1 **ipv4 dst-port port-range** 8080

% set services qos policy HTB **shaping-htb class** GOOSE **priority** 0 **committed-rate** 100 **max-rate** 800 **classifier [** GOOSE **]**

% set services qos policy HTB **shaping-htb class** VIDEO **priority** 1 **committed-rate** 200 **max-rate** 400 **classifier [** VIDEO **]**

% set services qos policy HTB **shaping-htb class** OTHER **priority** 16 **committed-rate** 500 **max-rate** 800

% set services qos policy HTB **shaping-htb committed-rate** 800 **max-rate** 800 **default-class** OTHER

% set services qos enabled true

% commit

```
% set interfaces interface NxRadio qos output HTB
commit
```

Example: modify fields in an IP packet before they egress an interface

This example The following assumes the cellular interface has an IP address of 3.0.0.9. When ingress traffic is destined for 192.168.2.10, the DSCP value of those packets will be set to 16. A route is set up to forward all traffic matching the 192.168.2.0/24 address range through the GRE tunnel. However, only traffic matching destination address 192.168.2.10 will be modified.

```
% set interfaces interface GRE type gre
% set interfaces interface GRE gre-config mode ip-over-gre
% set interfaces interface GRE gre-config src-address 3.0.0.9
% set interfaces interface GRE gre-config dst-address 3.0.0.10
% set interfaces interface GRE filter input IN_TRUSTED
% set interfaces interface GRE filter output OUT_TRUSTED
% commit

% set services qos classifier DST-IP match 1 ipv4 dst-address address 192.168.2.10/32
% set services qos policy DSCP-POLICY modify dscp value 16
% commit

% set routing static-routes ipv4 route 1 outgoing-interface GRE
% set routing static-routes ipv4 route 1 dest-prefix 192.168.2.0/24
% commit
```

Monitoring

At this time there are no commands to monitor traffic statistics for packets being scheduled by the QoS service. This feature may be added to future revisions of firmware.

3.8.20 SNMP

Understanding

The Orbit platform incorporates a SNMP agent to enable monitoring of system and network interface status with MDS PulseNET or other SNMP Managers. The SNMP agent on the Orbit platform provides following functionality:

- SNMP version v1, v2c and v3. Each of these versions can be enabled or disabled independently.
  - Ability to bind to a specific UDP port and one or more IPv4/v6 addresses (selected from the list of addresses assigned to various interfaces in the system). This allows the user to restrict SNMP service to specific network segments (for example, management VLAN).
- SNMPv3 security configuration
  - User Security Model (USM) - Ability to configure user authentication (md5 or sha1) and encryption (DES or AES).
  - View based Access Control Module (VACM) - Ability to configure VACM groups and views.
- SNMP traps/informs
  - The agent supports v1 traps, v2c/v3 traps and informs.
  - Ability to configure a list of SNMP targets (managers) that shall receive traps and informs. The unit sends SNMP traps/informs to the configured SNMP targets (managers) when events are logged (and if the SNMP notification has been enabled for those events).
  - Traps can use single-trap-type or unique-trap-type operation

- single-trap-type operation uses one SNMP trap with one common OID for all events. The variable-binds section of the packet contained a single CEE encoded string (JSON) that contains all the information on the particular event. (This is the default for compatibility with existing deployments).
- unique-trap-type operation maps events into their own unique OIDs. Parameters for the events are mapped to their own event-specific variable binds.

- Standard MIBs supported
  - SNMPv2-MIB (RFC 3418)
  - SNMP-COMMUNITY-MIB (RFC 3584)
  - SNMP-USER-BASED-SM-MIB (RFC 3414)
  - SNMP-VIEW-BASED-ACM-MIB (RFC 3415)
  - SNMP-TARGET-MIB and SNMP-NOTIFICATION-MIB (RFC 3413)
  - IANAifType-MIB.mib
  - IF-MIB.mib (only ifTable and ifXtable are supported from this MIB). This is the interfaces group from MIB-II (RFC 2863).
  - IP-MIB.mib (supporting pAddressTable, ipv4InterfaceTable, ipv6InterfaceTable, ipAddressPrefixTable, ipNetToPhysicalTable and ipDefaultRouterTable)
- MDS specific MIBs supported
  - MDS-REG-MIB.mib - Top level MDS products' MIB.
  - MDS-ORBIT-SMI-MIB.mib - Top level MDS MIB for ORBIT platform.
  - MDS-DEFAULT-EVENT-MIB.mib - MDS MIB for ORBIT events with unique-trap-type.
  - MDS-EVENT-MIB.mib - MDS MIB for ORBIT events with common-trap-type.
  - MDS-SYSTEM-MIB.mib - MDS MIB for ORBIT system status.
  - MDS-SERVICES-MIB.mib - MDS MIB for ORBIT services status.
  - MDS-SERIAL-MIB.mib - MDS MIB for ORBIT terminal server status.
  - MDS-IF-CELL-MIB.mib - MDS MIB for ORBIT Cellular interface status.
  - MDS-IF-IEEE80211-MIB.mib - MDS MIB for ORBIT Wi-Fi interface status.
  - MDS-IF-NX-MIB.mib - MDS MIB for ORBIT NX915 interface status.
  - MDS-IF-LN-MIB.mib - MDS MIB for ORBIT LNxxx interface status.

Configuring

SNMP service configuration items can be divided up into the following categories related to SNMP

Table 3-31. SNMP Categories

agent	Configuration of the SNMP agent
community	List of communities
notify	List of notify names and tags
system	System group configuration
target	List of targets for notifications (traps/informs)
usm	Configuration of the User-based Security Model
vacm	Configuration of the View-based Access Control Model

In the Web UI these are provided on the screen by Navigating to: ***SNMP Agent ---> Advanced Config.***

GE VERNOVA

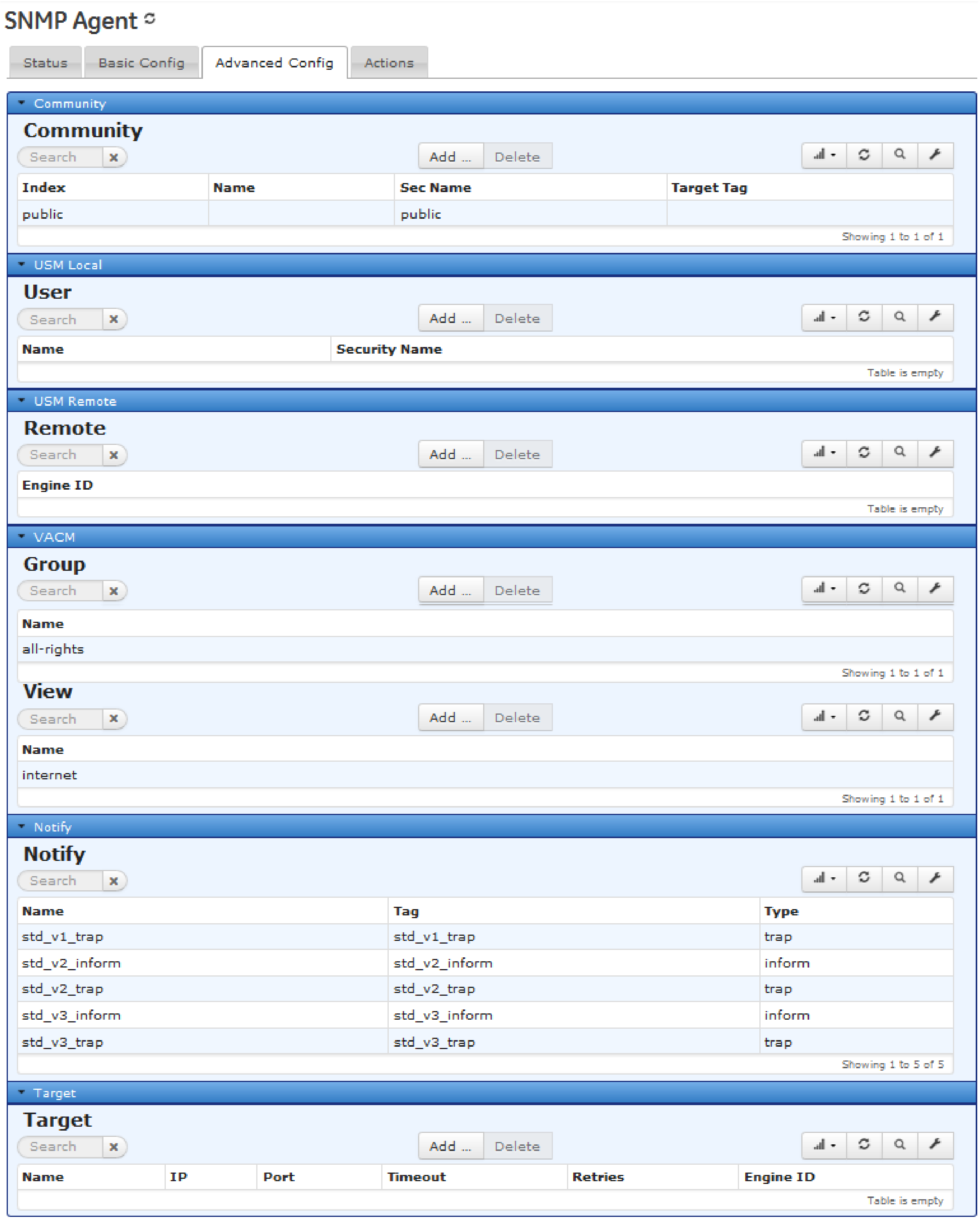


Figure 3-262. SNMP Main Page

NOTES:

1. The sections below describe SNMP configuration in terms of use cases and do not attempt to list every available configuration parameter. The user should refer to the UI of the latest firmware version running on the unit to look at all available parameters.
2. The examples shown below use SNMP manager command line tools (provided by NET-SNMP package) running on a PC connected to LAN port of Orbit.

Default Configuration

The unit as shipped (with factory defaults) has the SNMP agent enabled with version v2c, listening on port 161 and configured with a community string of "public", a VACM group named "all-rights" that allows access to all SNMP parameters supported by the unit. This allows the user to start monitoring the unit via SNMP v2c without needing any additional configuration. (Also works for v1).

The example below shows how to do an SNMP walk using "snmpwalk" tool (from NET-SNMP package):

1. Unzip the provided MIB package into r current folder. For example, for the Orbit product the MIB package is named "orbit-mib-X_Y_Z.zip", where X.Y.Z is the corresponding firmware version.
2. Use "snmpwalk" tool to do SNMP walk on the unit (only small subset of output is shown for the sake of brevity)

```
$ snmpwalk -M +./  -c public  -v2c 192.168.1.1 internet
SNMPv2-MIB::sysDescr.0 = STRING: GE MDS Orbit SNMP Agent
SNMPv2-MIB::sysObjectID.0 = OID: MDS-ORBIT-SMI-MIB::mdsOrbit
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (14841) 0:02:28.41
SNMPv2-MIB::sysContact.0 = STRING:
SNMPv2-MIB::sysName.0 = STRING:
SNMPv2-MIB::sysLocation.0 = STRING:
SNMPv2-MIB::sysServices.0 = INTEGER: 72
SNMPv2-MIB::sysORLastChange.0 = Timeticks: (0) 0:00:00.00
```

Configuring the SNMP agent

The unit ships with default configuration that has SNMP agent enabled. This section provides addition detail for understanding the different parts of SNMP configuration.

On the Web UI, click on the Agent from the SNMP main screen and set/verify the parameters:

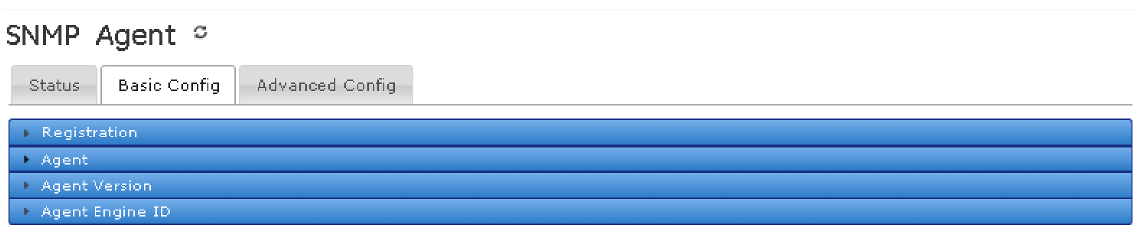
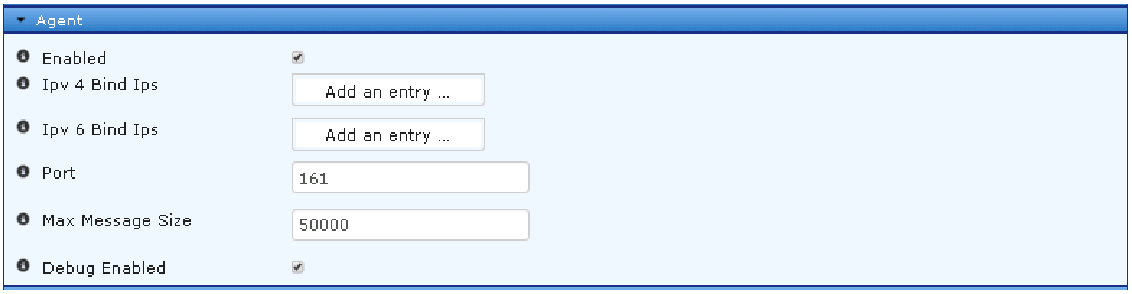


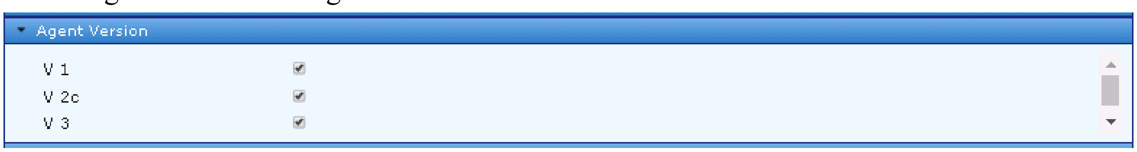
Figure 3-263. SNMP Agent Configuration

- Agent settings:



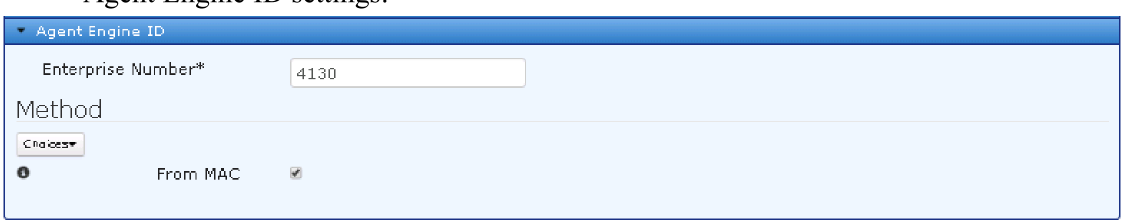
- **Enabled –** If checked (true) , the SNMP support is available.
- **Ipv 4 Bind Ips** – Restrict the server to only listen for connections on the specified IPv4 addresses. If not specified, the server will listen on all IPv4 addresses.
- **Ipv 6 Bind Ips** – Restrict the server to only listen for connections on the specified IPv6 addresses. If not specified, the server will listen on all IPv6 addresses.
- **Port** – UDP protocol port to be used for communication Valid values: 0—65535 Default: 161
- **Max Message Size** – maximum length in octets of an SNMP message which this SNMP engine can process (applies to both send and receive)
- **Debug Enabled** – If checked (true) , additional debug information is logged.

- Agent Version settings:



- **V 1** – SNMP version 1: Only requires a plain-text community, with 32 bit counters, and minimal security.
- **V 2C** – SNMP version 2 C: V 2c is basically equivalent to version 1, except it adds support for 64 bit counters.
- **V 3 -** SNMP version 3: adds both encryption and authentication, which can be used or in combination**.**

- Agent Engine ID settings:



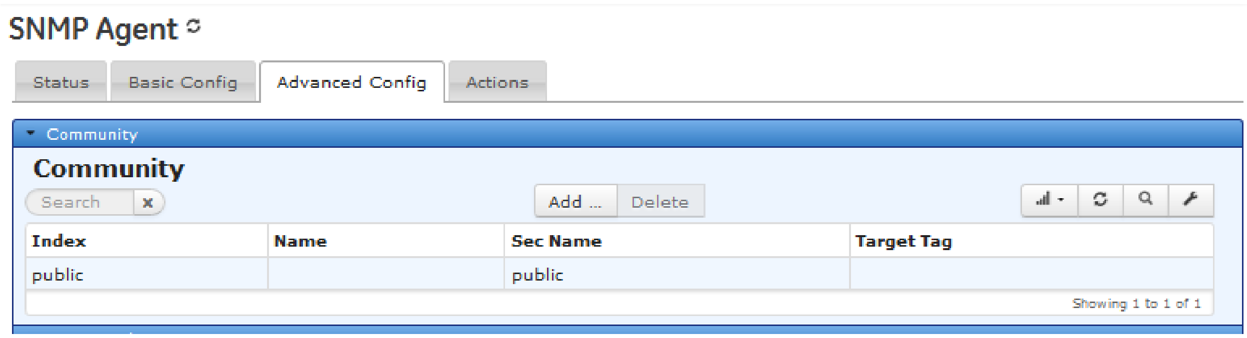
- **Enterprise Number –** This value may be left at default and is an administratively unique identifier for the SNMPv3 engine. Combined with value from the selected method below is used to create the Engine ID which is used in SNMPv3 to generate authentication and encryption keys. DEFAULT: 4130
- **Method:**
  - From IP – Generate SNMP engine ID based on the specified IP address
  - From Mac (DEFAULT) – Generate SNMP engine ID based on the ethernet MAC address
  - From Text – Generate SNMP engine ID based on specified text string 1 to 27 letters.
  - From Other - Generate SNMP engine ID based on specified hex string

From the CLI, filling in the SNMP parameter values can be accomplished using the following commands:

```
% set services snmp agent enabled true
% set services snmp agent port 161
% set services snmp agent version v1
% set services snmp agent version v2c
% set services snmp agent engine-id from-mac
```

Advanced Configuration

The example below shows how to create an SNMP community named "public" with security name "public". On the Web UI, click on the community panel under advanced config tab on SNMP Agent main screen and set/verify the parameters:



Filling in the parameter values can be accomplished via the CLI using the following commands:

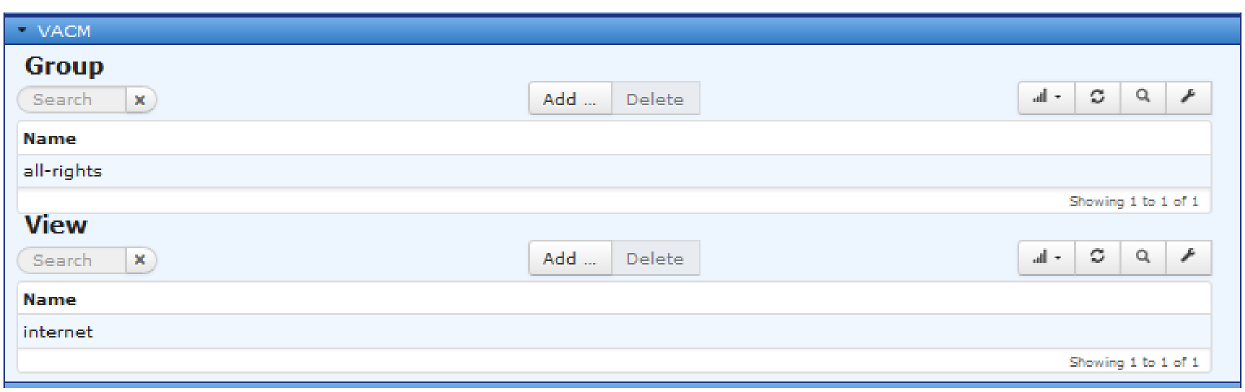
```
% set services snmp community public sec-name public
```

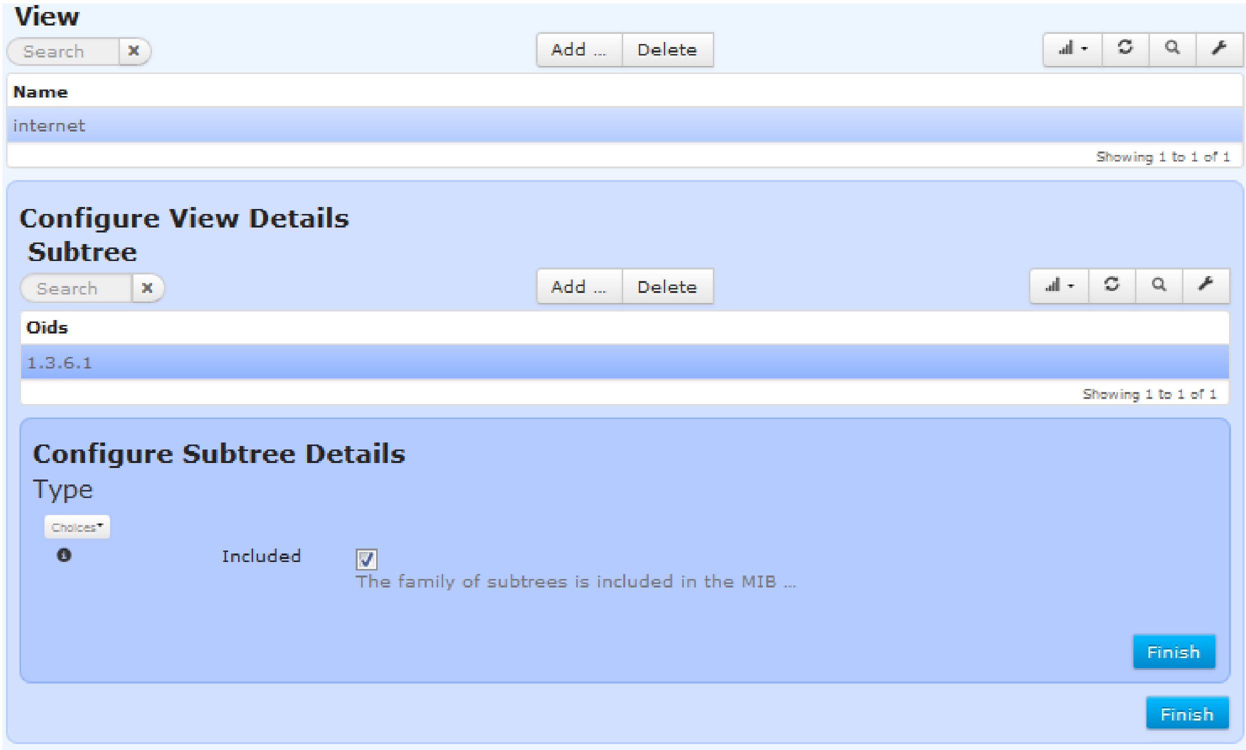
Create VACM group named "all-rights" and a view named "internet"

The VACM determines whether a SNMP request that has been authenticated by matching community security name (in case of SNMP v1/v2c) or by USM (in case SNMP v3) is authorized to access the MIB object that is contained in the request.

VACM view: A VACM view is a MIB view that includes an OID subtree value and a type that determines if the OID subtree is included or excluded from the view. For example in the case below, the view name is "internet" with subtree OID value of 1.3.6.1 and type "included". This view basically includes all OIDs at or below 1.3.6.1 OID subtree.

On the Web UI, on the SNMP main screen scroll down to the bottom and click on **VACM** and set/verify the parameters. These parameters are nested and an example shown below:





- **Type:** Choices: (click on the box or select from the choices pulldown)
  - Included (DEFAULT) – The family of subtrees is included in the MIB view
  - Excluded – The family of subtrees is excluded in the MIB view

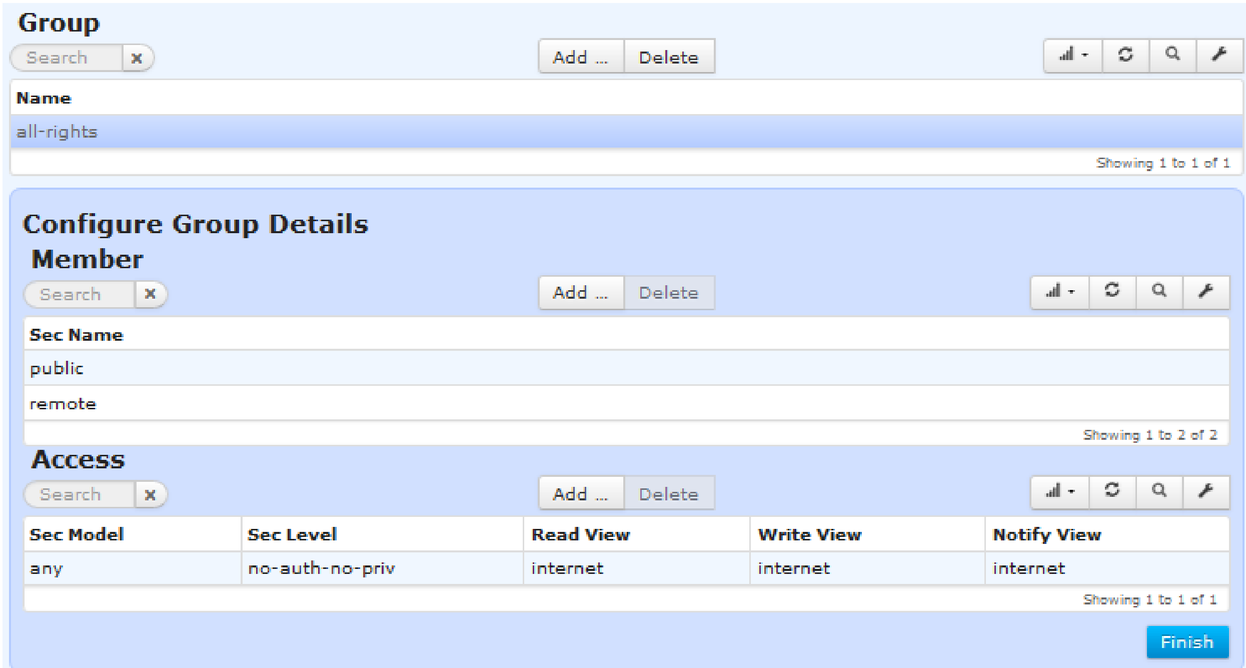
Filling in the VACM View parameter values can be accomplished via the CLI using the following commands:

% set services snmp vacm view internet **subtree** 1.3.6.1 **included**

- **VACM group** - A VACM group is used to organize a set of users (in case of SNMP v3) or a set of community security names (in case of SNMP v1 and v2c) for the purpose of managing their access rights to MIB parameters (OIDs). For example in the case below, the group name is “all-rights” with one member whose security name is “public” (as defined in snmp community configuration earlier) and whose “security model “ is v1 and v2c. In addition, the “all-rights” group has access to “internet” view under “any” security model and “no-auth-no-priv” security level. That is, the members of “all-rights” group can access internet view without any authentication (auth) or encryption (priv).

On the Web UI, on the SNMP main screen scroll down on each section and set/verify the parameters. These parameters are nested as shown in the example below:

Click on **all-rights** to see member and access definitions:



Filling in the VACM Group parameter values can be accomplished via the CLI using the following commands:

% set services snmp vacm group all-rights **member public** sec-model **[** v1 v2c **]**

% set services snmp vacm group all-rights **access** any **no-auth-no-priv read-view internet**

3. Click “Save” on the Web UI.

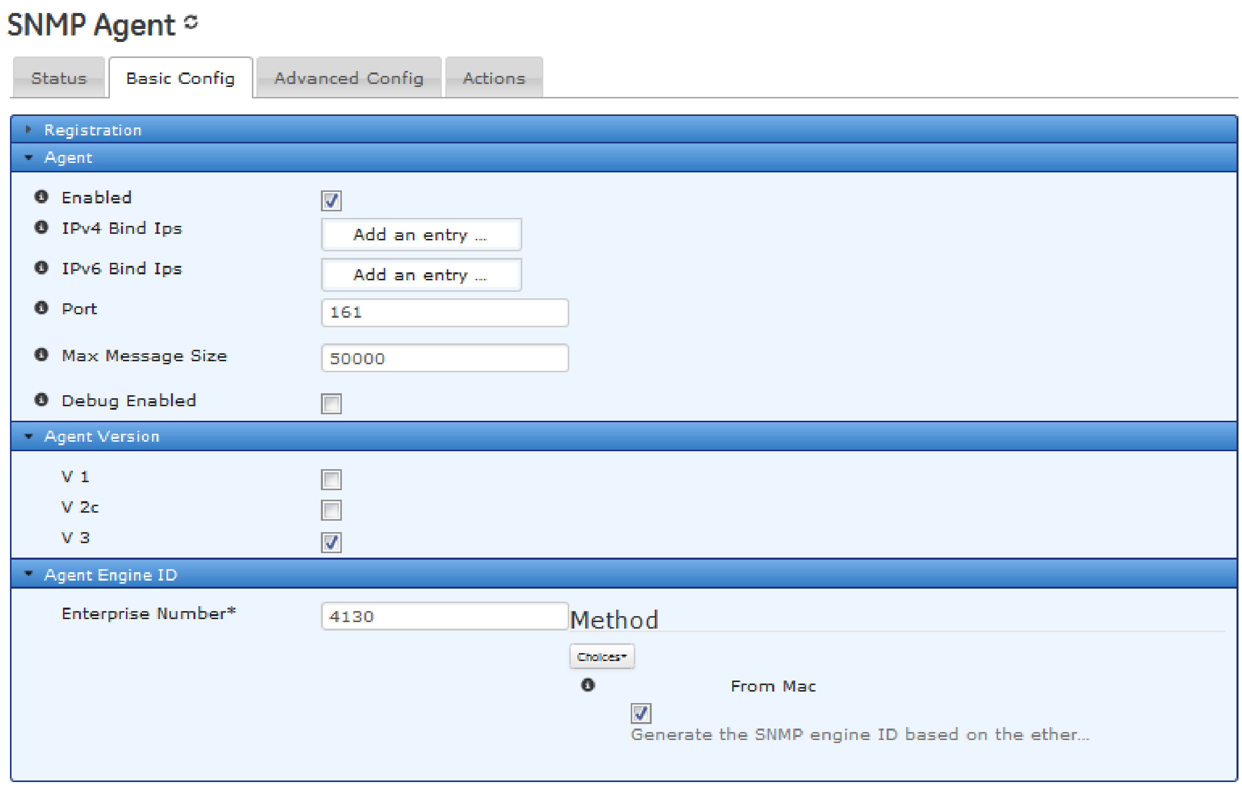
Via the CLI using the following commands:

% commit

Configuring the SNMP agent for v3-only operation (w/ Authentication and Encryption)

The example below assumes SNMP agent has factory default configuration (see section “Default Configuration on Page 403”).

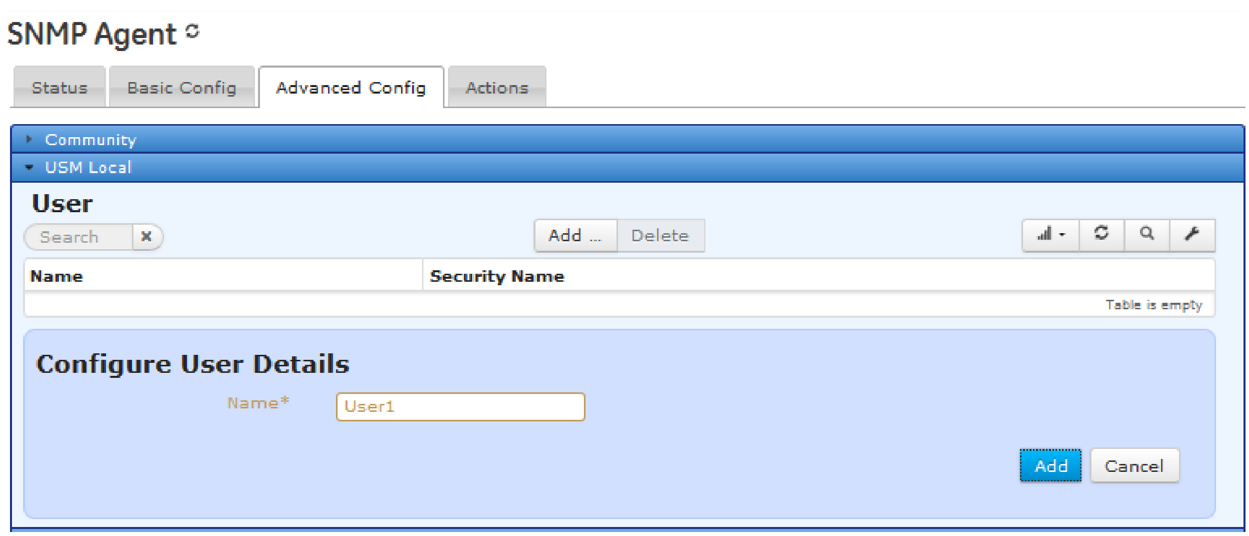
1. Disable v1/v2c and enable v3



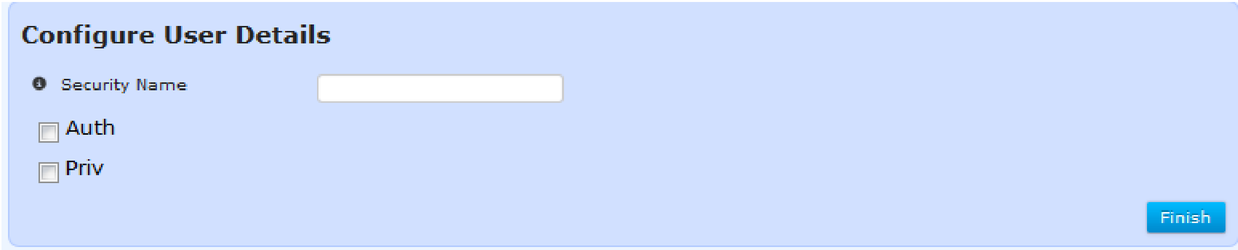
Setting the SNMP configuration can be accomplished via the CLI using the following commands:

% delete services snmp agent version v1
% delete services snmp agent version v2c
% set services snmp agent version v3

2. Create a local user named "User1" with SHA1 authentication with password "sha1Password" and AES encryption with password "aesPassword".

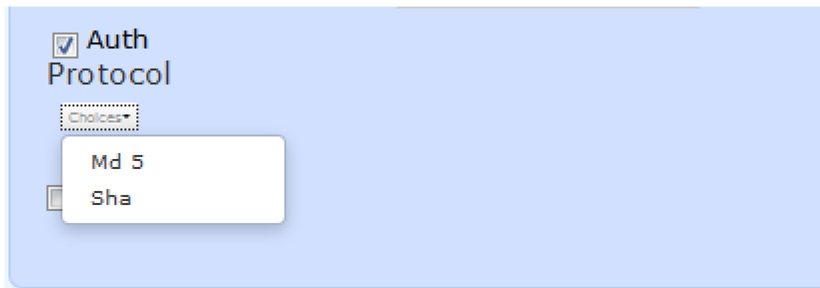


Click on the **Add** button in the User table and then enter "User 1". Once done, click the **Add** button. This will then prompt the user for additional information.

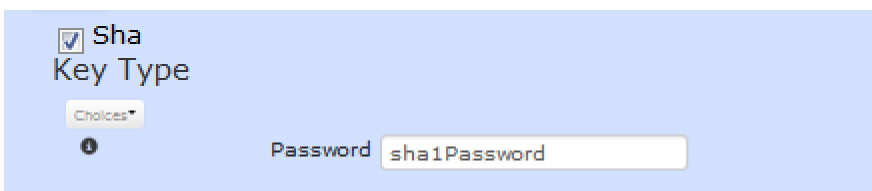


- Security Name – If not set, it is the same as the username.
- Auth – The parameters to configure message authentication.
- Priv - The parameters to configure messages encryption.

When the checkbox next to **Auth** is clicked, the following choices will appear for configuration.

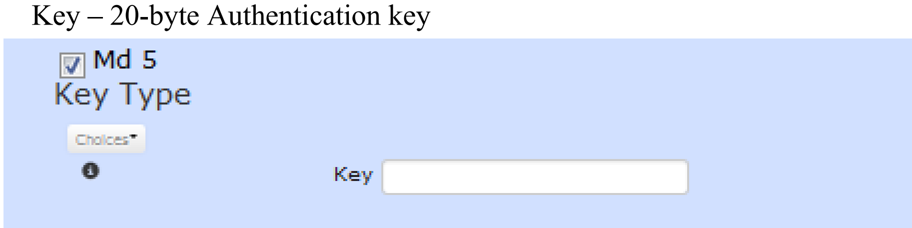


- **Choices** (select from the pulldown)
  - Sha (DEFAULT) – "secure hash algorithm" (SHA-1) - a cryptographic hash function producing a 160-bit (20-byte) hash value
  - Md5 – "message digest 5" - cryptographic hash function producing a 128-bit (16-byte) hash value



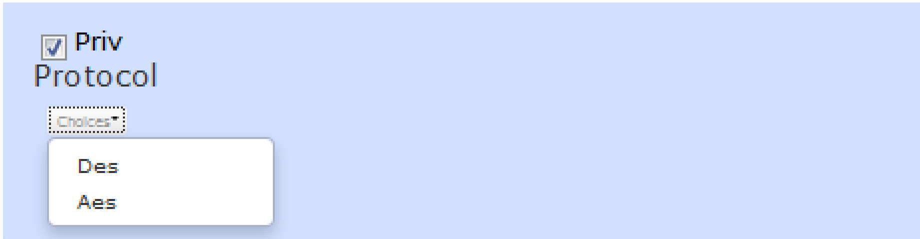
NOTE In FIPS mode, MD5 Auth is prohibited. Use SHA only.

- **SHA Key Type:** Choices: (select from the choices pulldown)
  - Password (DEFAULT) – Used to create a localized key.
  - Key – 20-byte Authentication key

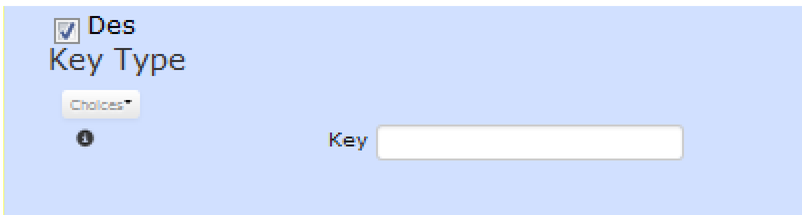


- **MD5 Key Type:** Choices: (select from the choices pulldown)
  - Password (DEFAULT) – Used to create a localized key.
  - Key – 16-byte Authentication key

When the checkbox next to **Priv** is selected, the following will appear;

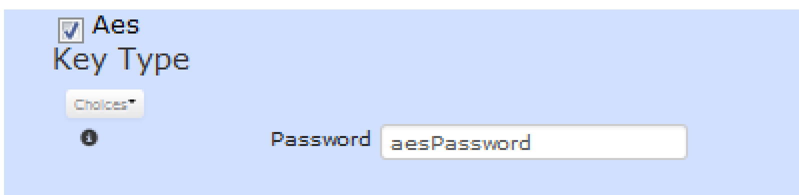


- **Choices** (select from the pulldown)
  - DES – Data Encryption Standard
  - AES – Advanced Encryption Standard.



NOTE In FIPS mode, DES Priv is prohibited. Use AES only.

- **Des Key Type:** Choices: (select from the choices pulldown)
  - Password (DEFAULT) – Used to create a localized key.
  - Key – 20-byte Authentication key



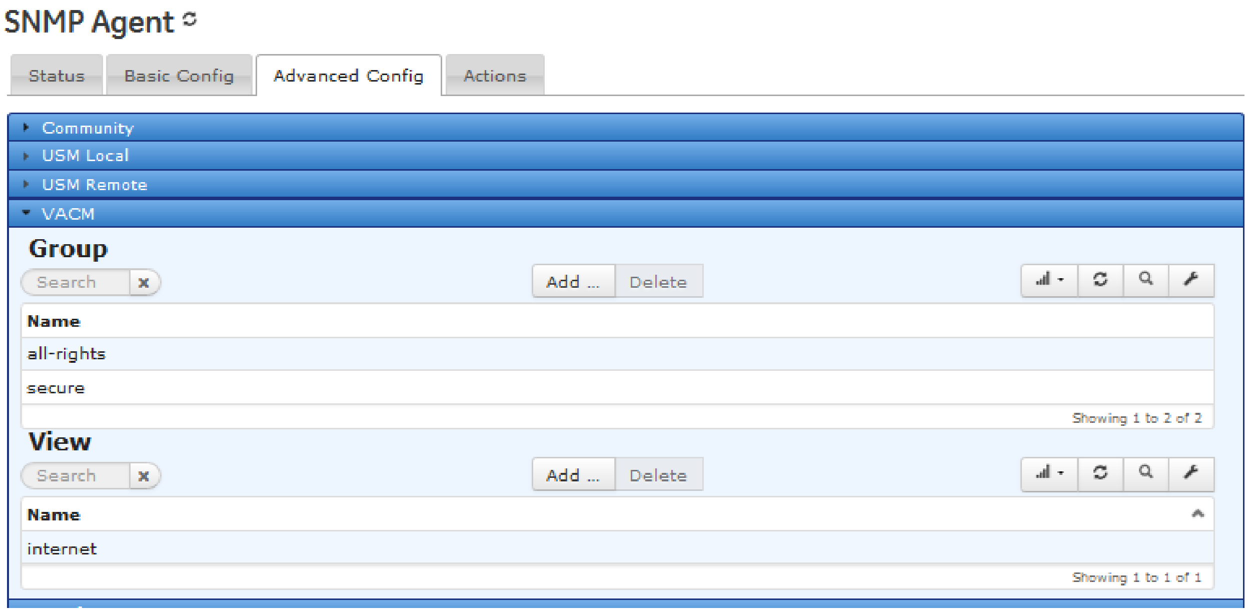
- **Aes Key Type:** Choices: (select from the choices pulldown)
  - Password (DEFAULT) – Used to create a localized key.
  - Key – 20-byte Authentication key

Filling in the User1 information values can be accomplished via the CLI using the following commands:

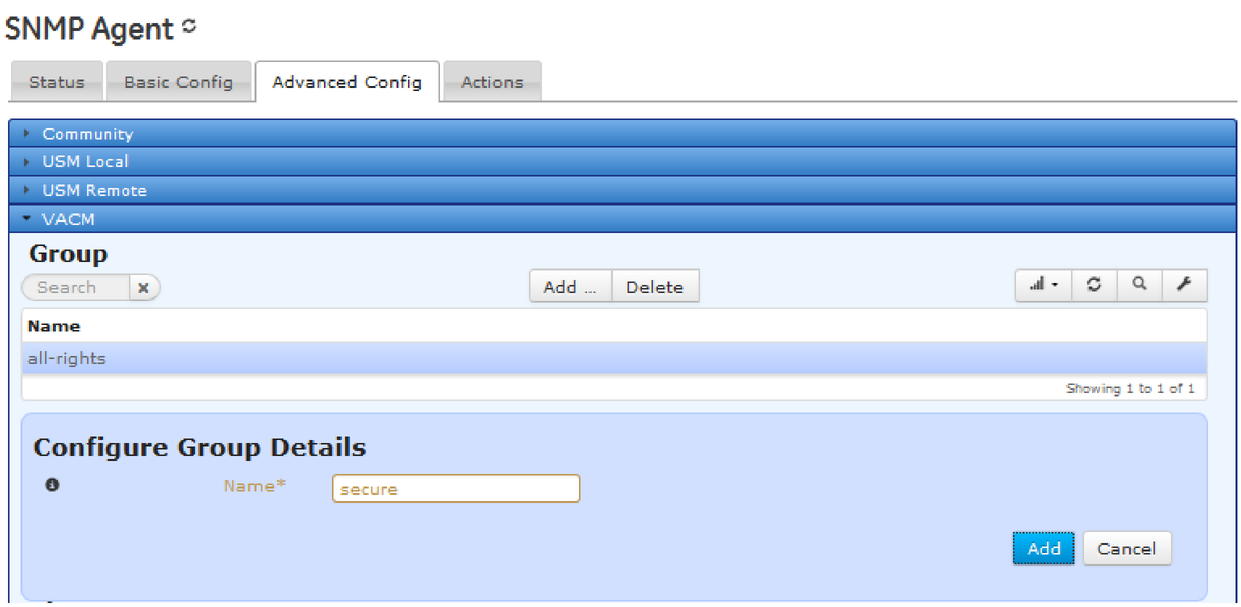
% set services snmp usm local user User1 **auth sha password** sha1Password
% set services snmp usm local user User1 **priv aes password** aesPassword

NOTE In FIPS mode, passwords entered must meet strength requirements set in Section 3.7.5

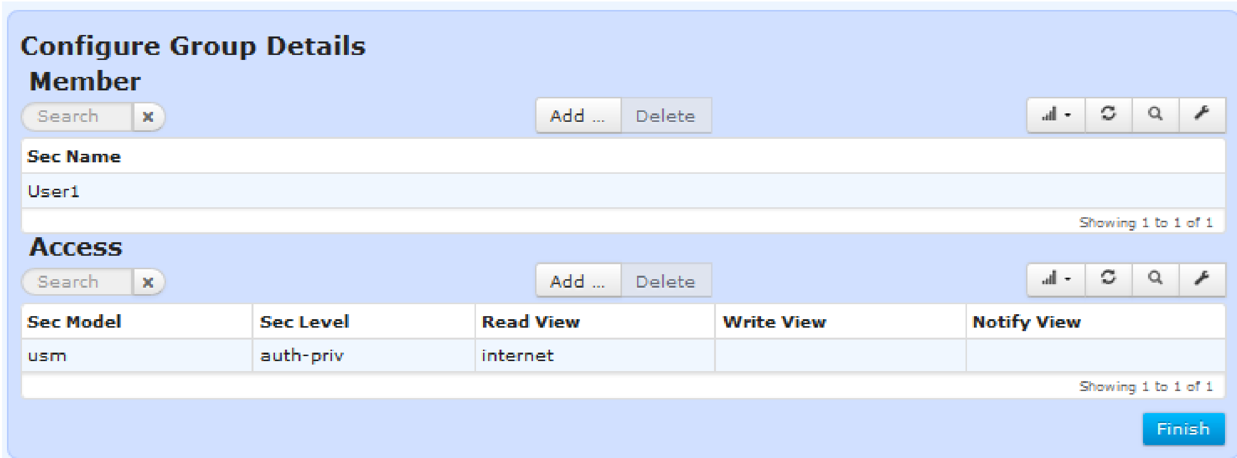
3. Create VACM group named "secure" and add "User1" to this group with security model "usm". Also, ensure group "secure" has read and notify access to "internet" view under "usm" security model and "auth-priv" security level. That is, the members of "secure" group can access internet view only with authentication (auth) or encryption (priv).



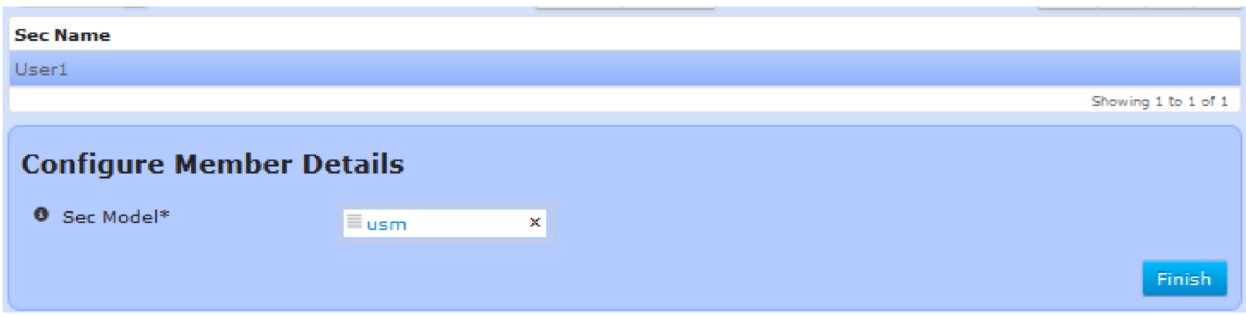
4. Click on **Add…** and configure a name for the group. In this example, the group name will be "secure".



5. Once finished, click the **Add** button, which will present additional configurable fields.

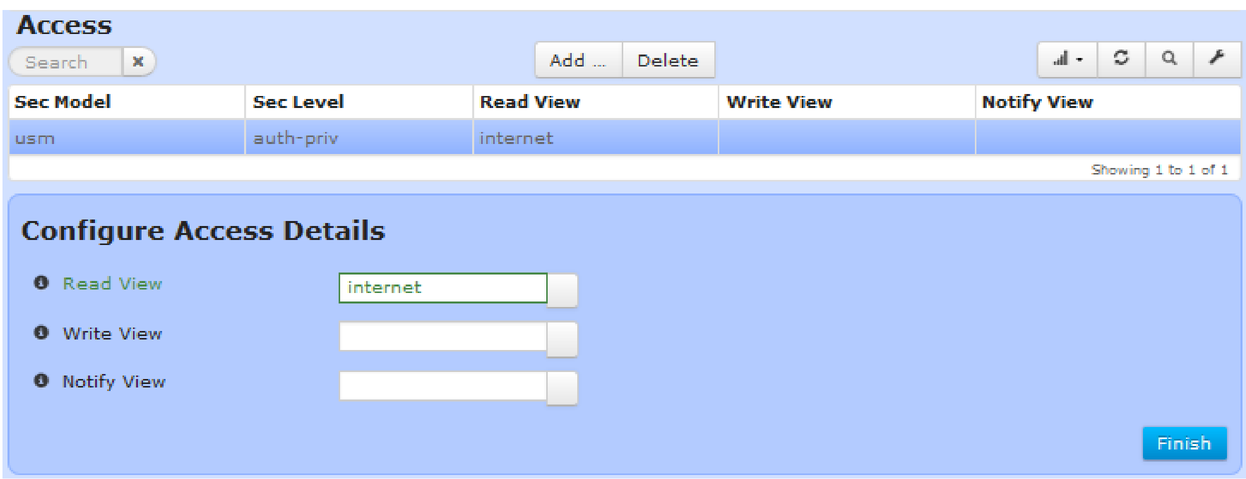


6. Assign a security model to User1 by clicking on the "User1" in the **Sec Name** table.



- **Sec Model** - The security models under which this security Name (i.e. USM) is a member of this group.

7. Next, assign the "internet" SNMP view as the **Read View** of the "usm" Access Sec Model.



- **Read View -** The name of the MIB view of the SNMP context authorizing read access.
- **Write View** - The name of the MIB view of the SNMP context authorizing write access**.**
- **Notify View** - The name of the MIB view of the SNMP context authorizing notify access**.**

8. Filling in the VACM Group parameter values can be accomplished via the CLI using the following commands:

   % set services snmp vacm group secure **member** User1 **sec-model** [usm]

   % set services snmp vacm group secure **access** usm **auth-priv read-view** internet

9. Commit configuration

   Click "Save" on the Web UI.

Via the CLI using the following commands:

% commit

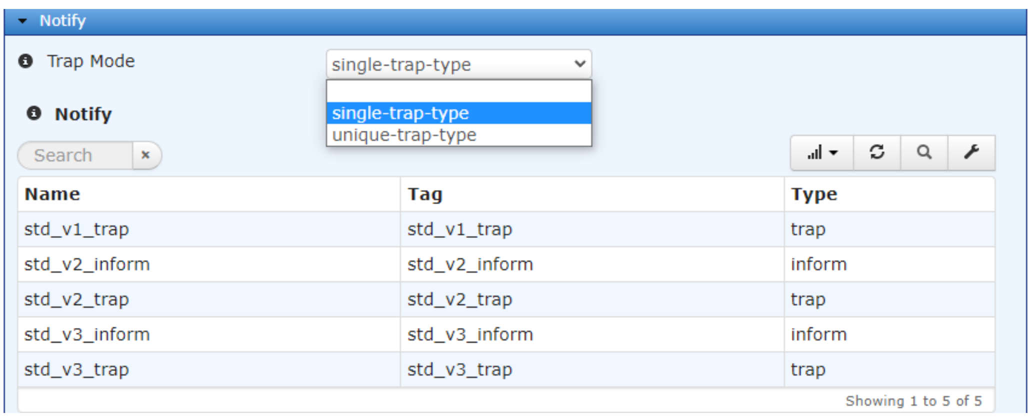
The snmpwalk tool can be used to test above configuration:

```
$ snmpwalk -M +./ -v3 -u User1 -a sha -A sha1Password -x aes -X aesPassword -l authpriv
   192.168.1.1 internet
SNMPv2-MIB::sysDescr.0 = STRING: GE MDS Orbit SNMP Agent
SNMPv2-MIB::sysObjectID.0 = OID: MDS-ORBIT-SMI-MIB::mdsOrbit
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (6128338) 17:01:23.38
SNMPv2-MIB::sysContact.0 = STRING:
SNMPv2-MIB::sysName.0 = STRING:
SNMPv2-MIB::sysLocation.0 = STRING:
SNMPv2-MIB::sysServices.0 = INTEGER: 72
SNMPv2-MIB::sysORLastChange.0 = Timeticks: (0) 0:00:00.00
```

Configuring the SNMP agent to send notifications (traps/informs)

The Orbit system can generate traps using either a single common format for all events or using a specialized unique format based on event type. By default all events will use the common format as specified by “single-trap-type”. Unique trap types can be selected if desired.

The SNMP notification table is preconfigured as follows::



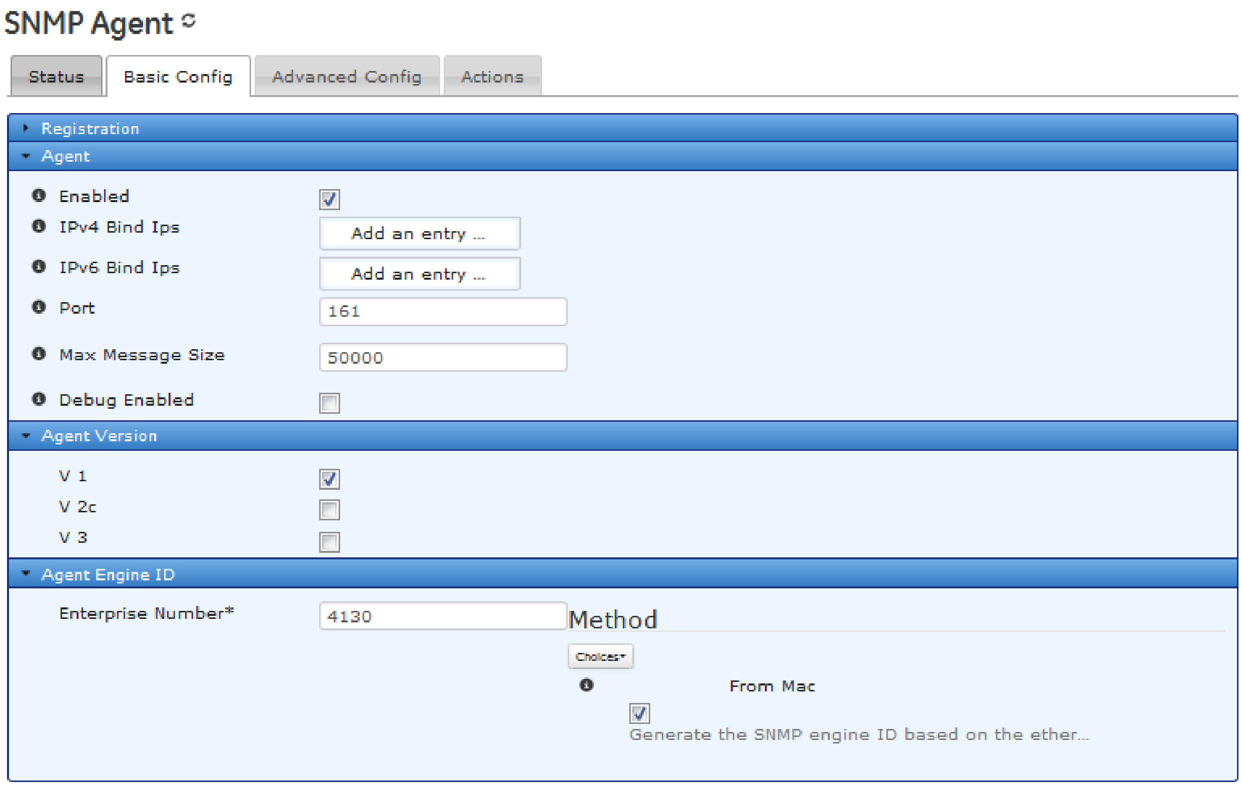
Each entry above specifies a SNMP notify name (e.g. std_v1_trap), the tag (e.g. std_v1_trap) and the type of notification (trap or inform). The notify and tag names are kept the same for ease of configuration of SNMP targets. The SNMP notify name is used to lookup up the tag (in notify table) that in turns is used to look up all the SNMP targets (in target table) to which the SNMP notification needs to be sent.

Each event in the Orbit system can be configured to send an SNMP notification (trap/inform). By default, all events are configured to send SNMP notification with SNMP notify name of “” (empty string). This selects all tags in the notify table and attempts to lookup the targets that have been configured for these tags. The user can also configure the SNMP notify name to be used for each event.

Sending all system events as SNMP v1 traps

Following example shows how to configure the unit to send v1 traps for all the events in the system to a specified SNMP target:

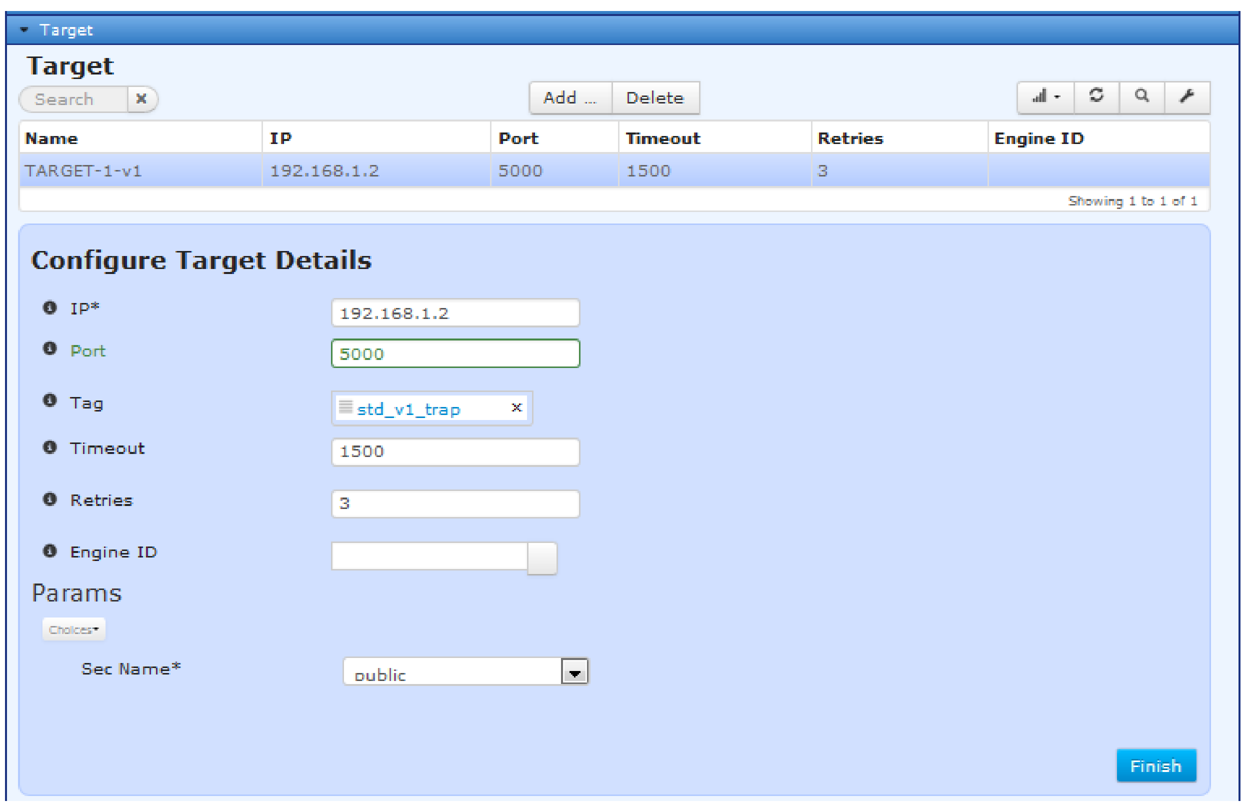
1. Ensure version v1 is enabled.



Filling in values can be accomplished via the CLI using the following commands:

% set services snmp agent version v1

2. Configure SNMP manager as a target ("TARGET-1-v1") that listens on port 5000, has IP address of 192.168.1.2, can receive v1 traps (tag "std_v1_trap") with security name of "public".



Filling in values can be accomplished via the CLI using the following commands:

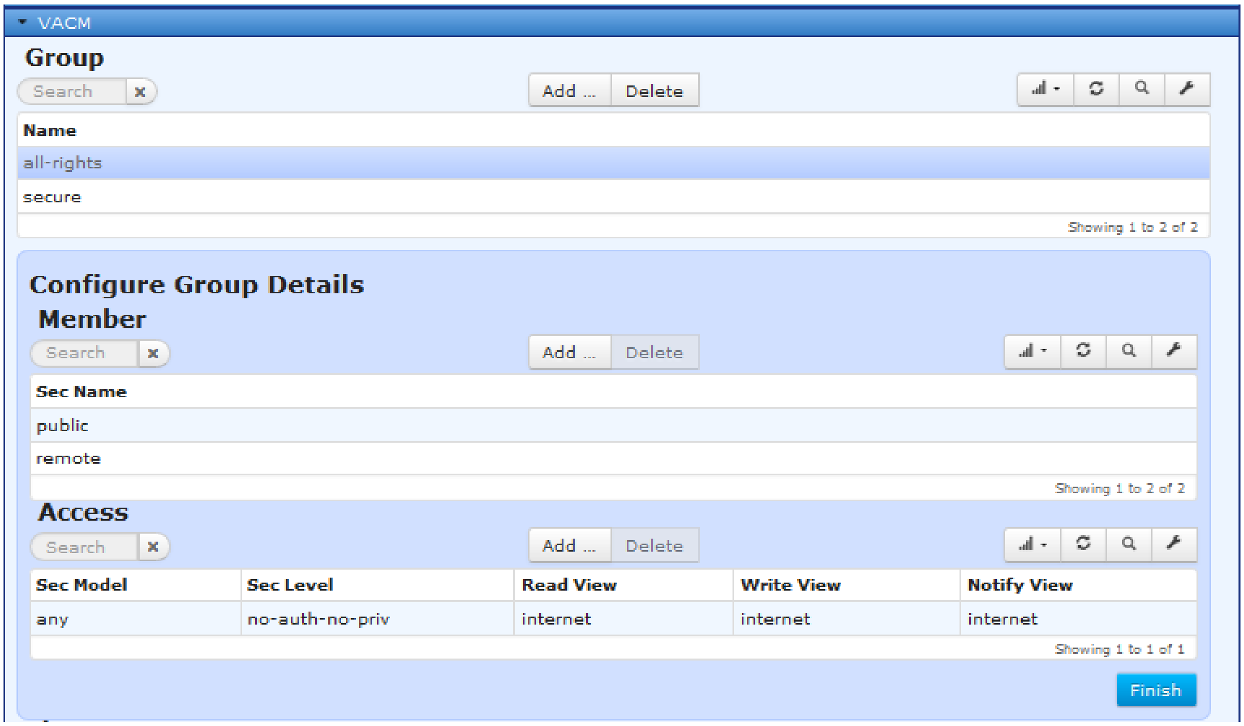
% set services snmp target TARGET-1-v1 **ip** 192.168.1.2

% set services snmp target TARGET-1-v1 **port** 5000

% set services snmp target TARGET-1-v1 **tag** std_v1_trap

% set services snmp target TARGET-1-v1 **v1 sec-name** public

3. Give the VACM group named "all-rights" (as configured in previous examples) notify access to "internet" view.



Filling in values can be accomplished via the CLI using the following commands:

% set services snmp vacm group all-rights **access** any **no-auth-no-priv notify-view** internet

4. Click "Save" on the Web UI.

Via the CLI using the following commands:

% commit

To test above configuration, start an SNMP trap receiver (like "snmptrapd" with configuration file as shown below) and generate "ssh_login" event by logging into the Orbit via SSH.

snmptrapd.conf:

engineID testing

snmpTrapdAddr 0.0.0.0:5000

authCommunity log,execute,net public

doNotFork yes

$ snmptrapd -M +./ -Lo -c snmptrapd.conf

NET-SNMP version 5.4.3

2014-04-22 13:39:02 0.0.0.0(via UDP: [192.168.1.1]:161->[192.168.1.2]) TRAP, SNMP v1, community public

MDS-EVENT-MIB::traps0 Enterprise Specific Trap (MDS-EVENT-MIB::mdsEvent) Uptime: 2:07:00.35

MDS-EVENT-MIB::mdsEventName.0 = STRING: "ssh_login"

MDS-EVENT-MIB::mdsEventInfoInCee.0 = STRING: "@cee:{\"host\":\"(none)\",\"pname\":\"loggingmgr\",\"time\":\"2014-04-

15T02:02:38.091753+00:00\",\"action\":\"login\",\"service\":\"ssh\",\"domain\":\"os\",\"o
bject\":\"session\",\"status\":\"success\",\"src_ipv4\":\"192.168.1.2\",\"src_port\":42135,\
"user_name\":\"admin\",\"event\":\"ssh_login\",\"profile\":\"http://gemds.com/cee_profil
e/1.0beta1.xsd\"}"

As can be seen above, the SNMP agent sent a v1 trap for "ssh_login" event

NOTE The following configuration are very similar to the WebUI Screens already presented. To save space only the CLI version is presented.

Sending all system events as SNMP v2c traps

Following example shows how to configure the unit to send v2c traps for all the events in the system to a specified SNMP target via the CLI command line:

1. Ensure version v2c is enabled.

   % set services snmp agent version v2c

2. Configure SNMP manager as a target that listens on port 5000, has IP address of 192.168.1.2, can receive v2c traps (tag "std_v2_trap") with security name of "public".

   % set services snmp target TARGET-1-v2c **ip** 192.168.1.2

   % set services snmp target TARGET-1-v2c **port** 5000

   % set services snmp target TARGET-1-v2c **tag** std_v2_trap

   % set services snmp target TARGET-1-v2c **v2c sec-name** public

3. Give the VACM group named "all-rights" (as configured in previous examples) notify access to "internet" view.

   % set services snmp vacm group all-rights **access** any **no-auth-no-priv notify-view** internet

4. Commit configuration.

   % commit

To test above configuration, start an SNMP trap receiver (like "snmptrapd" with configuration file as shown below) and generate "ssh_login" event by logging into the Orbit via SSH.

```
snmptrapd.conf:
engineID testing
snmpTrapdAddr 0.0.0.0:5000
authCommunity log,execute,net public
doNotFork yes

$ snmptrapd -M +./  -Lo -c snmptrapd.conf
NET-SNMP version 5.4.3

192.168.1.1 [UDP: [192.168.1.1]:161->[192.168.1.2]]: Trap ,
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (592863) 1:38:48.63,
SNMPv2-MIB::snmpTrapOID.0 = OID: MDS-EVENT-MIB::mdsEvent,
MDS-EVENT-MIB::mdsEventName.0 = STRING: "ssh_login",
MDS-EVENT-MIB::mdsEventInfoInCee.0 = STRING:
   "@cee:{\"host\":\"(none)\",\"pname\":\"loggingmgr\",\"time\":\"2014-04-
   15T01:34:26.373312+00:00\",\"action\":\"login\",\"service\":\"ssh\",\"domain\":\"os\",\"o
   bject\":\"session\",\"status\":\"success\",\"src_ipv4\":\"192.168.1.2\",\"src_port\":42031,\
   "user_name\":\"admin\",\"event\":\"ssh_login\",\"profile\":\"http://gemds.com/cee_profil
   e/1.0beta1.xsd\"}"
```

As can be seen above, the SNMP agent sent a v2 trap for "ssh_login" event.

Sending all system events as SNMP v3 traps (w/ Authentication and Encryption)

Following example shows how to configure the unit to send v3 traps with authentication and encryption for all the events in the system to a specified SNMP target via the CLI command line:

1. Ensure version v3 is enabled.

   % set services snmp agent version v3

2. Configure SNMP manager as a target that listens on port 5000, has IP address of 192.168.1.2, can receive v3 traps (tag "std_v3_trap") using user name "User1" (Please refer to the section on configuring SNMP v3-only to see how to configure local user "User1").

   % set services snmp target TARGET-1-v3 **ip** 192.168.1.2

   % set services snmp target TARGET-1-v3 **port** 5000

   % set services snmp target TARGET-1-v3 **tag** std_v3_trap

   % set services snmp target TARGET-1-v3 **usm user-name** User1

   % set services snmp target TARGET-1-v3 **usm sec-level** auth-priv

3. Give the VACM group named "secure" (as configured in example on SNMP v3-only configuration) notify access to "internet" view.

   % set services snmp vacm group secure **access** usm **auth-priv notify-view** internet

4. Commit configuration.

   % commit

To test above configuration, start an SNMP trap receiver (like "snmptrapd" with configuration file as shown below) and generate "ssh_login" event by logging into the Orbit via SSH.

NOTE When using SNMPv3 traps, the Orbit is the authoritative engine since it is the one sending the trap. Therefore, the user created in snmptrapd.conf must be tied to the EngineID of Orbit. The EngineID of Orbit can be obtained by running following command:

```
% run show SNMP-FRAMEWORK-MIB snmpEngine snmpEngineID
SNMP-FRAMEWORK-MIB snmpEngine snmpEngineID 80:00:10:22:03:00:06:3d:06:ea:96
snmptrapd.conf:
engineID testing
snmpTrapdAddr 0.0.0.0:5000
createUser -e 800010220300063d06ea96 User1 SHA sha1Password AES aesPassword
doNotFork yes
authUser log,execute,net User1

$ snmptrapd -M +./  -Lo -c snmptrapd.conf
NET-SNMP version 5.4.3

2014-04-22 13:59:13 192.168.1.1 [UDP: [192.168.1.1]:161->[192.168.1.2]]:
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (883103) 2:27:11.03
SNMPv2-MIB::snmpTrapOID.0 = OID: MDS-EVENT-MIB::mdsEvent
MDS-EVENT-MIB::mdsEventName.0 = STRING: "ssh_login"
MDS-EVENT-MIB::mdsEventInfoInCee.0 = STRING:
   "@cee:{\"host\":\"(none)\",\"pname\":\"loggingmgr\",\"time\":\"2014-04-
   15T02:22:48.771834+00:00\",\"action\":\"login\",\"service\":\"ssh\",\"domain\":\"os\",\"o
   bject\":\"session\",\"status\":\"success\",\"src_ipv4\":\"192.168.1.2\",\"src_port\":42156,\
   "user_name\":\"admin\",\"event\":\"ssh_login\",\"profile\":\"http://gemds.com/cee_profil
   e/1.0beta1.xsd\"}"
```

As can be seen above, the SNMP agent sent a v3 trap for "ssh_login" event. If the authentication or encryption password for user "User1" as set in snmptrapd.conf file does not match as that configured in the unit, snmptrapd will not display the received trap.

Sending all system events as SNMP v2c informs

An SNMP inform is an acknowledged trap. Following example shows how to configure the unit to send v2c informs for all the events in the system to a specified SNMP target:

1. Ensure version v2c is enabled.

   % set services snmp agent version v2c

2. Configure SNMP manager as a target that listens on port 5000, has IP address of 192.168.1.2, can receive v2c informs (tag "std_v2_inform") with security name of "public", with retry timeout of 15 seconds (timeout parameter is in units of 0.01 seconds) and max number of retries of 3.

   % set services snmp target TARGET-1-v2c-inform **ip** 192.168.1.2

   % set services snmp target TARGET-1-v2c-inform **port** 5000

   % set services snmp target TARGET-1-v2c-inform **tag** std_v2_inform

   % set services snmp target TARGET-1-v2c-inform **v2c sec-name** public

   % set services snmp target TARGET-1-v2c-inform **timeout** 1500

   % set services snmp target TARGET-1-v2c-inform **retries** 3

3. Give the VACM group named "all-rights" (as configured in previous examples) notify access to "internet" view.

   % set services snmp vacm group all-rights **access** any **no-auth-no-priv notify-view** internet

4. Commit configuration.

   % commit

To test above configuration, start an SNMP trap receiver (like "snmptrapd" with configuration file as shown below) and generate "ssh_login" event by logging into the Orbit via SSH.

```
snmptrapd.conf:
engineID testing
snmpTrapdAddr 0.0.0.0:5000
authCommunity log,execute,net public
doNotFork yes

$ snmptrapd -M +./  -Lo -c snmptrapd.conf
NET-SNMP version 5.4.3

2014-04-22 16:02:17 192.168.1.1 [UDP: [192.168.1.1]:161->[192.168.1.2]]:
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (271741) 0:45:17.41
SNMPv2-MIB::snmpTrapOID.0 = OID: MDS-EVENT-MIB::mdsEvent
MDS-EVENT-MIB::mdsEventName.0 = STRING: "ssh_login"
MDS-EVENT-MIB::mdsEventInfoInCee.0 = STRING:
   "@cee:{\"host\":\"(none)\",\"pname\":\"loggingmgr\",\"time\":\"2014-04-
   15T04:25:53.677885+00:00\",\"action\":\"login\",\"service\":\"ssh\",\"domain\":\"os\",\"o
   bject\":\"session\",\"status\":\"success\",\"src_ipv4\":\"192.168.1.2\",\"src_port\":42694,\
   "user_name\":\"admin\",\"event\":\"ssh_login\",\"profile\":\"http://gemds.com/cee_profil
   e/1.0beta1.xsd\"}"
```

Sending all system events as SNMP v3 informs

Following example shows how to configure the unit to send v3 informs for all the events in the system to a specified SNMP target via the CLI command line:

1. Ensure version v3 is enabled.

   % set services snmp agent version v3

2. Create a remote user named "RemUser1" with engine-id of SNMP inform receiver (80:00:1f:88:04:74:65:73:74:69:6e:67) and SHA1 authentication with password "sha1Password" and AES encryption with password "aesPassword".

NOTE When using SNMPv3 informs, the inform receiver is the authoritative engine.

   % set services snmp usm remote 80:00:1f:88:04:74:65:73:74:69:6e:67 **user** RemUser1 **auth sha password** sha1Password

   % set services snmp usm remote 80:00:1f:88:04:74:65:73:74:69:6e:67 **user** RemUser1 **priv aes password** aesPassword

3. Configure SNMP manager as a target with engine id 80:00:1f:88:04:74:65:73:74:69:6e:67 that listens on port 5000, has IP address of 192.168.1.2, can receive v3 informs (tag "std_v3_inform") with user name of "RemUser1", with retry timeout of 15 seconds (timeout parameter is in units of 0.01 seconds) and max number of retries of 3.

   % set services snmp target TARGET-1-v3-inform **ip** 192.168.1.2
   % set services snmp target TARGET-1-v3-inform **port** 5000
   % set services snmp target TARGET-1-v3-inform **tag** std_v3_inform
   % set services snmp target TARGET-1-v3-inform **timeout** 1500
   % set services snmp target TARGET-1-v3-inform **retries** 3
   % set services snmp target TARGET-1-v3-inform **engine-id** 80:00:1f:88:04:74:65:73:74:69:6e:67
   % set services snmp target TARGET-1-v3-inform **usm user-name** RemUser1
   % set services snmp target TARGET-1-v3-inform **usm sec-level** auth-priv

4. Add "RemUser1" to VACM group "secure" (as configured in example on SNMP v3-only configuration) with security model "usm". Also, ensure VACM group "secure" has notify access to "internet" view under "usm" security model and "auth-priv" security level.

   % set services snmp vacm group secure **member** User1 **sec-model [**usm**]**
   % set services snmp vacm group secure **access** usm **auth-priv notify-view** internet

5. Commit configuration.

   % commit

To test above configuration, start an SNMP trap receiver (like "snmptrapd" with configuration file as shown below) and generate "ssh_login" event by logging into the Orbit via SSH.

```
snmptrapd.conf:
engineID testing
snmpTrapdAddr 0.0.0.0:5000
createUser RemUser1 SHA sha1Password AES aesPassword
authUser log,execute,net RemUser1
doNotFork yes

$ snmptrapd -M +./  -Lo -c snmptrapd.conf
NET-SNMP version 5.4.3

2014-04-22 16:02:17 192.168.1.1 [UDP: [192.168.1.1]:161->[192.168.1.2]]:
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (271741) 0:45:17.41
SNMPv2-MIB::snmpTrapOID.0 = OID: MDS-EVENT-MIB::mdsEvent
MDS-EVENT-MIB::mdsEventName.0 = STRING: "ssh_login"
MDS-EVENT-MIB::mdsEventInfoInCee.0 = STRING:
   "@cee:{\"host\":\"(none)\",\"pname\":\"loggingmgr\",\"time\":\"2014-04-
   15T04:25:53.677885+00:00\",\"action\":\"login\",\"service\":\"ssh\",\"domain\":\"os\",\"o
   bject\":\"session\",\"status\":\"success\",\"src_ipv4\":\"192.168.1.2\",\"src_port\":42694,\
   "user_name\":\"admin\",\"event\":\"ssh_login\",\"profile\":\"http://gemds.com/cee_profil
   e/1.0beta1.xsd\"}"
```

Monitoring

Ensure the CLI is in operational mode. Check SNMP agent status

```
> show SNMPv2-MIB
SNMPv2-MIB system sysDescr "GE MDS Orbit SNMP Agent"
SNMPv2-MIB system sysObjectID 1.3.6.1.4.1.4130.10
SNMPv2-MIB system sysUpTime 911614
SNMPv2-MIB system sysServices 72
SNMPv2-MIB system sysORLastChange 0
SNMPv2-MIB snmp snmpInPkts 0
```

SNMPv2-MIB snmp snmpInBadVersions 0
SNMPv2-MIB snmp snmpInBadCommunityNames 0
SNMPv2-MIB snmp snmpInBadCommunityUses 0
SNMPv2-MIB snmp snmpInASNParseErrs 0
SNMPv2-MIB snmp snmpSilentDrops 0
SNMPv2-MIB snmp snmpProxyDrops 0
SNMPv2-MIB snmpSet snmpSetSerialNo 3928852

> **show** SNMP-FRAMEWORK-MIB
SNMP-FRAMEWORK-MIB snmpEngine snmpEngineID 80:00:10:22:03:00:06:3d:06:ea:96
SNMP-FRAMEWORK-MIB snmpEngine snmpEngineBoots 36
SNMP-FRAMEWORK-MIB snmpEngine snmpEngineTime 9151
SNMP-FRAMEWORK-MIB snmpEngine snmpEngineMaxMessageSize 50000

> **show** SNMP-USER-BASED-SM-MIB
SNMP-USER-BASED-SM-MIB usmStats usmStatsUnsupportedSecLevels 0
SNMP-USER-BASED-SM-MIB usmStats usmStatsNotInTimeWindows 0
SNMP-USER-BASED-SM-MIB usmStats usmStatsUnknownUserNames 0
SNMP-USER-BASED-SM-MIB usmStats usmStatsUnknownEngineIDs 0
SNMP-USER-BASED-SM-MIB usmStats usmStatsWrongDigests 0
SNMP-USER-BASED-SM-MIB usmStats usmStatsDecryptionErrors 0

> **show** SNMP-MPD-MIB
SNMP-MPD-MIB snmpMPDStats snmpUnknownSecurityModels 0
SNMP-MPD-MIB snmpMPDStats snmpInvalidMsgs 0
SNMP-MPD-MIB snmpMPDStats snmpUnknownPDUHandlers 0

> **show** SNMP-TARGET-MIB
SNMP-TARGET-MIB snmpTargetObjects snmpUnavailableContexts 0
SNMP-TARGET-MIB snmpTargetObjects snmpUnknownContexts 0

3.8.21 Network Monitor Service

Understanding

Network monitor service consists of various “monitor” operations which monitor various aspects of the device functionality and signal whether the operation is DOWN or UP. These network monitor operations can be tied (through configuration) to various “consumers” of these operations, which can then make decisions based on the state of the operation.

Following network monitor operations are supported:

- Interface-monitor – Monitor oper-status of an interface
- Icmp-echo-monitor – Monitors IP connectivity using ICMP ECHO (ping) messages.
- Bgp-neighbor-monitor – Monitors BGP connection state.
- Cell-signal-monitor – Monitors cellular 2G/3G/4G service state and signal metrics.
- Vrrp-monitor – Monitors state of VRRP instance.
- Radio-monitor – Monitors state of LN radio.
- Logic-monitor- Allows user to create a logical expression composed of other netmon operations.

Following “client” subsystems can utilize the network monitor operations:

- Static routes – An icmp-echo monitor can be used to enable static route failover from primary to secondary route based reachability of a configured host through the primary path.

- System restart- Orbit device can be configured to reboot based on state of any network monitor operation to allow automated recovery.
- Cellular connection manager- The cellular connection manager can be configured to switch connection profiles to enable APN/SIM switching or just reset the cellular modem based state of any network monitor operation.
- LN connection manager- The Licensed narrowband (LN) connection manager can be configured to switch connection profiles based on state of any network monitor operation. It can also be configured to conditionally operate based on state of any network monitor operation
- VRRP- VRRP on the secondary router can be configured to assume "master" role (and hence default gateway for downstream hosts) if path to a configured upstream host through the primary router is not available as determined by icmp-echo monitor operation.
- IPsec VPN – The IPsec VPN connection can be configured to conditionally operate based on state of any network monitor operation.

INTERFACE-MONITOR

This operation monitors operational status (oper-status) of an interface, with monitor operation state being false (i.e. DOWN) when interface oper-status is DOWN and monitor operation state being true (i.e. UP) when interface oper-status is UP.

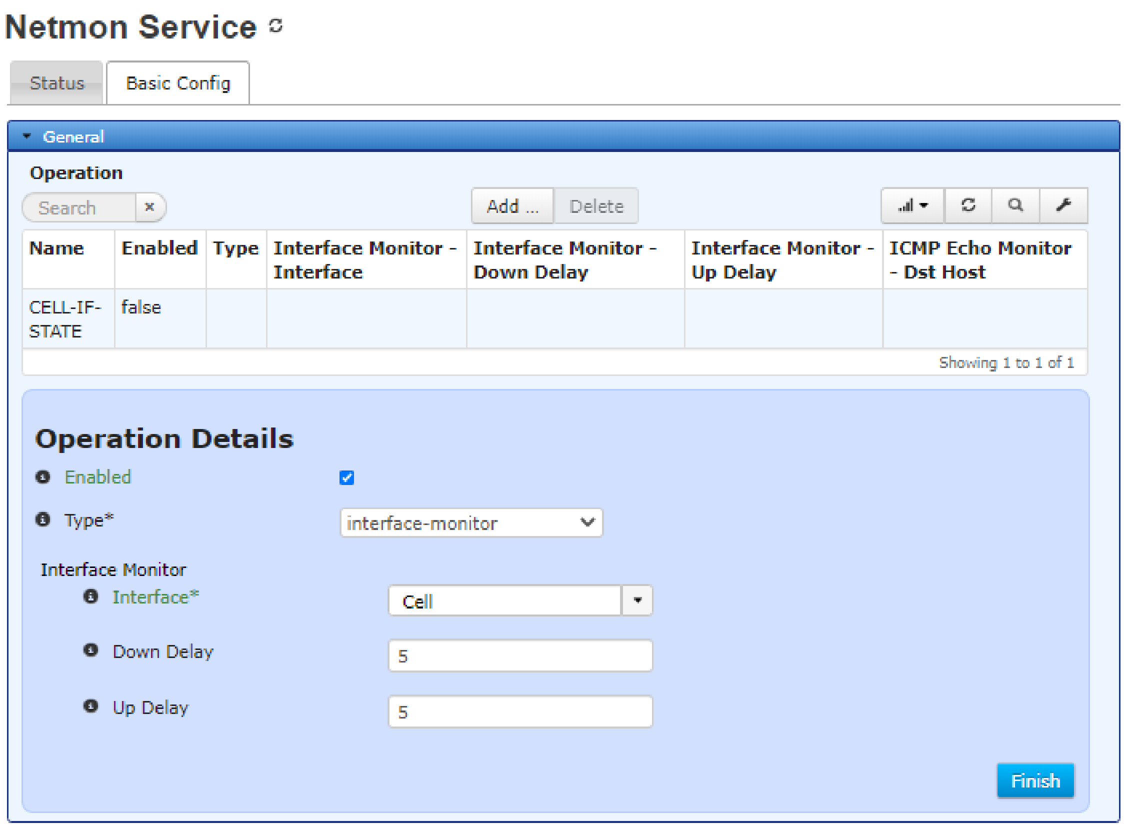
NOTE It is recommended that ICMP-ECHO monitor be used to check link availability/reachability since it is possible in some degenerate cases that interface oper-status is UP but traffic does not pass.

Configuration

Using the WebUI

Following example shows how to configure interface-monitor operation.

Click '**Add**' at ***Netmon --->Basic Config / General*** and create an interface-monitor operation with a descriptive name, say, CELL-IF-STATE



Enabled - Whether or not to run this operation

- **Type** - Type of monitor operation
- **Interface Monitor**
  - Interface – The interface whose oper-status is to be monitored
  - Down Delay – The time interval (in seconds) to wait after interface oper-status is DOWN before changing monitor operation state to false (i.e. DOWN).
  - Up Delay - The time interval (in seconds) to wait after interface oper-status is UP before changing monitor operation state to true (i.e. UP).

Using the CLI

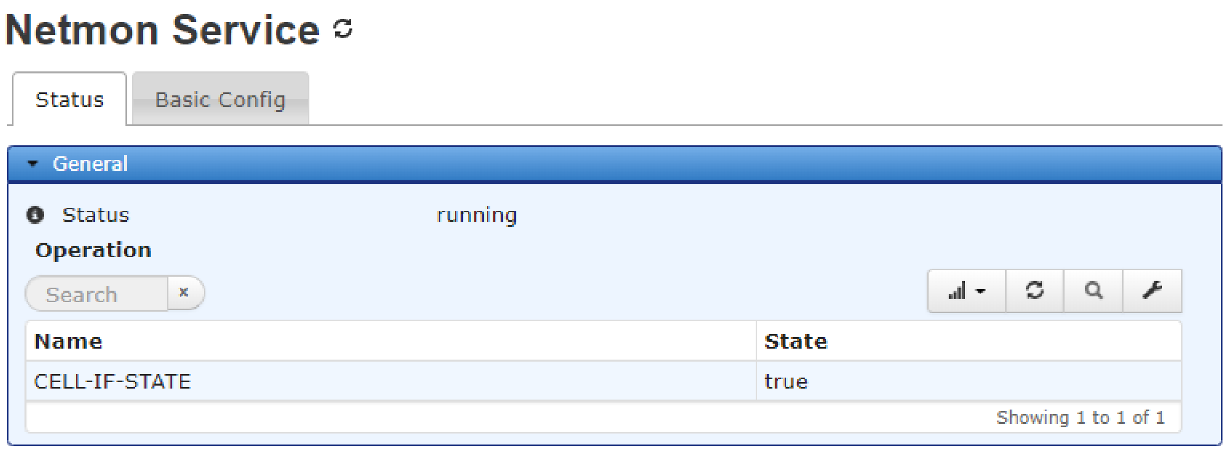
Ensure the CLI is in configuration mode. Following example illustrates setting up the interface-monitor using the CLI.

```
% set services netmon operation CELL-IF-STATE type interface-monitor
% set services netmon operation CELL-IF-STATE interface-monitor
% set services netmon operation CELL-IF-STATE interface-monitor interface Cell
% commit
```

Monitoring

Using the WebUI

The status of the all configured netmon operations can be seen on the Status tab:



Using the CLI

Ensure the CLI is in operational mode.

```
> show services netmon
NAME          STATE
---------------------
CELL-IF-STATE  true
```

NOTE If the netmon monitor operation is disabled by configuration, then the operation state will be true (UP). This ensures that operations that have been disabled do not factor into decision making by other Orbit subsystems that would otherwise take any corrective action based on state being false (down).

ICMP-ECHO-MONITOR

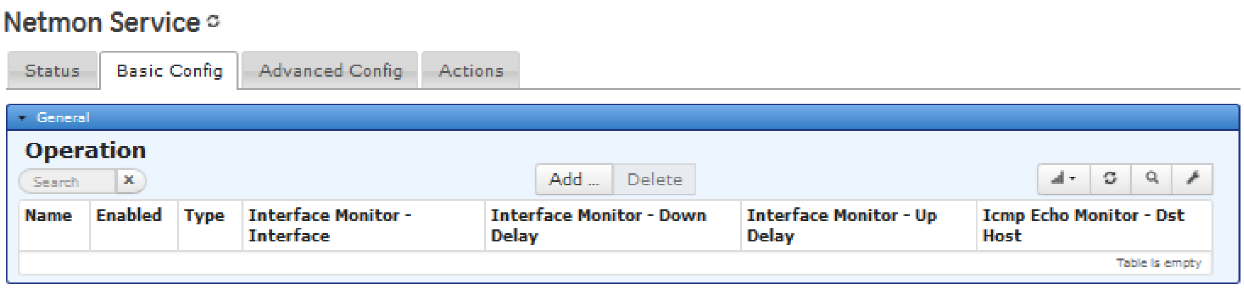
This operation monitors IP connectivity to a configured host using ICMP ECHO (i.e. PING) messages. This operation can also just be used to generate periodic traffic towards a specific host.

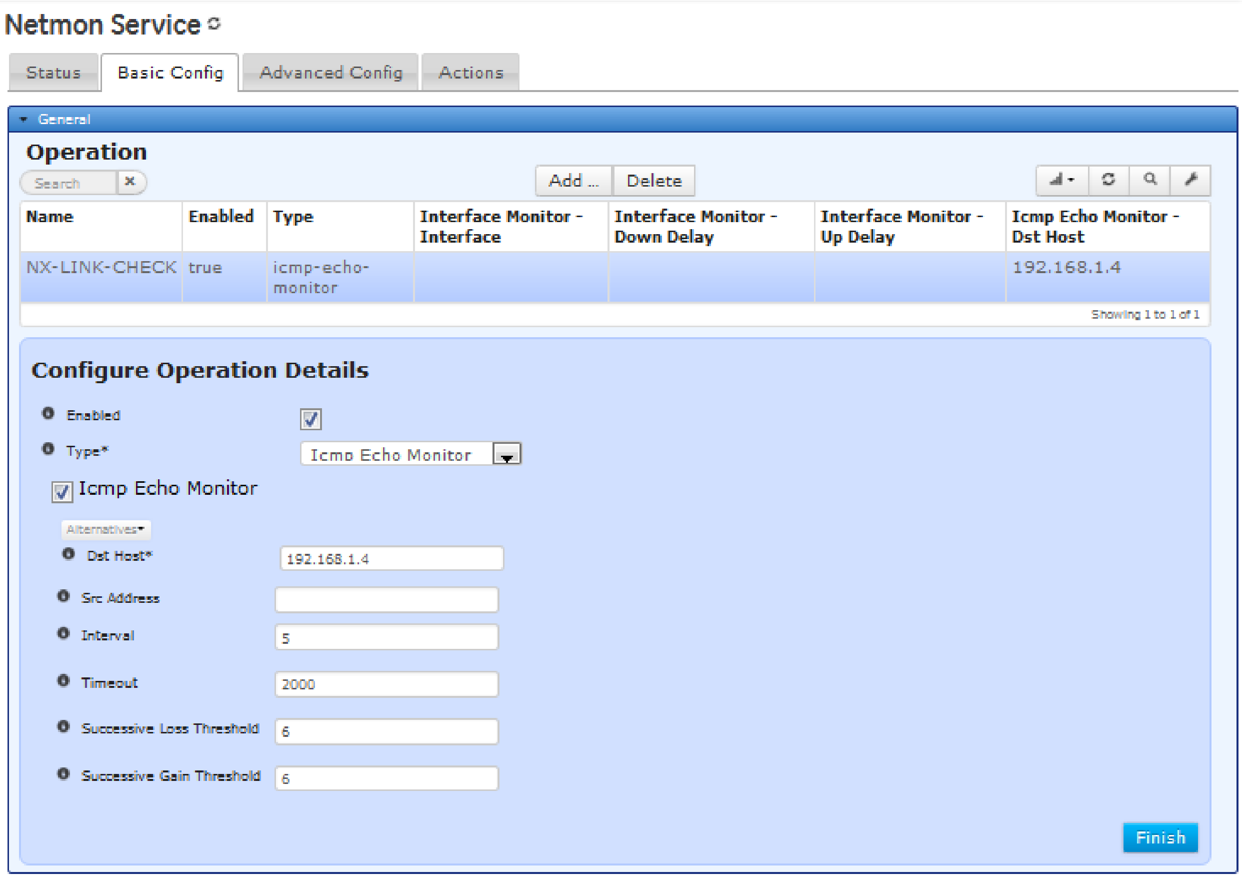
Configuration

Using the WebUI

Following example shows how to configure icmp-echo-monitor operation for verifying that the link over NX is working.

Click '**Add**' at ***Netmon --->Basic Config / General*** and create an operation with a descriptive name, say, NX-LINK-CHECK.

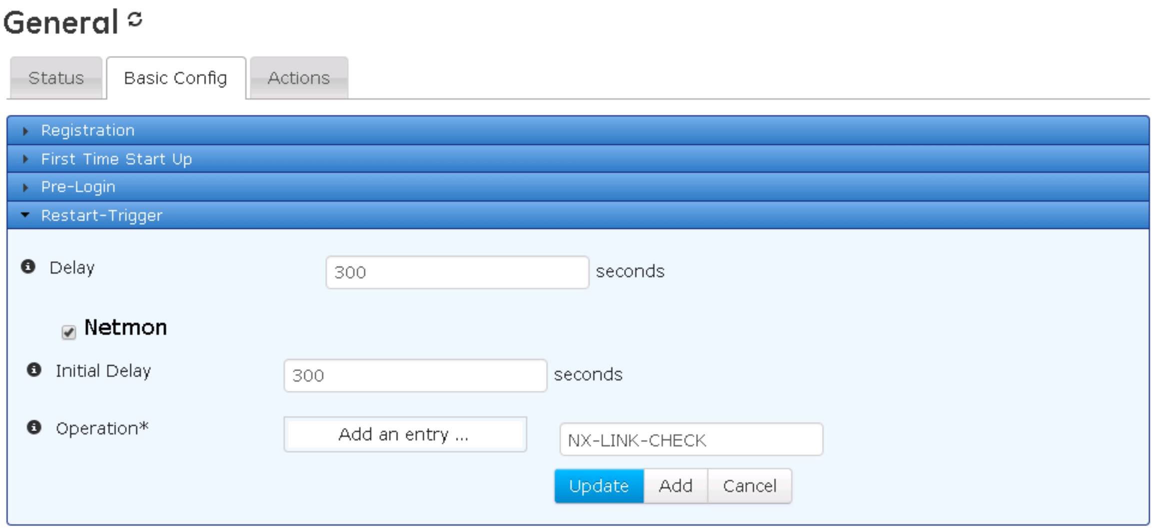




The above configuration will indicate that the link is down (or up) if 6 successive pings fail (or succeed).

- **Enabled** - Whether or not to run this operation
- **Type** - Type of monitor operation
- Icmp Echo Monitor
  - Dst Host - Destination IP address or DNS name to send icmp-echo to.
  - Src Address - Source address to use for icmp-echo request
  - Interval - Time interval (in seconds) between icmp-echo requests. Value range [1..86400] DEFAULT=5
  - Timeout - Time to wait (in milliseconds) for icmp-echo response. Value range [1..5000] DEFAULT=2000
  - Successive Loss Threshold - Number of consecutive icmp-echo requests for which no responses need to be received before destination is declared unreachable. Value range [1..32] DEFAULT = 6
  - Successive Gain Threshold - Number of consecutive icmp-echo requests for which no responses need to be received before destination is declared reachable. Value range [1..32] DEFAULT = 6

To configure the system to trigger a device restart on monitor failure, navigate to ***System / General ---> Basic Config / Restart-Trigger***. Click the ***Netmon*** box and add the operation “NX-LINK-CHECK”.



Using the CLI

This example illustrates setting up the icmp-echo-monitor using the CLI

> **% set services netmon operation *NX-LINK-CHECK* enabled** true
>
> **% set services netmon operation *NX-LINK-CHECK* type icmp-echo-monitor**
>
> **% set services netmon operation *NX-LINK-CHECK* icmp-echo-monitor dst-host** 192.168.1.4
>
> **% set services netmon operation *NX-LINK-CHECK* icmp-echo-monitor interval** 5
>
> **% set services netmon operation *NX-LINK-CHECK* icmp-echo-monitor timeout** 1000
>
> **% set services netmon operation *NX-LINK-CHECK* icmp-echo-monitor successive-loss-threshold** 6
>
> **% set services netmon operation *NX-LINK-CHECK* icmp-echo-monitor successive-gain-threshold** 6

To configure the system to trigger a device reboot on monitor failure, add the following:

> **% set system power restart-trigger netmon initial-delay 300**
>
> **% set system power restart-trigger netmon operation [*NX-LINK-CHECK*]**

Following is another example of using icmp-echo-monitor to reboot the Orbit device based on low duty cycle connectivity check over cellular link:

1. Configure NETMON ping operation

> **% set services netmon operation PROBE-1 enabled true**
>
> **% set services netmon operation PROBE-1 type icmp-echo-monitor**

NOTE: Replace IP to ping (8.8.8.8) per your setup

> **% set services netmon operation PROBE-1 icmp-echo-monitor dst-host 8.8.8.8**

Configure ping to be sent every 300 seconds (5mins)

> **% set services netmon operation PROBE-1 icmp-echo-monitor interval 300**

Number of pings that have to fail successively (i.e. no replies) before netmon operation state is changed to “false” (i.e. DOWN). With setting of 6, probe will go down in about ~300 * 6 = 1800 seconds (30mins) when there is no connectivity

% set services netmon operation PROBE-1 icmp-echo-monitor successive-loss-threshold 6

Number of pings that have to be successful (i.e. replies) before netmon operation state is changed to "true" (i.e. UP). With setting of 1, probe will go up in about ~300 seconds (5mins) when connectivity is restored.

% set services netmon operation PROBE-1 icmp-echo-monitor successive-gain-threshold 1

2. Configure the device to reboot based on state of PROBE-1:

Set the restart delay to 30 seconds. This ensures that once netmon operation indicates that it is down, unit is rebooted after 30 seconds.

% set system power restart-trigger delay 30

Set initial-delay in seconds before netmon status is checked after system boot. This should be set to a high value to give unit ample time to connect and gain connectivity.

% set system power restart-trigger netmon initial-delay 300

Attach PROBE-1 netmon operation to system reboot action

% set system power restart-trigger netmon operation [PROBE-1]

Save and apply configuration

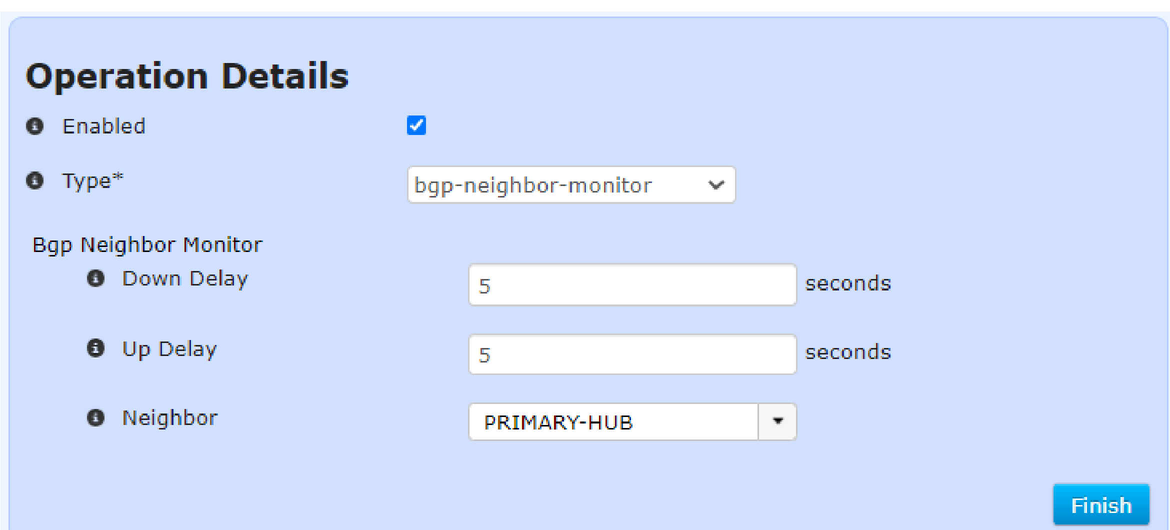
% commit

BGP-NEIGHBOR-MONITOR

This operation monitors the BGP connection status of a configured neighbor. For DMVPN setups that use BGP for exchanging routes through the tunnel, it can be advantageous to use the BGP connection status as a liveliness check for the tunnel instead of using a separate ICMP-ECHO monitor operation, since BGP protocol already uses keepalives to monitor peer connection.

Configuration

Using the WebUI



- **Enabled** - Whether or not to run this operation
- **Type** - Type of monitor operation

- **BGP Monitor**
  - Down Delay – The time interval (in seconds) to wait after BGP neighbor connection status is DOWN before changing monitor operation state to false (i.e. DOWN).
  - Up Delay - The time interval (in seconds) to wait after BGP neighbor connection status is UP before changing monitor operation state to true (i.e. UP).
  - Neighbor – The BGP neighbor whose connection status has to be monitored (see BGP configuration under Routing section of this manual).

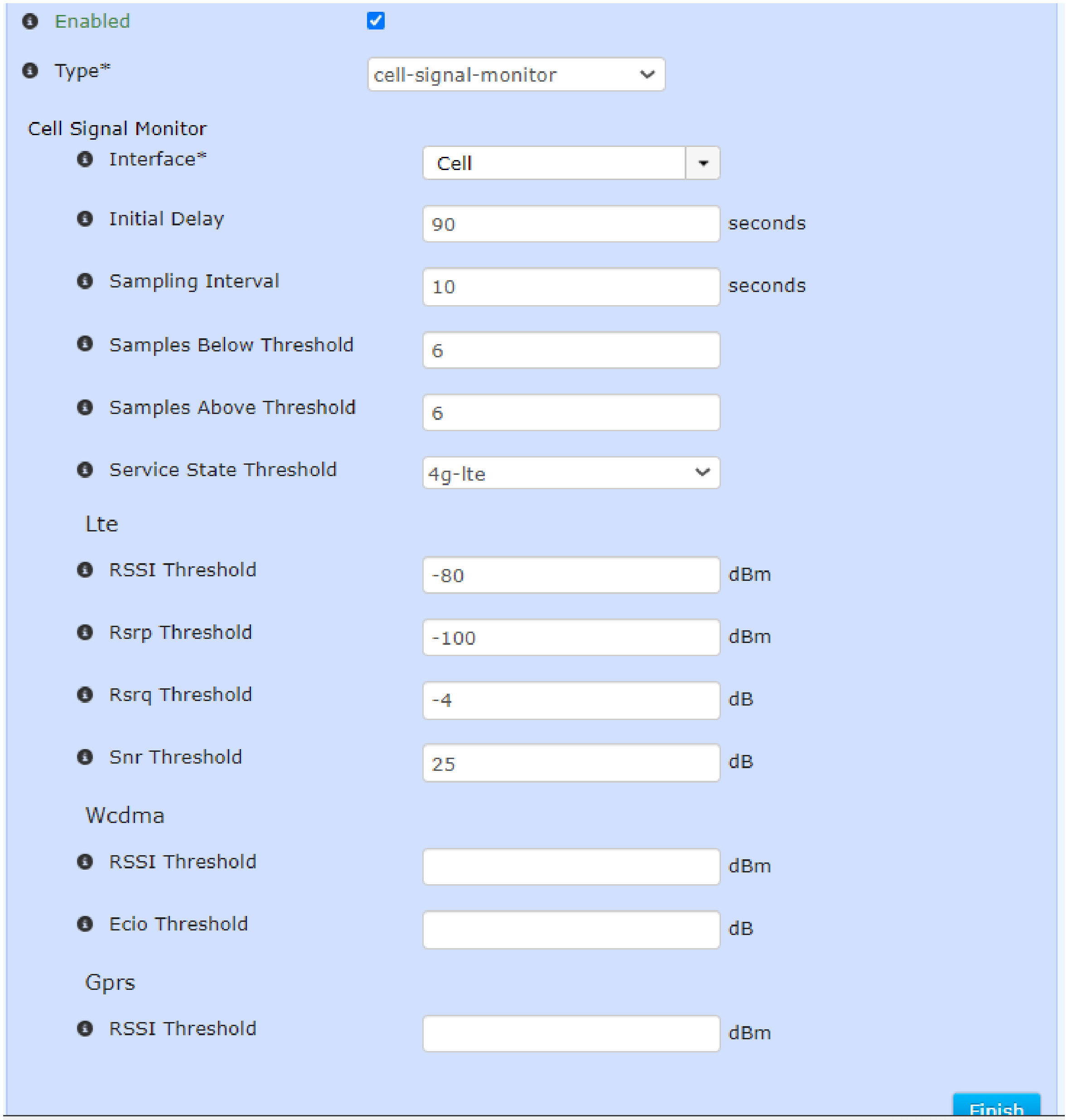
CELL-SIGNAL-MONITOR

The cellular signal monitor operation monitors service-state (i.e. 2G/3G/4G) of the Cellular interface as well corresponding signal metrics. The operation state is set to "true" when signal levels are above for **ALL** configured thresholds for specified number of samples. Otherwise, the operation state is set to false (DOWN) when this condition is not met specified number of samples. This NETMON operation can then be tied to various NETMON clients in Orbit, one of which is cellular connection profile switching, which can monitor state of the NETMON operation and switch profiles when it indicates false (i.e. "down" state).

Configuration

Using the WebUI

The following example illustrates a configuration where the operation state will be set to true (UP) if the service-state = 4G LTE AND RSSI is >=-80 AND RSRP >= -100 AND RSRQ >= -4 AND SNR >= 25 for 6 consecutive samples. The operation state will be set to false if above expression is false for 6 consecutive samples.



- **Enabled** - Whether or not to run this operation
- **Type** - Type of monitor operation
- **Cell-signal-Monitor**
  - Interface – Cellular interface to monitor.
  - Initial-delay – time delay in seconds before interface status is checked after operation or interface (re)start. DEFAULT=90
  - Sampling Interval - Time interval (in seconds) at which signal levels are sampled. DEFAULT =10.
  - Samples below threshold - Number of samples for which signal needs to be below threshold(s) before signal monitor operation state is changed to false (down/bad). DEFAULT=6.
  - Samples above threshold- Number of samples for which signal needs to be above threshold(s) before signal monitor operation state is changed to true (up/good). DEFAULT=6.

- Service state threshold - The desired service state of the connection. If the service state falls below this state, then the operation state is changed to false (down/bad).
- LTE signal thresholds
    - rssi-threshold- Received signal strength indicator (dBm) threshold.
    - rsrp-threshold -Reference signal received power (dBm) threshold.
    - rsrq-threshold - Reference signal received quality (dB) threshold.
    - Snr-threshold - Signal to interference plus noise ratio (dB) threshold.
- WCDMA signal thresholds
    - rssi-threshold - Received signal strength indicator (dBm) threshold.
    - ecio-threshold - CDMA/UMTS Carrier to interference plus noise ratio (dB) threshold.
- GSM signal thresholds
    - rssi-threshold - Received signal strength indicator (dBm) threshold.

Using the CLI

Following example illustrates setting up cell-signal-monitor using CLI. Ensure the CLI is in configuration mode

% set services netmon operation PROBE-1 enabled true

% set services netmon operation PROBE-1 type cell-signal-monitor

% set services netmon operation PROBE-1 cell-signal-monitor

% set services netmon operation PROBE-1 cell-signal-monitor interface Cell

% set services netmon operation PROBE-1 cell-signal-monitor initial-delay 90

% set services netmon operation PROBE-1 cell-signal-monitor sampling-interval 10

% set services netmon operation PROBE-1 cell-signal-monitor samples-below-threshold 6

% set services netmon operation PROBE-1 cell-signal-monitor samples-above-threshold 6

% set services netmon operation PROBE-1 cell-signal-monitor service-state-threshold 4g-lte

% set services netmon operation PROBE-1 cell-signal-monitor lte rssi-threshold -80

% set services netmon operation PROBE-1 cell-signal-monitor lte rsrp-threshold -100

% set services netmon operation PROBE-1 cell-signal-monitor lte rsrq-threshold -4

% set services netmon operation PROBE-1 cell-signal-monitor lte snr-threshold 25

% commit

Following example illustrates configuring cell connection profile/SIM switching based on cell-signal-monitor state on a dual SIM Orbit device:

Configure connection profile named PROFILE-1 that uses SIM-A

% set interfaces interface Cell cell-config connection-profile PROFILE-1 bearer-config apn www.dau.dau

% set interfaces interface Cell cell-config connection-profile PROFILE-1 bearer-config protocol ip

% set interfaces interface Cell cell-config connection-profile PROFILE-1 service-recovery netmon

% set interfaces interface Cell cell-config connection-profile PROFILE-1 service-recovery netmon initial-delay 300

% set interfaces interface Cell cell-config connection-profile PROFILE-1 service-recovery netmon operation [PROBE-1]

% set interfaces interface Cell cell-config connection-profile PROFILE-1 sim-slot SIM-A

Configure connection profile named PROFILE-2 that uses SIM-B

% set interfaces interface Cell cell-config connection-profile PROFILE-2 bearer-config apn www.dau.dau

% set interfaces interface Cell cell-config connection-profile PROFILE-2 bearer-config protocol ip

% set interfaces interface Cell cell-config connection-profile PROFILE-2 service-recovery netmon

% set interfaces interface Cell cell-config connection-profile PROFILE-2 service-recovery netmon initial-delay 300

% set interfaces interface Cell cell-config connection-profile PROFILE-2 service-recovery netmon operation [PROBE-1]

% set interfaces interface Cell cell-config connection-profile PROFILE-2 sim-slot SIM-B

Enable connection profile switching based on NETMON operation state

% set interfaces interface Cell cell-config connection-profile-switching switch-to-next-on-netmon true

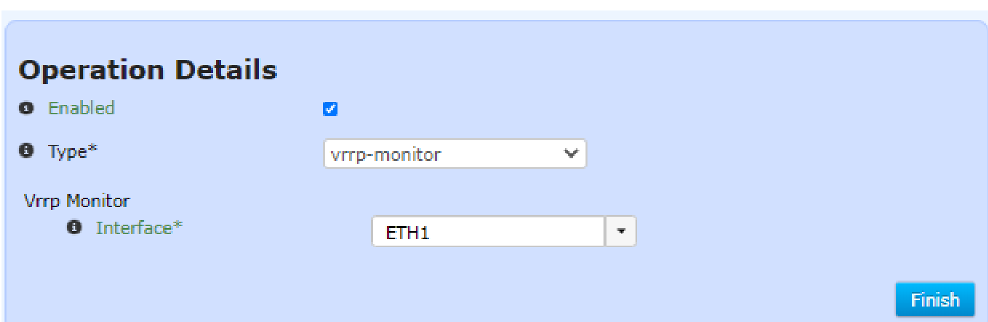
% commit

VRRP- MONITOR

The vrrp monitor operation monitors the state of the VRRP instance configured on a particular network interface. The operation state is set to true (UP) when the vrrp state is “master” and is set to false (DOWN) when it is “backup”.

Configuration

Using the WebUI



Using the CLI

Ensure the CLI is in configuration mode

% set services netmon operation VRRP-1 type vrrp-monitor
% set services netmon operation VRRP-1 vrrp-monitor interface ETH1
% commit

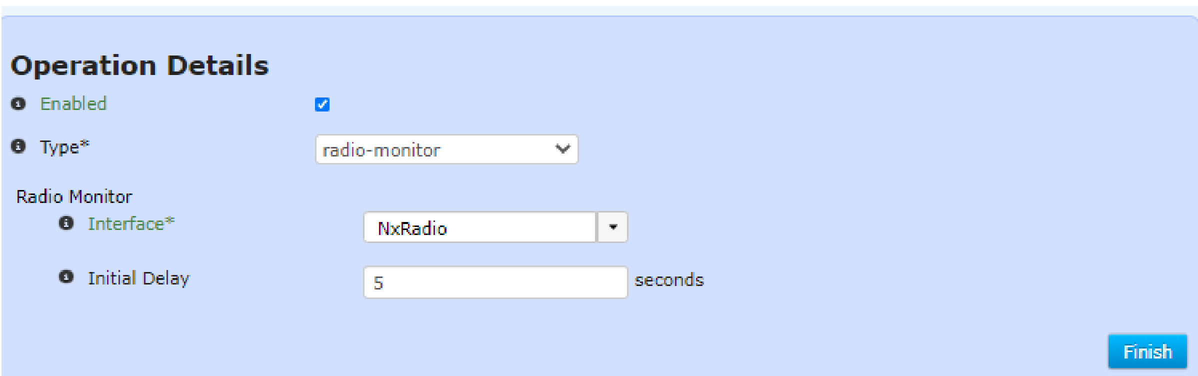
RADIO-MONITOR

The radio monitor operation monitors the radio status of Licensed narrowband (LnRadio), Unlicensed 900Mhz (NxRadio) and Licensed Wideband (LwRadio) radio interfaces. The operation state is set to false (DOWN) when radio's init-status is 'error' and, true, otherwise. This radio monitor (along with other Orbit functionality) enables the user to setup redundant APs.

Configuration

Using the WebUI

Following example configuration show radio monitor operation monitoring status of NxRadio interface.



- **Enabled** - Whether or not to run this operation
- **Type** - Type of monitor operation
- **Radio-Monitor**
  - Interface – LnRadio, NxRadio or LwRadio interface to monitor.
  - Initial Delay – The time delay (in seconds) before interface status is checked after operation or interface (re)start. DEFAULT = 5.

Using the CLI

Ensure the CLI is in configuration mode

```
% set services netmon operation NX-RADIO-MON enabled true
% set services netmon operation NX-RADIO-MON type radio-monitor
% set services netmon operation NX-RADIO-MON radio-monitor interface NxRadio
% set services netmon operation NX-RADIO-MON radio-monitor initial-delay 5
% commit
```

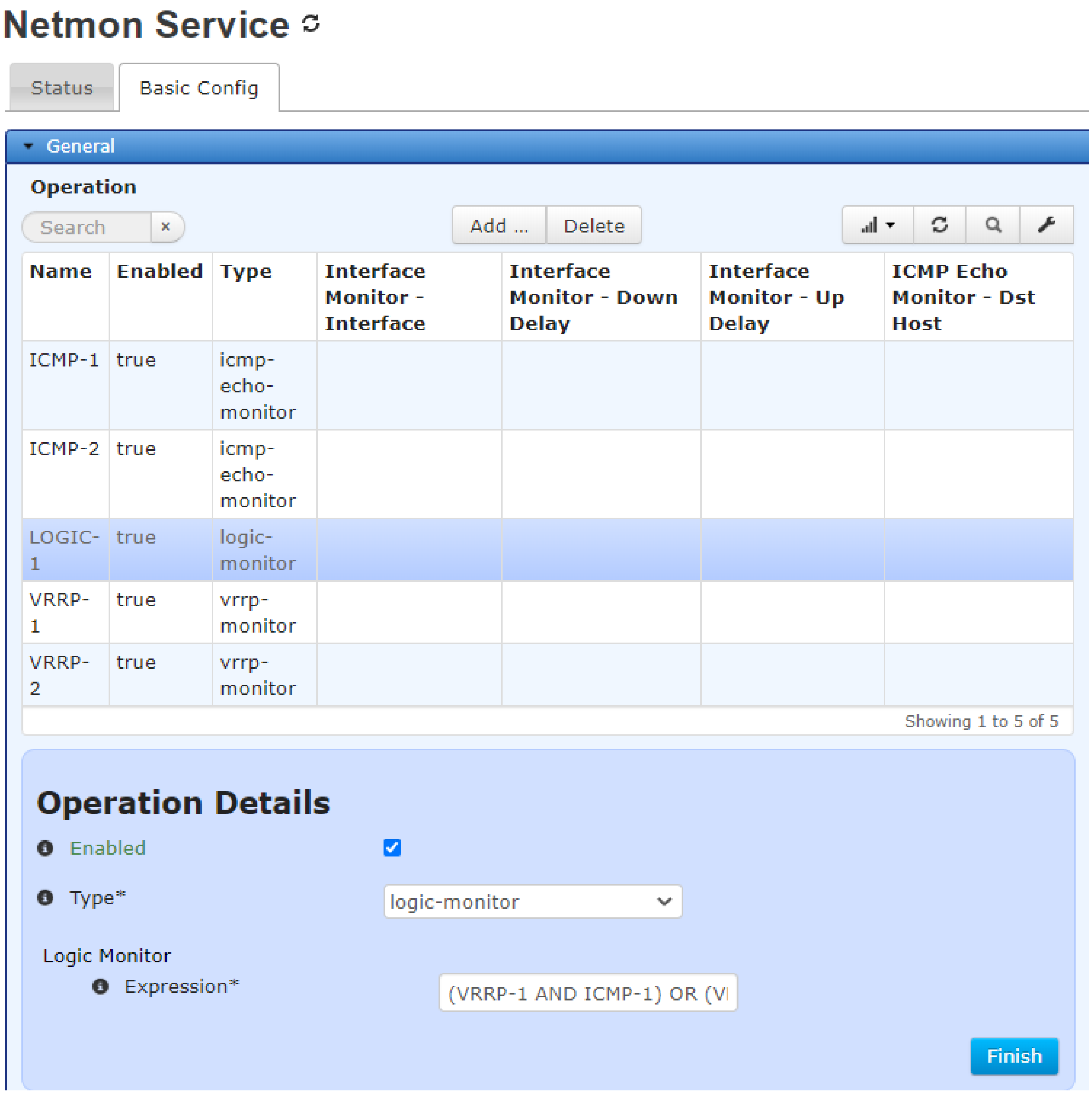
LOGIC-MONITOR

The logic monitor allows user to create a logical expression composed of other netmon operations using following operators: AND, and, OR, or, NOT, not, &&, ||, !.

Configuration

Using the WebUI

Following example show logic monitor operation composed of VRRP-1, ICMP-1, VRRP-2 and ICMP-2 operations with following logical expression: (VRRP-1 AND ICMP-1) OR (VRRP-2 AND ICMP-2).This expression can also be written/entered as: (VRRP-1 && ICMP-1) || (VRRP-2 && ICMP-2). The operation state is set to result of the logical expression which is evaluated during initialization as well as when state of any operation in the expression is updated.



Using the CLI

Ensure the CLI is in configuration mode

% set services netmon operation LOGIC1 enabled true

% set services netmon operation LOGIC1 type logic-monitor

% set services netmon operation LOGIC1 logic-monitor

% set services netmon operation LOGIC1 logic-monitor expression "(VRRP-1 and ICMP-1) OR (VRRP-2 and ICMP-2)"

% commit

3.8.22 Network Link Failover/Failback

Understanding

The unit incorporates integrated bridging and routing functionality with multiple wired and wireless interfaces. The reliability of network links can be enhanced using network link failover/failback features.

The unit supports following two types of network link failover and failback features:

Route (Layer-3) Failover - The unit supports this feature by enabling configuration of multiple routes to same destination network with different preference (metric) values, enabling traffic to be sent using the route with high preference in normal scenario and failing back to the route with lower preference when the destination network is not reachable through the higher preference route.

Link (Layer-2) Failover - The unit supports this feature by creation of a bond interface in an active-backup mode that can aggregate a primary and secondary layer-2 link. When primary link is down, the secondary link is used to send layer-2 traffic etc.

Use Case#1 High Reliability SCADA back office to Remote Sites Network

Following figure shows a setup to achieve a high reliability network communications between a SCADA back office and remote sites using 900 MHz and Cellular communications in a redundant network setup using routing functionality

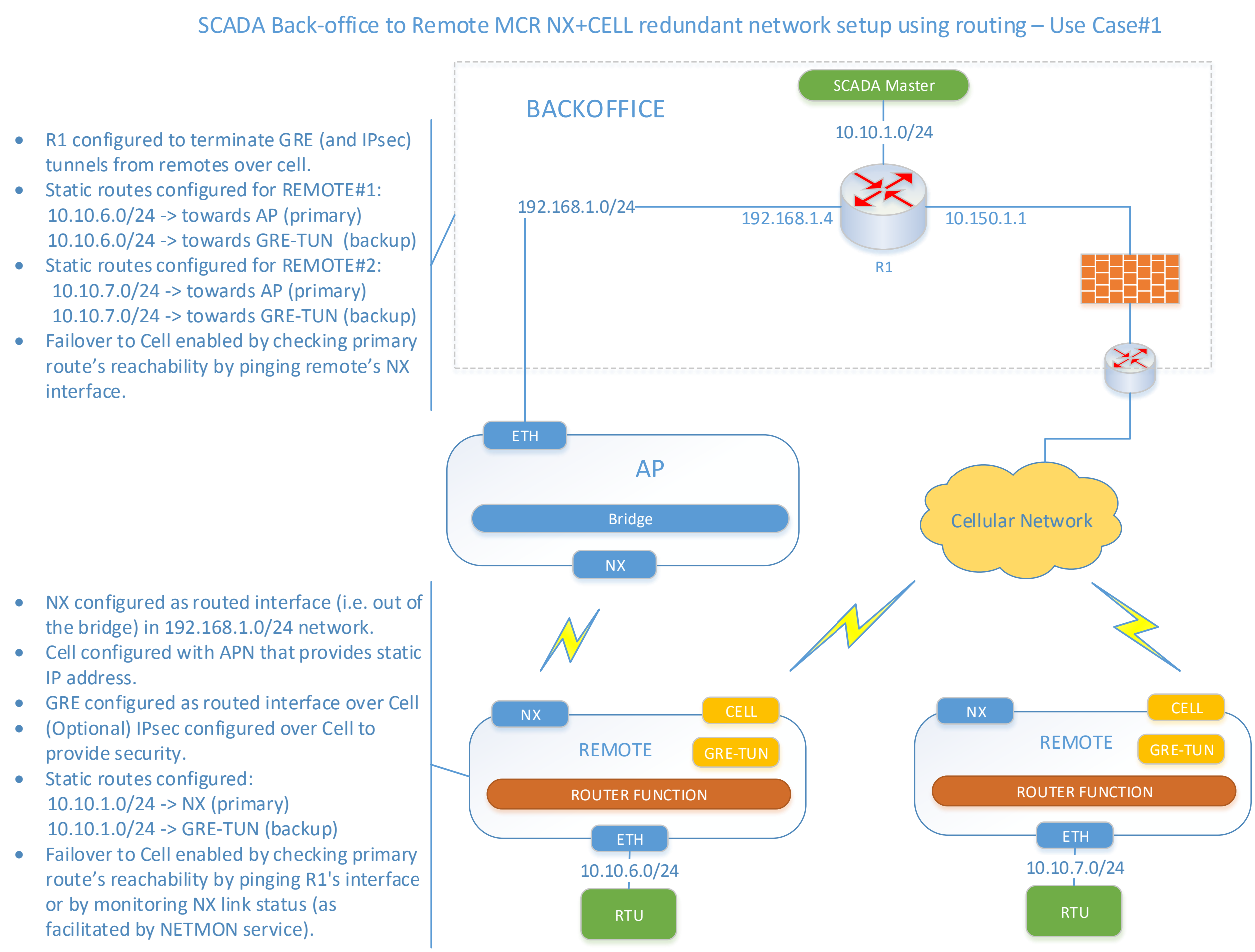


Figure 3-264. SCADA Back-office to Remote Orbit NX+CELL redundant setup using routing

In above use case, the SCADA back-office application sends/receives data to/from a remote asset connected to remote Orbit (called REMOTE hereafter) that has both 900 MHz radio (NX) and Cellular radio options. The IP packets sent by back-office application to the remote asset are normally routed by the back-office router (R1) towards Orbit configured as the NX AP (called AP hereafter). The IP packets sent by remote asset to the back-office application are normally routed by the REMOTE towards the AP. Both R1 and REMOTE verify the primary link (NX) connectivity by sending periodic ICMP echo requests (pings). In the event that N (configurable) successive pings are lost, both R1 and REMOTE update their routing tables to direct traffic over cellular network instead. Both still keep checking the primary link connectivity. Once primary link connectivity is restored (i.e. N successful pings), both R1 and REMOTE update their routing tables to direct traffic back over NX network.

The above setup on remote Orbit is facilitated by following functionality available on the unit:

1. Ability to configure multiple routes towards back-office network with different preference values. The primary route towards back-office network over NX is configured with lower preference value (lower the value more preferred the route) than secondary route towards back-office network over Cellular.
2. Ability to associate the primary route with verify-reachability operation, which checks the reachability of the back-office network via this route. The reachability check is done by configuring a NETMON service operation, which checks connectivity based on either the link status of the primary interface (NX) or on ICMP ECHO requests (pings) towards a host reachable via the primary interface. If the reachability check determines that the network link is down, then that primary route is removed and, as a result, the traffic towards the back-office network now uses the secondary route (over Cell). If the reachability check determines that the network link is back up, the primary route is added back and, as a result, the traffic towards the back-office network now uses the primary route (over NX) again.
3. Ability to tunnel private customer traffic over public cellular network using GRE tunneling (IP-OVER-GRE mode) or GRE with IPsec tunneling, in case, end-to-end security is desired. The GRE tunnel provides a routed interface that can then be used as the outgoing interface in the secondary route.

AP Configuration

In this use case, the AP is not involved in the failover and hence should be configured as usual with NX interface in AP mode.

Router R1 Configuration

The R1 router in this case could be a routing appliance from Cisco or Juniper etc. Following features need to be configured on this device:

1. IPsec transport mode connection – To secure GRE traffic from back-office to the Remotes over Cellular network.
2. GRE tunnel – To route the traffic from back-office to the Remotes over Cellular network.
3. A network/link monitoring operation that checks connectivity to each remote over the primary interface and that enables primary route to be used when connectivity is up and secondary route to be used when connectivity is down.
4. Primary and secondary routes towards each Remote LAN network.

The user should refer to user manual of the specific device to configure these features.

REMOTE#1 Configuration

Following features need to be configured on this device:

1. IPsec transport mode connection– To secure GRE traffic from local LAN segment to back-office over Cellular network.
2. GRE tunnel – To route the traffic from local LAN segment to back-office over Cellular network.

3. A network monitoring operation that checks connectivity to back-office network over the primary interface (i.e. NX) and that enables primary route to be used when connectivity is up and secondary route to be used when connectivity is down.
4. Primary and secondary routes towards the back-office network.

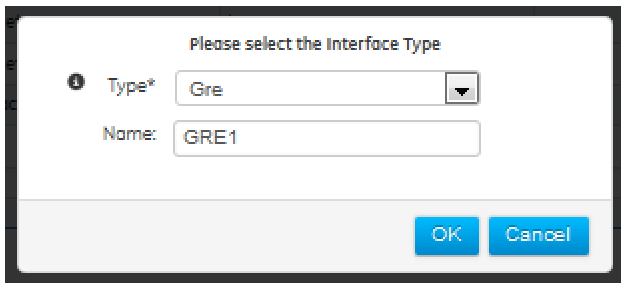
Using the Web UI

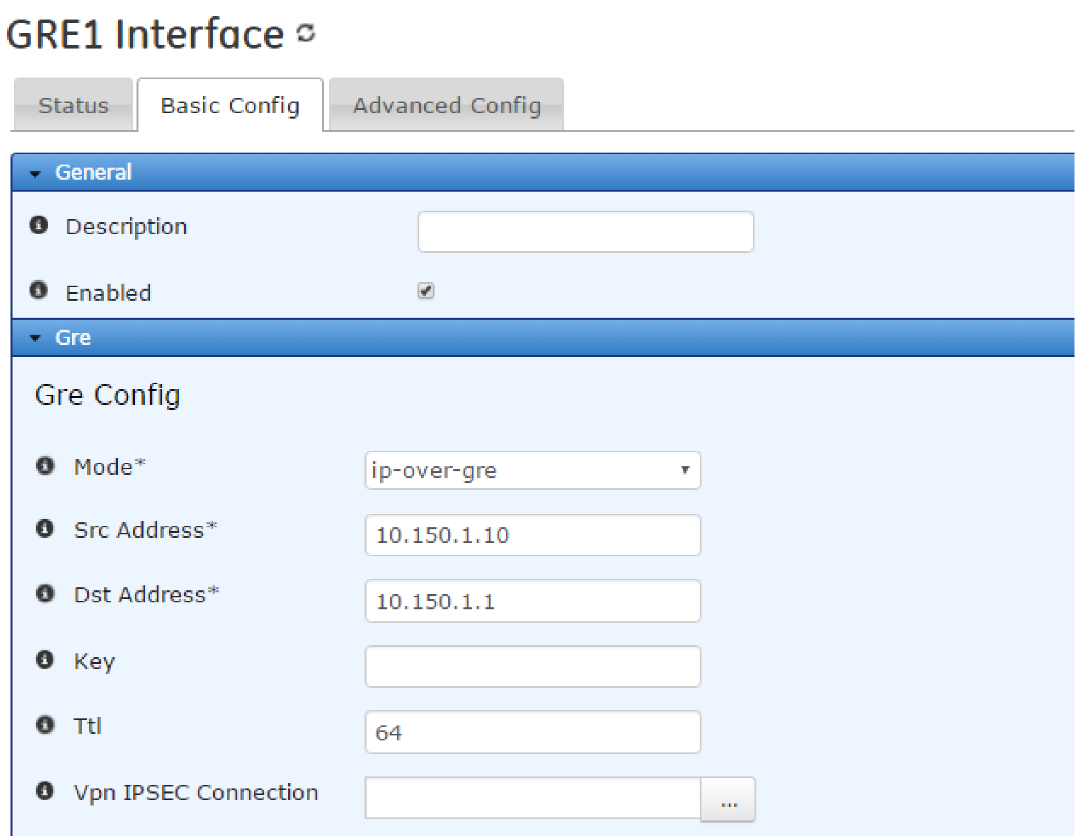
Configure IPsec Transport Mode Connection

5. Configure an IPsec VPN connection with host-to-host connection type. Please refer to section on VPN for help with configuring IPsec VPN using Web UI.

Configure GRE tunnel

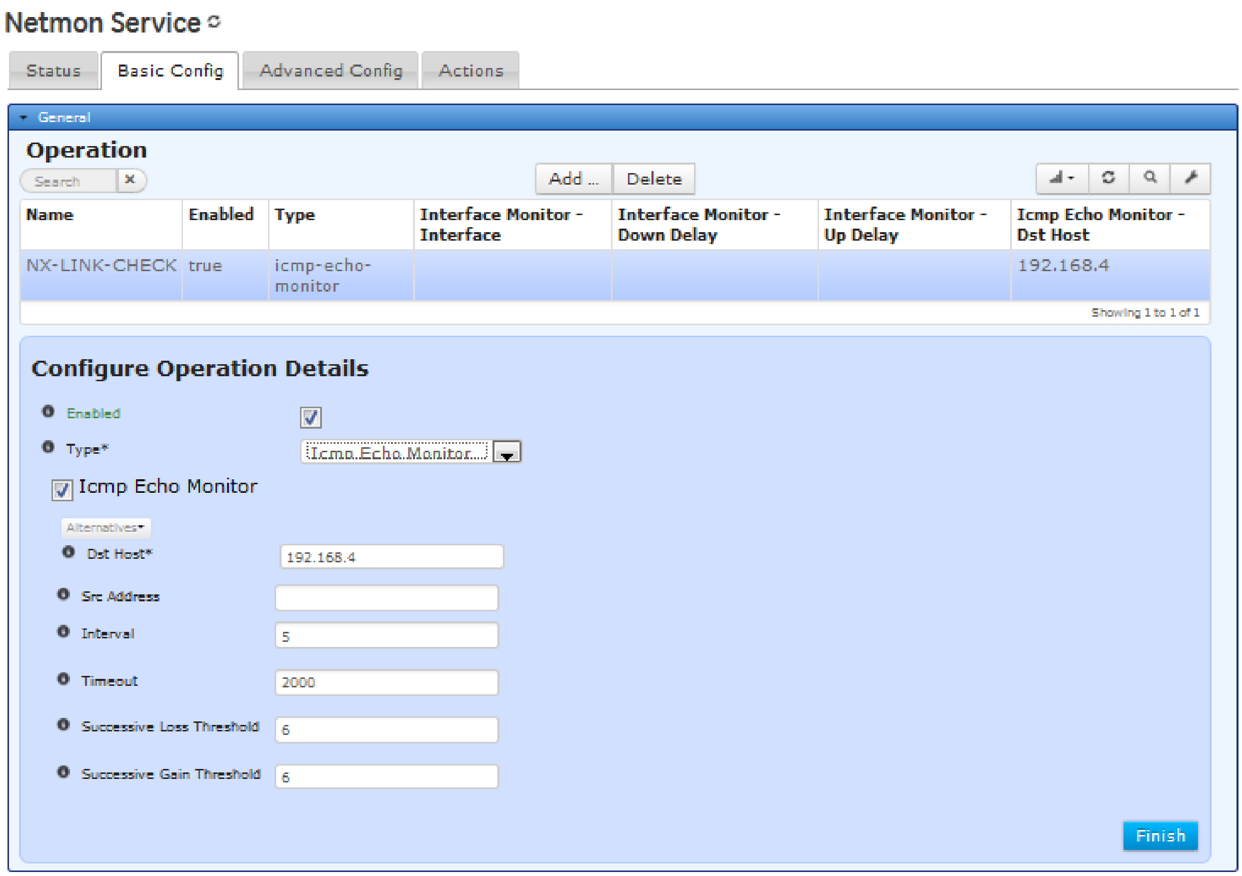
6. Configure GRE tunnel interface with mode = ip-over-gre, src-address = 10.150.1.10 (the local Cell interface address) and dst-address = 10.150.1.1 (the WAN address of the R1 router).
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click 'Add' to create new interface named 'GRE1':





Configure Network Monitor Operation

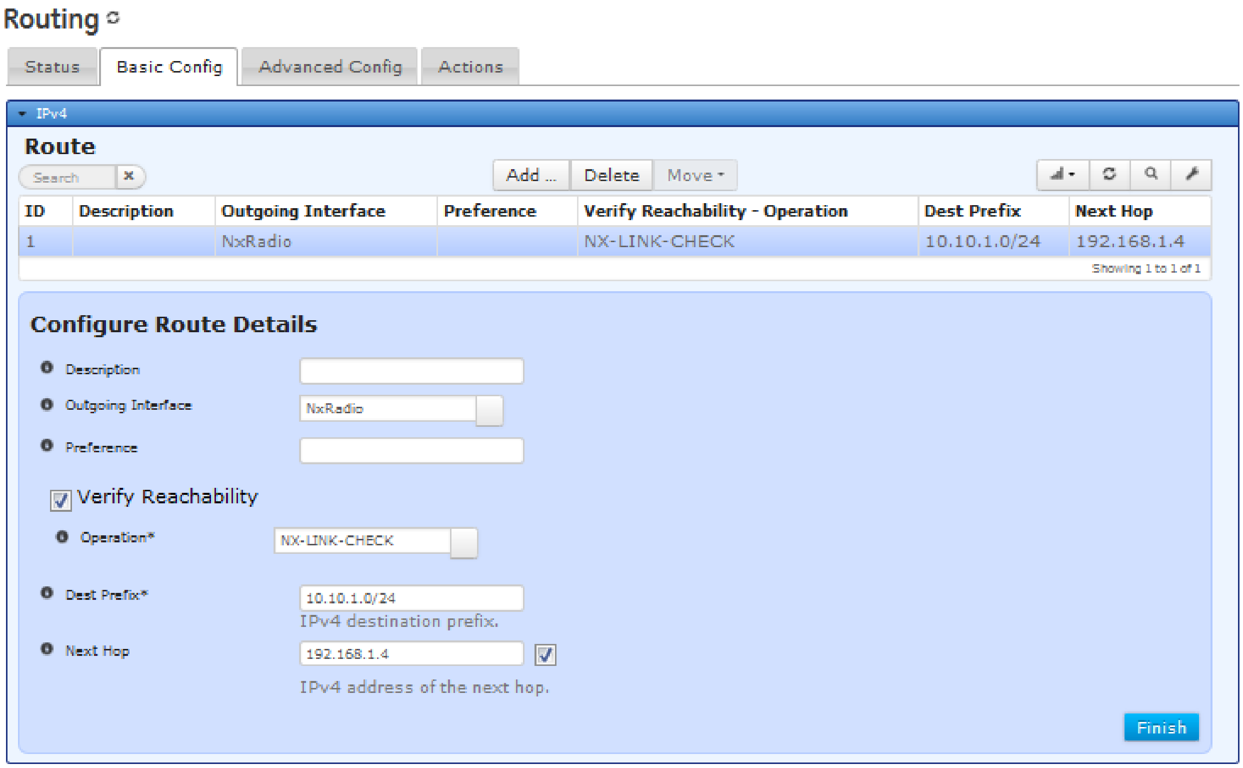
7. Configure a NETMON service icmp-echo-monitor operation named NX-LINK-CHECK that does a periodic link check by pinging R1 over NX interface. Please refer to NETMON service section for further help with configuration.



Configure Primary and Secondary routes towards back-office network

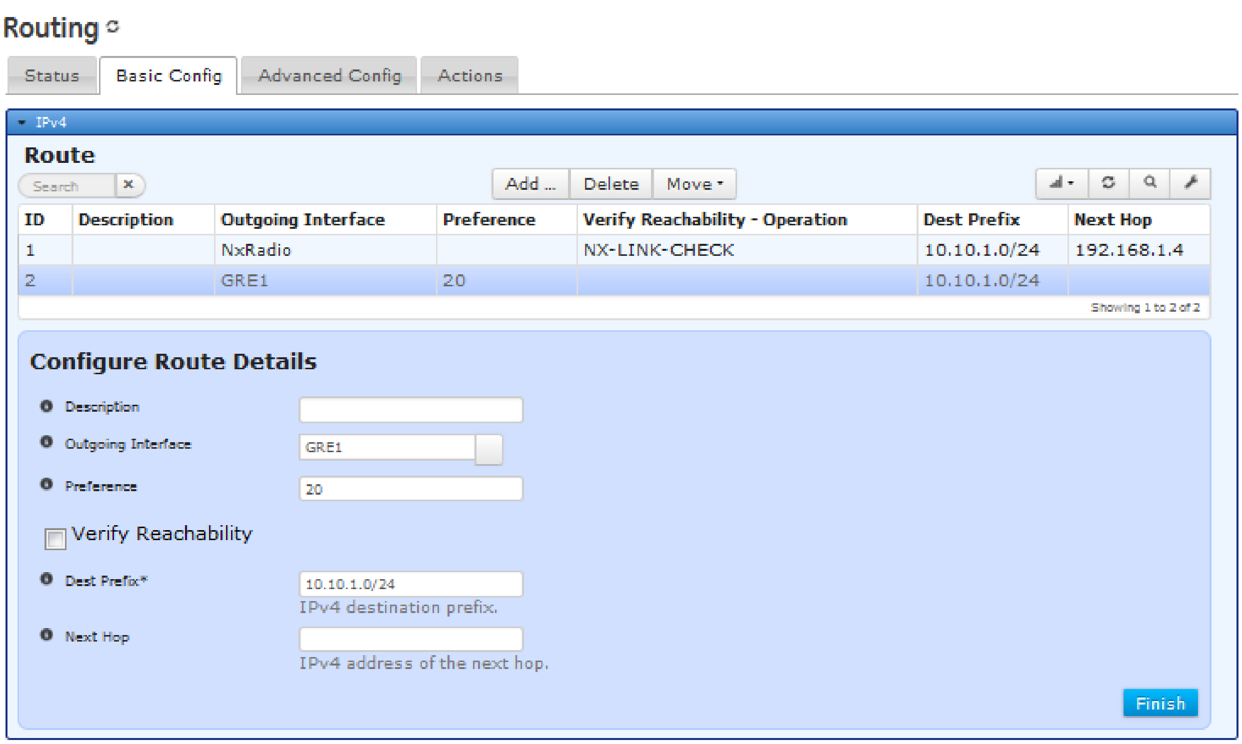
5. Configure primary route towards SCADA back-office network (10.10.1.0/24) with NX as the outgoing interface and with address of R1's interface on NX backhaul as the next-hop. Also, configure this route with verify-reachability using NX-LINK-CHECK operation, which checks the reachability of the back-office network via this route.

   - Navigate to ***Routing ---> Basic Config / IPv4*** and click 'Add' to add the primary route over NX:



6. Configure secondary route towards SCADA back-office network (10.10.1.0/24) with GRE1 as the outgoing interface and preference value of 20.

- From the same page, click ‘Add’ to add the secondary route over GRE1 tunnel interface:



Using the CLI

- Configure IPsec transport mode connection (a pre-shared-key based example shown below) from REMOTE to SCADA router R1. It is assumed that REMOTE's cell IP address is 10.150.1.10 and R1's is reachable over cell using 10.150.1.1

% **set services vpn ike policy** IKE-POLICY-PSK-R1 **auth-method pre-shared-key**
% **set services vpn ike policy** IKE-POLICY-PSK-R1 **pre-shared-key** test123
% **set services vpn ike policy** IKE-POLICY-PSK-R1 **ciphersuite** CS1 **encryption-algo** aes128-cbc
% **set services vpn ike policy** IKE-POLICY-PSK-R1 **ciphersuite** CS1 **mac-algo** sha256-hmac
% **set services vpn ike policy** IKE-POLICY-PSK-R1 **ciphersuite** CS1 **dh-group** dh14
% **set services vpn ike peer** R1 **ike-policy** IKE-POLICY-PSK-R1
% **set services vpn ike peer** R1 **local-endpoint address** 10.150.1.10
% **set services vpn ike peer** R1 **local-identity default**
% **set services vpn ike peer** R1 **peer-endpoint address** 10.150.1.1
% **set services vpn ike peer** R1 **peer-identity default**
% **set services vpn ike peer** R1 **role** initiator
% **set services vpn ike peer** R1 **initiator-mode on-demand**
% **set services vpn ipsec policy** IPSEC-POLICY **ciphersuite** CS1 **encryption-algo** aes128-cbc
% **set services vpn ipsec policy** IPSEC-POLICY **ciphersuite** CS1 **mac-algo** sha256-hmac
% **set services vpn ipsec policy** IPSEC-POLICY **ciphersuite** CS1 **dh-group** dh14
% **set services vpn ipsec connection** R1 **ike-peer** R1
% **set services vpn ipsec connection** R1 **ipsec-policy** IPSEC-POLICY
% **set services vpn ipsec connection** R1 **host-to-host**
% **set services vpn ipsec connection** R1 **filter input** IN_TRUSTED
% **set services vpn ipsec connection** R1 **filter output** OUT_TRUSTED

- Configure GRE tunnel interface with mode = ip-over-gre, src-address = Local cell address and dst-address = R1's WAN address.

% **set interfaces interface** GRE1 **type gre**
% **set interfaces interface** GRE1 **gre-config mode ip-over-gre**
% **set interfaces interface** GRE1 **gre-config src-address** 10.150.1.10
% **set interfaces interface** GRE1 **gre-config dst-address** 10.150.1.1
% **set interfaces interface** GRE **filter input** IN_TRUSTED
% **set interfaces interface** GRE **filter output** OUT_TRUSTED

- Configure a NETMON service icmp-echo-monitor operation named NX-LINK-CHECK that does a periodic link check by pinging R1 over NX interface.

% **set services netmon operation** NX-LINK-CHECK **enabled true**
% **set services netmon operation** NX-LINK-CHECK **icmp-echo-monitor dst-host** 192.168.1.4

- Configure primary route towards SCADA back-office network (10.10.1.0/24) with NX as the outgoing interface and with address of R1's interface on NX backhaul as the next-hop. Also, configure this route with verify-reachability using NX-LINK-CHECK operation, which checks the reachability of the back-office network via this route.

% **set routing static-routes** ipv4 **route** 1 **dest-prefix** 10.10.1.0/24
% **set routing static-routes** ipv4 **route** 1 **next-hop** 192.168.1.4
% **set routing static-routes** ipv4 **route** 1 **outgoing-interface** NxRadio
% **set routing static-routes** ipv4 **route** 1 **verify-reachability operation** NX-LINK-CHECK

- Configure secondary route towards SCADA back-office network (10.10.1.0/24) with GRE1 as the outgoing interface and preference value of 20.

% **set routing static-routes** ipv4 **route** 2 **dest-prefix** 10.10.1.0/24
% **set routing static-routes** ipv4 **route** 2 **outgoing-interface** GRE1
% **set routing static-routes** ipv4 **route** 2 **preference** 20

Use Case#2 High Reliability Orbit AP to REMOTE Layer-3 Network

Following figure shows a setup to achieve a high reliability network communications between an Orbit AP and REMOTE using 900 MHz and Cellular communications in a redundant layer-3 network setup using routing functionality.

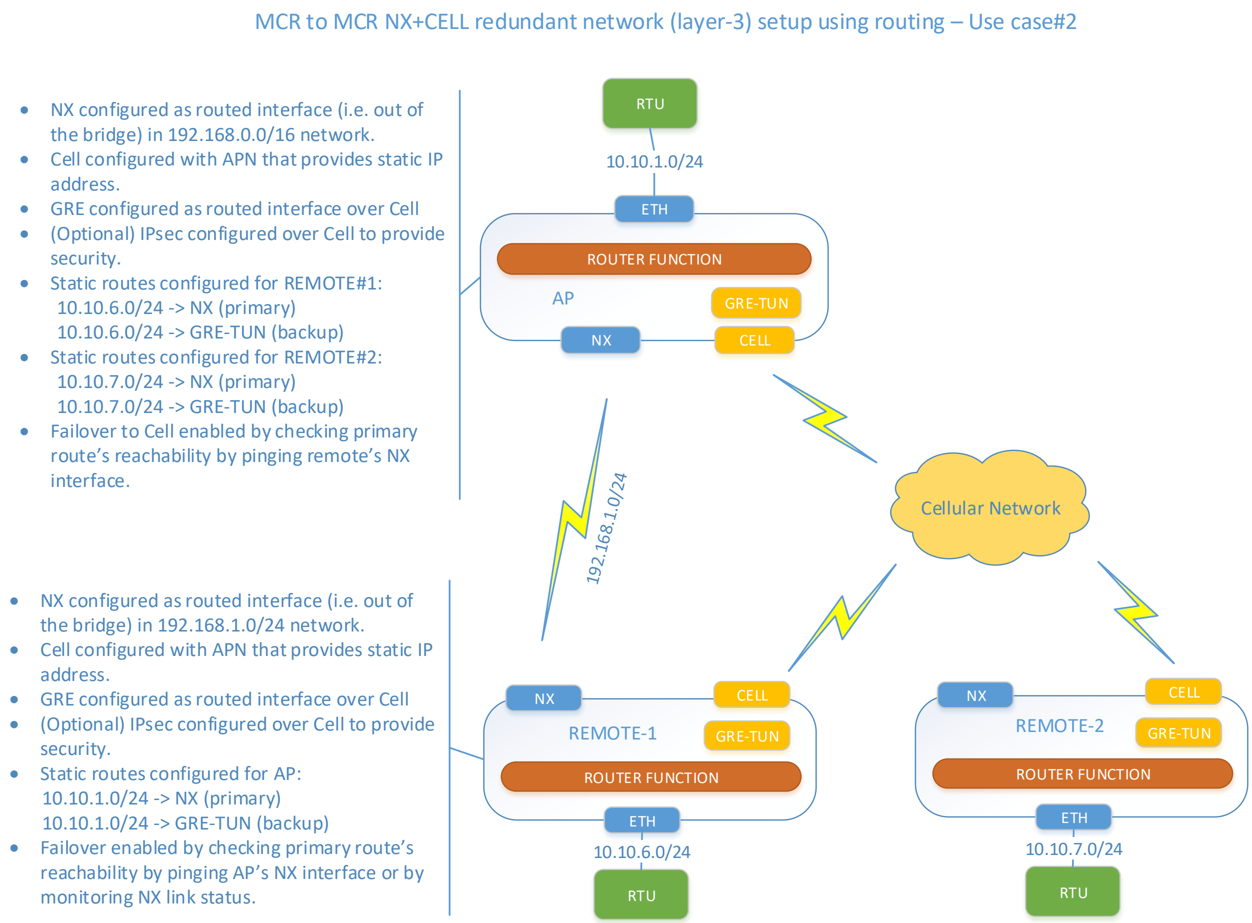


Figure 3-265. Orbit to Orbit NX+CELL redundant network (layer-3) setup using routing

In above use case, a remote asset (e.g. RTU) connected to AP can send/receive data to/from another remote asset connected to a REMOTE. Both, AP and REMOTE Orbit have 900 MHz radio (NX) and Cellular radio options. The NX interface is configured as a routed interface (i.e. outside of the Bridge). All REMOTEs have non-overlapping LAN subnet configuration. The IP packets sent by remote asset connected to AP are normally routed by the AP towards the REMOTE over the NX interface. The IP packets sent by remote asset connected to REMOTE are normally routed by the REMOTE towards the AP over the NX interface. Both AP and REMOTE verify the primary link (NX) connectivity by sending periodic ICMP echo requests (pings). In the event that N (configurable) successive pings are lost, both AP and REMOTE update their routing tables to direct traffic over cellular network instead. Both still keep checking the primary link connectivity. Once primary link connectivity is restored (i.e. N successful pings), both AP and REMOTE update their routing tables to direct traffic over NX network.

The above setup is facilitated by same functionality as described in previous section.

Configuration

The configuration for the REMOTEs and AP for this use case is similar to configuration of REMOTE as described in use case#1, except that at the AP the IPsec is configured in responder mode.

Use Case#3 High Reliability Orbit AP to REMOTE Layer-2 Network

Following figure shows a setup to achieve a high reliability network communications between an Orbit AP and REMOTE using 900 MHz and Cellular communications in a redundant layer-2 network setup using bridging and bonding functionality.

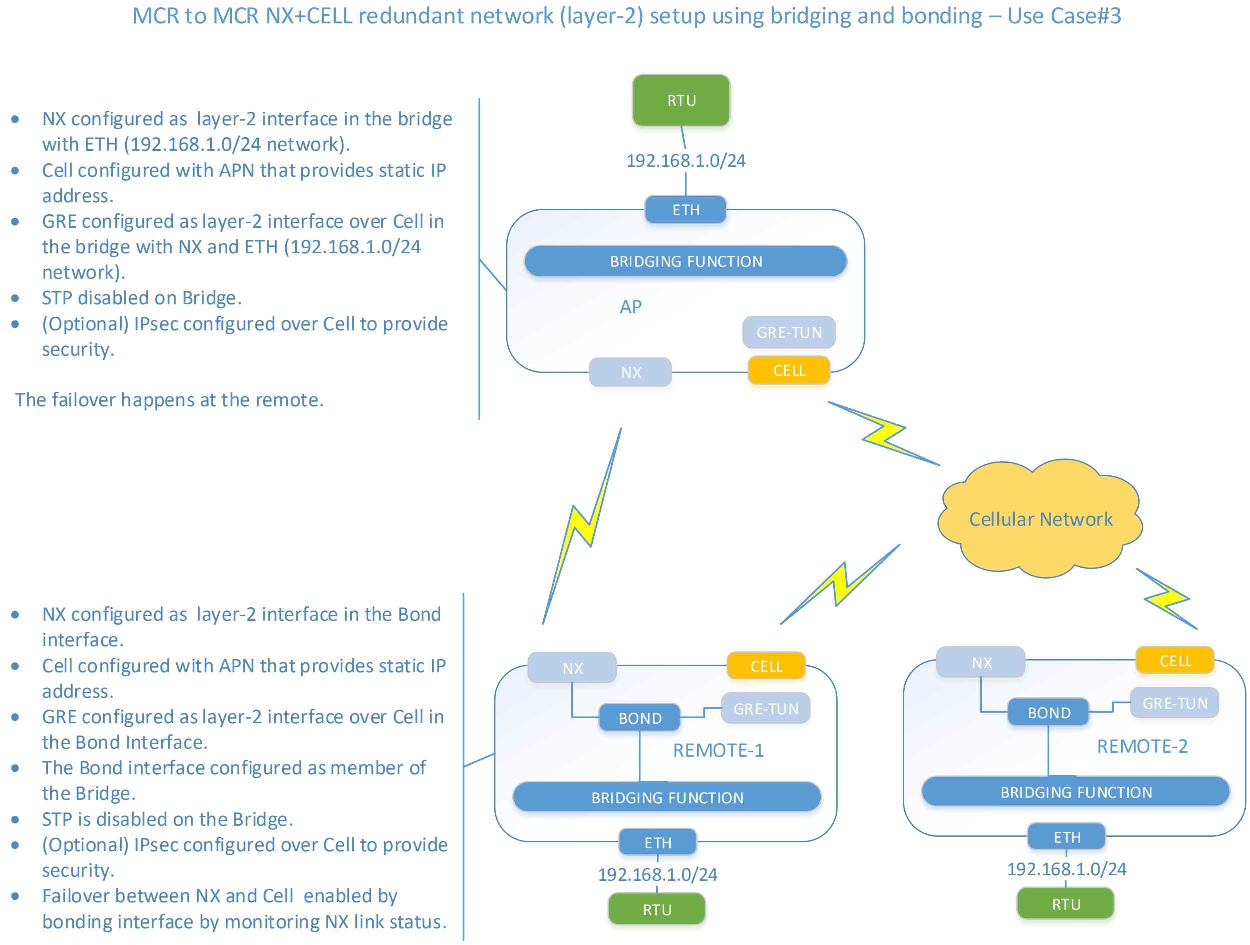


Figure 3-266. Orbit to Orbit NX+CELL redundant network (layer-2) setup using Bridging and Bonding

In above use case, a remote asset (e.g. RTU) connected to AP can send/receive data to/from another remote asset connected to a REMOTE. Both, AP and REMOTE Orbit have 900 MHz radio (NX) and Cellular radio options. This is a typical NX setup where LAN networks connected to both AP and REMOTEs are bridged to enable Ethernet communication between any remote assets on the LAN networks. A layer-2 GRE tunnel (ETHERNET-OVER-GRE mode) is setup over Cell. The redundant layer-2 link between AP and REMOTE is achieved by use of a BOND interface on the REMOTE.

A BOND interface bonds two layer-2 interfaces together and presents them as a single layer-2 interface to the rest of the system. Specifically, the BOND interface in active-backup mode enables redundancy between the enslaved interfaces by activating the secondary member link when primary link goes down.

On each REMOTE, the BOND interface bonds NX interface (primary) with GRE layer-2 tunnel interface (secondary) and is itself bridged with the LAN interface. On the AP, the NX and layer-2 GRE tunnel interfaces are bridged with the LAN interface.

On the REMOTE, when the NX link goes down, the BOND interface makes GRE layer-2 tunnel interface as the active interface (after some configurable delay to avoid link flapping) thereby tunneling LAN traffic through the cellular network. When NX link comes back up, the BOND interface makes it the active interface (after some configurable delay to avoid link flapping) thereby restoring layer-2 communications over the NX link.

NOTE In this setup, the failover is initiated by the REMOTE. Therefore, a periodic traffic stream is required from REMOTE towards the AP, to update the Bridge forwarding table on the AP, so that traffic for remote assets connected to failed-over REMOTE is sent over the GRE layer-2 tunnel for that REMOTE at the AP. If there is no periodic application data stream from remote assets towards the AP, it is recommended that a NETMON service be setup on the REMOTE that sends ICMP ECHO (ping) requests periodically (say, every 30 secs.) to the AP. The time interval of this periodic data stream will determine the fail-over time for traffic from AP towards the failed-over REMOTE.

Using the Web UI

AP Configuration

Following features need to be configured on the AP:

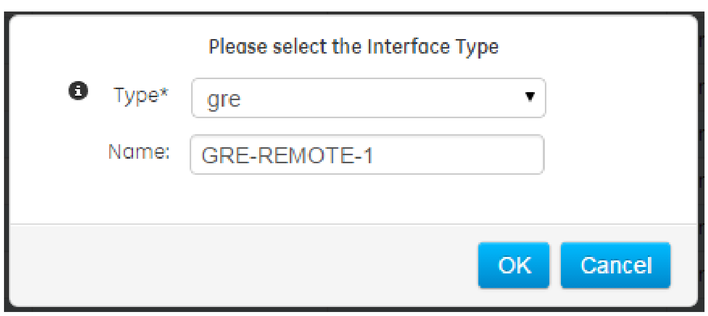
1. IPsec transport mode connection – To secure GRE traffic to/from REMOTE-1 and REMOTE-2 over Cellular network.
2. GRE tunnel – To send/receive layer-2 traffic to/from REMOTE-1 and REMOTE-2's LAN segments over Cellular network.
3. Adding GRE tunnels to the Bridge interface – To enable flow of layer-2 traffic between local LAN segment and REMOTE-1 and REMOTE-2's LAN segments over Cellular network.

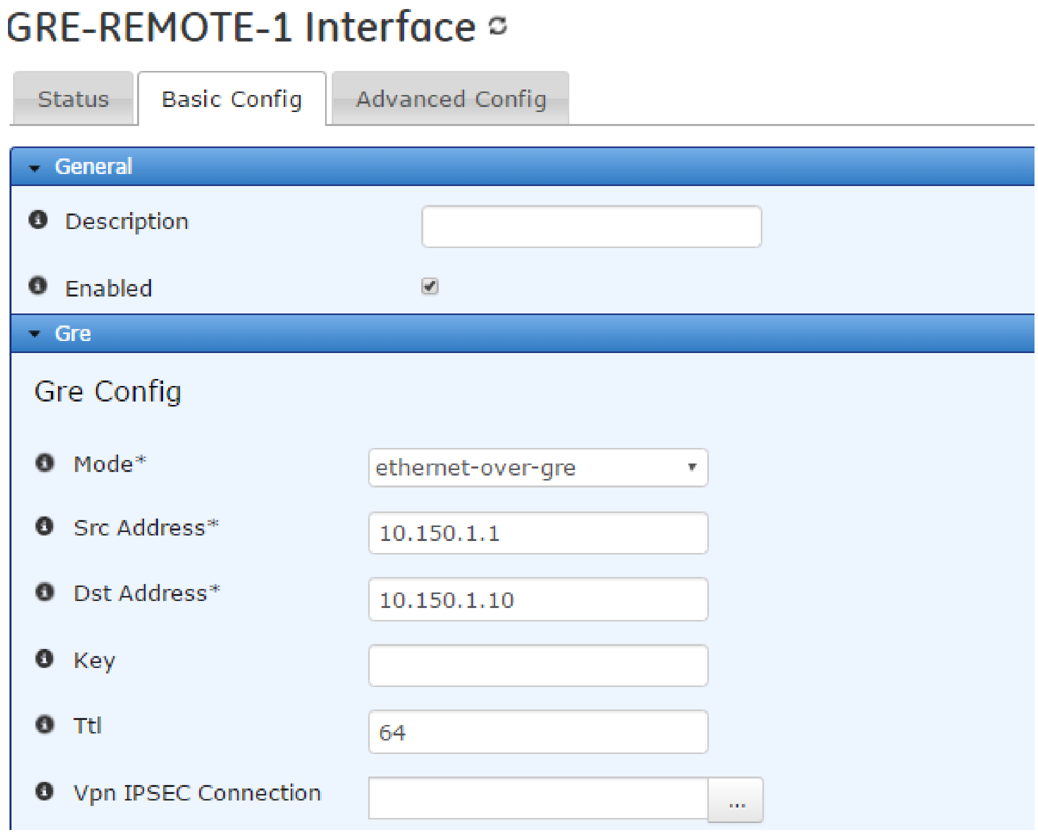
Configure IPsec Transport Mode Connections

1. Configure an IPsec VPN transport mode connection for the REMOTE-1. Please refer to section on IPsec VPN for help with configuring IPsec VPN using Web UI.
2. Configure an IPsec VPN transport mode connection for the REMOTE-2. Please refer to section on IPsec VPN for help with configuring IPsec VPN using Web UI.

Configure GRE tunnels

1. Configure GRE tunnel interface towards REMOTE-1 with mode = ethernet-over-gre, src-address = 10.150.1.1 (the local Cell interface address as used in IPsec VPN towards REMOTE-1) and dst-address = 10.150.1.10 (the remote Cell interface address as configured in IPsec VPN towards REMOTE-1).
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click 'Add' to create new interface named 'GRE-REMOTE-1':

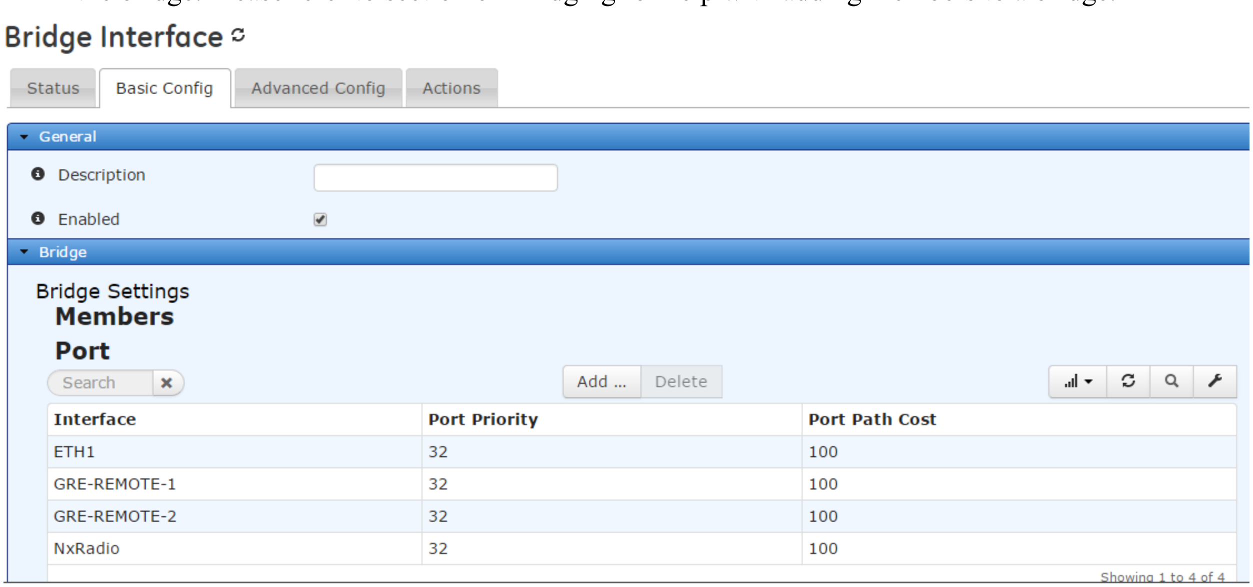




2. Configure GRE tunnel interface towards REMOTE-2 with mode = ethernet-over-gre, src-address = 10.150.1.1 (the local WAN address as used in IPsec VPN towards REMOTE-2) and dst-address = 10.150.1.20 (the remote WAN address as configured in IPsec VPN towards REMOTE-2).

Add GRE tunnels to the Bridge interface

1. Add the GRE-REMOTE-1 tunnel interface to the bridge that has NX interface and disable STP on the bridge. Please refer to section on Bridging for help with adding members to a bridge.
2. Add the GRE-REMOTE-2 tunnel interface to the bridge that has NX interface and disable STP on the bridge. Please refer to section on Bridging for help with adding members to a bridge.



REMOTE#1 Configuration

Following features need to be configured on this device:

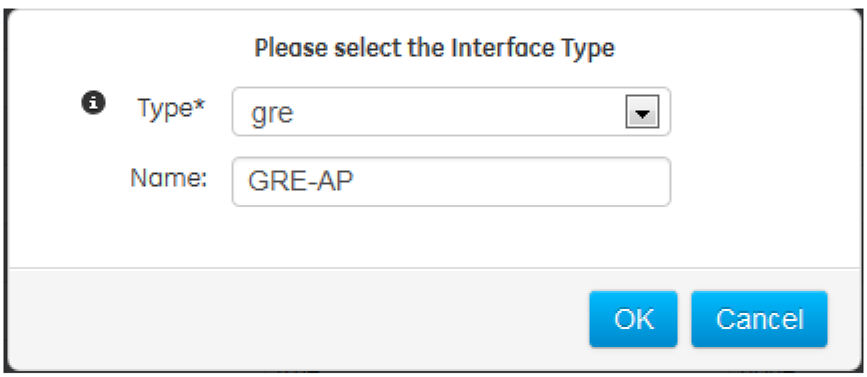
1. IPsec transport mode connection – To secure GRE traffic to/from AP over Cellular network.
2. GRE tunnel – To send/receive layer-2 traffic to/from AP's LAN segments over Cellular network.
3. Bond Interface – To enable failover of layer-2 traffic between NX (primary interface) and GRE tunnel (secondary/backup interface).
4. Adding Bond interface to the Bridge interface – To enable flow of layer-2 traffic between local LAN segment and AP's LAN segments.
5. Network Monitor Operation – To send a periodic traffic to enable failover at the AP as described in the NOTE earlier in this section.

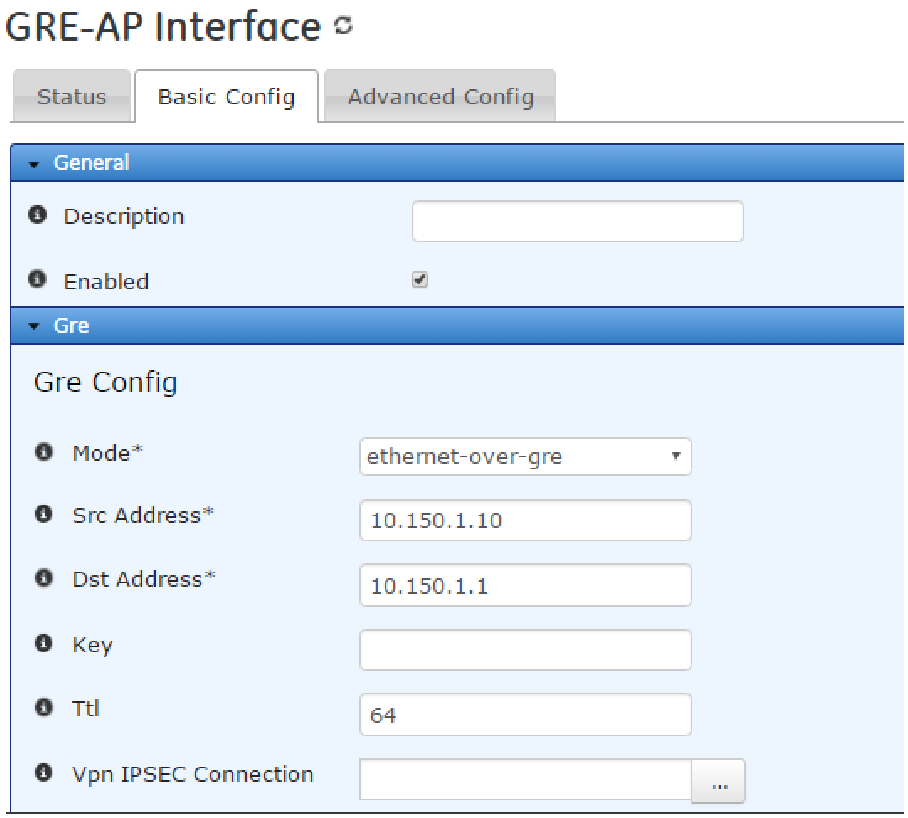
Configure IPsec Transport Mode Connection

1. Configure an IPsec VPN transport mode connection (host-to-host connection type) for the AP. Please refer to section on IPsec VPN for help with configuring IPsec VPN using Web UI.

Configure GRE tunnel

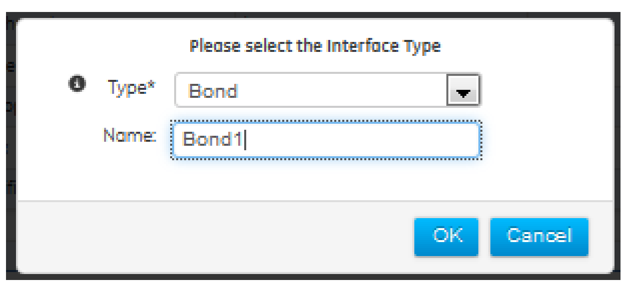
1. Configure GRE tunnel interface towards AP with mode = ethernet-over-gre, src-address = 10.150.1.10 (the local Cell interface address as used in IPsec VPN towards AP) and dst-address = 10.150.1.1 (the remote Cell interface address as configured in IPsec VPN towards AP).
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click 'Add' to create new interface named 'GRE1':

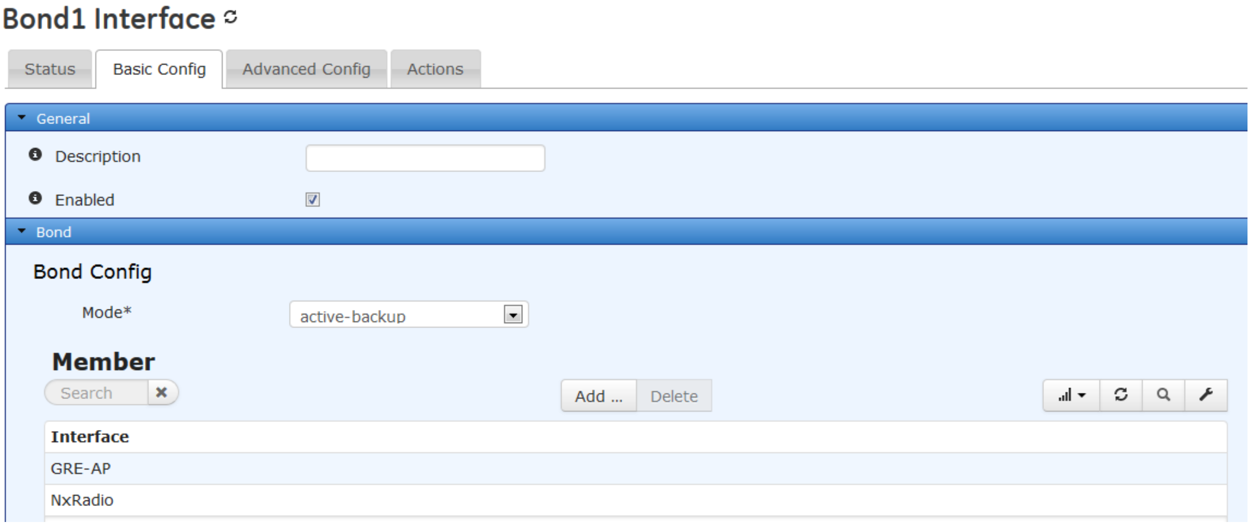




Configure BOND interface

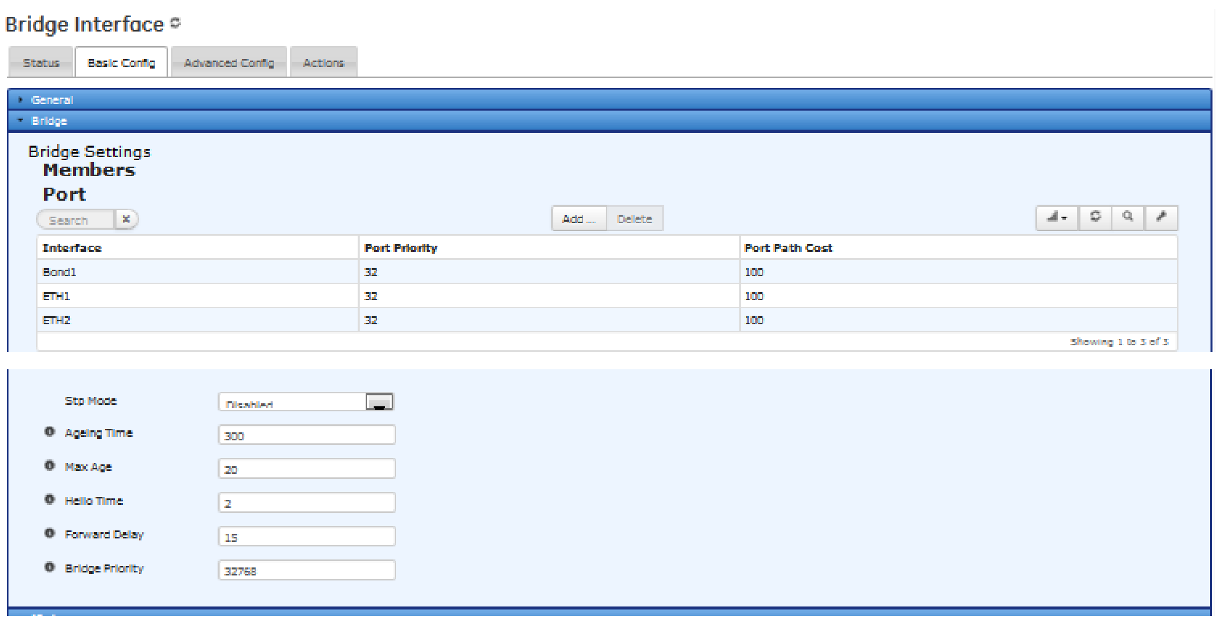
1. Configure BOND interface in ‘active-backup’ mode with NxRadio and GRE-AP as members and NxRadio as the primary member.
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click ‘Add’ to create new interface named ‘Bond1’:





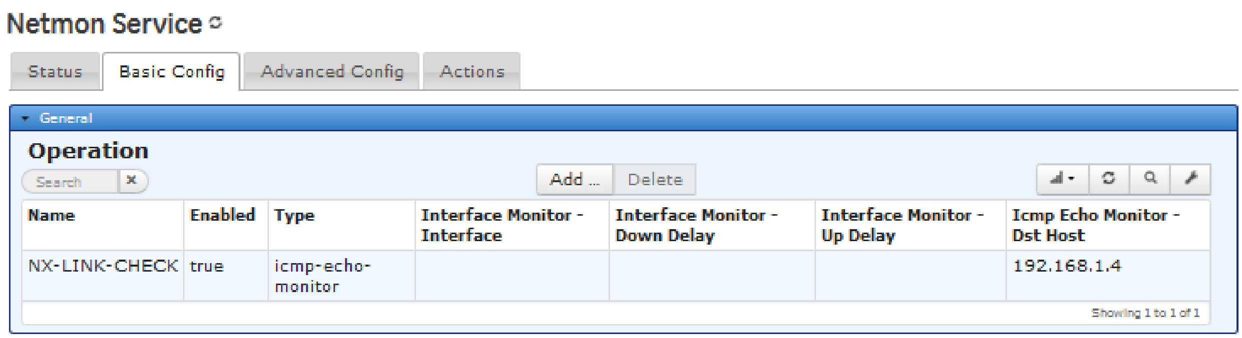
Add BOND interface to the Bridge

1. Add the **Bond1** tunnel interface to the bridge that has NX interface and disable STP on the bridge. Please refer to section on Bridging for help with adding members to a bridge.



Configure NETMON operation

1. Configure a **NETMON** service icmp-echo-monitor operation named NX-LINK-CHECK that does a periodic link check by pinging AP. This is needed to generate a periodic traffic towards AP to enable the latter to update its bridge forwarding table when the REMOTE switches its link from NX to/from GRE tunnel. The time interval of this traffic determines the time interval of failover at the AP. Please refer NETMON service section for help with configuration.



REMOTE#2 Configuration

Following features need to be configured on this device:

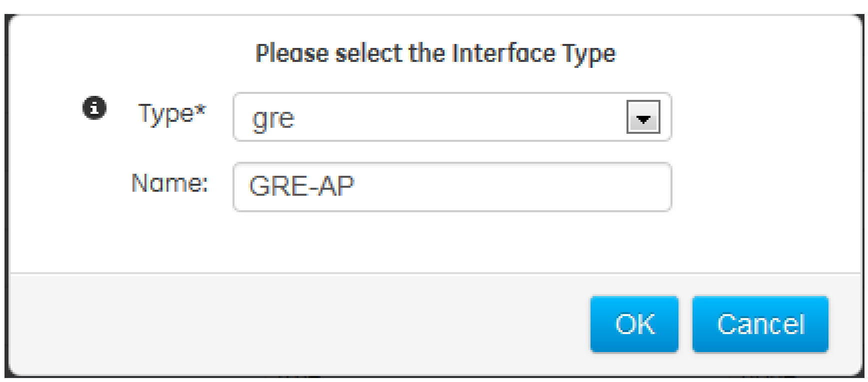
1. IPsec transport mode connection – To secure GRE traffic to/from AP over Cellular network.
2. GRE tunnel – To send/receive layer-2 traffic to/from AP's LAN segments over Cellular network.
3. Bond Interface – To enable failover of layer-2 traffic between NX (primary interface) and GRE tunnel (secondary/backup interface).
4. Adding Bond interface to the Bridge interface – To enable flow of layer-2 traffic between local LAN segment and AP's LAN segments.
5. Network Monitor Operation – To send a periodic traffic to enable failover at the AP as described in the NOTE earlier in this section.

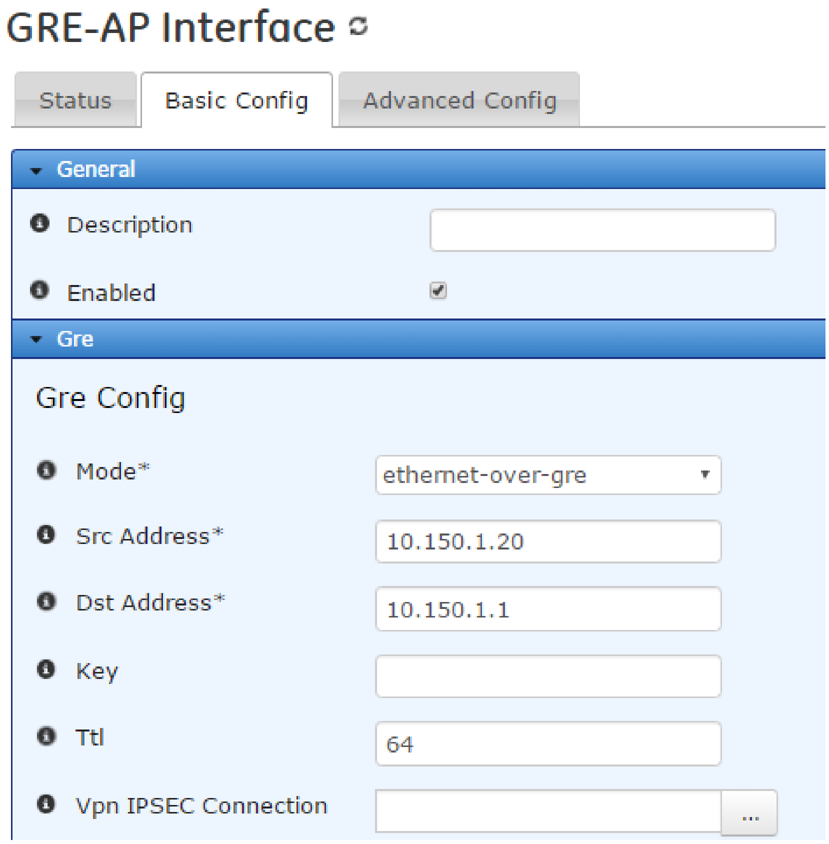
Configure IPsec transport mode connection

1. Configure an IPsec VPN transport mode connection (host-to-host connection type) for the AP. Please refer to section on IPsec VPN for help with configuring IPsec VPN using Web UI.

Configure GRE tunnel

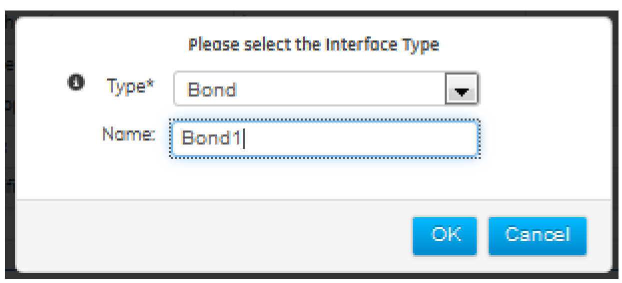
1. Configure GRE tunnel interface towards AP with mode = ethernet-over-gre, src-address = 10.150.1.20 (the local Cell interface address as used in IPsec VPN towards AP) and dst-address = 10.150.1.1 (the remote Cell interface address as configured in IPsec VPN towards AP).
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click 'Add' to create new interface named 'GRE-AP':

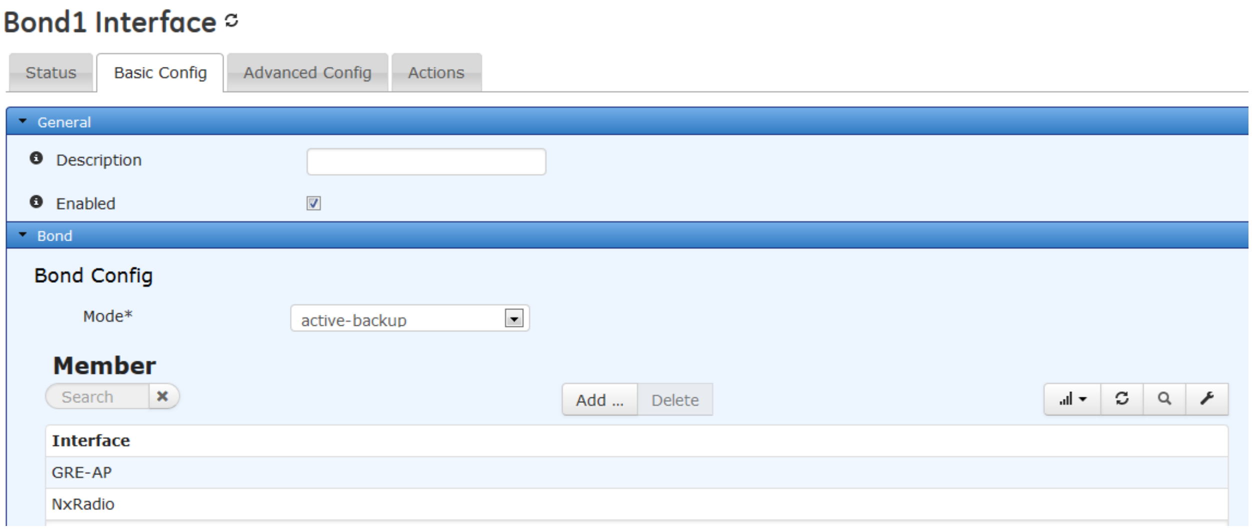




Configure BOND interface

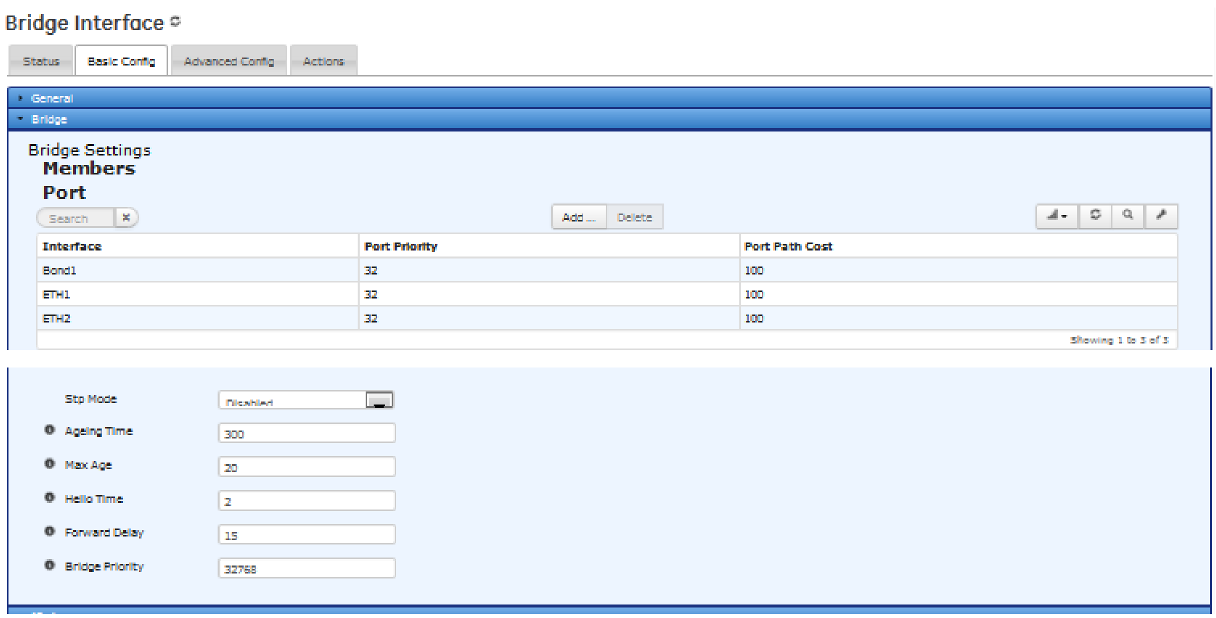
1. Configure BOND interface in ‘active-backup’ mode with NxRadio and GRE-AP as members and NxRadio as the primary member.
   - Navigate to ***Interfaces / Add/Delete Interfaces*** and click ‘Add’ to create new interface named ‘Bond1’:





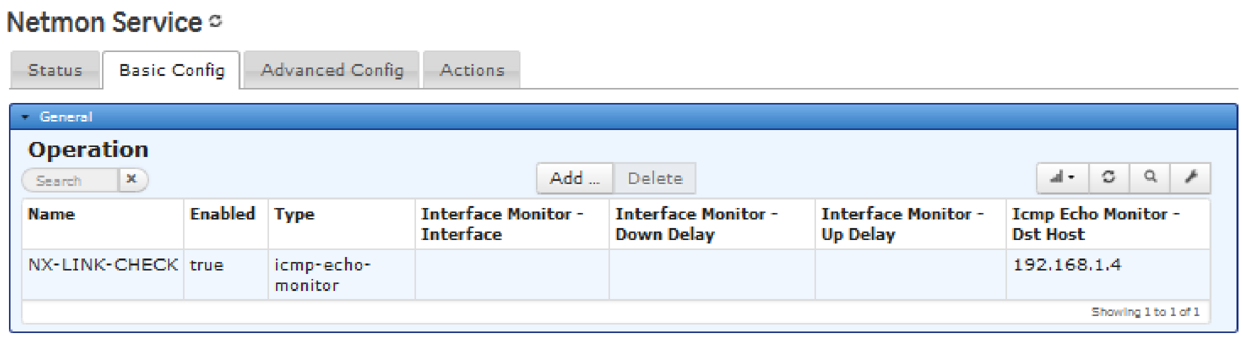
Add BOND interface to the Bridge

1. Add the **Bond1** tunnel interface to the bridge that has NX interface and disable STP on the bridge. Please refer to section on Bridging for help with adding members to a bridge.



Configure NETMON operation

1. Configure a **NETMON** service icmp-echo-monitor operation named NX-LINK-CHECK that does a periodic link check by pinging AP. This is needed to generate a periodic traffic towards AP to enable the latter to update its bridge forwarding table when the REMOTE switches its link from NX to/from GRE tunnel. The time interval of this traffic determines the time interval of failover at the AP. Please refer NETMON service section for help with configuration.



Above NETMON configuration assumes AP's bridge interface IP address is 192.168.1.4.

NOTE Since the AP and REMOTEs are now part of a single layer-2 network, the bridge interfaces need to be assigned distinct IP addresses.

Using the CLI

Configurable IPsec tunnel (a pre-shared-key based example shown below) from REMOTE to AP. It is assumed that REMOTE-1's cell IP address is 10.150.1.10, REMOTE-2's cell IP address is 10.150.1.20 and AP's cell IP address is 10.150.1.1.

AP Configuration

- Configure IPsec transport mode connections

% set services vpn enabled true
% set services vpn ike policy REMOTE-1_ike_policy **auth-method** pre-shared-key
% set services vpn ike policy REMOTE-1_ike_policy **pre-shared-key** remote1
% set services vpn ike policy REMOTE-1_ike_policy **ciphersuite** ike_policy_cipher0
% set services vpn ike policy REMOTE-1_ike_policy **life-time** 180
% set services vpn ike peer REMOTE-1_ike_peer **ike-policy** REMOTE-1_ike_policy
% set services vpn ike peer REMOTE-1_ike_peer **local-endpoint address** 10.150.1.1
% set services vpn ike peer REMOTE-1_ike_peer **local-identity default**
% set services vpn ike peer REMOTE-1_ike_peer **peer-endpoint address** 10.150.1.10
% set services vpn ike peer REMOTE-1_ike_peer **peer-identity default**
% set services vpn ike peer REMOTE-2_ike_peer **role** responder
% set services vpn ipsec policy REMOTE-1_ipsec_policy **ciphersuite** ipsec_policy_cipher0
% set services vpn ipsec policy REMOTE-1_ipsec_policy **life-time** 60
% set services vpn ipsec connection REMOTE-1 **ike-peer** REMOTE-1_ike_peer
% set services vpn ipsec connection REMOTE-1 **ipsec-policy** REMOTE-1_ipsec_policy
% set services vpn ipsec connection REMOTE-1 **host-to-host**
% set services vpn ipsec connection REMOTE-1 **filter input** IN_TRUSTED
% set services vpn ipsec connection REMOTE-1 **filter output** OUT_TRUSTED

% set services vpn ike policy REMOTE-2_ike_policy **auth-method** pre-shared-key
% set services vpn ike policy REMOTE-2_ike_policy **pre-shared-key** remote2
% set services vpn ike policy REMOTE-2_ike_policy **ciphersuite** ike_policy_cipher0
% set services vpn ike policy REMOTE-2_ike_policy **life-time** 180
% set services vpn ike peer REMOTE-2_ike_peer **ike-policy** REMOTE-2_ike_policy
% set services vpn ike peer REMOTE-2_ike_peer **local-endpoint address** 10.150.1.1
% set services vpn ike peer REMOTE-2_ike_peer **local-identity default**
% set services vpn ike peer REMOTE-2_ike_peer **peer-endpoint address** 10.150.1.20
% set services vpn ike peer REMOTE-2_ike_peer **peer-identity default**
% set services vpn ike peer REMOTE-2_ike_peer **role** responder

% set services vpn ipsec policy REMOTE-2_ipsec_policy **ciphersuite** ipsec_policy_cipher0
% set services vpn ipsec policy REMOTE-2_ipsec_policy **life-time** 60
% set services vpn ipsec connection REMOTE-2 **ike-peer** REMOTE-2_ike_peer
% set services vpn ipsec connection REMOTE-2 **ipsec-policy** REMOTE-2_ipsec_policy
% set services vpn ipsec connection REMOTE-2 **host-to-host**
% set services vpn ipsec connection REMOTE-2 **filter input** IN_TRUSTED
% set services vpn ipsec connection REMOTE-2 **filter output** OUT_TRUSTED

- Configure GRE tunnel interfaces in ethernet-over-gre mode

% set interfaces interface GRE-REMOTE-1 **type** gre
% set interfaces interface GRE-REMOTE-1 **gre-config mode** ethernet-over-gre
% set interfaces interface GRE-REMOTE-1 **gre-config src-address** 10.150.1.1
% set interfaces interface GRE-REMOTE-1 **gre-config dst-address** 10.150.1.10

% set interfaces interface GRE-REMOTE-2 **type** gre
% set interfaces interface GRE-REMOTE-2 **gre-config mode** ethernet-over-gre
% set interfaces interface GRE-REMOTE-2 **gre-config src-address** 10.150.1.1
% set interfaces interface GRE-REMOTE-2 **gre-config dst-address** 10.150.1.20

- Add the GRE tunnel interfaces to the bridge and disable STP on the bridge

% set interfaces interface Bridge **bridge-settings members port** GRE-REMOTE-1
% set interfaces interface Bridge **bridge-settings members port** GRE-REMOTE-2
% set interfaces interface Bridge **bridge-settings stp-mode** disabled

REMOTE#1 Configuration

- Configure IPsec tunnel

% set services vpn enabled true
% set services vpn ike policy AP_ike_policy **auth-method pre-shared-key**
% set services vpn ike policy AP_ike_policy **pre-shared-key** remote1
% set services vpn ike policy AP_ike_policy **ciphersuite** ike_policy_cipher0
% set services vpn ike policy AP_ike_policy **life-time** 180
% set services vpn ike policy AP_ike_policy **reauth** true
% set services vpn ike peer AP_ike_peer **ike-policy** AP_ike_policy
% set services vpn ike peer AP_ike_peer **local-endpoint address** 10.150.1.10
% set services vpn ike peer AP_ike_peer **local-identity default**
% set services vpn ike peer AP_ike_peer **peer-endpoint address** 10.150.1.1
% set services vpn ike peer AP_ike_peer **peer-identity default**
% set services vpn ike peer AP_ike_peer **role initiator**
% set services vpn ike peer AP_ike_peer **initiator-mode on-demand**
% set services vpn ipsec policy AP_ipsec_policy **ciphersuite** ipsec_policy_cipher0
% set services vpn ipsec policy AP_ipsec_policy **life-time** 60
% set services vpn ipsec connection AP **ike-peer** AP_ike_peer
% set services vpn ipsec connection AP **ipsec-policy** AP_ipsec_policy
% set services vpn ipsec connection AP **host-to-host**
% set services vpn ipsec connection AP **filter input** IN_TRUSTED
% set services vpn ipsec connection AP **filter output** OUT_TRUSTED

- Configure GRE tunnel interface

% set interfaces interface GRE-AP **type gre**
% set interfaces interface GRE-AP **gre-config mode** ethernet-over-gre
% set interfaces interface GRE-AP **gre-config src-address** 10.150.1.10
% set interfaces interface GRE-AP **gre-config dst-address** 10.150.1.1

•Configure BOND interface in 'active-backup' mode with NxRadio and GRE-AP as members and NxRadio as the primary member.

% set interfaces interface Bond1 **type bond**

% set interfaces interface Bond1 **bond-config mode active-backup**

% set interfaces interface Bond1 **bond-config member** NxRadio

% set interfaces interface Bond1 **bond-config member** GRE-AP

% set interfaces interface Bond1 **bond-config primary-member** NxRadio

•Add BOND1 interface to Bridge disable STP on the bridge.

% set interfaces interface *Bridge* **bridge-settings members port** *Bond1*

% set interfaces interface *Bridge* **bridge-settings stp-mode disabled**

•Configure a NETMON service icmp-echo-monitor operation named NX-LINK-CHECK that does a periodic link check by pinging AP. This is needed to generate a periodic traffic towards AP (say every 5 secs) to enable the latter to update its bridge forwarding table when the REMOTE switches its link from NX to/from GRE tunnel.

% set services netmon operation NX-LINK-CHECK **enabled true**

% set services netmon operation NX-LINK-CHECK **icmp-echo-monitor dst-host** 192.168.1.4

% set services netmon operation NX-LINK-CHECK **icmp-echo-monitor interval** 5

REMOTE#2 Configuration

Configuration is similar to REMOTE#1.

3.8.23 Dynamic Routing

Understanding

Dynamic routing consists of routers building and maintaining routing tables automatically through an ongoing communication between them. This communication is facilitated by a routing protocol, which consists of a series of periodic or on-demand messages containing routing information that is exchanged between the routers.

The unit supports following routing protocols to enable dynamic routing:

- Routing Information protocol (RIP)- The unit support RIPv2 (RFC 1723, RFC4822)
- Open Shortest Path First (OSPF) – The unit supports OSPFv2 (RFC 2328) and OSPFv3
- Border Gateway Protocol (BGP) – The unit support BGPv4 (RFC 4271).

The user can control the routes that are imported into the routing table from the routing protocol and those that are exported into the routing protocol from the routing table by using ***route filters***.

The *import* route filter controls the routes that are imported into the routing table by the routing protocol. By default, the routing protocol allows all routes received from the peer router to be imported into the routing table. That is, if no import filter is configured, default action is ACCEPT.

The *export* route filter controls the routes that are exported into the routing protocol from the routing table. By default, the routing protocol prevents export of any routes from the local routing table to the peer router. That is, if no export filter is configured, default action is NONE.

A route filter consists of one or more rules sorted by a numeric identifier. Each rule in route filter consists of ‘match’ and ‘actions’ configuration. The parameters in the match are compared against the route being imported (if this route filter is used as import filter) or exported (if this route filter is used as export filter) into/from the routing table. If the route matches, the action (ACCEPT OR REJECT) specified in the actions configuration is applied.

When routing protocol receives a route from the peer router it checks whether the route is allowed by the import filter by comparing it against one or more rules configured in the filter (in order of their configuration). If any rule matches, the corresponding action (ACCEPT or REJECT) is applied. Similarly, for each route in the routing table, the routing protocol checks whether it is allowed by the export filter before exporting it to the peer routers. In addition, some general attributes of the route like NEXT-HOP or routing protocol specific attributes like BGP AS-PATH, LOCAl-PREF etc can be modified when exporting routes using ‘set’.

Use Cases

The figure below describes one of the use cases for dynamic routing on the unit. In this case, dynamic a routing protocol is used to exchange locally connected LAN route with a router in the back-office (and vice versa) over the Cellular WAN interface. Both OSPF and RIP exchange routing updates with peers using multicast. BGP uses TCP connection with peer to exchange routes. The cellular interface by itself is not capable multicasting. Therefore, in this use case, a GRE tunnel interface needs to be used over Cell. Further, IPsec in transport mode can be used to secure GRE traffic over Cell. Please refer to sections on GRE and IPsec on how to setup GRE over IPsec. The configuration examples below assume that an interface named ‘GRE’ has been configured to tunnel routing updates to the back-office router.

NOTE The GRE interface needs to be configured with an IP address for the dynamic routing protocols to operate over it.

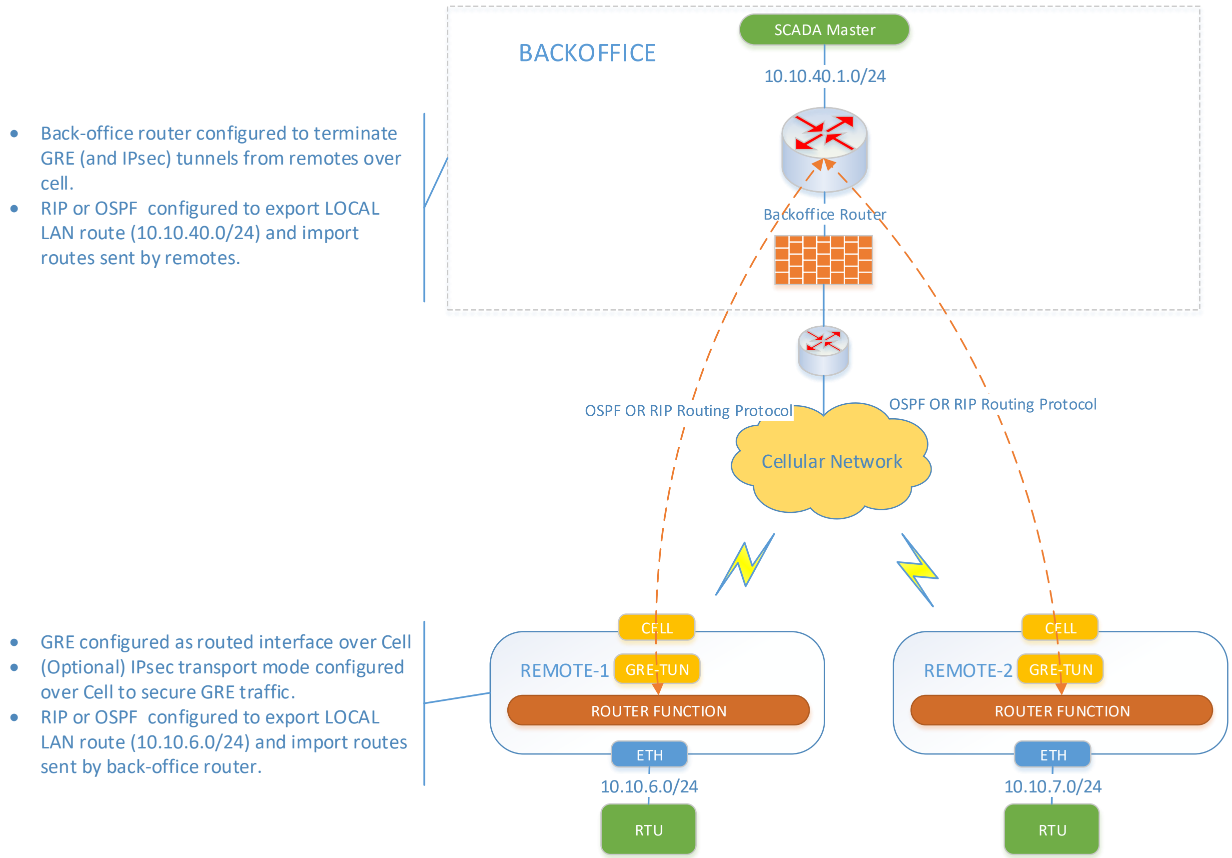


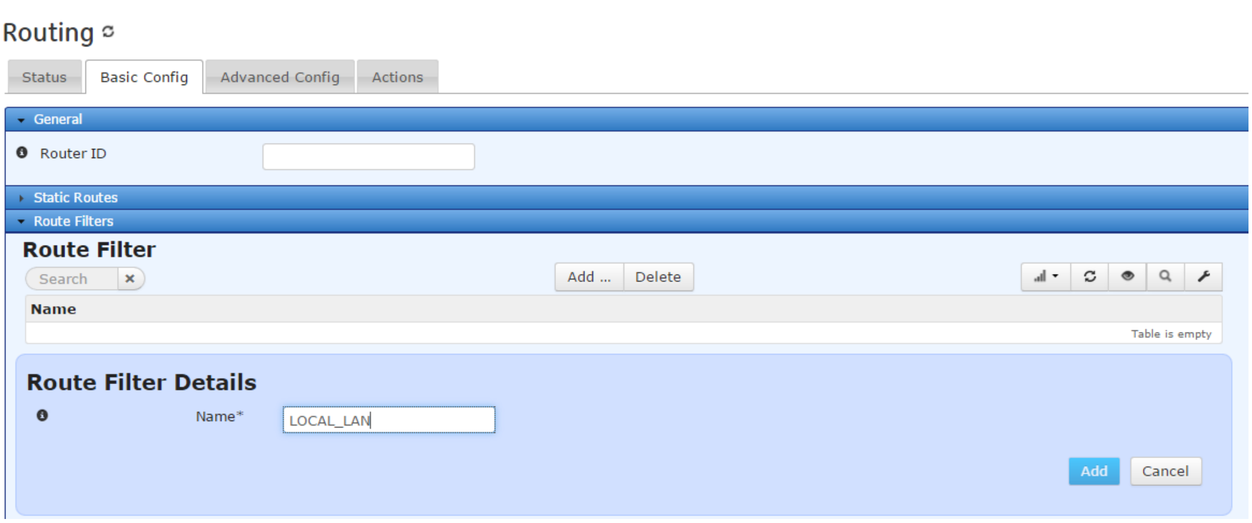
Figure 3-267. Dynamic Routing between SCADA Back-office and Remote LAN

Configuring

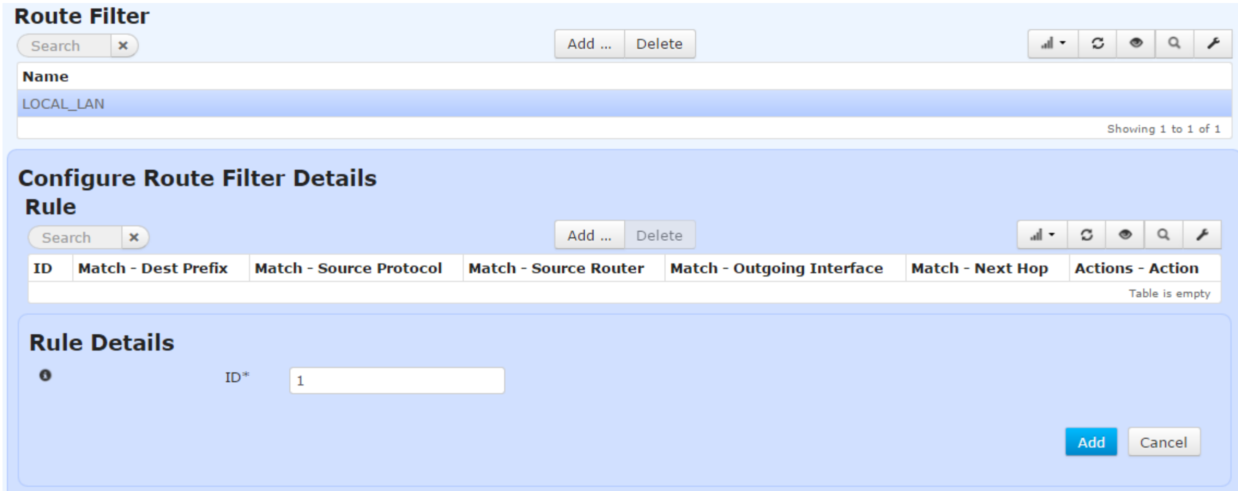
Following example shows how to create a route filter to export route for a directly connected local LAN (i.e. direct/interface route for Bridge interface for a unit with factory default configuration).

Navigate to ***Routing-> Basic Config->Route filters***

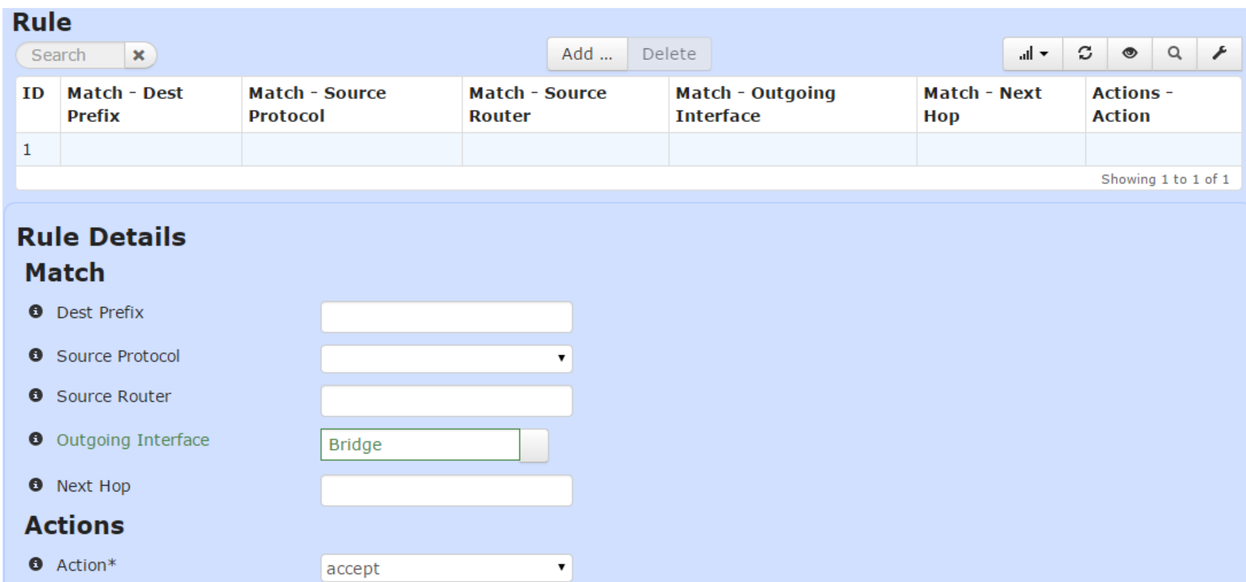
Click 'Add' to create a route filter named **LOCAL_LAN**.



Select the newly created **LOCAL_LAN** route filter and click '**Add'** to add a rule with **ID=1** to this filter.



Select ‘**outgoing-interface= Bridge**’ and **Action=’accept**’.



Click **Finish** on the panels to close them.

To apply configuration, click **Save.**

NOTE At this point route filter has been created. However, one needs to use the route filter as an export/import filter in the routing protocol configuration for it to take effect.

Using CLI

In **configuration** mode, enter following commands:

> **% set routing route-filter** LOCAL_LAN **rule** 1 **match outgoing-interface** Bridge
> **% set routing route-filter** LOCAL_LAN **rule** 1 **actions action** accept
> **% commit**

Following sections describe configuration for specific routing protocols.

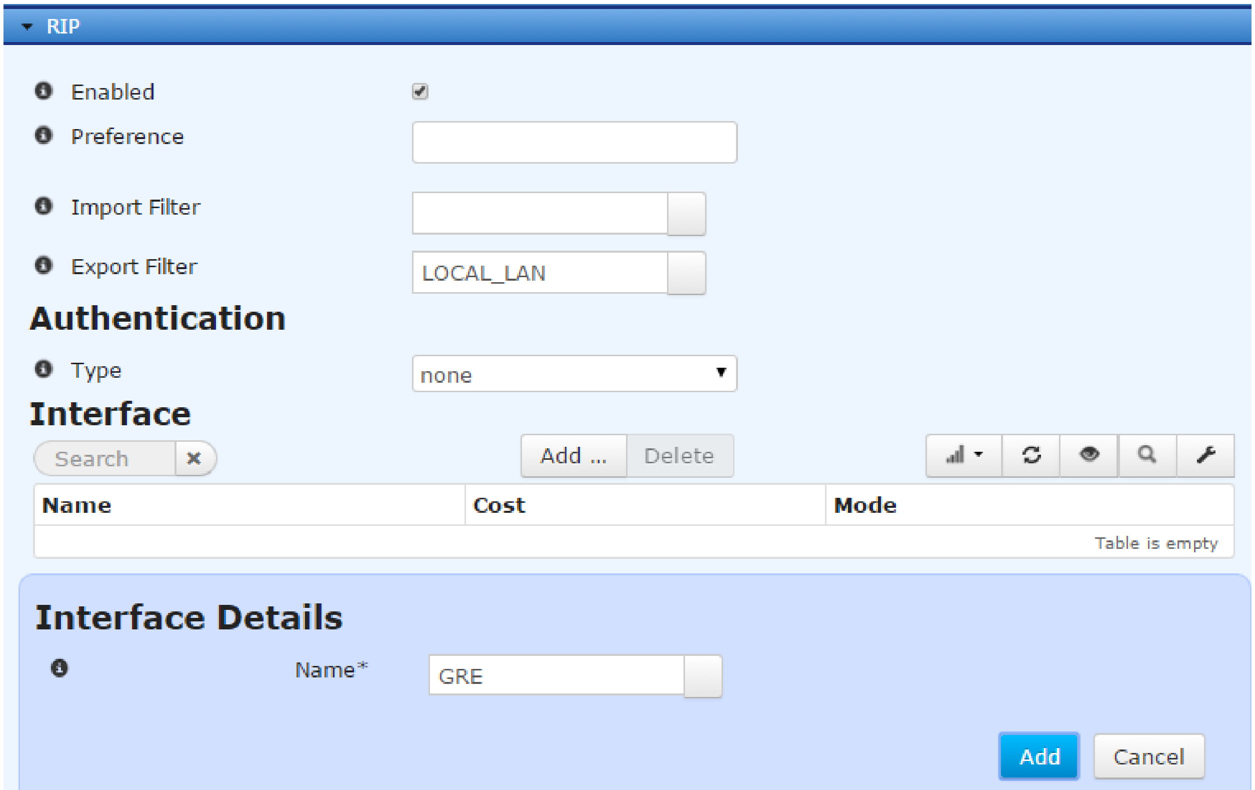
RIP

The basic RIP configuration consists of enabling the protocol and adding interfaces on which it should operate and configuring an export filter. In addition, MD5 authentication can be used to secure routing protocol updates. In the example, below RIP is enabled on GRE interface along with LOCAL_LAN as the export filter.

Navigate to ***Routing-> Basic Config->RIP***

Select '**LOCAL_LAN**' as the export filter.

Under '**Interface**', click '**Add**' to add an interface on which RIP should operate.



To apply configuration, click **Save.**

NOTE In FIPS mode, only the default of NONE is supported for Authentication Type.

Using CLI

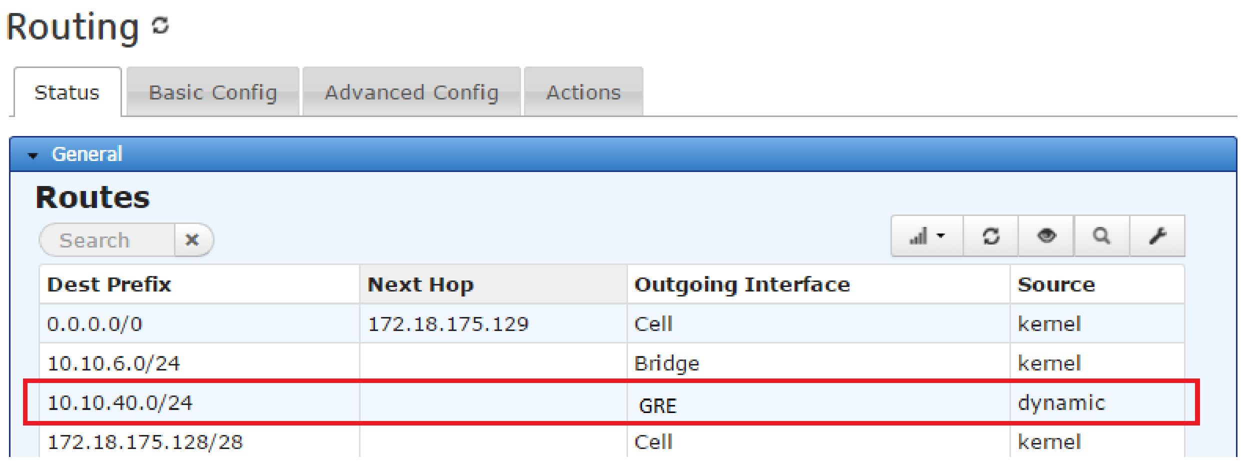
In configuration mode, enter following commands:

% set routing rip **enabled true**
% set routing rip **export-filter** LOCAL_LAN
% set routing rip **interface** GRE
% commit

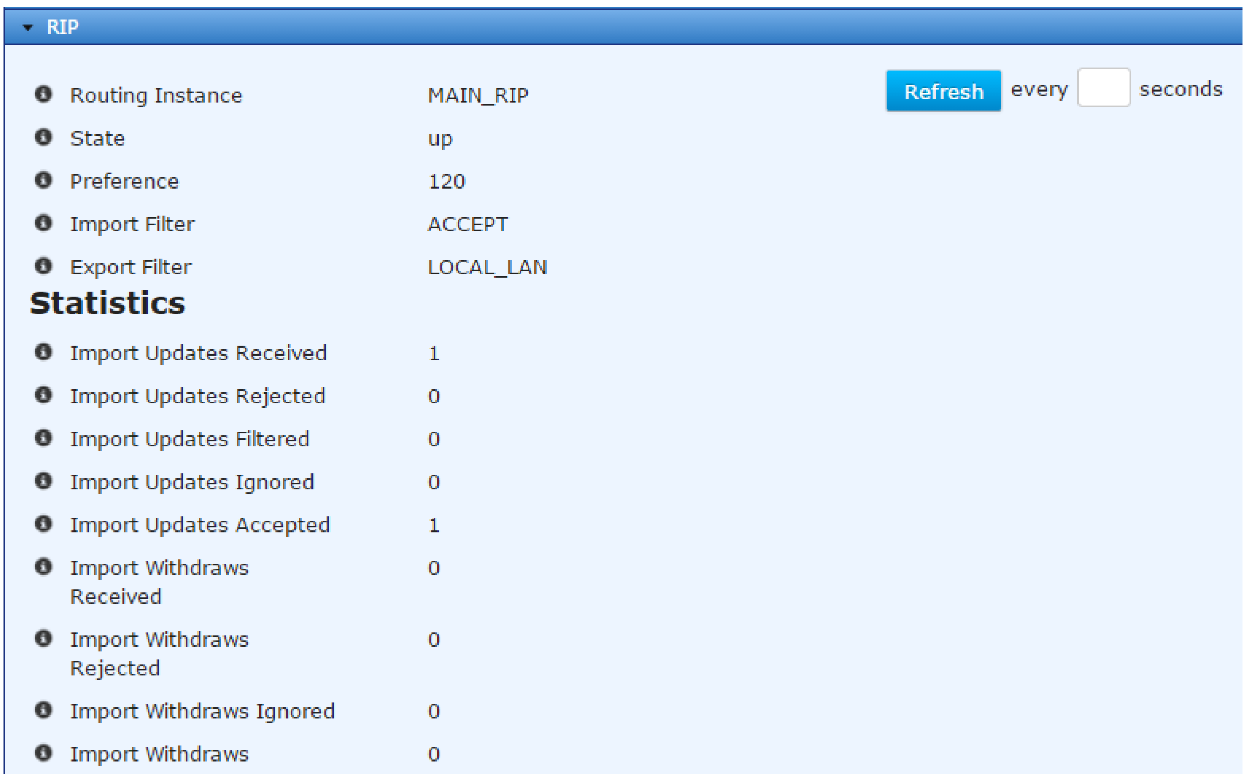
Monitoring

Navigate to ***Routing-> Status***

The user can check the routing table in the '**General**' panel to ensure a **dynamic** route for the back-office has been received from the back-office router.



The ‘RIP’ panel displays the state of RIP routing protocol including route import/export statistics.



Using CLI

In **operational** mode, enter following commands:

```
> show routing-state routes
                                            OUTGOING
DEST PREFIX          NEXT HOP               INTERFACE    SOURCE
----------------------------------------------------------------------------------------------
0.0.0.0/0            172.18.175.129         Cell         kernel
10.10.6.0/24         -                      Bridge       kernel
10.10.40.0/24        -                      GRE          dynamic
172.18.175.128/28    -                      Cell         kernel

> show routing-state rip
routing-state rip routing-instance MAIN_RIP
routing-state rip state up
routing-state rip preference 120
routing-state rip import-filter ACCEPT
routing-state rip export-filter LOCAL_LAN
routing-state rip statistics import-updates-received 1
routing-state rip statistics import-updates-rejected 0
routing-state rip statistics import-updates-filtered 0
routing-state rip statistics import-updates-ignored 0
routing-state rip statistics import-updates-accepted 1
routing-state rip statistics import-withdraws-received 0
routing-state rip statistics import-withdraws-rejected 0
routing-state rip statistics import-withdraws-ignored 0
routing-state rip statistics import-withdraws-accepted 0
routing-state rip statistics export-updates-received 10
routing-state rip statistics export-updates-rejected 1
routing-state rip statistics export-updates-filtered 7
routing-state rip statistics export-updates-accepted 2
routing-state rip statistics export-withdraws-received 0
routing-state rip statistics export-withdraws-accepted 0
```

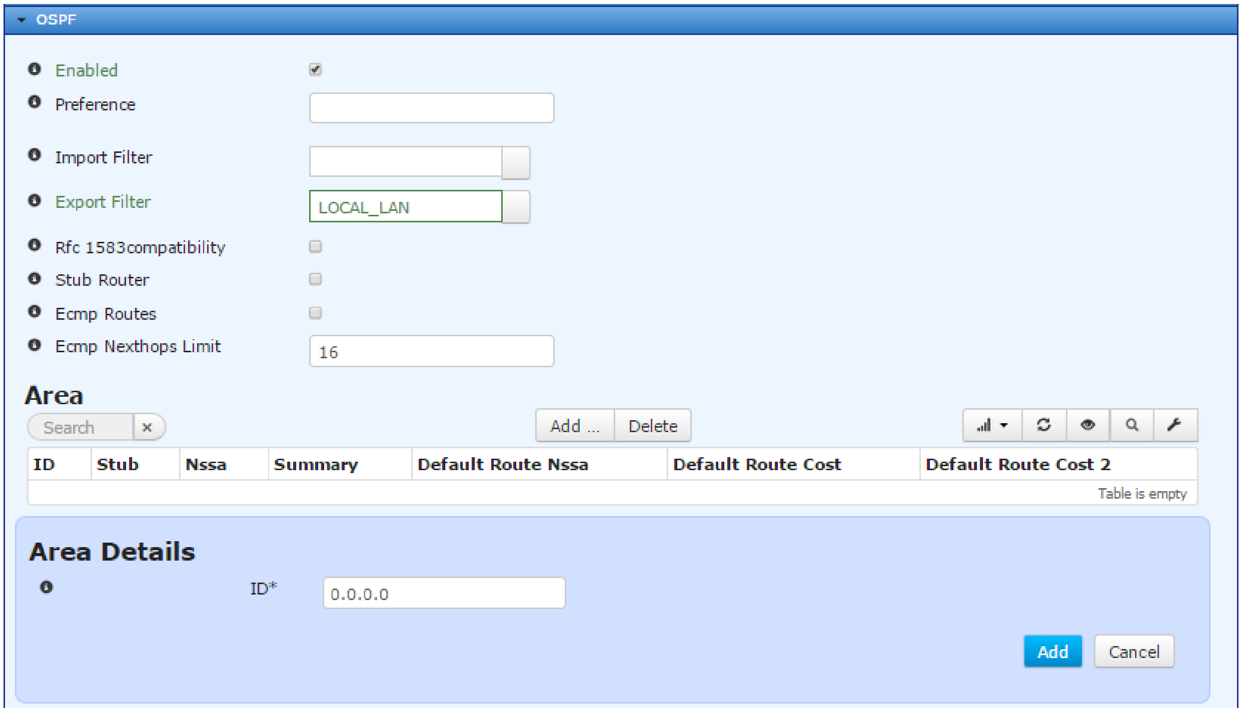
OSPF

The basic OSPF configuration consists of enabling the protocol, creating backbone area 0.0.0.0 and adding interfaces to this area on which the protocol should operate and configuring an export filter. In addition, MD5 authentication can be used to secure routing protocol updates on per-interface basis. In the example below, OSPF is enabled with area 0.0.0.0 containing GRE interface along with LOCAL_LAN as the export filter.

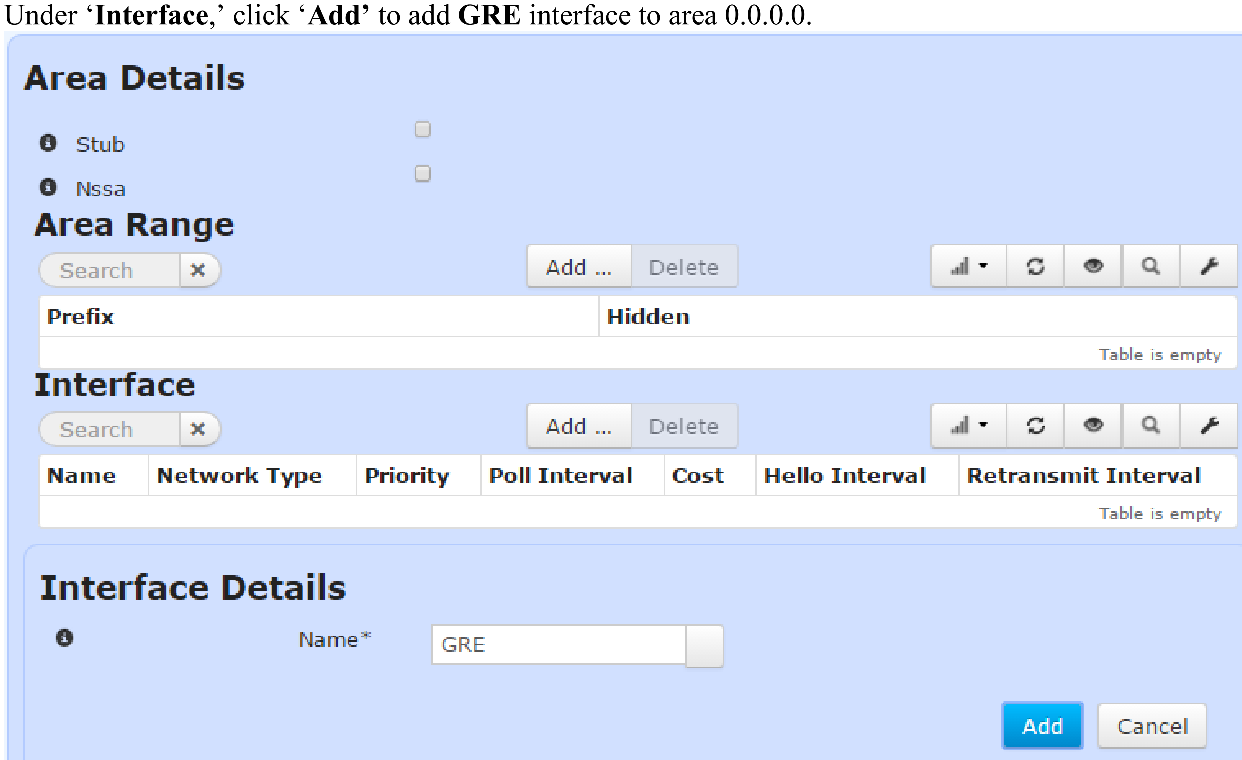
Navigate to ***Routing-> Basic Config->OSPF***

Select '**LOCAL_LAN**' as the export filter.

Under ‘**Area**,’ click ‘**Add’** to add area 0.0.0.0 (backbone)



Under ‘**Interface**,’ click ‘**Add’** to add **GRE** interface to area 0.0.0.0.



To apply configuration, click **Save.**

NOTE In FIPS mode, only the default of NONE is supported for Authentication Type.

Using CLI

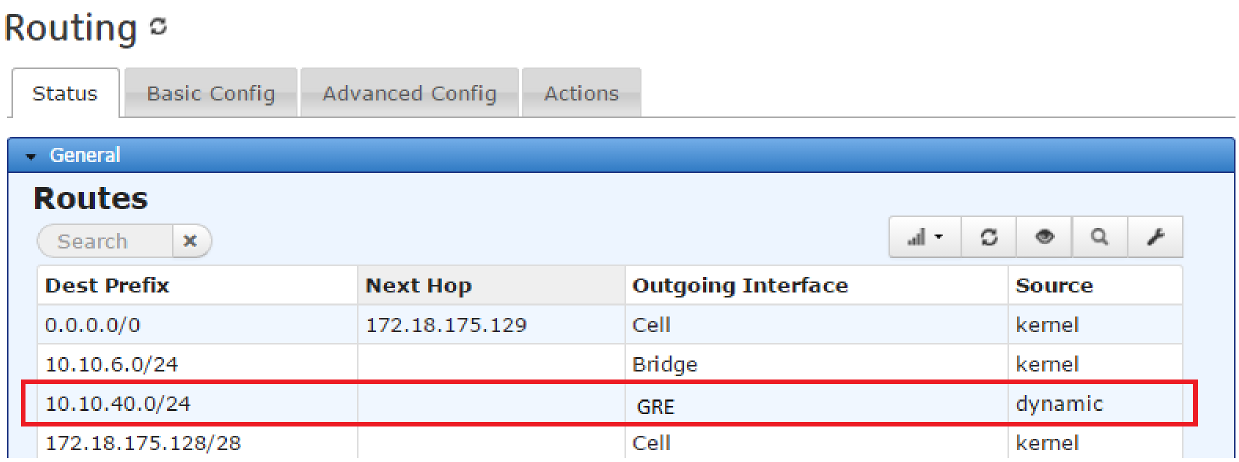
In **configuration** mode, enter following commands:

> **% set routing** ospf **enabled** true
> **% set routing** ospf **export-filter** LOCAL_LAN
> **% set routing** ospf **area** 0.0.0.0 **interface** GRE
> **% commit**

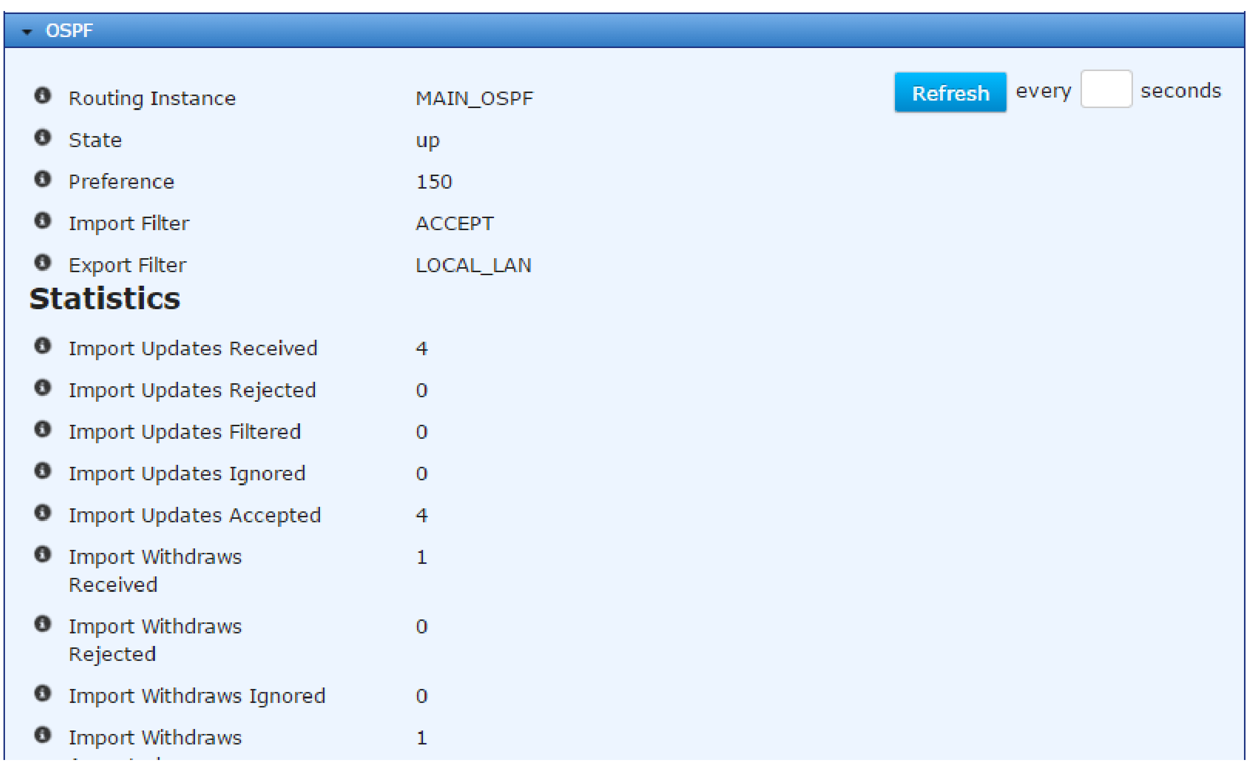
Monitoring

Navigate to ***Routing-> Status***

The user can check the routing table in the 'General' panel to ensure a dynamic route for the back-office has been received from the back-office router.



The 'OSPF' panel, displays the state of OSPF routing protocol including route import/export statistics and other OSPF protocol status.



The ‘**Area**’ table displays status of OSPF areas. The ‘**Interface**’ table displays interface state. The ‘**Neighbor**’ table displays the routers with which the unit has exchanged OSPF ‘Hello’ messages and those with it has established adjacencies (i.e. exchanged routing database).

Area

ID	Stub	Nssa	Transit	Nssa Translation	Num Interfaces	Num Neighbors
0.0.0.0	false	false	false	false	1	1

Showing 1 to 1 of 1

Interface

Name	Virtual Link	Peer Address	Transit Area ID	Network Type	Area ID	State
GRE	false			bcast	0.0.0.0	bdr

Showing 1 to 1 of 1

Neighbor

ID	Address	Interface	State	Priority	Dead Time
2.2.2.2	192.168.1.4	GRE	Full/DR	128	37

Showing 1 to 1 of 1

The ‘Lsa’ table displays all link state advertisements (LSAs) received by this router.

Lsa

Scope	Type	Ls ID	Adv Router	Age	Sequence	Checksum
Global	0005	10.10.40.0	2.2.2.2	67	80000001	105e
Global	0005	10.10.6.255	10.10.6.1	69	80000001	cb9a
Area 0.0.0.0	0002	192.168.1.4	2.2.2.2	21	80000002	049b
Area 0.0.0.0	0001	2.2.2.2	2.2.2.2	21	80000004	8785
Area 0.0.0.0	0001	10.10.6.1	10.10.6.1	22	80000002	d25b

Showing 1 to 5 of 5

Using CLI

In **operational** mode, enter following commands:

> show routing-state routes

```
                                  OUTGOING
DEST PREFIX        NEXT HOP       INTERFACE    SOURCE
-----------------------------------------------------------------
0.0.0.0/0          172.18.175.129 Cell         kernel
10.10.6.0/24       -              Bridge       kernel
10.10.40.0/24      -              GRE          dynamic
172.18.175.128/28  -              Cell         kernel
```

> show routing-state ospf

```
routing-state ospf routing-instance MAIN_OSPF
routing-state ospf state up
routing-state ospf preference 150
routing-state ospf import-filter ACCEPT
```

```
routing-state ospf export-filter LOCAL_LAN
routing-state ospf statistics import-updates-received 4
routing-state ospf statistics import-updates-rejected 0
routing-state ospf statistics import-updates-filtered 0
routing-state ospf statistics import-updates-ignored 0
routing-state ospf statistics import-updates-accepted 4
routing-state ospf statistics import-withdraws-received 1
routing-state ospf statistics import-withdraws-rejected 0
routing-state ospf statistics import-withdraws-ignored 0
routing-state ospf statistics import-withdraws-accepted 1
routing-state ospf statistics export-updates-received 7
routing-state ospf statistics export-updates-rejected 2
routing-state ospf statistics export-updates-filtered 4
routing-state ospf statistics export-updates-accepted 1
routing-state ospf statistics export-withdraws-received 1
routing-state ospf statistics export-withdraws-accepted 0
routing-state ospf area 0.0.0.0
 stub                   false
 nssa                   false
 transit                false
 nssa-translation       false
 num-interfaces         1
 num-neighbors          1
 num-adjacent-neighbors 1
 area-networks          [ ]
routing-state ospf interface GRE
routing-state ospf routing-instance MAIN_OSPF
routing-state ospf state up
routing-state ospf preference 150
routing-state ospf import-filter ACCEPT
routing-state ospf export-filter LOCAL_LAN
routing-state ospf statistics import-updates-received 4
routing-state ospf statistics import-updates-rejected 0
routing-state ospf statistics import-updates-filtered 0
routing-state ospf statistics import-updates-ignored 0
routing-state ospf statistics import-updates-accepted 4
routing-state ospf statistics import-withdraws-received 1
routing-state ospf statistics import-withdraws-rejected 0
routing-state ospf statistics import-withdraws-ignored 0
routing-state ospf statistics import-withdraws-accepted 1
routing-state ospf statistics export-updates-received 7
routing-state ospf statistics export-updates-rejected 2
routing-state ospf statistics export-updates-filtered 4
routing-state ospf statistics export-updates-accepted 1
routing-state ospf statistics export-withdraws-received 1
routing-state ospf statistics export-withdraws-accepted 0
routing-state ospf area 0.0.0.0
 stub                   false
 nssa                   false
 transit                false
 nssa-translation       false
 num-interfaces         1
```

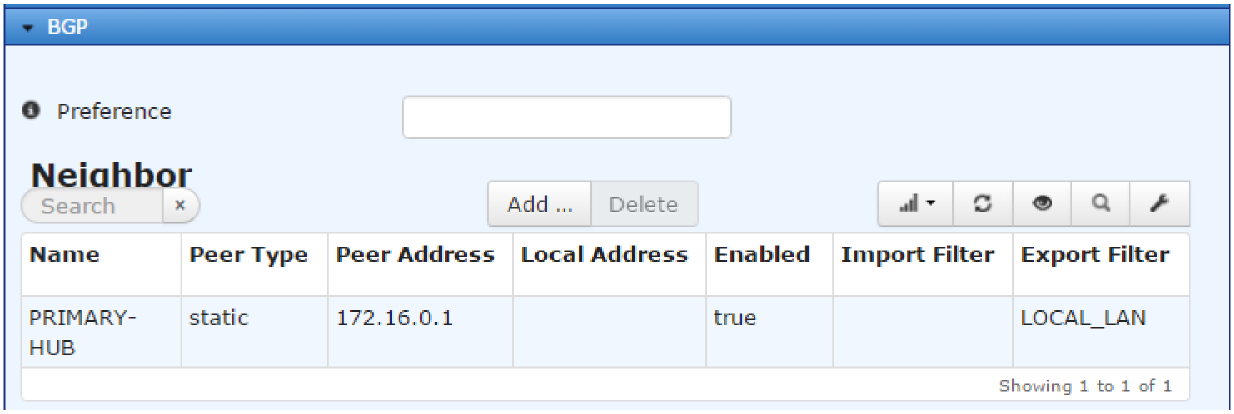
```
 num-neighbors               1
 num-adjacent-neighbors   1
 area-networks          [ ]
routing-state ospf interface GRE
 virtual-link                  false
 network-type                 bcast
 area-id                        0.0.0.0
 state                           bdr
 priority                       1
 cost                            10
 hello-interval              10
 wait-interval               40
 dead-interval               40
 retransmit-interval        5
 designated-router-id                     2.2.2.2
 designated-router-address             192.168.1.4
 backup-designated-router-id          10.10.6.1
 backup-designated-router-address  192.168.6.5
                                                                 DEAD
ID        ADDRESS          INTERFACE    STATE   PRIORITY   TIME
---------------------------------------------------------------------------------------------------------
2.2.2.2  192.168.1.4      GRE           Full/DR    128          37

                    ADV
SCOPE             TYPE   LS ID          ROUTER     AGE   SEQUENCE    CHECKSUM
--------------------------------------------------------------------------------------------------------------------------
Global           0005   10.10.40.0     2.2.2.2        1012   80000001     105e
Global           0005   10.10.6.255   10.10.6.1     1014   80000001     cb9a
Area 0.0.0.0    0002   192.168.1.4   2.2.2.2        966     80000002     049b
Area 0.0.0.0    0001   2.2.2.2         2.2.2.2        966     80000004     8785
Area 0.0.0.0    0001   10.10.6.1      10.10.6.1            967       80000002     d25b
```

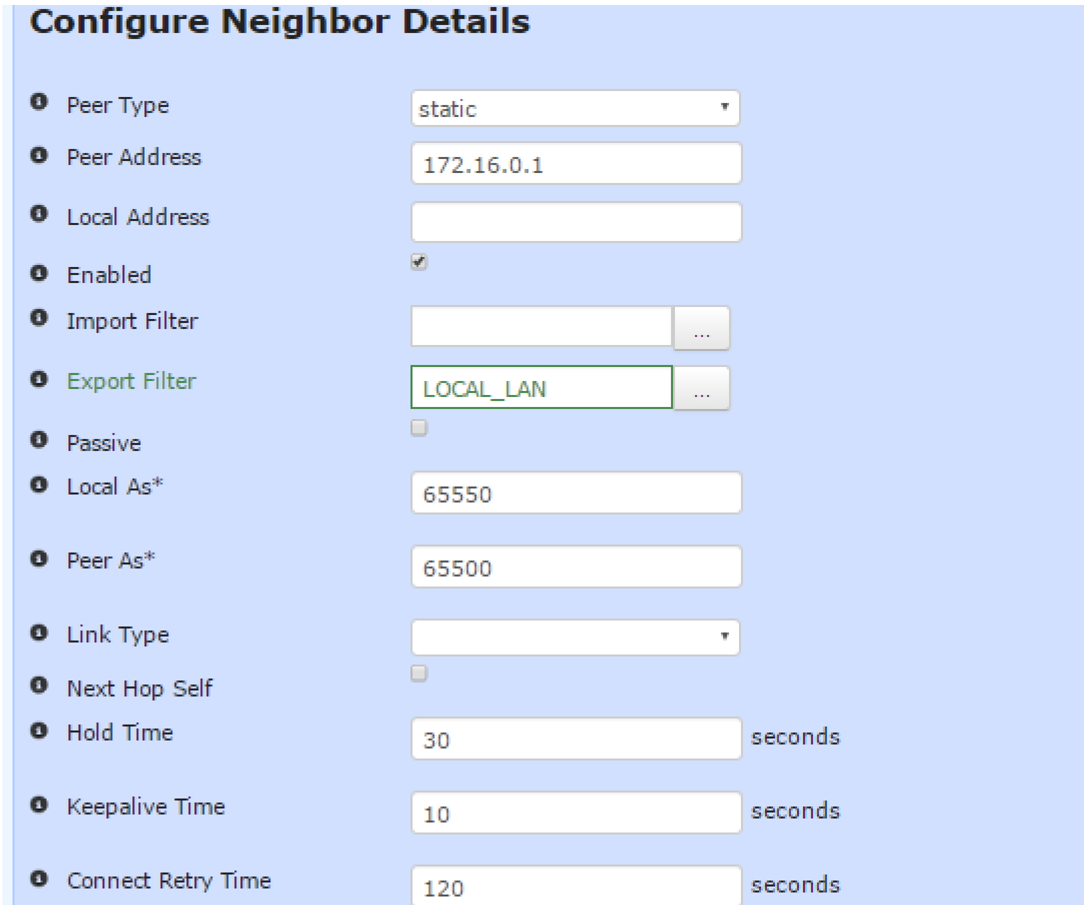
BGP

The basic BGP configuration consists of adding a neighbor entry for each peer and configuring an export filter. BGP can operate in two modes: External BGP (EBGP) and Internal (IBGP). EBGP is used between BGP routers that are in different Autonomous (AS) systems and IBGP is used between BGP routers in the same ASes (to redistribute routes learned from external BGP routers to internal BGP routers). The mode is not configured explicitly but is activated based on AS number configuration for the local BGP router and the neighbor. When the AS number is different, BGP operates in EBGP mode and when it is the same it operates in IBGP mode. In the example below, BGP is configured with one external neighbor with LOCAL_LAN as the export filter.

Navigate to ***Routing-> Basic Config->BGP***

Select ‘**LOCAL_LAN’** as the export filter.





To apply configuration, click **Save.**

NOTE Please see section 12.3.2.1 for an example on use of BGP to exchange routes over DMVPN network.

Using CLI

In **configuration** mode, enter following commands:

% set routing bgp neighbor PRIMARY-HUB **peer-address** 172.16.0.1

% set routing bgp neighbor PRIMARY-HUB **enabled** true

% set routing bgp neighbor PRIMARY-HUB **export-filter** LOCAL_LAN

% set routing bgp neighbor PRIMARY-HUB **local-as** 65550

% set routing bgp neighbor PRIMARY-HUB **peer-as** 65500

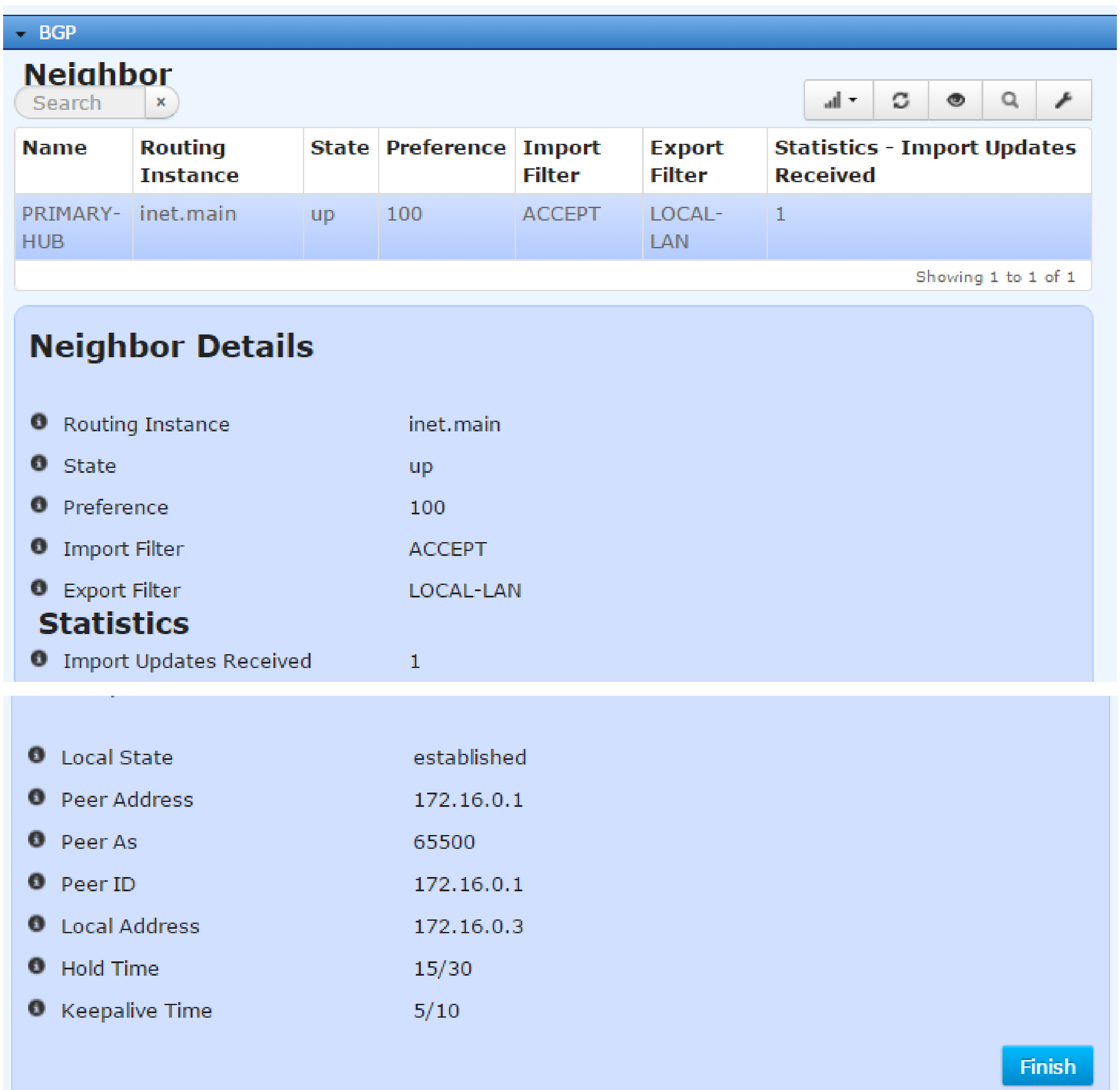
% set routing bgp neighbor PRIMARY-HUB **hold-time** 30

% set routing bgp neighbor PRIMARY-HUB **keepalive-time** 10

Monitoring

Navigate to ***Routing-> Status***

The user can check the routing table in the 'General' panel to ensure a dynamic route for the back-office has been received from the back-office router.



Using CLI

In **operational** mode, enter following commands:

>show routing-state bgp

routing-state bgp neighbor PRIMARY-HUB

```
routing-instance inet.main
state          up
preference      100
import-filter   ACCEPT
export-filter   LOCAL-LAN
statistics import-updates-received 1
statistics import-updates-rejected 0
statistics import-updates-filtered 0
statistics import-updates-ignored 0
statistics import-updates-accepted 1
statistics import-withdraws-received 0
statistics import-withdraws-rejected 0
statistics import-withdraws-ignored 0
statistics import-withdraws-accepted 0
statistics export-updates-received 8
statistics export-updates-rejected 1
statistics export-updates-filtered 6
statistics export-updates-accepted 1
statistics export-withdraws-received 0
statistics export-withdraws-accepted 0
local-state     established
peer-address     172.16.0.1
peer-as         65500
peer-id         172.16.0.1
local-address    172.16.0.3
hold-time        23/30
keepalive-time   7/10
```

3.8.24 GPS Service

Understanding

A unit may be equipped with internal GPS support. The GPS service obtains location information from the GPS sources in the system and makes it available as status data to all northbound management interfaces like CLI/SSH, NETCONF, SNMP and WebUI. As of this writing, GPS service supports following data sources on MCR and ECR:

- Standalone GPS receiver in 4G cellular modules (4Gx in the model string).

The table below Table 3-32 displays the approved GPS antennas that can be used.

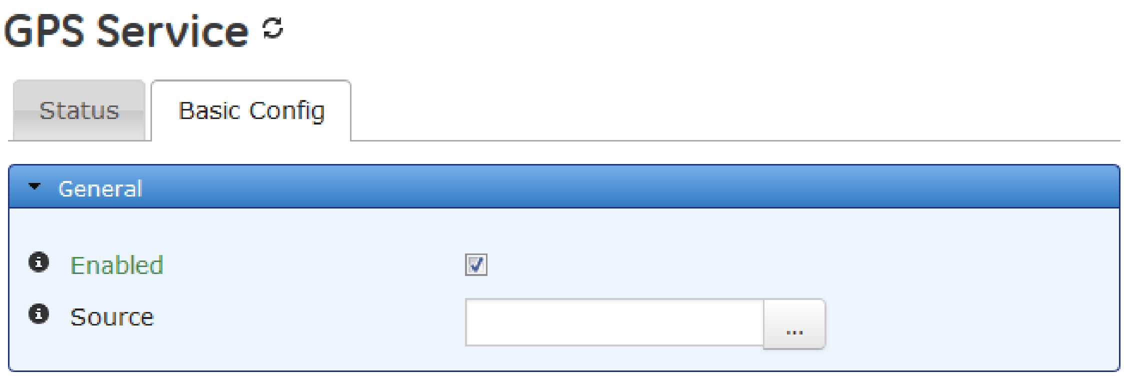
Application	Location	Frequency Range	Gain	Antenna Description	MDS Part Number
GPS					97-3194A33

Table 3-32. Approved GPS Antenna Types

NOTE A GPS equipped unit has a dedicated GPS antenna port which provides 3.3V, 100mA max DC bias and can be used with active GPS antennas.

Configuring

Navigate to ***Services->GPS Service--> Basic Config***



The GPS service has very minimal configuration. The user simply has to enable the GPS service for it to start collecting data from the first detected GPS data source in the system. If there are more sources in the system, then user can select the specific data source by configuring the ‘source’ parameter.

To apply configuration, click **Save.**

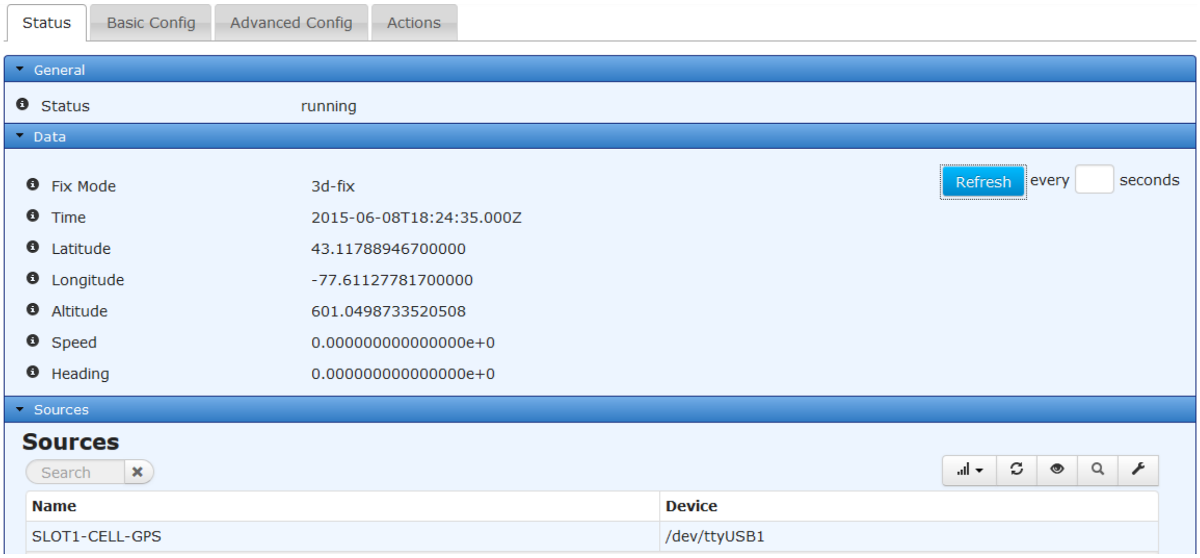
Using CLI

```
% set services gps enabled true
% commit
```

NOTE Enabling/Disabling GPS service will reset cellular modem (that supports standalone GPS receiver).

Monitoring

Navigate to ***Services --> GPS Service --> Status***



The ‘General’ panel shows the general status of the service i.e. whether it is running or not. The ‘Data’ panel displays the GPS location information as reported by the GPS data source. The ‘Sources’ panel displays the GPS data sources detected in the system. In the above example, GPS service is collecting data from the GPS receiver in the cellular module.

Using CLI

```
> show services gps
  services gps status fix-mode 3d-fix
  services gps status time 2015-06-08T18:27:44.000Z
  services gps status latitude 43.11787493300000
  services gps status longitude -77.61123601700000
  services gps status altitude 588.5826816558838
  services gps status speed 0.000000000000000e+0
  services gps status heading 0.000000000000000e+0
  NAME           DEVICE
  -----------------------------
  SLOT1-CELL-GPS  /dev/ttyUSB1
```

3.8.25 I/O Service

Understanding

Orbit Input/Output (I/O) Service is used to monitor I/O lines and generate alarms and events when certain conditions, or triggers, are detected on the I/O line. This service can be used to interface to external devices that sense and react to changes in the environment. The Orbit Radio can then forward the information about the change to NMS systems in the form of logged events or SNMP traps.

Orbit MCR/ECR supports monitoring the input voltage on pin #3 of the COM1 port (the DTR pin).

NOTE COM1 pin #3 uses RS232 level input signals (+5/-5VDC)

Orbit can detect and generate events when the voltage transitions from high-to-low, low-to-high, or on both transitions (toggle). The logged events can be configured to alarm the radio, indicating an important event has occurred and operators must investigate the new state of the radio and its environment. An optional setting called automatic-clear can be used to de-alarm the radio whenever the offending I/O trigger condition is cleared. If automatic-clear is not used, then the radio can remain alarmed until an operator manually clears the alarm status.

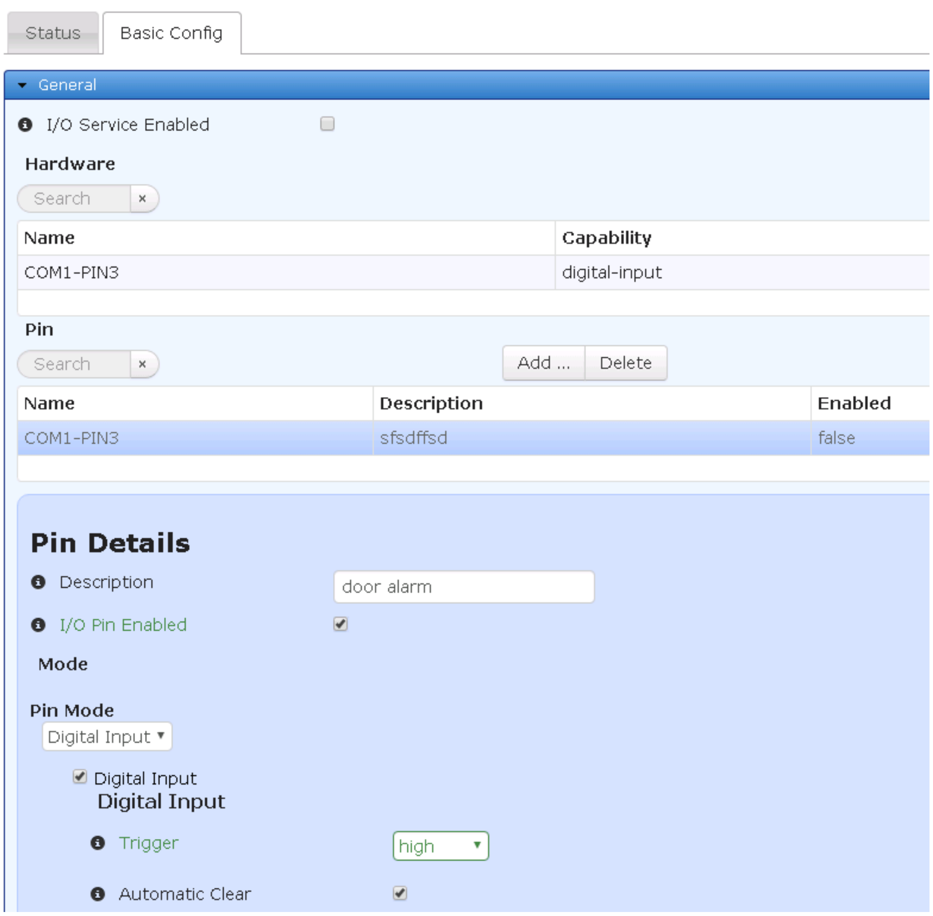
An example setup is connecting a Door Sensor to the radio I/O line. After configuring the radio, it will generate and forward events to an NMS system when the open or close state of the door is detected.

Configuring

The following example uses the CLI in configuration mode. It shows how to configure the I/O Service with alarms and SNMP traps enabled. This example assumes the SNMP parameters from the Factory Default configuration are present and have not been deleted or modified.

```
set services io enabled true
set services io pin COM1-PIN3 description "door alarm"
set services io pin COM1-PIN3 enabled true
set services io pin COM1-PIN3 mode digital-input trigger high
set services io pin COM1-PIN3 mode digital-input automatic-clear true

set logging event-rule io_pin snmp-notification true
set logging event-rule io_pin alarm true
set logging event-rule io_pin alarm-outputs [ POWER_LED ]

set services snmp target TARGET-1-v1 ip 192.168.1.2
set services snmp target TARGET-1-v1 port 5000
set services snmp target TARGET-1-v1 tag [ std_v1_trap ]
set services snmp target TARGET-1-v1 timeout 1500
set services snmp target TARGET-1-v1 retries 3
set services snmp target TARGET-1-v1 v1 sec-name public
```

To configure via the web interface. Navigate to ***Services->I/O Service--> Basic Config***



Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the last recorded status of the COM1 pin #3.

```
> show services io
NAME      STATE
-----------------
COM1-PIN3  high
```

The history of logged events can be viewed, as shown below.

```
> show logging event-log | tab | match io_pin


210  2020-03-17T16:18:14.153611+00:00  notice    io_pin                 ongoing
  action update, service io, status ongoing, msg Pin COM1-PIN3 changed to high,
208  2020-03-17T05:04:20.024196+00:00  notice    io_pin                 cancel
  action update, service io, status cancel, msg Pin COM1-PIN3 changed to low,
```

Alarm status can be viewed, as shown below.

```
> show logging current-alarms | tab
          EVENT
          LOG    EVENT
NAME      ID     TYPE    STATUS   MESSAGE                            TIME STAMP
-------------------------------------------------------------------------------------------------
POWER_LED  225    io_pin  ongoing  Pin COM1-PIN3 changed to high  2020-03-17T17:12:28.909196+00:00
```

Monitoring via SNMP

All SNMP traps in Orbit appear via a common trap type 1. For convenience, I/O events also generate a custom trap type 2 specific to I/O events. This simplies parsing requirements for systems that want a simple SNMP notification of I/O changes. See MIB definition files for this Orbit Release. Also see section 3.8.20 SNMP.

3.8.26 Dynamic DNS

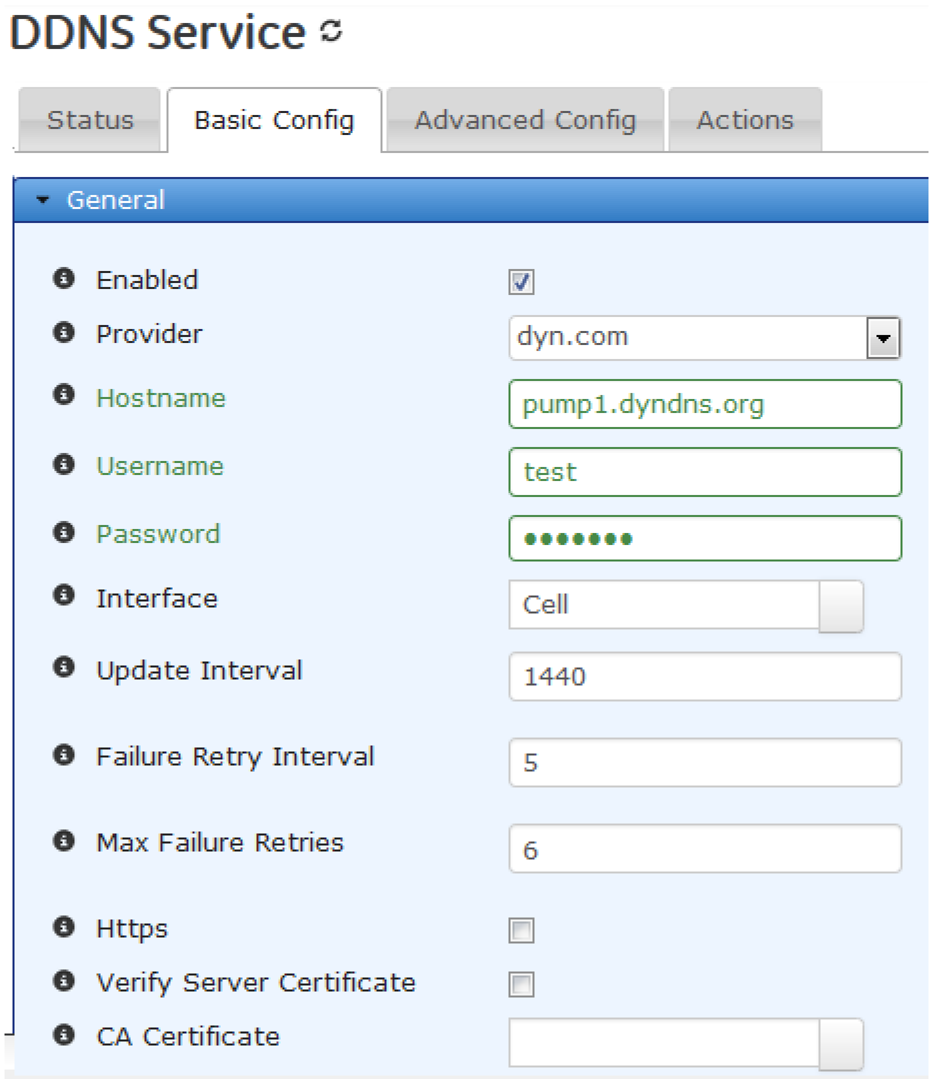
Understanding

The unit supports Dynamic DNS (DDNS) service that enables update of the dynamic address of an interface (typically, cellular WAN interface) on the unit against a pre-registered fully qualified domain name (FQDN) (for example, pump1.dyndns.org) with a DDNS provider. The update occurs when the interface address changes as well as periodically. This enables a host or application to contact a remote unit using a fixed domain name even if the IP address of the remote unit is dynamic.

There is built in support for DynDNS.com and No-IP.com DDNS providers. The service also supports user specified URL for updating DDNS providers that do not have built-in support.

Configuring

Navigate to ***Services->DDNS Service--> Basic Config***



- **Provider** – The DDNS service provider .
- **Hostname** – The fully qualified domain name (FQDN) for the unit.
- **Username** – The username for the DDNS service provider account.
- **Password-** The password for the DDNS service provider account.
- **Interface** – The interface whose dynamic IP address needs to be registered with the DDNS service provider.
- **Update Interval** – The interval, in minutes, at which periodic update interval will occur.
- **Failure Retry Interval** – The interval, in seconds, at which retries will occur if connection cannot be made to DDNS service provider.
- **Max Failure Retries** –The maximum number of times to retry connecting to the DDNS service provider for an update.
- **HTTPS** – Whether or not to use HTTPS when sending DDNS updates.
- **Verify Server Certificate** – Whether or not to verify DDNS service provider.
- **CA Certificate** – Locally stored certificate to us to verify DDNS service provider.

For DDNS service providers other than ‘dyn.com’ and ‘no-ip.com’, the user can choose ‘Other’ as the DDNS service provider and enter the URL to which DDNS updates should be posted. Each DDNS service provider has different URL format but with following common fields:

- Username
- Password
- Hostname
- IP address

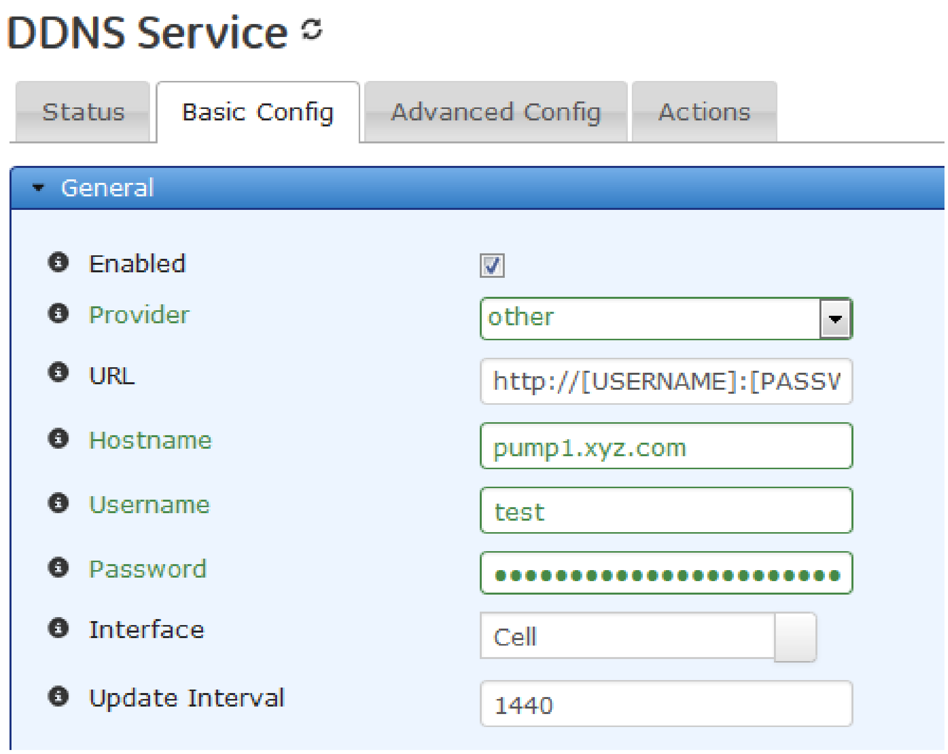
For example, if service provider XYZ has following format for posting update for hostname=pump1.xyz.com with IP address 1.1.1.1 and with username=test and password=test123:

http://test:test123@xyz.com/update?hostname=pump1.xyz.com&myip=1.1.1.1

Then, user should enter following in the URL field:

http://[USERNAME]:[PASSWORD]@xyz.com/update?hostname=[HOSTNAME]&myip=[IP]

The username, password, hostname fields will be replaced with those configured when posting the DDNS update along with dynamic IP address of the configured interface.



NOTE In firmware versions prior to 4.x.x, the user might need to click the refresh symbol next to ‘DDNS service’ to make the URL field show up after Provider = ‘Other’ is selected.

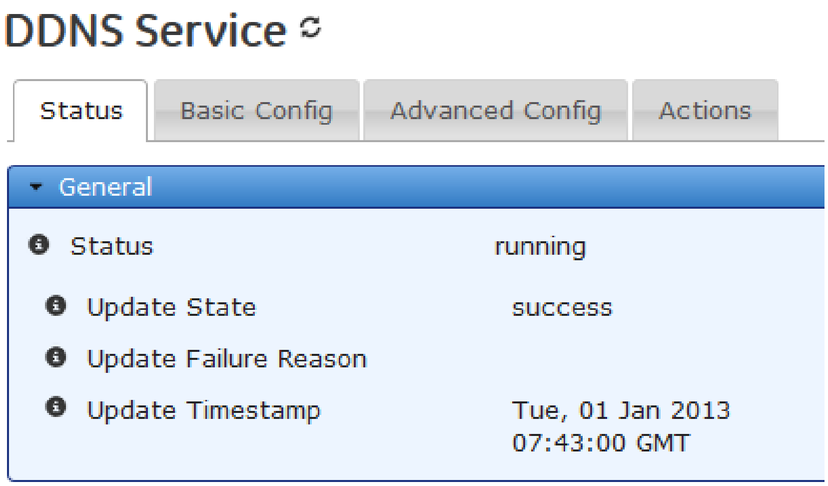
To apply configuration, click **Save.**

Using CLI

```
% set services ddns enabled true
% set services ddns provider dyn.com
% set services ddns hostname pump1.dyndns.org
% set services ddns username test
% set services ddns password test123
% set services ddns interface Cell
% commit
```

Monitoring

Navigate to ***Services--> DDNS Service--> Status***



- **Status -** Indicates whether the service is enabled/running.
- **Update State**- Current state of DDNS update operation.
- **Update failure reason** – A message indicating the reason for a failed DDNS update.
- **Update Timestamp** – The timestamp of last update.

Using CLI

```
> show services ddns
services ddns status update-state success
services ddns status update-failure-reason ""
services ddns status update-timestamp 2013-01-01T07:43:00+00:00
```

3.8.27 VRRP – Virtual Router Redundancy Protocol

Understanding

VRRP is a method of setting up multiple routers to provide redundant routing capability. It is defined in the IETF RFC5798. In VRRP, a group of physical routers are configured similarly with VRRP settings and together they act as one virtual router on the network. Only one physical router is negotiated as the Master router at a time; the remaining routers act as Backup until it has been determined that the Master has gone offline. This failover mechanism is automatic and built into VRRP. The group collectively uses the same Virtual IP (VIP), but it is only active on the Master at any given time. When failover occurs, the next negotiated router becomes the Master and assumes the VIP. This provides reliable network connectivity and simplifies configuration of hosts on the network. The hosts need to be configured to communicate to only one router IP address, the VIP, and whichever physical router is currently designated as the Master will have that VIP address assigned to its interface.

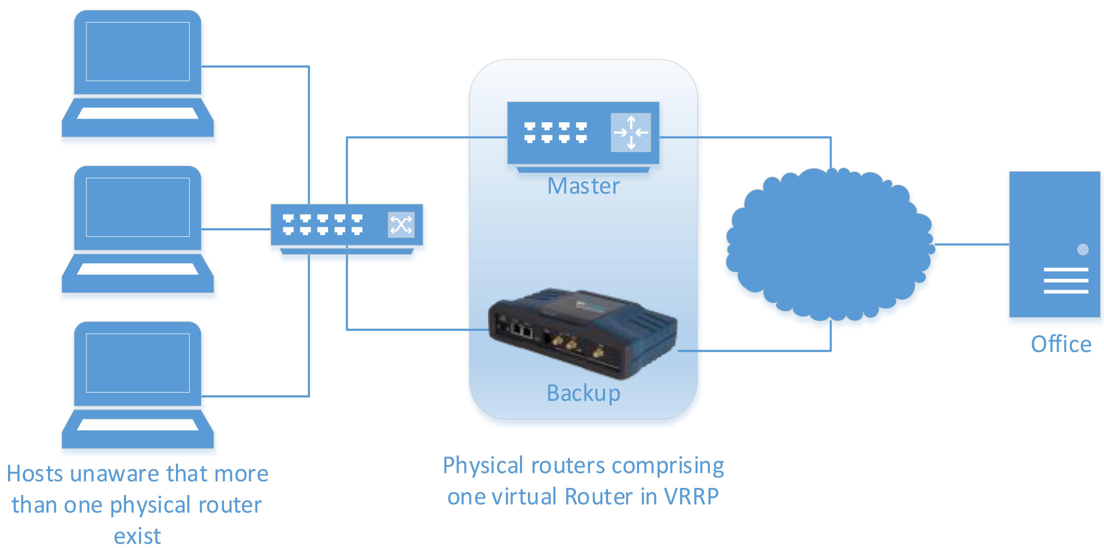


Figure 3-268. Example of VRRP configuration

Configuration

VRRP can be enabled on select interfaces, including Ethernet, Bridge, and VLAN interfaces. For example:

```
configure

%set interfaces interface ETH2 vrrp address 192.168.1.1 subnet-mask 255.255.255.0 id 1
   priority 100
```

The following items are configurable VRRP settings for each interface:

- **enabled** – whether or not VRRP is enabled on the interface
- **address** – the Virtual IP (VIP) assigned to the physical routers in a VRRP group.
- **subnet-mask** – corresponding subnet-mask to the VIP
- **id** – a numeric value that indicates which VRRP group this router belongs to.
- **priority** – each physical router in a group gets its own priority. The higher the number, the higher the priority that the physical router will be become the Master during negotiation.
- **advertisement-interval** – The Master router advertises its presence to the Backups. This controls the frequency of those advertisements. Note: The advertisement-interval should be the same on all units.
- **preemption** – whether or not to allow higher priority routers become Master when they come online.

All physical routers in a VRRP group must be configured with same VIP address/subnet and id. Each router should have a unique priority value. Lastly, each router could have an additional, unique, IP/subnet on the same interface that VRRP is running on to facilitate administration and diagnostics.

Monitoring

Read-only parameters for interfaces with VRRP show the state of the router:

```
show interfaces-state interface ETH2 vrrp
```

The router status will be displayed as one of the following states:

vrrp disabled – VRRP is disabled on this interface.
vrrp initializing – VRRP is starting.
vrrp master – This interface is acting as the Master router. It will have the VIP/subnet applied to it and will be routing traffic.
vrrp backup – This interface is acting as one of the Backup routers. It will not have the VIP/subnet applied to it and will not be routing traffic.

3.8.28 IP Passthrough

Understanding

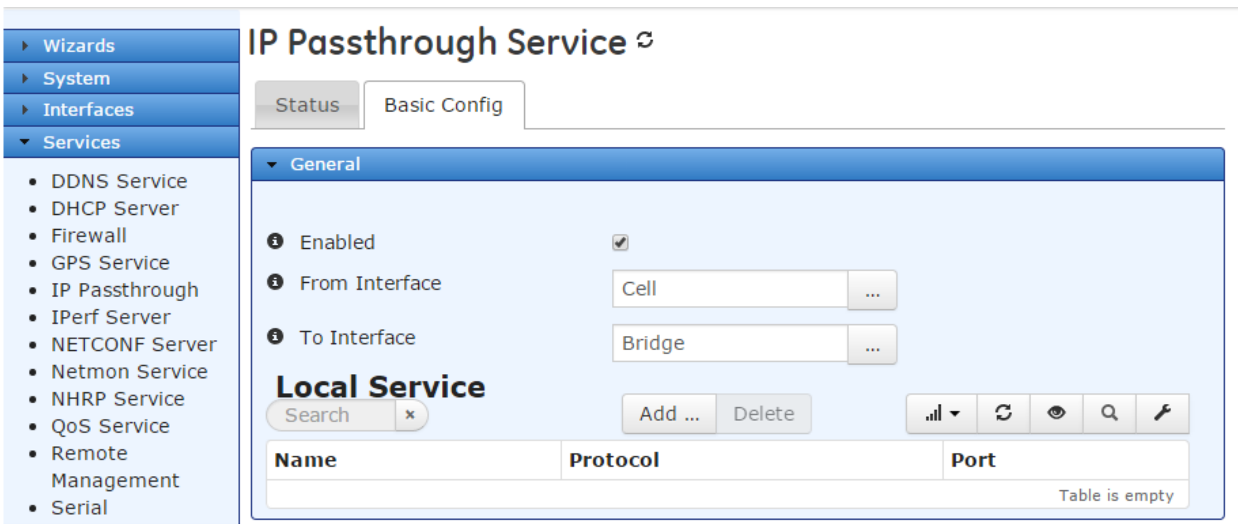
This service enables an outside interface's (e.g. Cell) IP address to be passed through to a device connected to an inside interface (e.g. Bridge) of Orbit, making Orbit act as a simple modem (like a traditional cable modem). The IP Passthrough service also enables user to configure certain traffic to be terminated at Orbit (for example, management) instead getting passed through. This service is typically used for Orbit devices with cellular interfaces where the Orbit is connected to the end-device via LAN and the IP address received from the cellular network needs to be passed to the end-device so it can be accessed using that address from the network.

Configuration

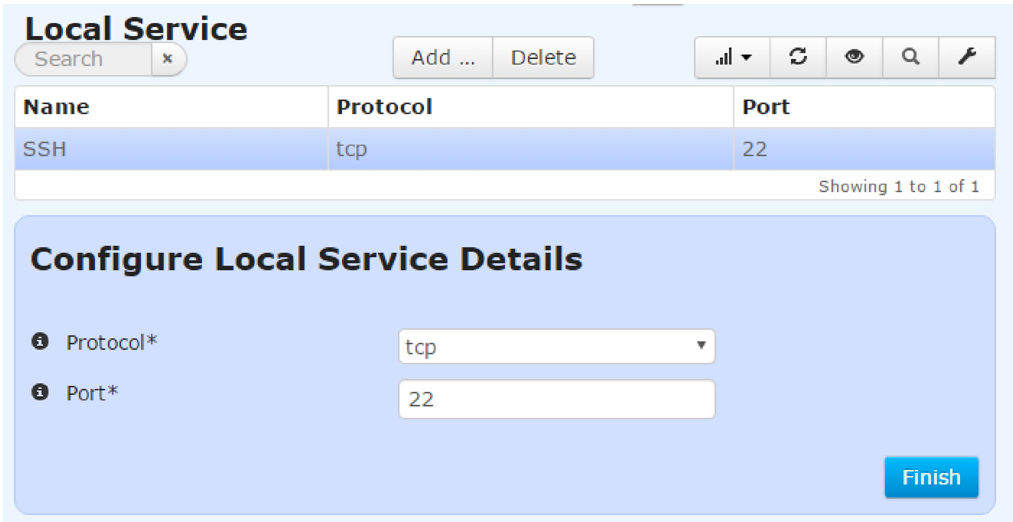
Using Web UI

Navigate to ***Services->IP Passthrough->Basic Config.***

Click 'Enable" to enable the passthrough service.



Add any local service that needs to be captured and terminated at the Orbit itself instead of getting passed through to the attached end-device. This is typically required to enable remote management of Orbit itself. The example below shows, SSH service being added as a local service. With this configuration any traffic destined for the cellular address on port 22 will be routed to Orbit instead of getting passed through to the end device. One can similarly configure entries for HTTP (TCP port 80) or HTTPS (tcp port 443) to enable remote access to Orbit's Web UI.



To apply configuration, click **Save.**

Using CLI

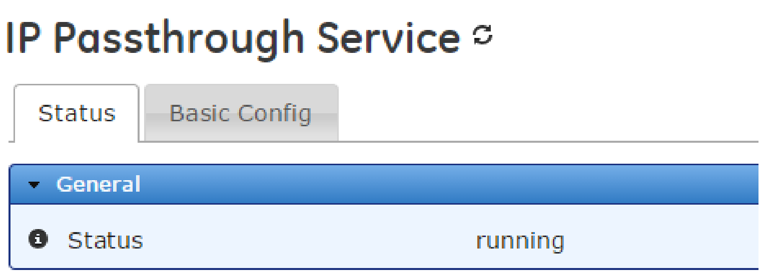
In configuration mode, enter following commands:

```
% set services ip-passthrough enabled true
% set services ip-passthrough local-service SSH protocol tcp port 22
% set services ip-passthrough local-service HTTP protocol tcp port 80
% set services ip-passthrough local-service HTTPS protocol tcp port 443
% commit
```

Monitoring

Using Web UI

Navigate to ***Services->IP Passthrough->Status***



3.9 Public Key and Certificates

3.9.1 Certificate Management and 802.1X Authentication

Understanding

A RADIUS server can be configured for 802.1X device authentication on the on the Orbit; WPA/WPA2-Enterprise privacy mode on the Wi-Fi or EAP security mode on the NX915 and LNxxx radio interfaces.

The device uses x509 public certificates and private keys for the following services:

- Secure Reprogramming
- Syslog over TLS
- IPsec VPN/IMA (when using pub-key, EAP-TLS or EAP-TTLS based authentication)
- WiFi (when doing EAP-TLS authentication in station mode)
- NxRadio (when **security-mode** is set to *EAP* on Remote units)

Certificates can be imported into the device using one of two methods: manually or via SCEP. Note that certificates for secure reprogramming can only be imported using the manual method.

The device can import certificates that are in DER, PEM, or encrypted PEM format. The device can import private keys that are in DER, PEM or encrypted PEM.

All certificates and private keys are stored in an encrypted database.

Configuring

The certificate database key is used to encrypt the data stored in the certificate database. In most cases, the factory default should be sufficient. However, the administrator may change this value.

NOTE In FIPS mode, this value must be changed to achieve FIPS operational status.

From the CLI:

% set pki db db-key 123456789abcdef0123456789abcdef0123456789abcdef0123456789abcdef

3.9.2 Private Keys

The device can manually import private keys, or can generate a new private key of a specified length.

From the WebUI, navigate to ***Certificate Management / Basic Config***. The **Private Keys** section shows the private keys currently loaded into the device.

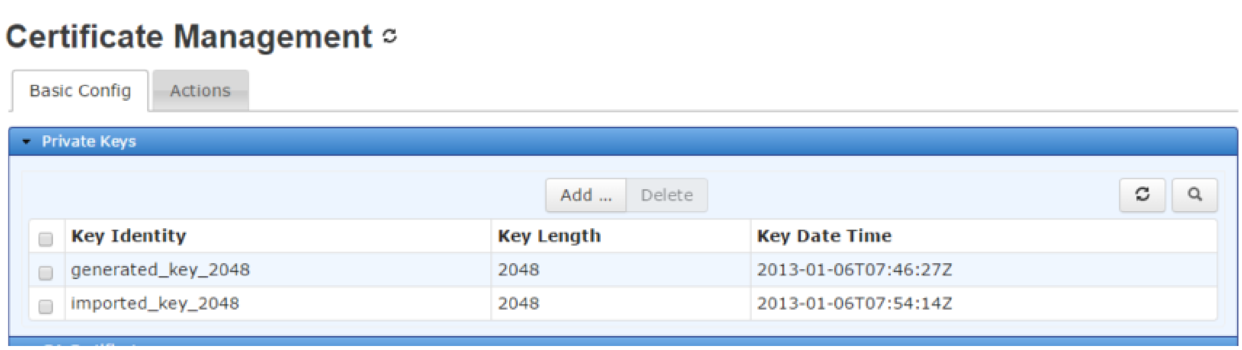


Figure 3-269. Private Keys

Ensure the CLI is in operational mode and follow the example below to view installed private keys:

```
> show pki private-keys show-all
                          KEY
KEY IDENTITY              LENGTH  KEY DATE TIME
-----------------------------------------------------------------------------------------------
generated_key_2048        2048    2013-01-06T07:46:27Z
imported_key_2048         2048    2013-01-06T07:54:14Z
```

Deleting

The device may delete a private key by clicking the **Delete** button on the web user interface or using the CLI in operational mode. See the following example for deleting private keys via the CLI:

> **> request pki private-keys delete key-identity** generated_key_2048

Configuring - Generation

To start generating a new private key, navigate to ***System / Certificate Management ---> Actions / Generate Private Key.*** Click on the **Begin Generation** button once the key identity and key size (in bits) is configured.

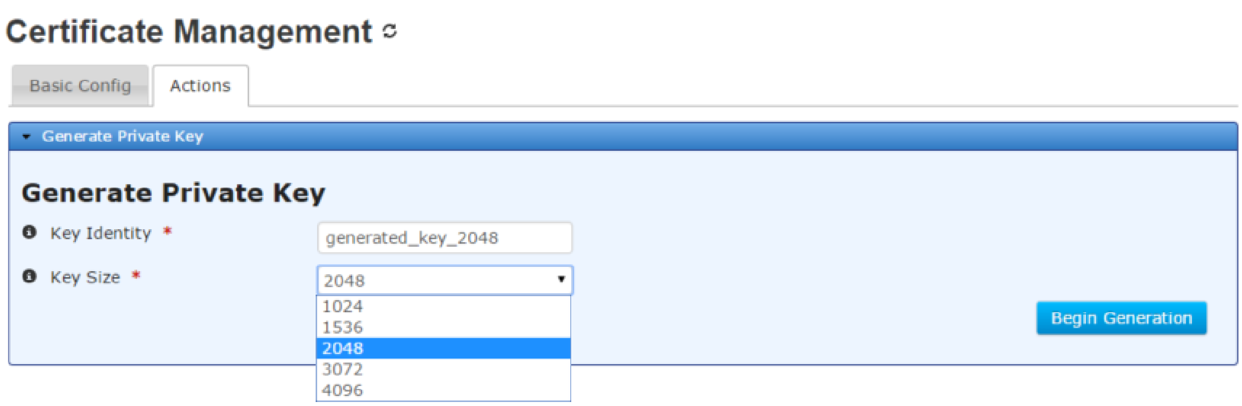


Figure 3-270. Generate Private Key

The device requires two parameters when generating a new private key.

- **Key Identity** - The ID to assign to the key once it is generated
- **Key Size** - The number of bits in the key. Allowed sizes include 1024, 1536, 2048, 3072, and 4096

NOTE In FIPS mode, key size must be 2048 bits or greater.

The following example shows how to have the device generate a private key of length 2048 bits with the identity generated_key_2048:

> **> request pki private_keys generate key-identity** generated_key_2048 **key-size** 2048

Monitoring - Generation

Once the generation is begun, the process may be cancelled by clicking the **Cancel Generation** button. The current status of the generation process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to generate a private key (in other words, if the state is “inactive”).

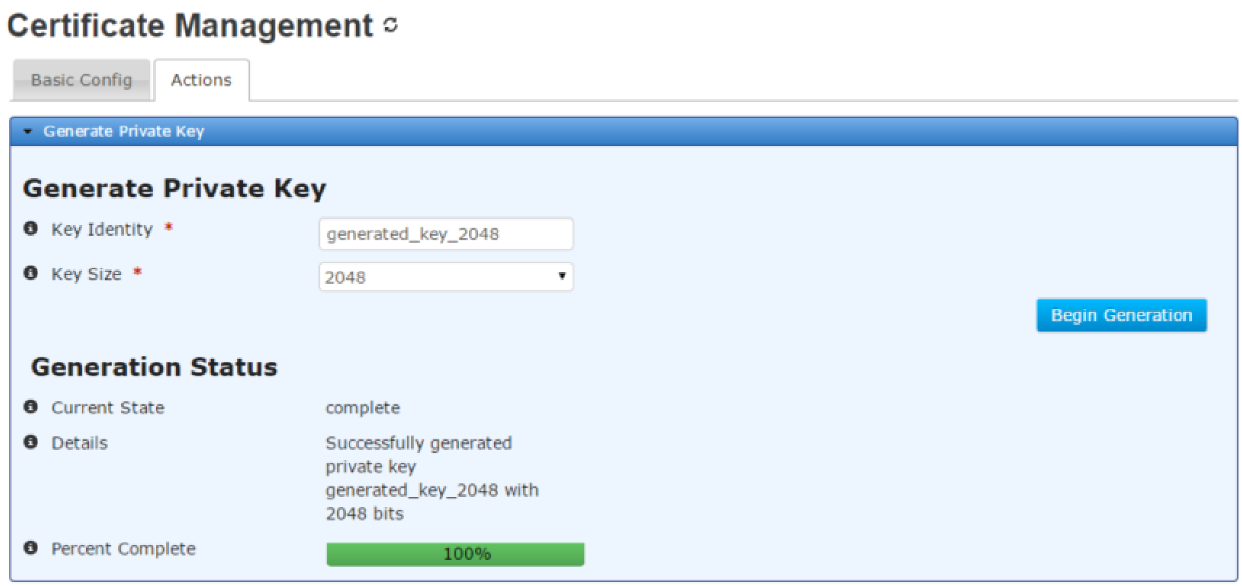


Figure 3-271. Generate Private Key Monitoring

The generation status contains the following items:

- **Current State** – The status of the generation task:
  - inactive
  - processing
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Generating private key*"
- **Size** – The total number of bytes in the key (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the generation process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show pki private-keys generate-status
  pki private-keys generate-status state complete
  pki private-keys generate-status detailed-message "Successfully generated private key
  generated_key_2048 with 2048 bits"
  pki private-keys generate-status size 256
  pki private-keys generate-status bytes-transferred 256
  pki private-keys generate-status percent-complete 100
```

Configuring - Import

The following example shows how to have the device import a private key by uploading a local file through the web browser.

Navigate to the **Private Keys** section in ***Certificate Management / Basic Config.***

Click on the **Add** button, and then click on the **Begin Importing** button once the key identity, the optional key passphrase, and the file source are configured.

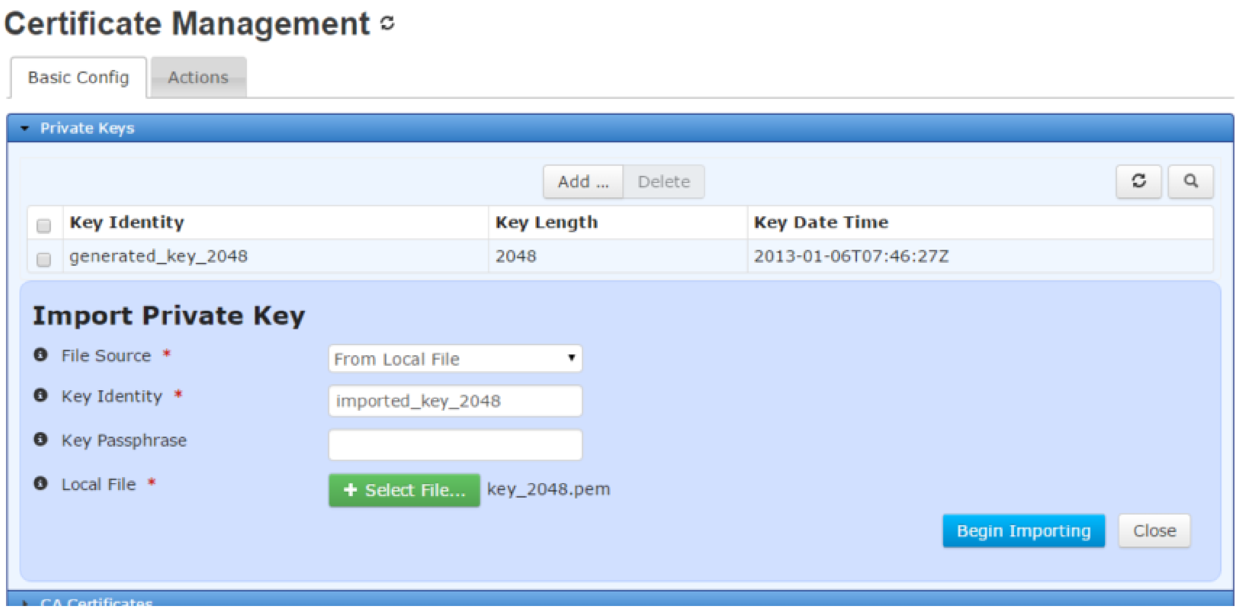


Figure 3-272. Import Private Key

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, and SFTP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, and From SFTP Server. Local file uploads are only available through the web UI and not through the CLI
- **Key Identity** - The ID to assign to the key once it is imported
- **Key Passphrase** – For encrypted PEM keys, the passphrase necessary to decrypt the key
- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP and SFTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For HTTP, FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device download a private key file (named imported_key_2048.pem) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the private key import from the CLI, enter the following command to download the private key file from the TFTP server:

```
> request pki private-keys import key-identity imported_key_2048 filename key_2048.pem
  manual-file-server { tftp { address 192.168.1.10 } }
```

Monitoring - Import

Once the import of a private key is begun, the process may be cancelled by clicking the **Cancel Import** button. The current status of the import process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to import a private key (in other words, if the state is "inactive").

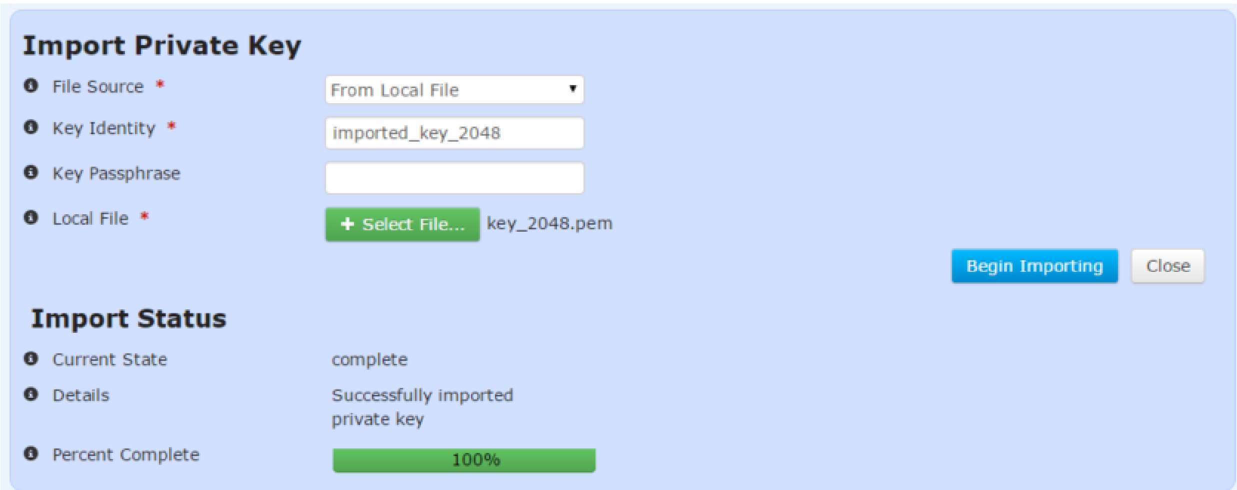


Figure 3-273. Import Private Key Monitoring

The import status contains the following items:

- **Current State** – The status of the import task:
  - inactive
  - transfering
  - processing
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Transferring private key*"
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the import process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show pki private-keys import-status
  pki private-keys import-status state complete
  pki private-keys import-status detailed-message "Successfully imported private key"
  pki private-keys import-status size 1191
  pki private-keys import-status bytes-transferred 1191
  pki private-keys import-status percent-complete 100
```

3.9.3 CA Certificates

The device can manually import CA certificates or obtain them via the SCEP protocol.

From the WebUI, navigate to ***Certificate Management / Basic Config***. The **CA Certificates** section shows the CA certificates currently loaded into the device.

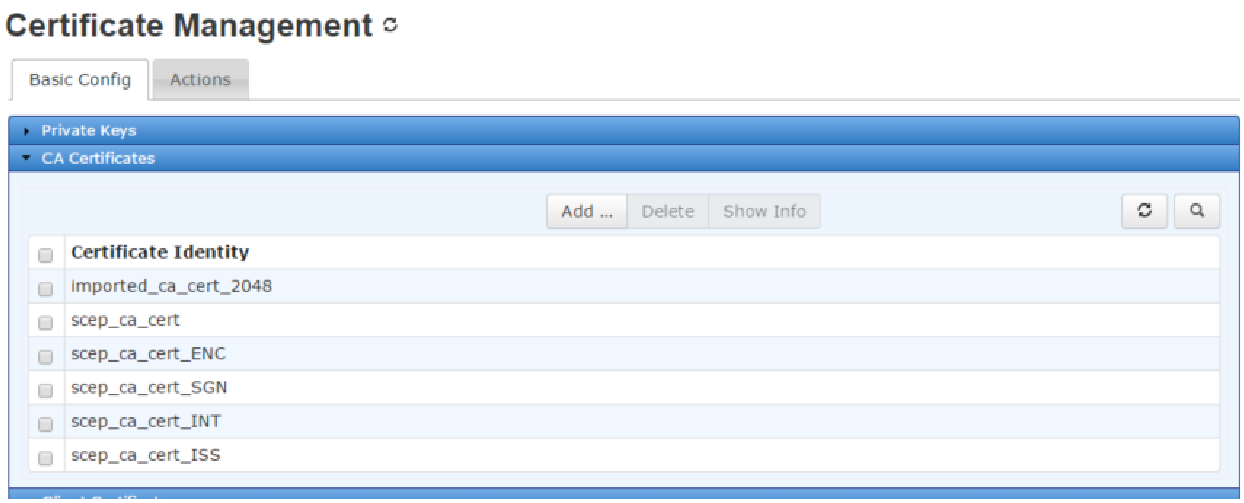


Figure 3-274. CA Certificates

Ensure the CLI is in operational mode and follow the example below to view the installed CA certificates:

```
> show pki ca-certs show-all
    CERT IDENTITY
    ----------------------
    imported_ca_cert_2048
    scep_ca_cert
    scep_ca_cert_ENC
    scep_ca_cert_SGN
    scep_ca_cert_INT
    scep_ca_cert_ISS
```

When using the SCEP protocol, additional CA server files sent as part of the request and needed later are saved with the base name selected for the CA server and an added extension. Some of the additional files that may be added are:

- _ENC , SCEP encryption certificate
- _SGN , SCEP digital signature certificate

Deleting

The device may delete a CA certificate by clicking the **Delete** button on the web user interface or using the CLI in operational mode. See the following example for deleting CA certificates via the CLI:

```
> request pki ca-certs delete cert-identity imported_ca_cert_2048
```

Configuring

The following example shows how to have the device import a CA certificate by uploading a local file through the web browser.

Navigate to the **CA Certificates** section in ***Certificate Management / Basic Config.***

Click on the **Add** button, and then click on the **Begin Importing** button once the certificate identity and the file source are configured.

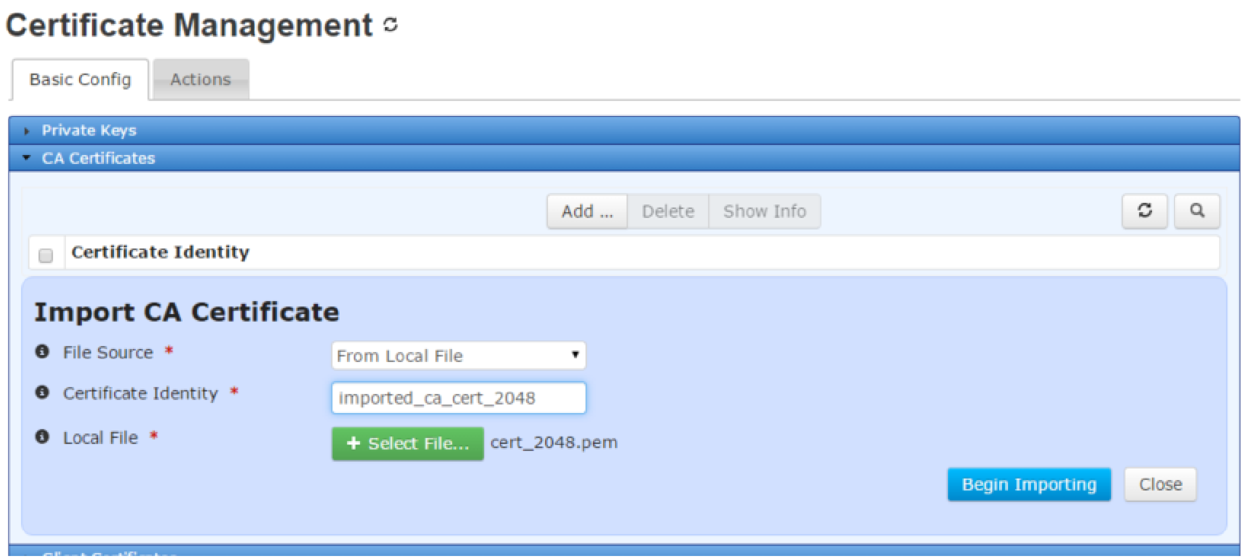


Figure 3-275. Import CA Certificate

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, SFTP, and SCEP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, From SFTP Server, and From SCEP Server. Local file uploads are only available through the web UI and not through the CLI
- **Certificate Identity** - The ID to assign to the certificate once it is imported
- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)
- **Certificate Server Identity** – For SCEP, the ID of a predefined certificate server to communicate with via the SCEP protocol
- **Issuing CA Server Identity** - For SCEP, the ID of a predefined issuing CA server

The following example shows how to have the device download a CA certificate file (named ca_cert_2048.pem) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the CA certificate import from the CLI, enter the following command to download the CA certificate file from the TFTP server:

> **request pki ca-certs import cert-identity** imported_ca_cert_2048 **file { filename** ca_cert_2048.pem **manual-file-server { tftp { address** 192.168.1.10 **} } }**

The following example shows how to have the device download a CA certificate file (named ca_cert_2048.pem) from a predefined SCEP server that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the CA certificate import from the CLI, enter the following command to download the CA certificate file from the SCEP server:

> **> request pki ca-certs import cert-identity** scep_ca_cert **scep {**
> **ca-issuer-identity** predefined_ca_server **cert-server-identity** predefined_cert_server **}**

Monitoring - Import

Once the import of a CA certificate is begun, the process may be cancelled by clicking the **Cancel Import** button. The current status of the import process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to import a CA certificate (in other words, if the state is "inactive").

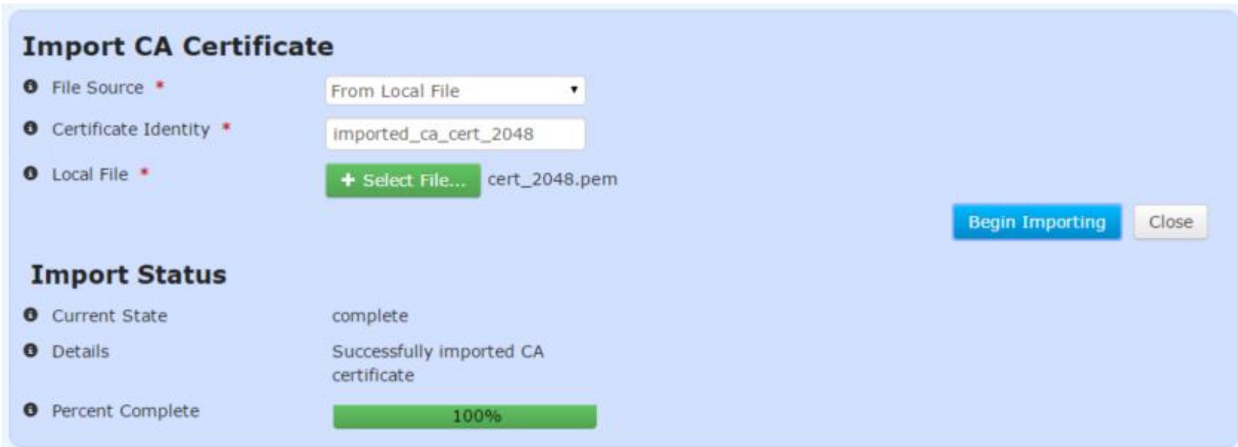


Figure 3-276. Import CA Certificate Monitoring

The import status contains the following items:

- **Current State** – The status of the import task:
  - inactive
  - transfering
  - processing
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Transferring CA certificate*"
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the import process in the CLI, ensure the CLI is in operational mode and then follow the example below:

> **> show pki ca-certs import-status**
> **pki ca-certs import-status state complete**
> **pki ca-certs import-status detailed-message "Successfully imported CA certificate"**
> **pki ca-certs import-status size 1586**
> **pki ca-certs import-status bytes-transferred 1586**

pki ca-certs import-status percent-complete 100

3.9.4 Client Certificates

The device can manually import client certificates or obtain them via the SCEP protocol. When obtaining a client certificate via the SCEP protocol, the SCEP server may be instructed to return a new certificate or renew an existing certificate.

From the WebUI, navigate to ***Certificate Management / Basic Config***. The **Client Certificates** section shows the client certificates currently loaded into the device.

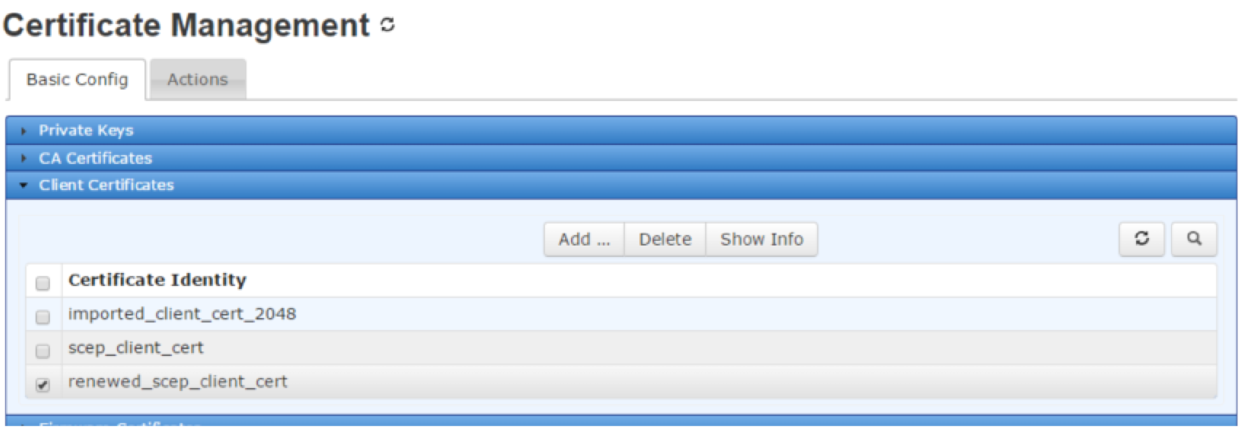


Figure 3-277. Client Certificates

Ensure the CLI is in operational mode and follow the example below to view the installed client certificates:

```
> show pki client-certs show-all
    CERT IDENTITY
    --------------------------
    imported_client_cert_2048
    scep_client_cert
    renewed_scep_client_cert
```

Deleting

The device may delete a client certificate by clicking the **Delete** button on the web user interface or using the CLI in operational mode. See the following example for deleting CA certificates via the CLI:

> request pki client-certs delete cert-identity *imported_client_cert_2048*

Configuring

The following example shows how to have the device import a client certificate by uploading a local file through the web browser.

Navigate to the **Client Certificates** section in ***Certificate Management / Basic Config.***

Click on the **Add** button, and then click on the **Begin Importing** button once the certificate identity and the file source are configured.

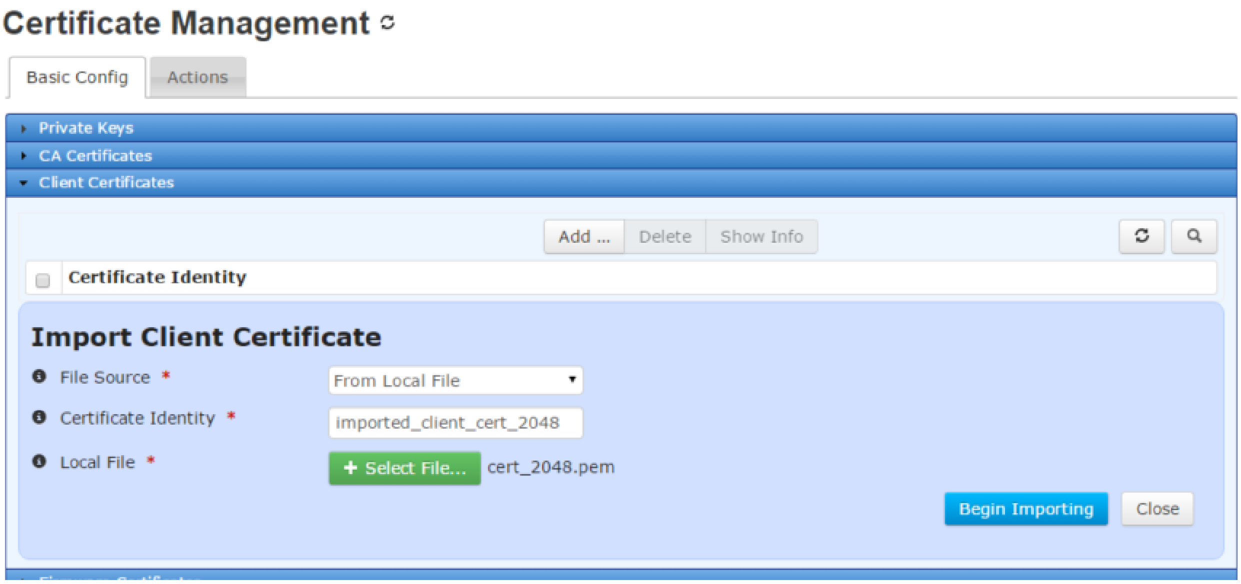


Figure 3-278. Import Client Certificate

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, SFTP, and SCEP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, From SFTP Server, and From SCEP Server. Local file uploads are only available through the web UI and not through the CLI
- **Certificate Identity** - The ID to assign to the certificate once it is imported
- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)
- **Certificate Server Identity** – For SCEP, the ID of a predefined certificate server to communicate with via the SCEP protocol
- **Issuing CA Server Identity** - For SCEP, the ID of a predefined issuing CA server
- **Certificate Info Identity** - For SCEP, the ID of a predefined set of certificate information used as the source for the common X.509 fields, such as country and locale
- **Key Identity** - For SCEP, the ID of an existing private key used to create the certificate
- **Import Intent** - For SCEP, determines whether to create a new certificate or renew an existing certificate
- **CA Challenge String** - For SCEP when creating a new certificate, the challenge string from the CA server that must be provided as part of the new client certificate request

- **Existing Certificate Identity** - For SCEP when renewing an existing certificate, the identity of the existing client certificate
- **Existing Key Identity** - For SCEP when renewing an existing certificate, the identity of the private key used to create the existing client certificate

The following example shows how to have the device download a client certificate file (named cert_2048.pem) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the client certificate import from the CLI, enter the following command to download the client certificate from the TFTP server:

> **request pki client-certs import cert-identity** scep_client_cert **scep { filename** cert_2048.pem **manual-file-server { tftp { address** 192.168.1.10 **} } }**

The following example shows how to have the device import a new client certificate from a predefined SCEP server that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the client certificate import from the CLI, enter the following command to download the new client certificate from the SCEP server:

> **request pki client-certs import cert-identity** scep_client_cert **scep { cert-server-identity** predefined_cert_server **ca-issuer-identity** predefined_ca_server **cert-info-identity** predefined_cert_info **ca-cert-identity** scep_ca_cert **private-key-identity** imported_key_2048 **ca-challenge** 36DE2A1E53BECF9AE5BB3E0B12D4C85E **}**

The following example shows how to have the device import a renewed client certificate from a predefined SCEP server that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the client certificate import from the CLI, enter the following command to download the renewed client certificate from the SCEP server:

> **request pki client-certs import cert-identity** renewed_scep_client_cert **scep { cert-server-identity** predefined_cert_server **ca-issuer-identity** predefined_ca_server **cert-info-identity** predefined_cert_info **ca-cert-identity** scep_ca_cert **private-key-identity** imported_key_2048 **existing-cert-identity** scep_client_cert **existing-private-key-identity** imported_key_2048 **}**

Monitoring - Import

Once the import of a client certificate is begun, the process may be cancelled by clicking the **Cancel Import** button. The current status of the import process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to import a CA certificate (in other words, if the state is "inactive").

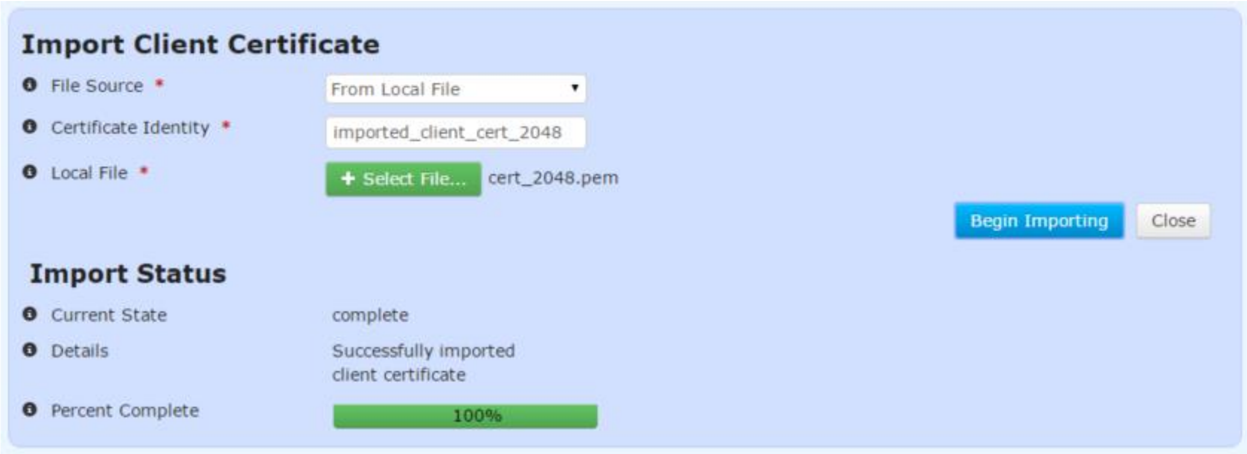


Figure 3-279. Import Client Certificate Monitoring

The import status contains the following items:

- **Current State** – The status of the import task:
    - inactive
    - transferring
    - processing
    - cancelling
    - complete
    - failure
    - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Transferring client certificate*"
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the import process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show pki client-certs import-status
  pki client-certs import-status state complete
  pki client-certs import-status detailed-message "Successfully imported client certificate"
  pki client-certs import-status size 1586
  pki client-certs import-status bytes-transferred 1586
  pki client-certs import-status percent-complete 100
```

For SCEP imports, additional status is displayed in the web page:

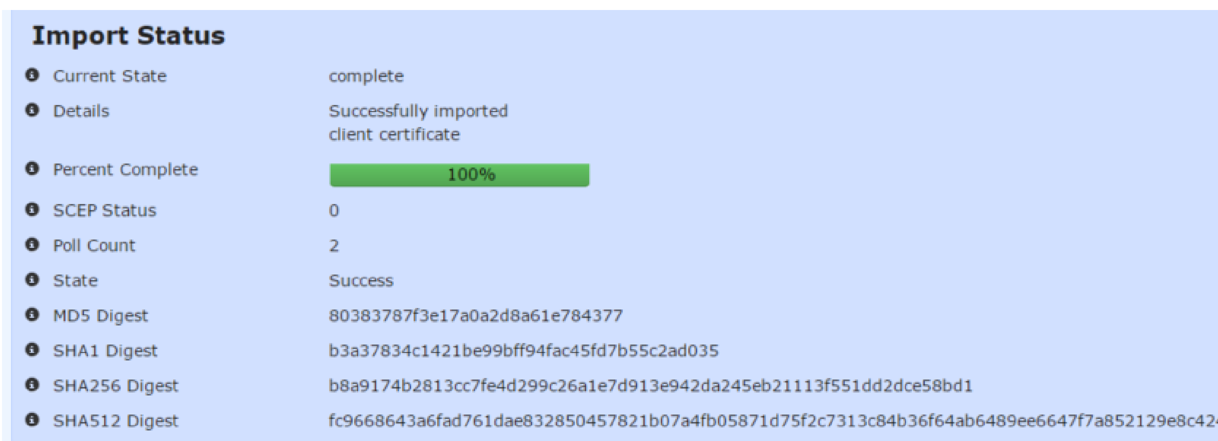


Figure 3-280. Import Client Certificate via SCEP Monitoring

The additional status related to SCEP contains the following items:

- **SCEP Status** – The last status returned from the SCEP server
- **Poll Count** – The number of times the SCEP server has been polled for completion
- **State** – The state of the SCEP transfer
- **MD5 Digest** – The SCEP request's MD5 digest
- **SHA1 Digest** – The SCEP request's SHA1 digest
- **SHA256 Digest** – The SCEP request's SHA256 digest
- **SHA512 Digest** – The SCEP request's SHA512 digest

To view the status of the import process in the CLI, ensure the CLI is in operational mode and then follow the example below:

```
> show pki client-certs import-scep-status
  pki client-certs import-scep-status last-status 0
  pki client-certs import-scep-status poll-count 2
  pki client-certs import-scep-status state Success
  pki client-certs import-scep-status req-fp-md5 80383787f3e17a0a2d8a61e784377
  pki client-certs import-scep-status req-fp-sha1
  b3a37834c1421be99bff94fac45fd7b55c2ad035
  pki client-certs import-scep-status req-fp-sha256
  b8a9174b2813cc7fe4d299c26a1e7d913e942da245eb21113f551dd2dce58bd1
  pki client-certs import-scep-status req-fp-sha512
  fc9668643a6fad761dae832850457821b07a4fb05871d75f2c7313c84b36f64ab6489ee6647f
  7a852129e8c42474ae4af4eab46658cba2fe73308f79b632
```

3.9.5 Firmware Certificates

The device can manually import firmware certificates.

NOTE When importing PEM files generated by OpenSSL 0.9.8 it is necessary to manually edit and remove the “Certificate:” section of the file.

From the WebUI, navigate to ***Certificate Management / Basic Config***. The **Firmware Certificates** section shows the firmware certificates currently loaded into the device.

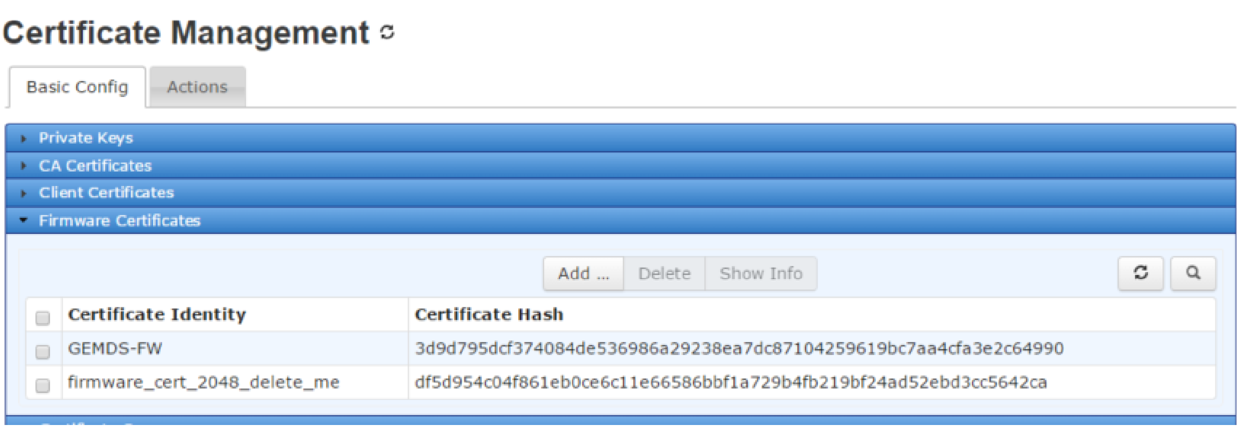


Figure 3-281. Firmware Certificates

Ensure the CLI is in operational mode and follow the example below to view the installed firmware certificates:

```
> show pki firmware-certs show-all
CERT IDENTITY                 CERT HASH
-------------------------------------------------------------------------------------------
GEMDS-FW                      3d9d795dcf374084de536986a29238ea7dc87104259619bc7aa4cfa3e2c64990
firmware_cert_2048_delete_me  df5d954c04f861eb0ce6c11e66586bbf1a729b4fb219bf24ad52ebd3cc5642ca
```

Deleting

The device may delete a firmware certificate by clicking the **Delete** button on the web user interface or using the CLI in operational mode. See the following example for deleting CA certificates via the CLI:

> **request pki firmware-certs delete cert-identity** *firmware_cert_2048_delete_me*

Configuring

The following example shows how to have the device import a firmware certificate by uploading a local file through the web browser.

Navigate to the **Firmware Certificates** section in ***Certificate Management / Basic Config.***

Click on the **Add** button, and then click on the **Begin Importing** button once the certificate identity and the file source are configured.

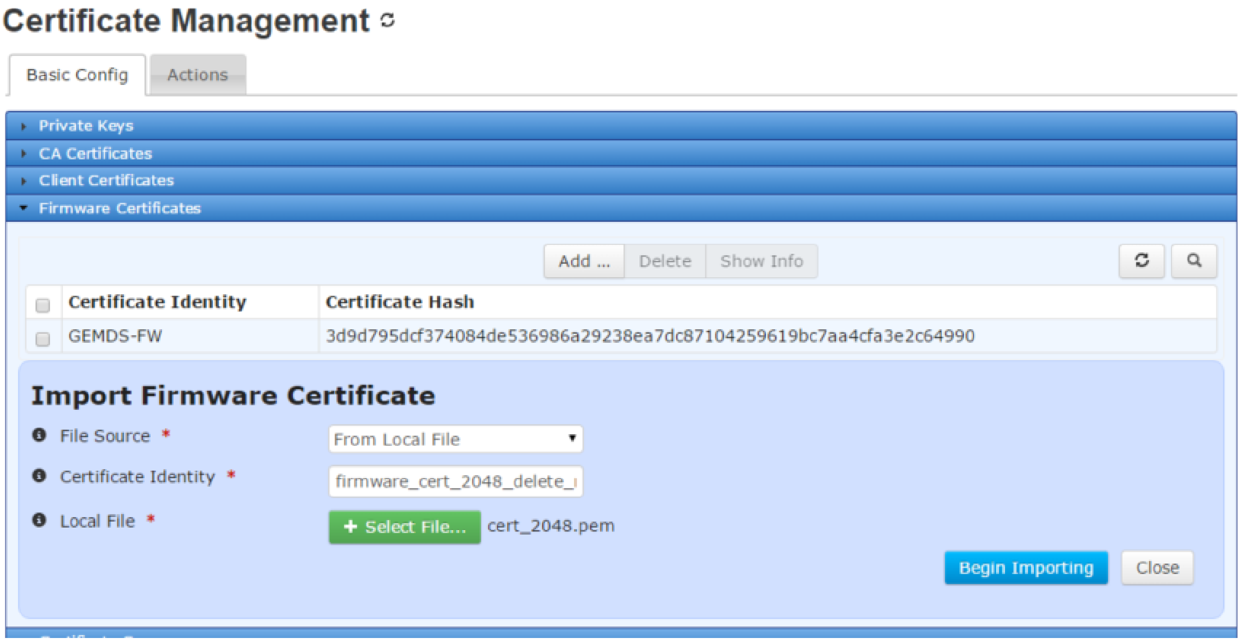


Figure 3-282. Import Firmware Certificate

The Orbit supports file uploads through a web browser from a local file on the user's PC. The Orbit also supports HTTP, FTP, TFTP, and SFTP file downloads using external remote servers.

NOTE In FIPS mode, only SFTP and local file (HTTPS) are allowed for file transfers.

- **File Source** - File transfer method to use. Available choices are From Local File (DEFAULT), From HTTP Server, From FTP Server, From TFTP Server, and From SFTP Server. Local file uploads are only available through the web UI and not through the CLI
- **Certificate Identity** - The ID to assign to the certificate once it is imported
- **Local File** - For a local file, the file to upload as chosen by the file dialog popped up by the **Select File...** button
- **URL** - For HTTP, the location of the source file
- **Server Address** - For FTP, TFTP, and SFTP, the remote server's host name or IP address
- **File Path** - For FTP, TFTP, and SFTP, the path to the source file on the remote server
- **User Name** - For FTP and SFTP, the user name on the remote server
- **Password** - For FTP and SFTP, the password on the remote server
- **Control Port** - For FTP, the TCP control port (advanced setting - use default)
- **Data Port** - For FTP, the TCP data port (advanced setting - use default)
- **Block Size** - For TFTP, the block size as defined in RFP 2348 (advanced setting - use default)
- **Timeout** - For FTP, TFTP, and SFTP, the timeout in seconds (advanced setting - use default)

The following example shows how to have the device download a firmware certificate file (named firmware_cert_2048.pem) from a TFTP server running on a host (address 192.168.1.10) that is accessible from the Orbit (e.g. a locally connected host or remote host accessible via cellular interface). To start the firmware certificate import from the CLI, enter the following command to download the firmware certificate file from the TFTP server:

> **request pki firmware-certs import cert-identity** firmware_cert_2048 **filename** firmware_cert_2048.pem **manual-file-server { tftp { address** 192.168.1.10 **} }**

Monitoring - Import

Once the import of a firmware certificate is begun, the process may be cancelled by clicking the **Cancel Import** button. The current status of the import process is displayed on the web page. Note that the web page does not display the current status if the device has not been instructed to import a firmware certificate (in other words, if the state is "inactive").

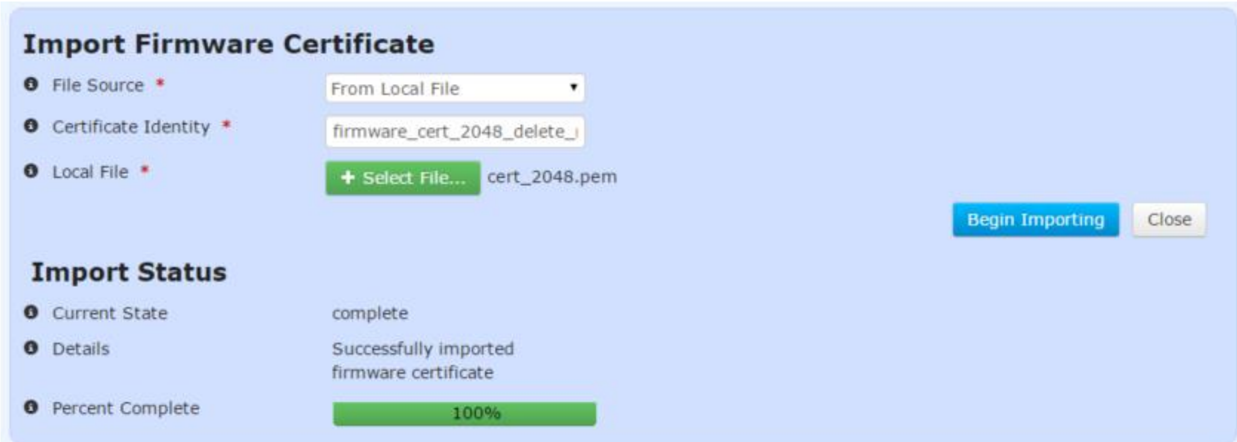


Figure 3-283. Import Firmware Certificate Monitoring

The import status contains the following items:

- **Current State** – The status of the import task:
  - inactive
  - transferring
  - processing
  - cancelling
  - complete
  - failure
  - cancelled
- **Detailed Message** – The details regarding the operation, such as "*Transferring CA certificate*"
- **Size** – The total number of bytes in the file (not displayed on the web UI)
- **Bytes Transferred** – The number of bytes already transferred or processed (not displayed on the web UI)
- **Percent Complete** – The percentage complete for the operation

To view the status of the import process in the CLI, ensure the CLI is in operational mode and then follow the example below:

> **show pki firmware-certs import-status**
> **pki ca-certs firmware-certs state complete**
> **pki ca-certs firmware-certs detailed-message "Successfully imported firmware certificate"**
> **pki ca-certs firmware-certs size 1586**
> **pki ca-certs firmware-certs bytes-transferred 1586**
> **pki ca-certs firmware-certs percent-complete 100**

3.9.6 SCEP and CA Configuration

The process of interacting with a SCEP server involves getting the currently published certificate(s) from the CA and then making a request for a client certificate with information and key material.

Before any attempt to interact with the SCEP server, the SCEP server itself, the CA associated with the SCEP server must be identified and the certificate information must be defined.

Configuring

The certificate server is defined under certificate-server. In the operation shown below, we define the SCEP server.

> **> set pki certificate-servers certificate-server** predefined_cert_server **server-type scep scep-server-setting uri** 10.15.60.39/certserv/mscep/mscep.dll **poll-interval** 5 **retry-count** 120 **digest-algo** sha256 **encrypt-algo** aes128_cbc

This defines the server that is running the SCEP protocol on an accessible network. The unit will append an 'http://' to the URL so it must not be entered as part of the uri parameter in the configuration. Note also, the above is just an example. The IP address, specific port (if different from the default) and path to .dll or .cgi or other SCEP server mechanism must be obtained from the System Administration or Security personnel.

NOTE In FIPS mode, MD5 and SHA1 are prohibited as the digest algorithm.

The configuration of the Certificate Authority that will be accessed at the above server is setup in a second command under ca-servers.

> **> set pki ca-servers ca-server** predefined_ca_server **ca-fingerprint** 8777AF0253204589452ECC3CDB9DEC77

The fingerprint of the CA server is another data item obtained from the System Administrator or Security personnel. The CA server name is the name that will be referenced in the SCEP operations described below. In general, it is simply for reference and does not have to be a specific name. In fact, it can be the same name as the ca-server if this helps to remember it. Also, client certificate information that goes in the “Subject” portion of an X.509 certificate must be configured. Some fields may be fixed/required by the specific SCEP server.

The CA fingerprint on the Orbit should contain only alpha-numeric characters without spaces or separators (i.e. commas, colons etc.).

The parameters that must be entered for the client certificate information must again be obtained from the System Administration or Security personnel. The common name will always be required. Other parameters may be required.

```
> set pki cert-info certificate-info predefined_cert_info
  Possible completions:
   common-name-x509  -
   country-x509      -
   locale-x509       -
   org-unit-x509     -
   organization-x509 -
   pkcs9-email-x509  -
   state-x509        -
```

Here is an example:

> **> set pki cert-info certificate-info** predefined_cert_info **organization-x509** “GE MDS LLC” **org-unit-x509** Engineering **common-name-x509** 00102200000102030411223344556670

Initial Enrollment of a New Certificate

To obtain a new client certificate from a SCEP server, the first step is to have a private key that you have imported or previously generated. The next step is to request the CA certificates from the SCEP server.

> **request pki ca-certs import cert-identity** scep_ca_cert **scep {**
> **ca-issuer-identity** predefined_ca_server **cert-server-identity** predefined_cert_server **}**

The next step is to request the new client certificate from the SCEP server.

> **request pki client-certs import cert-identity** scep_client_cert **scep {**
> **cert-server-identity** predefined_cert_server **ca-issuer-identity** predefined_ca_server **cert-info-identity** predefined_cert_info **ca-cert-identity** scep_ca_cert **private-key-identity** imported_key_2048 **ca-challenge** 36DE2A1E53BECF9AE5BB3E0B12D4C85E **}**

Manual Renewal or Re-Enrollment

At some point, the dates on the certificate will need to be renewed due to time or security policy. A client certificate can be renewed using the existing certificate with the same key as originally used when it was generated. An alternative is to provide a new key and identify for the certificate that is to be renewed and rekeyed.

The following example shows how to renew an existing client certificate from the SCEP server, using the existing private key and issued client certificate, without the need to provide the ca-challenge:

> **request pki client-certs import cert-identity** renewed_scep_client_cert **scep { cert-server-identity** predefined_cert_server **ca-issuer-identity** predefined_ca_server **cert-info-identity** predefined_cert_info **ca-cert-identity** scep_ca_cert **private-key-identity** imported_key_2048 **existing-cert-identity** scep_client_cert **existing-private-key-identity** imported_key_2048 **}**

The following example shows how to re-enroll for a new client certificate from the SCEP server that belongs to a new private key, using the existing private key and issued client certificate, without the need to provide the ca-challenge:

> **request pki client-certs import cert-identity** reenrolled_scep_client_cert **scep { cert-server-identity** predefined_cert_server **ca-issuer-identity** predefined_ca_server **cert-info-identity** predefined_cert_info **ca-cert-identity** scep_ca_cert **private-key-identity** new_key_2048 **existing-cert-identity** scep_client_cert **existing-private-key-identity** imported_key_2048 **}**

Automatic Renewal or Re-Enrollment

In addition to manually renewing an existing certificate via SCEP, the device can be configured to perform automated renewal of client certificates and/or CA certificates that were previously obtained through initial enrollment via SCEP.

Configuring

The following example shows how to have the device configured to setup Automatic Renewal through the web browser.

Navigate to the **Automatic Renewal** section in ***Certificate Management / Advanced Config.***

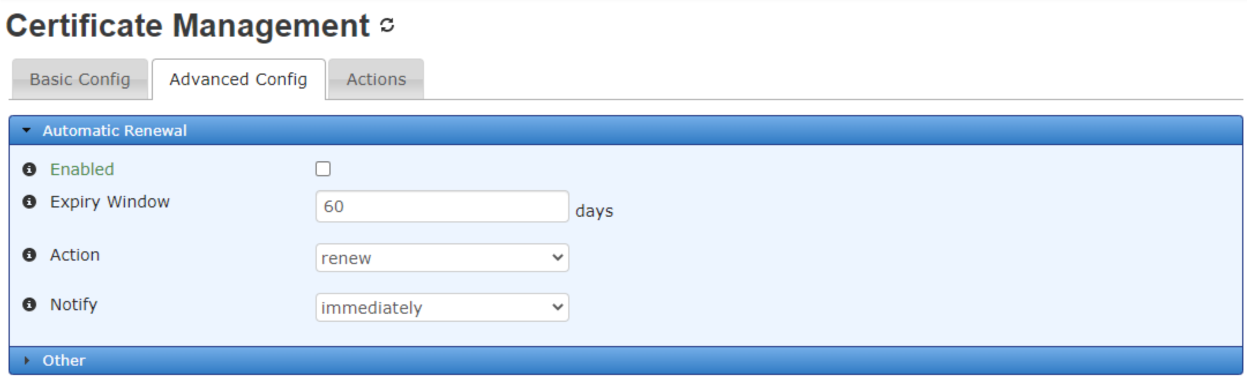


Figure 3-284. Automatic Renewal

- **Enabled** - Whether or not to run automated processing of client and CA certificates to check and attempt to automatically obtain updated versions of the certificates that have previously been obtained via SCEP. Default = false.
- **Expiry Window** - The number of days left until the certificate expires before the automated processing begins. Default = 60 days.
- **Action** - The type of SCEP processing that should be performed. When “renew” is selected, the automated processing will perform a renewal of the existing certificate from the SCEP server, using the existing private key and issued client certificate. When “re-enroll” is selected, the automated processing will re-enroll for a new client certificate from the SCEP server that belongs to a new private key, using the existing private key and issued client certificate. The new private key will be generated by the automated processing. Default = renew.
- **Notify** - Upon successful completion of obtaining a new certificate from the SCEP server, if set to “immediately”, the automated process will notify all services that are currently configured to use the certificate that the certificate has been changed. This will result in the service automatically resetting to begin use of the new certificate. If set to “disabled”, no notification of the change to the certificate is sent. This will result in the services continuing to use the previous certificate until some other change causes the service to restart (e.g. a configuration change to the service or a reboot). Default = immediately.

To apply configuration, click **Save.**

Using CLI

In configuration mode, enter following commands:

```
% set pki auto-renew enabled true
% set pki auto-renew expiry-window 60
% set pki auto-renew action renew
% set pki auto-renew notify immediately
% commit
```

Monitoring

When the Automatic Renewal is enabled, the device will begin checking the installed client and CA certificates 5 minutes after bootup. This 5 minute delay is to allow the device time to boot all the way up, establish data connections, and obtain current date/time (if configured to get date/time).

The automated processing will first check each client certificate. If the client certificate is found to have the "Validity Not After" within the expiry-window and certificate was previously imported via SCEP, and the stored certificate has information about the SCEP options that was used to initially import the certificate via SCEP, then the automated processing will begin attempting to obtain a new certificate using the SCEP settings that were previously used. The processing will log the auto_renew event indicating the start and either the successful completion or the failure of the automated processing on the certificate, indicating the certificate identity that as assigned to it by the user during initial enrollment. The automated processing includes multiple steps, which can include generating a new private key, fetching the CA certificates from the SCEP server, and importing the client certificate from the SCEP server. Each of these steps will be recorded as private key, CA certificate, and client certificate processing events, as each of the steps would be recorded to the event log if performed manually. In addition, the processing is done to temporary identity names based on the existing identity value, but with the "AUTORENEW_" prefix. Upon successful completion, the automated processing will also delete the existing PKI material, then rename the PKI material from the "AUTORENEW_" names to the existing identity names. Upon failure, the "AUTORENEW_" PKI material will be deleted. The event log will include events for the deleting and rename events for the PKI material.

After checking all of the client certificates, the automated processing will check each CA certificate. If the CA certificate is found to have the "Validity Not After" within the expiry-window and certificate was previously imported via SCEP, and the stored certificate has information about the SCEP options that was used to initially import the certificate via SCEP, then the automated processing will begin attempting to obtain a new certificate using the SCEP settings that were previously used. The processing will log the auto_renew event indicating the start and either the successful completion or the failure of the automated processing on the certificate, indicating the certificate identity that as assigned to it by the user during initial import. The automated processing will the fetch the CA certificates from the SCEP server. The import of the CA certificates will be recorded to the event log as if performed manually. In addition, the processing is done to temporary identity names based on the existing identity value, but with the "AUTORENEW_" prefix. Upon successful completion, the automated processing will also delete the existing PKI material, then rename the PKI material from the "AUTORENEW_" names to the existing identity names. Upon failure, the "AUTORENEW_" PKI material will be deleted. The event log will include events for the deleting and rename events for the PKI material.

You can examine the event log to monitor the automated processing.

Manual Notification of PKI Material Updates

You can manually send update notification to all services that are currently configured to use PKI material, in the event that the PKI material has been changed. This will result in the service automatically resetting to begin use of the new PKI material.

Configuring

The following example shows how to have the device send the update notification of the PKI material through the web browser.

Navigate to the **Send Update Notification** section in ***Certificate Management / Actions.***

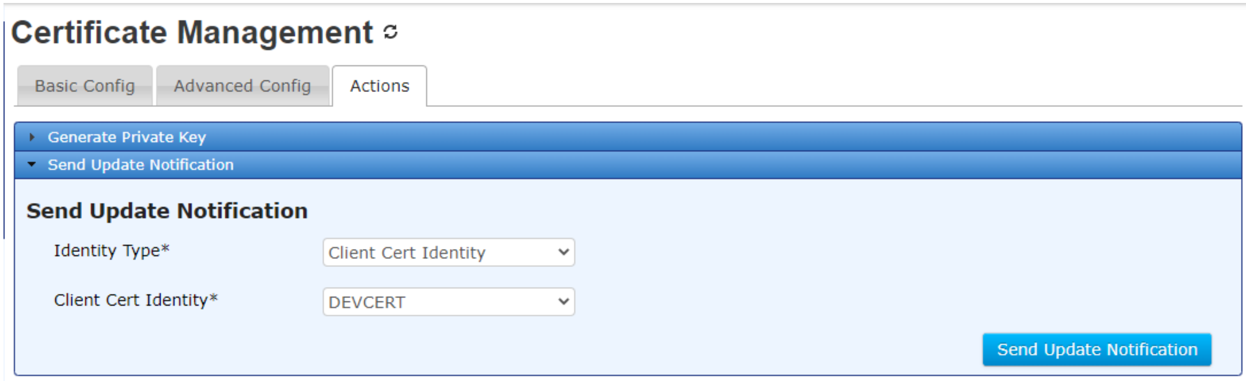


Figure 3-285. Automatic Renewal

- **Identity Type** – Choose the identity type of the PKI material, to then be able to select the identity value for that type.
    a. **Key Identity** - The identity of the private key that has been updated.
    b. **CA Cert Identity** - The identity of the CA certificate that has been updated.
    c. **Client Cert Identity** - The identity of the client certificate that has been updated.

Click **Send Update Notification**, to send the notification to the services.

Using CLI

The following are example CLI commands to send the update notifications for PKI material:

```
> request pki send-update-notification key-identity DEVKEY
> request pki send-update-notification ca-cert-identity CACERT
> request pki send-update-notification client-cert-identity DEVCERT
```

4.0 TECHNICAL REFERENCE

4.1 Troubleshooting

All units must meet the basic requirements listed below for proper operation. Check these items first when troubleshooting a system problem:

- Adequate and stable primary power
- Secure connections (antennas, data and power)
- A clear transmission path between associated units
- An efficient, properly installed antenna system
- Proper configuration of unit settings
- Correct interface between the unit and other equipment

4.1.1 LED Status Indicators

The LEDs on the unit are visual indications of the status of the device. These indicators can provide useful information when troubleshooting. Refer to the tables below.

Depending on the interfaces ordered, the NIC1 and NIC2 slot can be populated with a Cellular modem, a WiFi interface, an LnRadio interface or an NxRadio interface. LED associations for NIC1 and NIC2 follow the physical left-to-right order of the physical connector positions as labeled on the faceplate of the Orbit device.

Described in Table 4-1 Descriptions and Table 4-2 are the possible NIC1 and NIC2 LED combinations based on the product configuration ordered.

Figure 4-1. LED Status Indicators

Table 4-1. MCR NIC LED Descriptions

Product Configuration	NIC1	NIC2
MCR-4G + WiFi	Cellular	WiFi
MCR-4G Only	Cellular	Off
MCR-WiFi only	Off	WiFi
MCR-900 + 4G	Cellular	900 ISM (NxRadio)
MCR-900 + WiFi	WiFi	900 ISM (NxRadio)
MCR-900 Only	Off	900 ISM (NxRadio)
MCR-LN + WiFi	WiFi	Lic. Narrowband (LnRadio)
MCR-LN Only	Off	Lic. Narrowband (LnRadio)
MCR-LN + RN	Off	Lic. Narrowband (LnRadio)

Table 4-2. ECR NIC LED Descriptions

Product Configuration	NIC1	NIC2
ECR-4G + WiFi	WiFi	Cellular
ECR-4G Only	Off	Cellular
ECR-WiFi only	WiFi	Off
ECR-900 + WiFi	WiFi	900 ISM (NxRadio)
ECR-900 Only	Off	900 ISM (NxRadio)
ECR-LN + WiFi	WiFi	Lic. Narrowband (LnRadio)
ECR-LN Only	Off	Lic. Narrowband (LnRadio)
ECR BPL Only	Off	BPL Interface (PL1)

Table 4-3. Cell Interface LED Descriptions

LED	LED State	Description
Cell Interface	Off Solid green	No cellular connection Cell connection

Table 4-4. WiFi Interface LED Descriptions

LED	LED State	Description
WiFi Interface	Off	Interface disabled
Access Point Mode	Solid Green Solid Red	Operating as AP and at least one client connection Operating as an AP and no client connection
Station Mode	Off Solid Green	No connection Wi-Fi connection established.

Table 4-5. NxRadio Interface LED Descriptions

LED	State	Description
NxRadio Interface	Off	Interface disabled
Access Point Mode	Blink Red Solid Red Solid Green	NIC Initialization No Remotes connected Linked with at least 1 Remote
Remote Mode	Blink Red Solid Green	NIC Initialization / Not linked to an Access Point Linked with Access Point

Table 4-6. LnRadio Interface LED Descriptions (QAM mode)

LED	State	Description
LnRadio Interface	Off	Interface disabled
Access Point Mode	Blink Red Solid Red Solid Green	LN NIC Initialization No Remotes connected Linked with at least 1 Remote
Remote Mode	Blink Red Solid Green	LN NIC Initialization / Not linked to an Access Point Linked with Access Point

Table 4-7. LwRadio Interface LED Descriptions

LED	State	Description
LwRadio Interface	Off	Interface disabled
Access Point Mode	Blink Red Solid Red Solid Green	LW NIC Initialization No Remotes connected Linked with at least 1 Remote
Remote Mode	Blink Red Solid Green	LW NIC Initialization / Not linked to an Access Point Linked with Access Point

Table 4-8. BPL Interface LED Descriptions

LED	LED State	Description
BPL Interface	Off Solid Green Solid Red	Interface disabled Interface enabled Interface in errored condition

NOTE In addition to the LEDs listed on the previous page, the Ethernet connector has two embedded LEDs. A yellow indicates a link at 100 Mbps operation. A flashing green indicates Ethernet data traffic.

4.1.2 Serial Data Analysis Tool (serdump)

The “serdump” facility provides a means to monitor the flow of serial payload data into and out of the Orbit. Serdump will not monitor console ports. Access to serdump is through the CLI. Enter the CLI command “unhide debug” to make this debugging facility visible.

The command `serdump list` shows the set of COM ports available for monitoring. Serdump can monitor both physical and virtual COM ports (including VRCs representing over-the-air interfaces). The facility is designed to track payload data; it will not monitor console ports.

Serdump accepts the following arguments:

```
hex-only  - removes ASCII and line count from the output
list      - display list of ports
```

```
no-header - suppresses the header (timestamp, direction and bytecount)
port      - the port to listen on
save      - write data captured to a file
wrap      - the number of bytes per line, set to 0 to disable, default 16
```

For example, entering serdump port COM2 will cause the system to monitor COM2 displaying a full header including timestamp, direction, and bytecount. The output can be further controlled using the wrap, hex-only, and no-header options.

To save the capture to a file, you can use the save option. For instance, the command `serdump port COM2 save test`, will generate a save file local to the Orbit.

Note that the user supplied name "test" is used a base for autogenerating a more complete name. The prefix "serdump_" is added and a numeric suffix is added (starting with "1"). During file capture once 500KB of data is collected, the current file is closed and a new one is opened, with a new incremented suffix (i.e. serdump_test1.bin is closed and serdump_test2.bin is opened). After 5 files are created, the oldest is automatically overwritten. This provides a sliding window of about 2000KB-2500KB of data with one serdump command.

Saved files can be viewed with the command: `show diagnostics capture-files`

```
NAME               SIZE  DATE

----------------------------------------------------

serdump_test1.bin  98    Thu Feb 28 19:58:41 2019
```

To export a saved file use a command like: `request diagnostics export-capture-files name serdump_test1.bin filename name_after_upload.txt` …. This will upload the file to be viewed as a text file.

4.2 Technical Specifications

ENVIRONMENTAL

Maximum Altitude

2000m

Relative Humidity

<95%, non condensing

Pollution Degree

2

GENERAL

Overvoltage Category

1

Input Power (Standard Models)

11 to 55 VDC, NOMINAL

10 to 60 VDC, 15 Watts maximum (depending on configuration)

MCR 4.5A Maximum
ECR 3.0A Maximum

Input Power (+/- 48V Models)

+/-48 VDC, NOMINAL

-38.4 to -57.6 VDC and +38.4 to +57.6 VDC, 10 Watts maximum

ECR 3.0A Maximum

Below are power consumption figures for common configurations:

Typical High Throughput Wi-Fi power consumption <= 4.1 Watts
Minimum Wi-Fi power consumption <= 3.4 Watts

Table 4-9. Orbit MCR-4G Power Consumption:

Power Consumption (nominal, 25C, **Cellular Only**)

Mode	**Power**	**13.8V**
Connected (Idle)	4.0W	292mA
Connected (Typical Download)	4.3W	310mA

Table 4-10.Orbit MCR-900 (NX915) Power Consumption:

Power Consumption (nominal, Output Power = 1W, 25C)

Mode	**Power**	**13.8V**
AP (Idle)	4.0W	293mA
AP (50% Duty)	5.3W	382mA
Remote (Associated, Idle)	3.2W	235mA
Remote (Associated, 50% Duty)	5.0W	365mA

Table 4-11.Orbit MCR-LN Power Consumption:

Power Consumption (nominal, Output Power = 10W, 25C)

Mode	Power	13.8V
AP (Idle)	12.6W	910mA
AP (50% Duty)	13.1W	950mA
Remote (Associated, Idle)	4.8W	350mA
Remote (Associated, 50% Duty)	10.8W	780mA

Serial Port(s)

RJ-45, supporting RS-232/RS-485

Ethernet Port(s)

RJ-45 10/100/1000 Mbps Auto-MDIX [SFP platform offering]
RJ-45 10/100 Mbps Auto-MDIX [All other platforms]

SFP Port(s)

Small Form Factor Pluggable 100/1000 Mbps

LAN Protocols

802.3 (Ethernet) 802.1D (Spanning Tree) TCP/IP, DHCP, ICMP, IGMP, FTP, TFTP, SFTP, UDP, SNMP, VPN, VLAN

Networking

DHCP, Port Forwarding, NAT, VLAN, SNMP

Configuration

Serial console, SSH, HTTP/HTTPS, NETCONF, Configuration files

Security

Encryption, Password access, RADIUS, TACACS+, Firewall, SCEP, VPN

Physical

Size

MCR 8.0” width (20.32 cm), 4.8” depth (12.19 cm), 1.75” height (4.45 cm)
ECR 4.3” width (10.92 cm), 4.6” depth (11.68 cm), 2.1” height (5.33 cm)

Housing

Die-cast Aluminum

Weight

MCR 2 lbs (0.91 kg) without mounting hardware
ECR 1.45 lbs (0.65 kg) without mounting hardware

Environmental

Operating Temperature Range

-40°C to +70°C

NOTE For Orbit ECR equipped with LN modules, the maximum continuous duty cycle while operating at 70C is 10%

NOTE Operating temperature range may be reduced based on model configuration. See product label for detail.

Caution: This device may exceed safe handling temperatures when operated in an ambient temperature above 55°.

Agency/Regulatory Approvals

FCC

Standard WiFi – M4Y-ZCN722MV1
Standard WiFi – E5MDS-AC720M
Enhanced WiFi – 2AG87NM-DB-3N
Enhanced WiFi – 2AG87NM-DB-3N-R2
4G cell (E4V) – PKRNVWE362
3G Cell – RI7HE910
4G cell (4G1..4G5) – N7NMC7355
4G cell (4GP) – N7NMC7354B
4G cell (4Gy) – N7NMC7455
4G cell (4Gc) – RI7LE910CXWWX
4G cell (4Gb) – N7NEN75S
4G cell (4Ga) – N7NEN75
4G/3G/2G cell (4Gd) - XMR201903EG25G
NX915 – E5MDS-NX915
LN100 – E5MDS-LN100
LN200 – E5MDS-LN200
LN400 – E5MDS-LN400
LN700 – E5MDS-LN700
LN900 – E5MDS-LN900
LN900 – E5MDS-LN900-1
LW700 – E5MDS-LW700

IC - Industry

Standard WiFi – 3195A-ZCN722MV1
4G cell (E4V) - 3229B-E362
3G Cell – 5131A-HE910
4G cell (4G1..4G5) - 2417C-MC7355
4G cell (4Gy) - 2417C-MC7455
4G cell (4Gc) – 5131A-LE910C4-WWX
4G cell (4Gb) - 2417C-EM75S
4G cell (4Ga) - 2417C-EM75
4G/3G/2G cell (4Gd) - 10224A-201903EG25G
NX915 – 101D-NX915
LN100 – 101D-LN100
LN200 – 101D-LN200
LN400 – 101D-LN400
LN900 – 101D-LN900

Anatel

4G/3G/2G cell (4Gd) - Certification Number 00116066
4G CAT-M1 cell (M1B) – Certificate of Homologation 07542-25-00450

Standard WiFi Specifications – W51, W53

Protocol	
	IEEE 802.11b/g/n OFDM 6 to 54Mbps, CCK 1 to 11Mbps
Frequency Range	
	2400 to 2500 MHz
Maximum Transmit Power	
	20 dBm (Default is 15 dBm)
Permissible Antennas	
	MDS 97-4278A01, 2.4-2.485GHz, 10 dBi, Yagi, 18" coax N-F
	MDS 97-4278A34, 2.4-2.5GHz, 3.2 dBi, Omni, RP-SMA-M
	MDS 97-4278A48, 2.4-2.5GHz, 2.0 dBi, Omni, N-M
	MDS 97-4278A78, Magnetic Mount, 5' Cable, RP-SMA-Plug
FCC	
	Part 15C
FCC ID	
	M4Y-ZCN722MV1 (W51)
	E5MDS-AC720M (W53)
WiFi Antenna Connector	
	Female Reverse SMA

Enhanced WiFi Specifications – W52

Protocol	
	IEEE 802.11a/b/g/n
Frequency Range	
	2400 to 2500 MHz, 5Ghz (UNII @ 5180-5230MHz and 5745-5825MHz)
Maximum Transmit Power	
	20 dBm (Default is 16 dBm)
Permissible Antennas	
	MDS 97-4278A88, 2.4-2.5GHz 2dBi / 4.9-5.9GHz 4dBi, Omni, MIMO, dual band
	MDS 97-4278A34, 2.4-2.5GHz, 3.2 dBi, Omni
FCC	
	Part 15C, 15E
FCC ID	
	2AG87NM-DB-3N
	2AG87NM-DB-3N-R2
WiFi Antenna Connector	
	Female Reverse SMA

4G LTE/CDMA (Verizon Only) – E4V

LTE 1900(B2), AWS (B4), 850(B5), 700 (B13), 700(B17), 1900(B25)

CDMA 1xRTT/EV-DO Rev A - 800(BC0), 1900(BC1), 800(BC10)

4G LTE, HSPA+, GSM/GPRS (EMEA/APAC) – E4S

LTE 2100(B1), 1800(B3), 2600(B7), 900(B8), 800(B20) MHz

GSM/GPRS/EDGE 850/900/1800/1900 MHz

UMTS/HSPA/HSPA+ 2100(B1), 1900(B2), 850(B5), 900(B8) MHz

4G LTE, HSPA+, GSM/GPRS (North America) - 4G1-4G5

LTE 1900(B2), AWS (B4), 850(B5), 700 (B13), 700(B17), 1900(B25)

GSM/GPRS/EDGE 850/900/1800/1900 MHz

UMTS/HSPA/HSPA+ 2100(B1), 1900(B2), AWS (B4), 850(B5), 900(B8) MHz

4G LTE, HSPA+, GSM/GPRS (North America, EMEA) - 4Gy

LTE 2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 2600(B7), 900(B8), 700(B12), 700(B13), 700(B17), 800(B20), 1900(B25), 850(B26), 700(B29), 2300(B30), 2500(B41)

UMTS/WCDMA 2100(B1), 1900(B2), 1800(B3), AWS (B4), 850(B5), 900(B8) MHz

4G/3G/2G, HSPA+, GSM/GPRS (North America) - 4Gc

LTE 2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 2600(B7), 900(B8), 700(B12), 700(B13), 850(B19), 800(B20), 850(B26), 700(B28),

WCDMA 2100(B1), 1900(B2), AWS (B4), 850(B5), 900(B8), 800(B19) MHz

GSM/EGSM/DCS/PCS 850/900/1800/1900 MHz

4G LTE, HSPA+, GSM/GPRS (International) - 4Ga

LTE 2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 2600(B7), 900(B8), 1800(B9), 700(B12), 700(B13), 850(B18), 850(B19), 800(B20), 850(B26), 700(B28), 3700(B29), 2300(B30), B32, 2500(B41), 3500(B42), 3700(B43), 5200(B46), 3600(B48), 1700(B66)

UMTS/WCDMA 2100(B1), 1900(B2), 1800(B3), AWS (B4), 850(B5), 900(B8) MHz

4G LTE, HSPA+, GSM/GPRS (North America) - 4Gb

LTE 2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 2600(B7), 900(B8), 1800(B9), 700(B12), 700(B13), 700(B14), 850(B18), 850(B19), 800(B20), 850(B26), 3700(B29), 2300(B30), B32, 2500(B41), 3500(B42), 3700(B43), 5200(B46), 3600(B48), 1700(B66)

UMTS/WCDMA 2100(B1), 1900(B2), 1800(B3), AWS (B4), 850(B5), 900(B8) MHz

4G/3G/2G (International) - 4Gd

LTE 2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 2600(B7), 900(B8), 700(B12), 700(B13), 850(B18), 850(B19), 800(B20), 1900(B25), 850(B26), 700(B28),

2600(B38), 1900(B39), 2300(B40), 2500(B41)

WCDMA 2100(B1), 1900(B2), AWS (B4), 850(B5), 800(B6), 900(B8), 800(B19) MHz

GSM/EGSM/DCS/PCS 850/900/1800/1900 MHz

4G Private LTE, 410MHz (International) - 4GG

1800(B3), 800(B20), 410(B87)

4G Private LTE, 450MHz (International) - 4GF

1800(B3), 2600(B7), 800(B20), 450(B31), 450(B72)

4G Private LTE, 450MHz (450 Connect) - 4GK

1800(B3), 2600(B7), 800(B20), 450(B72)

4G CAT-M1, 450MHz (Europe) - M1A

LTE 2100(B1), 1800(B3), 850(B5), 900(B8), 800(B20), 700(B28), 450(B31), 450(B72), 450(B73), 410(B87), 410(B88)

4G CAT-M1 (International, Australia, Brazil) - M1B

LTE 2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 900(B8), 700(B12), 700(B13), 850(B18), 850(B19), 800(B20), 1900(B25), 850(B26), 700(B28), 1700(B66), 700(B85)

3G Cell – 3G1

GSM/GPRS/EDGE 850/900/1800/1900 MHz

UMTS/HSPA/HSPA+ 800/850, 900, AWS1700, 1900, 2100 MHz

900 MHz ISM – Unlicensed

Frequency Range	
	902 to 928 MHz (U91)
Power Output	
	20 dBm to 30 dBm in 1.0 dBm steps (DEFAULT = 30 dBm)
Output Impedance	
	50 Ohms
Permissible Antennas	
	MDS 93-/97-3194A14, 10dBd (12.15dBi) YAGI Antenna
	MDS 93-/97-3194A23, 7dBd (9.15dBi) 5/8 wavelength OMNI
Antenna Connector	
	TNC female
Number of Frequency Channels	
	Selectable 50 to 81 for FHSS, 1 to 20 for DTS
Channel Separation	
	307.5 kHz minimum
Modulation Type	
	2-Level GFSK / 4-Level GFSK
Data Rates	
	125, 250, 500, 1000, 1000W, 1250 kbps
Peak Frequency Deviation	
	1250 kbps / 4-level GFSK: 550 kHz
Beacon Interval	
	10 to 300 ms (DEFAULT is 150)
Dwell Time	
	10 to 400 ms (DEFAULT is 50)
FCC Part 15.247 under modular rules per DA00-1407	
FCC ID	
	E5MDS-NX915
IC	
	101D-NX915
Modulation rate / bandwidth combinations	
	See Table 3-10

100 MHz Licensed Narrowband Transceiver

Frequency Range(s)	
	135 to 156 MHz (L1B)
	150 to 174 MHz (L1C)
Power Output	
	30 dBm to 40 dBm in 1.0 dBm steps (DEFAULT = 40 dBm)
Output Impedance	
	50 Ohms
Permissible Antennas	
	Various options based on user license, including ..
	MDS 93-/97-4728A20, 150-174MHz, 7 dBi YAGI
	MDS 93-/97-4728A21, 150-174MHz, 9.2 dBi YAGI
	MDS 93-/97-4728A22, 150-174MHz, 10.2 dBi YAGI
	MDS 93-/97-4728A26, 150-156MHz, 3dBi OMNI
	MDS 93-/97-4278A27, 156-162MHz, 3dBi OMNI
	MDS 93-/97-4278A29, 168-174MHz, 3dBi OMNI
Antenna Connector	
	TNC female
Modulation Type	
	QAM (QPSK, 16QAM, 64QAM)
	FSK (3FSK, 7FSK – legacy MDS modems)
Data Rates (QAM)	
	20, 40, 60 kbps (in 12.5Khz)
	40, 80, 120 kbps (in 25.0Khz)
FCC Part 90	
FCC ID	
	E5MDS-LN100
IC	
	101D-LN100

NOTE Channel Bandwidth and step size availability based on hardware model and license restrictions

200 MHz Licensed Narrowband Transceiver

Frequency Range(s)	
	216 to 237 MHz (L2X)
	220 to 222 MHz (L2B)
Power Output	
	30 dBm to 40 dBm in 1.0 dBm steps (DEFAULT = 40 dBm)
Output Impedance	
	50 Ohms
Permissible Antennas	
	Various options based on user license, including ..
	MDS 93-/97-2027A19, 216-240MHz, 5 dBd YAGI
	MDS 93-/97-4278A24, 215-225MHz, 9.2 dBi YAGI
	MDS 93-/97-4278A54, 215-225MHz, 6 dBd YAGI
	MDS 93-/97-4278A55, 215-225MHz, 9 dBi YAGI
	MDS 93-/97-4278A56, 215-225MHz, 7 dBi YAGI
	MDS 93-/97-4278A57, 216-225MHz, 5.0 dBd 2-element dipole
Antenna Connector	
	TNC female
Modulation Type	
	QAM (QPSK, 16QAM, 64QAM)
	FSK (3FSK, 7FSK – legacy MDS modems)
Data Rates (QAM, L2X)	
	20, 40, 60 kbps (in 12.5Khz)
	40, 80, 120 kbps (in 25.0Khz)
	80, 160, 240 kbps (in 50.0Khz)
Data Rates (QAM, L2B)	
	6, 12, 18 kbps (in 5.0Khz)
FCC Parts 80, 90, 95F	
FCC ID	
	E5MDS-LN200
IC	
	101D-LN200

NOTE Channel Bandwidth and step size availability based on hardware model and license restrictions

400 MHz Licensed Narrowband Transceiver

Frequency Range(s)	
	330 to 406 MHz (L4A)
	406 to 470 MHz (L4E)
	450 to 520 MHz (L4C)
Power Output	
	30 dBm to 40 dBm in 1.0 dBm steps (DEFAULT = 40 dBm)
Output Impedance	
	50 Ohms
Permissible Antennas	
	Various options based on user license, including ..
	MDS 93-/97-3194A18, 406-430MHz, 7 dBi OMNI w/16” Jumper N-F Conn & Mnt
	MDS 93-/97-3194A19, 430-450MHz, 7 dBi OMNI w/16” Jumper N-F Conn & Mnt
	MDS 93-/97-3194A20, 450-470MHz, 7 dBi OMNI w/16” Jumper N-F Conn & Mnt
	MDS 93-/97-3194A02, 406-430MHz, 12 dBi YAGI w/N-F Conn & Mnt
	MDS 93-/97-3194A04, 406-430MHz, 12 dBi YAGI w/N-F Conn & Mnt
	MDS 93-/97-3194A06, 450-470MHz, 12 dBi YAGI w/N-F Conn & Mnt
Antenna Connector	
	TNC female
Modulation Type	
	QAM (QPSK, 16QAM, 64QAM)
	FSK (3FSK, 7FSK – legacy MDS modems)
Data Rates (QAM)	
	20, 40, 60 kbps (in 12.5Khz)
	40, 80, 120 kbps (in 25.0Khz)
	80, 160, 240 kbps (in 50.0Khz)
FCC Part 90	
FCC ID	
	E5MDS-LN400
IC	
	101D-LN400

NOTE Channel Bandwidth and step size availability based on hardware model and license restrictions

700 MHz Licensed Narrowband Transceiver

Frequency Range

757 to 758 MHz and 787 to 788 MHz (L7A)

Power Output

30 dBm to 40 dBm in 1.0 dBm steps (DEFAULT = 40 dBm)

Output Impedance

50 Ohms

Permissible Antennas

Various options based on user license, including ..
MDS 93-/97-3194A35, 746-869MHz, 3 dBi OMNI N-F Conn
MDS 93-/97-3194A36, 745-806MHz 10 dBd YAGI 7 Element 2' COAX N-F
MDS 93-/97-3194A37, 698-960MHz 6.5 dBi PANEL 80° N-F
MDS 93-/97-3194A38, 698-960MHz 3 dBi OMNI LOW PROFILE N-F
MDS 93-/97-3194A39, 698-960MHz 15 dBi PANEL 63° BEAM 7/16 EDIN
MDS 93-/97-3194A40, 698-960MHz 16 dBi PANEL 120° BEAM 7/16 EDIN

Antenna Connector

TNC female

Modulation Type

QAM (QPSK, 16QAM, 64QAM)

Data Rates

20, 40, 60 kbps (in 12.5Khz)
40, 80, 120 kbps (in 25.0Khz)
80, 160, 240 kbps (in 50.0Khz)

FCC Part 27

FCC ID

E5MDS-LN700

Special Rules for FCC Part 27 ERP Limit Compliance

757-758MHz, 1000W ERP max, = +60 dBm
787-788MHz, 30W ERP max, = +44.77 dBm

Max Antenna Gains

3dBi Omni + 40dBm = 20W ERP
12dBi Yagi +40dBm = 158W ERP
16dBi Panel + 40dBm = 398W ERP

NOTE Channel Bandwidth and step size availability based on hardware model and license restrictions

900 MHz Licensed Narrowband Transceiver

Frequency Range(s)	
	800 to 870 MHz (L9A)
	896 to 960 MHz (L9C)
Power Output	
	30 dBm to 40 dBm in 1.0 dBm steps (DEFAULT = 40 dBm)
Output Impedance	
	50 Ohms
Permissible Antennas	
	Various options based on user license, including ..
	MDS 93-/97-3194A17, 902-928MHz, 9 dBi OMNI w/16” Jumper N-F Conn
	MDS 93-/97-3194A14, 902-960MHz, 12 dBi YAGI 6 Element w/N-F Conn
	MDS 93-/97-3194A13, 902-960MHz, 8.5 dBi YAGI 3 Element w/N-F Conn
Antenna Connector	
	TNC female
Modulation Type	
	QAM (QPSK, 16QAM, 64QAM)
	FSK (3FSK, 7FSK – legacy MDS modems)
Data Rates (QAM)	
	20, 40, 60 kbps (in 12.5Khz)
	40, 80, 120 kbps (in 25.0Khz)
	80, 160, 240 kbps (in 50.0Khz)
FCC Part 90 & Part 101	
FCC ID	
	E5MDS-LN900 and E5MDS-LN900-1
IC	
	101D-LN900

NOTE Channel Bandwidth and step size availability based on hardware model and license restrictions

Licensed Narrowband Receiver (for 3-Port operation)

Frequency Range(s)
: See table below

Permissible Antennas
: Matches corresponding Licensed Narrowband Transceiver

Antenna Connector(s)
: SMA – RX IN female
: SMA – RX OUT female

The table below provides the required pairings for NIC transceiver and receiver-only modules. Also shown are the maximum electrical limits when using an external passive filter connected between RX IN and RX OUT

Table 4-12: 3-Port Operation Electrical Limits

LN Media		Frequency Range	External Passive Filter	
Transceiver NIC	RX-Only NIC		Maximum Inductance	Maximum Capacitance
L1B	R1B	135 to 156 MHz	41nH	81pF
L1C	R1C	150 to 174 MHz	41nH	81pF
L2B	R2B	220 to 222 MHz	25nH	51pF
L2X	R2X	216 to 237 MHz	25nH	51pF
L4A	R4A	330 to 406 MHz	13nH	27pF
L4C	R4C	406 to 470 MHz	13nH	27pF
L4E	R4E	450 to 520 MHz	13nH	27pF
L7A	R7A	757 to 758 MHz / 787 to 788 MHz	7nH	14pF
L9A	R9A	800 to 870 MHz	7nH	14pF
L9C	R9C	896 to 960 MHz	7nH	14pF

NOTE Check Grid Solutions Online Store for availability.

Licensed Narrowband RF input limits (attenuator guidance)

Max. RF input

0dbm

Max. Operational RF input

-25dbm

Licensed Narrowband Receive Sensitivity

The table below provides the *minimum* sensitivity for all LN modules. Many LN modules will exceed these minimum specifications.

Table 4-13: LN Radio Minimum Sensitivity

80% Received Packet Success Rate at 25C

Channel(kHz)	FEC	QPSK(dBm)	16QAM(dBm)	32QAM(dBm)	64QAM(dBm)
6.25	disabled	-115	-106	-102	-99
12.5	disabled	-112	-104	-100	-97
25	disabled	-111	-102	-99	-95
50	disabled	-108	-99	-96	-92
6.25	low-gain	-117	-112	-107	-104
12.5	low-gain	-115	-110	-106	-103
25	low-gain	-114	-108	-105	-101
50	low-gain	-111	-105	-102	-98

700 MHz Wide

Frequency Range	
	757 to 758 MHz and 787 to 788 MHz (L7W)
Power Output	
	20 dBm to 30 dBm in 1.0 dBm steps (DEFAULT = 30 dBm)
Output Impedance	
	50 Ohms
Permissible Antennas	
	Various options based on user license, including ..
	MDS 93-/97-3194A35, 746-869MHz, 3 dBi OMNI N-F Conn
	MDS 93-/97-3194A36, 745-806MHz 10 dBd YAGI 7 Element 2' COAX N-F
	MDS 93-/97-3194A37, 698-960MHz 6.5 dBi PANEL 80° N-F
	MDS 93-/97-3194A38, 698-960MHz 3 dBi OMNI LOW PROFILE N-F
	MDS 93-/97-3194A39, 698-960MHz 15 dBi PANEL 63° BEAM 7/16 EDIN
	MDS 93-/97-3194A40, 698-960MHz 16 dBi PANEL 120° BEAM 7/16 EDIN
Antenna Connector	
	TNC female
Modulation Type	
	OFDM-QAM (QPSK, 16QAM)
Data Rates	
	50, 100, 150, 200, 300 kbps (in 195Khz)
	100, 200, 300, 400, 600 kbps (in 315Khz)
	200, 400, 600, 800, 1200 kbps (in 570Khz)
FCC Part 27	
FCC ID	
	E5MDS-LW700
Special Rules for FCC Part 27 ERP Limit Compliance	
	757-758MHz, 1000W ERP max, = +60 dBm
	787-788MHz, 30W ERP max, = +44.77 dBm
Max Antenna Gains	
	10dBi Omni + 30dBm < 20W ERP
	19dBi Yagi + 30dBm < 158W ERP

BPL Interface – Nessum Wire

Frequency Range (on two selectable channels)

Channel 'x-4': 1.7 to 7 MHz
Channel 'x-5': 8 to 15 MHz

Power Output

Typical Power Output (PSD): -48dbm/Hz
Maximum Power Output (PSD): -35dBm/Hz
Power control (fine adjustment): 0 to -42db
Power control boost (coarse adjustment): 0db, 6db, 12db

Output Impedance

50 Ohms

Connector

6-pin 5.08MM pitch terminal block connector
(BNC adapter available)

Modulation Type

Wavelet OFDM (per IEEE 1901:2020)
Real Time adaptive modulation (2-PAM to 16-PAM) and FEC per carrier

Data Rates

Channel 'x-4': 34 Mbps
Channel 'x-5': 42 Mbps

CE Mark

EMC Directive 2014/30/EU
Low Voltage Directive LVD 2014/35/EU

NOTE Check Grid Solutions Online Store for availability.

NOTE All specifications above are subject to change without notice or obligation.

5.0 Glossary of Terms and Abbreviations

If you are new to wireless communications systems, some of the terms used in this guide may be unfamiliar. The following glossary explains many of these terms and will prove helpful in understanding the operation of the unit. While some of these terms may not appear in the text, they are included here to promote a more complete understanding of wireless technology. Some GE Vernova MDS specific terms have been added to complement understanding of general terms.

3-Port LN: An Orbit Licensed Narrowband interface with 3-port filtering capability, comprised of two paired media types: a standard LN Transceiver NIC plus a matching LN receive-only NIC. The 3-Port name refers to the number of antenna connectors. 1 TNC (labeld TX-RX) plus 2 SMAs (labled RX IN and RX OUT), respectively.

4G: A reference to a 4G LTE (Long Term Evolution). See *LTE*

Antenna System Gain: A figure, normally expressed in dB, representing the power increase resulting from the use of a gain-type antenna. System losses (from the feedline and coaxial connectors, for example) are subtracted from this figure to calculate the total antenna system gain.

Bit: The smallest unit of digital data, often represented by a one or a zero. Eight bits (plus start, stop, and parity bits) usually comprise a byte.

Bits-per-second: See *BPS*.

BPS (Bits-per-second): A measure of the information transfer rate of digital data across a communication channel.

BPL: Broadband over Power Line. BPL is a type of Power Line Communication (PLC) technology that sends relatively highspeed data over existing power lines.

Bridging: (see Ethernet Bridging)

Byte: A string of digital data usually made up of eight data bits and start, stop and parity bits.

CLI: Command Line Interface. A method of user control where commands are entered as character strings to set configuration and operating parameters.

CTS: Clear to Send

Decibel (dB): A measure computed from the ratio between two signal levels. Frequently used to express the gain (or loss) of a system.

Data Circuit-terminating Equipment: See *DCE*.

Data Communications Equipment: See *DCE*.

Data Terminal Equipment: See *DTE*.

dBi: Decibels referenced to an "ideal" isotropic radiator in free space, frequently used to express antenna gain.

dBd: Decibels referenced to a dipole antenna, used to express antenna gain.

dBm: Decibels referenced to one milliwatt. An absolute unit used to measure signal power, as in transmitter power output, or received signal strength.

DCE (Data Circuit-terminating Equipment) (or Data Communications Equipment): In data communications terminology, this is the "modem" side of a computer-to-modem connection. The unit described in this manual is hardwired as a DCE device.

DLINK: MDS Proprietary diagnostic link protocol, applicable to Orbit LN operating in backward compatible modes.

DTE (Data Terminal Equipment): A device that provides data in the form of digital signals at its output. DTE connects to the DCE device.

Enhanced WiFi: Orbit WiFi interface with MIMO operating at 2.4GHz or 5GHz; max 32 clients.

ETH: Ethernet

Ethernet Bridging: Involves combining an Ethernet interface with one or more other interfaces under a single interface.

Fade Margin: The greatest tolerable reduction in average received signal strength that will be anticipated under most conditions. It provides an allowance for reduced signal strength due to multipath, slight antenna movement or changing atmospheric losses. A fade margin of 20 to 30 dB is usually sufficient in most systems.

Frame: A segment of data that adheres to a specific data protocol and contains definite start and end points. It provides a method of synchronizing transmissions.

Hardware Flow Control: A feature used to prevent data buffer overruns when the unit is handling high-speed data from an RTU or PLC. When the buffer approaches overflow, the unit drops the clear-to-send (CTS) line, which instructs the RTU or PLC to delay further transmission until CTS again returns to the high state.

Host Computer: The computer installed at the master unit, which controls the collection of data from one or more remote sites.

IP: Internet Protocol

LAN: Local Area Network

LED: Light Emitting Diode

LN Receive-Only: A dedicated LN receiver module. See *3-Port LN.*

LNxxx: Orbit NIC transceiver module supporting licensed narrowband operation.

LN100: Orbit NIC transceiver module supporting licensed narrowband operation at 100 MHz.

LN200: Orbit NIC transceiver module supporting licensed narrowband operation at 200 MHz.

LN400: Orbit NIC transceiver module supporting licensed narrowband operation at 400 MHz.

LN700: Orbit NIC transceiver module supporting licensed narrowband operation at 700 MHz.

LN900: Orbit NIC transceiver module supporting licensed narrowband operation at 900 MHz.

LTE: Long Term Evolution. LTE is a standard for mobile devices and cellular networks specified by 3GPP (3rd Generation Partnership Project)

LW700: Orbit NIC transceiver module supporting wide channels at 700 MHz.

mA: Milliamperes

MAC: Media Access Control

Narrowband: These are channel sizes of 50KHz and down. The LN NIC module supports Licensed Narrowband.

Nessum WIRE: A power line communication technology standard based on IEEE 1901-2020, IEEE 1901c, and ITU-T G.9905

NIC: Network Interface Card. This is another name for the modules that are selectively included in the product based on Orbit order entry.

NX915: Orbit NIC module supporting unlicensed operation at 900 MHz.

Poll: A request for data issued from the host computer (or master PLC) to a Remote unit.

PLC (Programmable Logic Controller): A dedicated microprocessor configured for a specific application with discrete inputs and outputs. It can serve as a host or as an RTU.

PLC (Power Line Communication): A wired data transmission technology using existing power lines.

PPM: Parts per Million

Programmable Logic Controller: See *PLC*.

RADIUS (Remote Authentication Dial-In User Service): A networking protocol that provides centralized authentication and authorization management for users and is the backend for 802.1X device authentication.

Remote Terminal Unit: See *RTU*.

RTS: Request-to-send

RTU: Remote Terminal Unit. A data collection device installed at a Remote unit site.

RX: Abbreviation for "Receive."

SAF (Store and Forward): An available feature of the unit whereby data is stored by a designated Remote, and then retransmitted to a station beyond the communication range of the AP.

SCADA (Supervisory Control And Data Acquisition): An overall term for the functions commonly provided through a multiple address radio system.

SCEP (Simple Certificate Enrollment Protocol): A scalable protocol for networks based on digital certificates, which can be requested by users without the need for assistance or manual intervention from a system administrator.

Signal-to-Noise Ratio: *See SNR.*

SNR (Signal-to-Noise ratio): A measure of how well the signal is being received at a radio relative to noise on the channel.

SSH: Secure Shell protocol for a network that allows users to open a window on a local PC and connect to a remote PC as if they were present at the remote.

SSID (Service Set Identifier): A name that identifies a particular 802.11wireless LAN.

Standard WiFi: Orbit WiFi interface operating at 2.4GHz; max 7 clients.

Supervisory Control And Data Acquisition: See *SCADA*.

TACACS (Terminal Access Controller Access-Control System)+: A networking protocol that provides centralized authentication and authorization management for users.

Telnet: A terminal emulation protocol that enables an Internet user to communicate with a Remote device for management activities as if it were locally connected to a PC.

TX: Abbreviation for "Transmit."

VRC: Virtual Radio Channel. This is a serial port abstraction that allows Orbit to send low overhead serial data without requiring IP addressing.

VRF (Virtual Routing and Forwarding): A technology that allows multiple instances of a routing table to co-exist within the same router at the same time. VRFs are the TCP/IP layer 3 equivalent of a VLAN.

WAN: Wide Area Network

6.0 APPENDIX A – Command Line Interface (CLI) Features

6.1 Operational Mode

Operational Mode is the initial mode that the CLI is in right after logging in. Users can view operational and configuration data but cannot change configuration data. The prompt will show a “>” character when it is in operational mode.

6.2 Configuration Mode

Configuration mode is entered when the user types “configure” after logging in. Configuration Mode can be exited by typing “exit”, which brings the user back to Operational Mode. Configuration data can only be altered while the user is in Configuration Mode. The prompt will have a “%” character when it is in configuration mode.

6.3 Changing Configuration Data

Configuration data can only be changed while the CLI is in Configuration Mode. Changing configuration requires the two-step process described earlier, where changes can be made first and then must be committed to complete the process.

Once all the changes have been made, they can be committed using the “commit” command. If there is an error during the commit due to missing data, conflicting settings, or other issue, then none of the changes will be committed and the CLI will provide feedback regarding the error. The changes that were pending will still be pending at that point. This gives the user the opportunity to discard the changes or to modify them and then try to commit them again.

6.4 Inputting Values

The format for each node in the data model is encoded in the data model itself. The CLI enforces the user input to be compliant to that format. There are several different formats of input, including numerics, strings, and limitations on the range and length of input. The CLI will provide assistance to the user when inputting values when the tab-completion feature is used (see Tab-completion section below).

The CLI includes processing of special characters (such as the question mark, hash mark, and space), to preserve these characters when setting a string parameter, you should surround the string with double quotes or escape the specific character with the backslash character '\'.

The example below shows the “possible completions” when the TAB key is pressed after the word “location”. In this case, the node “location” can take a value that is a string with 0-255 characters.

```
% set system location
Possible completions:
  <string, min: 0 chars, max: 255 chars>
% set system location “Rochester, NY”
[ok][2012-06-19 00:56:49]

[edit]
% commit
Commit complete.
[ok][2012-06-19 00:57:01]
```

6.5 Input of a List of Values

A node can take a list of values if it has been defined that way in the data model. The CLI will indicate a node can take a list by displaying a bracket [, as shown below at the end of the possible completions information. Items in the list are separated by a space character.

This example shows that there are three ways to input values to a list node:

```
% set system dns search
Possible completions:
<IP address> <string, min: 1 chars, max: 253 chars>
```

1. Without brackets, the value will be appended to the existing list gemds
   ```
   % set system dns search gemds
   ```
2. With brackets, for a list that contains one value: “ [gemds] ”
   ```
   % set system dns search [gemds]
   ```
3. With brackets, for a list that contains more than one value: “ [ge gemds] ”
   ```
   % set system dns search [ge gemds]
   ```

NOTE Use caution when deleting a list element. In the CLI, deleting a single entry with bracket notation will *delete the entire list*. Do not use brackets in the command when deleting an element in the list.

6.6 Tab-Completion

Tab-completion is a powerful feature that presents CLI users with assistance while typing. Depending on the text that was already typed, tab-completion will display different possible completions.

When the tab key is pressed and no text has been typed, the CLI shows all of the possible commands that can be typed, as shown below. In this example, the CLI is in configuration mode and the following commands are relevant to configuration mode only.

```
%
Possible completions:
annotate - Add a comment to a statement
commit   - Commit current set of changes
compare - Show configuration differences
copy     - Copy a dynamic element
delete   - Delete a data element
edit     - Edit a sub-element
exit     - Exit from this level
help     - Provide help information
insert   - Insert a parameter
move     - Move a parameter
quit     - Exit from this level
rename   - Rename an identifier
request - Make system-level requests
resolved - Conflicts have been resolved
revert   - Copy configuration from running
rollback - Roll back database to last committed version
run - Run an operational-mode command
set - Set a parameter
```

```
show - Show a parameter
status - Display users currently editing the configuration
tag - Manipulate statement tags
top - Exit to top level and optionally run command
up - Exit one level of configuration
validate - Validate current configuration
```

When the tab key is pressed after a typed command, then the CLI will show the user all the possible options that are pertinent to that command. In the example below the tab key was pressed after the word “set“. The list of possible completions is shown to user.

```
% set
Possible completions:
SNMP-Community-MIB
SNMP-Target-MIB
SNMP-User-Based-SM-MIB
SNMP-View-Based-ACM-MIB
file-servers     -
interfaces       - Interface parameters.
logging-
pki              - Public Key and Certificate Options
routing -
services         - Services which are configurable on this system
system           - System group configuration
```

When the tab is key is pressed after the name of a data node that the user is trying to configure, then the CLI will show the user the format of the data that is acceptable for that data node. In the example below, the tab key was pressed after the word “search”. In this case, the node “search” can take a list of values that are IP addresses or strings, each with 0-255 characters.

```
% set system dns search
Possible completions:
<IP address> <string, min: 1 chars, max: 253 chars>

% set system dns search mds
```

6.7 CLI Environment

There are a number of session variables in the CLI. They are only used during the session and are not persistent. Their values are inspected using “show cli” and set using “set” in operational mode.

```
> show cli
autowizard true;
complete-on-space true;
display-level 99999999;
history 100;
idle-timeout 1800;
ignore-leading-space false;
output {
   file terminal;
}
paginate true;
prompt1 \u@\h\M \t> ;
prompt2 \u@\h\M \t% ;
screen {
   length 24;
   width 80;
```

```
}
show {
   defaults false;
}
terminal linux;
```

The different values control different parts of the CLI behavior.

autowizard (true | false)

- When enabled, the CLI will prompt the user for required settings when a new identifier is created and for mandatory action parameters.
- For example, the “filename” parameter will be requested from the user since it is mandatory and yet it was not supplied in the initial request:

```
% request system firmware reprogram-inactive-image preconfigured-file-server
   {configuration_name fs1}
Value for 'filename' (<string>): fw.pkg
```

- To avoid prompting, it is recommended to disable the **autowizard** before pasting in a list of commands. A good practice is to start all such scripts with a line that disables the

autowizard:

```
set autowizard false
...
set autowizard true
```

complete-on-space (true | false)

- Controls if command completion should be attempted when <space> is entered. Entering <tab> always results in command completion.

ignore-leading-space (true | false)

- Controls if leading spaces should be ignored or not. This is useful to turn off when pasting commands into the CLI.

history (<integer>)

- Size of CLI command history.

idle-timeout (<seconds>)

- Maximum idle time before being logged out. Use 0 (zero) for infinity.

paginate (true | false)

- Some commands paginate their output, for example. This can be disabled or enabled. It is enabled by default.

screen width (<integer>)

- Current width of terminal. This is used when paginating output to get proper line count.

screen length (<integer>)

- Current length of terminal. This is used when paginating output to get proper line count.

terminal (string)

- Terminal type. This setting is used for controlling how line editing is performed. Supported terminals are: dumb, vt100, xterm, linux, and ansi. Other terminal types may also work, but have no explicit support.

6.8 Command Output Processing

It is possible to process the output from a command using an output redirect. This is done using the | character. The commands can be chained to achieve more complex processing.

```
> show configuration |
```

```
Possible completions:
  annotation - Show only statements whose annotation matches a pattern
  context match - context match
  count      - Count the number of lines in the output
  csv        - Emit table output in CSV format
  de-select  - select columns to not include
  details    - Display details
  display    - Display options
  except     - Show only text that does not matches a pattern
  extended   - Show referring elements
  find       - Search for the first occurrence of a pattern
  hide       - Hide display options
  linnum     - Enumerate lines in the output
  match      - Show only text that matches a pattern
  match-all  - All selected filters must match
  match-any  - At least one filter must match
  more       - Paginate output
  nomore     - Suppress pagination
  select     - Select additional columns
  tab        - Enforce table output
  tags       - Show only statements whose tags matches a pattern
  until      - Display until the first occurrence of a pattern
admin@(none) 17:20:27> show configuration |
```

6.9 Count the Number of Lines in the Output

This redirect target counts the number of lines in the output. For example:

```
> show configuration | count
[ok][2007-08-31 13:49:44]
Count: 99 lines
> show configuration interfaces | count
[ok][2007-08-31 13:50:12]
Count: 90 lines
```

6.10 Search for a String in the Output

The match target is used to only include lines matching a regular expression. For example:

```
> show configuration logging | match date
event-rules date_time_from_ntp {
event-rules date_time_from_user {
event-rules date_time_not_set {
```

In the example above only lines containing “date” are shown. Similarly lines not containing a regular expression can be included.

```
> show interface-state | except counters
interfaces supported-interfaces bridge true
interfaces interface eth0
 if-index 2
 status mac-address 1e:ed:19:27:1a:b3
 status mtu  1500
 status link up
 status ipv4 address [ 192.168.1.10/24 ]
 status ipv6 address [ fe80::1ced:19ff:fe27:1ab3/64 ]
```

It is also possible to display the output starting at the first match of a regular expression, using the find target. For example:

```
> show interface-state | find tx
 status counters tx_aborted_errors 0
 status counters tx_bytes 238574
 status counters tx_carrier_errors 0
 status counters tx_compressed 0
 status counters tx_dropped 0
 status counters tx_errors 0
 status counters tx_fifo_errors 0
 status counters tx_heartbeat_errors 0
 status counters tx_packets 1731
 status counters tx_window_errors 0
```

Output can also be ended when a line matches a regular expression. This is done with the until target. For example:

```
> show interface-state | find tx | until compressed
 status counters tx_aborted_errors 0
 status counters tx_bytes 250246
 status counters tx_carrier_errors 0
 status counters tx_compressed 0
```

6.11 Regular Expressions

The regular expressions is a subset of the regular expressions found in egrep and in the AWK programming language. Some common operators are:

.	Matches any character.
^	Matches the beginning of a string.
$	Matches the end of a string.
[abc...]	Character class, which matches any of the characters abc... Character ranges are specified by a pair of characters separated by a -
[^abc...]	negated character class, which matches any character except abc....
r1 | r2	Alternation. It matches either r1 or r2.
r1r2	Concatenation. It matches r1 and then r2.
r+	Matches one or more rs.
r*	Matches zero or more rs.
r?	Matches zero or one rs.
(r)	Grouping. It matches r.

For example, to only display uid and gid you can do the following:

```
> show configuration | match "(uid) | (gid)"
uid 1000;
gid 100;
uid 1000;
gid 100;
uid 1000;
gid 100;
uid 1000;
gid 100;
```

6.12 Display Line Numbers

The linnum target causes a line number to be displayed at the beginning of each line in the display.

```
> show configuration | match "(uid) | (gid)" | linnum
1: uid 1019;
2: gid 1013;
3: uid 1019;
4: gid 1013;
5: uid 1019;
6: gid 1013;
7: uid 1019;
8: gid 1013;
```

6.13 Showing Information

Reserved for a future release.

6.14 Control Sequences

The default key strokes for editing the command line and moving around the command history are as follows.

Move the cursor back one character	Ctrl-b or Left Arrow
Move the cursor back one word	Esc-b or Alt-b
Move the cursor forward one character	Ctrl-f or Right Arrow
Move the cursor forward one word	Esc-f or Alt-f
Move the cursor to the beginning of the command line	Ctrl-a or Home
Move the cursor to the end of the command line	Ctrl-e or End
Delete the character before the cursor	Ctrl-h, Delete, or Backspace
Delete the character following the cursor	Ctrl-d
Delete all characters from the cursor to the end of the line	Ctrl-k
Delete the whole line	Ctrl-u or Ctrl-x
Delete the word before the cursor	Ctrl-w, Esc-Backspace, or Alt-Backspace
Delete the word after the cursor	Esc-d or Alt-d
Insert the most recently deleted text at the cursor	Ctrl-y
Scroll backward through the command history	Ctrl-p or Up Arrow
Scroll forward through the command history	Ctrl-n or Down Arrow
Search the command history in reverse order	Ctrl-r
Show a list of previous commands	run the “show cli history” command
Capitalize the word at the cursor	Esc-c
Change the word at the cursor to lowercase	Esc-l
Change the word at the cursor to uppercase	Esc-u
Abort a command/Clear line	Ctrl-c
Quote insert character	Ctrl-v/ESC-q
Redraw the screen	Ctrl-l
Transpose characters	Ctrl-t
Enter multi-line mode	ESC-m

6.15 Commands

The commands available to the user differs, depending on whether the CLI is in operational mode or configuration mode. The following commands are described in the next sections:

Operational Mode Commands	Configuration Mode Commands
change-password	annotate
clear history	commit
commit	compare
configure	copy
exit	delete
help	edit
iperf	exit
iper3	help
netdump	insert
ping	move
ping6	quit
quit	rename
request	request
serdump	resolved
set	revert
set-path	rollback
show	run
ssh	set
telnet	show
top	status
traceroute	tag
up	top
	up
	validate

6.16 Operational Mode Commands

change-password - <admin | tech | oper>

- Change a user's password.

clear history

- Clear command history.

commit (abort | confirm) [persist-id <id>]

- Abort or confirm a pending confirming commit. A pending confirming commit will also be aborted if the CLI session is terminated without doing commit confirm (default is confirm). If the confirming commit was initiated with a persist argument, then the same token needs to be supplied using the persist-id argument to this command.

configure (private, exclusive, shared)

- Enter configure mode. The default is private.
  - Private - Edit private copy of running configuration.
  - Exclusive - Lock and edit candidate configuration.
  - Shared - Edit candidate configuration without locking it.

exit

- Exits the CLI session.

help <command>

- Display help text related to <command>.

iperf

- Linux iperf command for performing TCP/UDP throughput measurements.
- Run with -h option to show help message.
- Specify --vrf VRF-NAME to run within a VRF.Ping an IP address or hostname.

iperf3

- Linux iperf3 command for performing TCP/UDP throughput measurements.
- Run with -h option to show help message.
- Specify --vrf VRF-NAME to run within a VRF.Ping an IP address or hostname.

netdump

- Monitor and analyze packets on interfaces.
  - expression - tcpdump packet filter expression
  - interface - the interface to listen on
  - save - write packets captured to a file
  - verbose - print link-level headers and data in hex and ASCII

ping

- Ping an IP address or hostname.

ping6

- Ping an IPv6 address or hostname.

quit

- Quit current operation.

request

- Performs a Remote Procedure Call, which instructs the device to perform some operation, i.e., a reboot.

serdump

- Monitor serial data passing through terminal-server or passthrough.
  - hex-only - removes ASCII and line count from the output
  - list - display list of ports
  - no-header - supresses the header (timestamp, direction and bytecount)
  - port - the port to listen on
  - save - write data captured to a file
  - wrap - the number of bytes per line, set to 0 to disable, default 16

set [environment]

- Set environment..

set-path

- Set relative show path.

show <command>

- The "show" command can be used to view information. Notice the information displayed is different, depending on which mode the CLI is in. The text which follows shows operational data when the CLI is in operational mode. Note that the following are examples and will vary from one system to the next:

```
> show configuration system
contact        Mark;
name           Orbit1;
location       Tank1;
clock {
   timezone-location America/New_York;
}
ntp {
   use-ntp true;
   ntp-server 216.171.112.36 {
      enabled true;
   }
}
dns {
   server [ 68.94.156.1 68.94.157.1 ];
}
tamper-detection {
   magnetometer {
      enabled false;
   }
}
pre-login-banner "Oil from Tanker1 ";
authentication {
   user-authentication-order [ local-users radius ];
   password-options {
      minimum-length            4;
      minimum-lower-case-letters 2;
      minimum-capital-letters    2;
      minimum-numeric           2;
      minimum-non-alpha-numeric  1;
   }
   }
}
```

- Showing configuration data when the CLI is in configuration mode:

```
% show system
name              "Device#42";
location  "North_Site"
clock {
   timezone-location America/New_York;
}
```

```
geographical-location {
        latitude 43.118376;
        longitude -77.61152;
        altitude 1.0;
}
```

- Normally, only those values explicitly set by the user will be displayed. Users can selectively view those nodes that assumed a default value by using the "details" modifier on the CLI, like the example shown on the next page.
- Showing the user's configuration and any nodes that assumed a default value:

```
> show configuration interfaces interface ETH1 | details
        type    ethernetCsmacd;
        enabled true;
        ipv4 {
           enabled       true;
           ip-forwarding false;
           address 192.168.1.10 {
              prefix-length 24;
           }
        }
        ipv6 {
           enabled                true;
           ip-forwarding          false;
           dup-addr-detect-transmits 1;
           autoconf {
              create-global-addresses      true;
              create-temporary-addressed   false;
              temporary-valid-lifetime     604800;
              temporary-preferred-lifetime 86400;
           }
}
```

- Showing the complete data model that the user has access to, while using additional CLI features:

```
> show configuration | details | display set | nomore
set logging event-rules console_login description ""
set logging event-rules console_login local true
set logging event-rules console_login priority notice
.....
<Remaining text omitted for brevity>
.....
```

show [path]

- Display CLI properties..

ssh

- Open a secure shell on another host

telnet

- Open a telnet session

top

- Exit to top level and optionally run command

traceroute

- Trace the route to a remote host

up

- Exit one level of configuration

6.17 Configure Mode Commands

commit (check | and-quit | confirmed [<timeout>] [persist <token>] to-startup) [comment <text>] [label <text>] [persist-id <id>]

- Commit current configuration to running.

check - Validate current configuration.

and-quit - Commit to running and quit configure mode.

confirmed -Commits the current configuration to running with a timeout. If no commit confirm command has been issued before the timeout expires, then the configuration will be reverted to the configuration that was active before the commit confirmed command was issued. If no timeout is given then the confirming commit will have a timeout period of 10 minutes. The configuration session will be terminated after this command since no further editing is possible. Only available in configure exclusive and configure shared mode.

The confirming commit will be rolled back if the CLI session is terminated before confirming the commit, unless the persist argument is given. If the persist command is given then the CLI session can be terminated and a later session may confirm the pending commit by supplying the persist token as an argument to the commit command using the persist-id argument.

comment <text> - Associate a comment with the commit. The comment can later be seen when examining rollback files.

label <text> - Associate a label with the commit. The label can later be seen when examining rollback files.

persist-id <id> - If a prior confirming commit operation has been performed with the persist argument, then to modify the ongoing confirming commit process the persist-id argument needs to be supplied with the same persist token. This makes it possible to, for example, abort an ongoing persist commit, or extend the timeout.

compare running [brief]

- If changes have been made, but have not yet been committed, then those changes can be reviewed prior to committing them by using the “compare” command. Differences will be annotated with - (removed) and + (added). If the brief option is specified, then only the differences will be shown.

copy

- Copy a list entry.

delete

- Delete a data element.

edit

- Edit a sub-element.

exit (level | configuration-mode)

level - Exit from current mode. If performed on the top level, will exit configure mode. This is the default if no option is given.

configuration-mode - Exit from configuration mode regardless of mode.

help <command>

- Shows help text for command.

insert <path>

- Inserts a new element. If the element already exists and has the indexed View option set in the data model, then the old element will be renamed to element+1 and the new element inserted in its place.

insert <path>[first|last|beforekey|afterkey] - Insert a new element into an ordered list. The element can be added first, last (default), before or after another element.

move <path>[first|last|beforekey|afterkey]

- Move an existing element to a new position in an ordered list. The element can be moved first, last (default), before or after another element.

quit

- Exit from this level.

rename <instance path> <new id>

- Rename an instance.

request

- Make system level requests.

resolved

- Conflicts have been resolved.

revert

- If changes have been made, but have not yet been committed, then those changes can be committed, reverted, or ignored by quitting the configuration mode of the CLI. Reverting the changes can be done using the “revert” command.

rollback [<number>]

- Return the configuration to a previously committed configuration. The system stores a limited number of old configurations. If more than the configured number of configurations are stored, then the oldest configuration is removed before creating a new one. The most recently committed configuration (the running configuration) is number 0, the next most recent 1, etc.

  Example:

```
admin@(none)% rollback 1
[ok][2012-06-19 16:28:55]
```

run

- Run an operational-mode command.

set

- Set a parameter.

show

- Show a parameter.

status

- Display users currently editing the configuration.

tag <add|clear|del>

tag add <statement> <tag> - Add a tag to a configuration statement.

tag del <statement> <tag> - Remove a tag from a configuration statement.

tag clear <statement> - Remove all tags from a configuration statement.

top

- Exit to top level and optionally run command.

up

- Exit one level of configuration.

validate

- Validates current configuration. This is the same operation as commit check.

7.0 APPENDIX B – Integrity Measurement Authority (IMA)

7.1 Understanding

The MDS Orbit supports the integrity measurement and attestation architecture as described by Trusted Network Connect (TNC) specifications, jointly developed and published by Trusted Computing Group (TCG) and IETF NEA working group.

The Orbit establishes secure IPsec VPN connection with the VPN gateway via mutual authentication based on certificates or pre-shared secrets. The TNC architecture adds the ability to measure, report and verify the security state of the Orbit (e.g. integrity of critical system configuration file) as a part of IPsec VPN authentication and authorization process.

Orbit supports TNCCS 2.0 protocol and subset of TCG's Platform trust Service (PTS). The Orbit supports only file measurement capability of the PTS protocol. Also, only measurements for following files are supported:

- /tmp/system.config - This file includes all current system configuration.
- /etc/tnc_config

Once the unit has been configured, the hash (sha256 or sha385) of system configuration file can be obtained via CLI (locally or remotely) and loaded into the Integrity Measurement Authority (IMA) database.

Typically, integrity measurement and attestation happens automatically as part of IPsec VPN "data" connection establishment using EAP-TTLS method (and EAP-TNC authentication within it) as instructed by the VPN-gateway. However, Orbit also supports an out-of-band IMA connection, where the unit connects to a separate IMA server not to pass data but just to perform integrity measurement and attestation. The IMA server, in such a setup, can then publish the unit's "health" information to the VPN server that is terminating the actual data connections. This allows VPN server to enforce permit/deny policy for incoming VPN data connections from the unit.

7.2 Configuring

The out of band IMA configuration is exactly similar to VPN configuration described in VPN section except that the IPsec connection is designated specifically as out-of-band IMA connection and local and remote ip subnet are all set 0.0.0.0/0 as shown below:

% set services vpn ipsec connection IMA-CONN-1 **is-out-of-band-ima** ***true***
% set services vpn ipsec connection IMA-CONN-1 **local-ip-subnet** 0.0.0.0/0
% set services vpn ipsec connection IMA-CONN-1 **remote-ip-subnet** 0.0.0.0/0
% set services vpn ipsec connection IMA-CONN-1 **periodic-retry-interval** 60

The "periodic-retry-interval" applies only to the IPsec connection designated as an "out-of-band" IMA connection. The Orbit attempts attestation every "periodic-retry-interval" if the previous attempt to connect with IMA server was unsuccessful.

In case of an out of band IMA server setup, the Orbit needs to be configured with an IMA IPsec connection and a VPN-GWY IPsec connection. An example follows:

```
connection IMA-CONN-1 {
   ike-peer            IMA-SERVER;
   ipsec-policy        IPSEC-POLICY-IMA;
   local-ip-subnet     0.0.0.0/0;
   remote-ip-subnet    0.0.0.0/0;
   is-out-of-band-ima  true;
```

```
    failure-retry-interval 1;
}
connection VPN-GWY-CONN-1 {
    ike-peer            VPN-GWY;
    ipsec-policy        IPSEC-POLICY-1;
    local-ip-subnet     192.168.1.0/24;
    remote-ip-subnet    192.168.2.0/16;
    failure-retry-interval 1;
}
```

IMA-CONN-1 is used for attestation and *VPN-GWY-CONN-1* is used for VPN data connection.

If more than one IPsec connection is configured on the unit, the unit initiates connections in round-robin fashion. For example, Orbit will follow the following sequence:

- Attempt connection to IMA-SERVER
- Attempt connection to VPN-SERVER (irrespective of IMA-SERVER connection outcome)
- Attempt connection to IMA-SERVER after failure-retry-interval if previous attempt to connect with it failed.
- Attempt connection to IMA-SERVER after periodic-retry-interval if previous attempt to connect with it succeeded.
- Attempt connection to VPN-SERVER after failure-retry-interval if it failed previously or got disconnected due to dead peer detection.
- and so on…

7.2.1 Obtaining Configuration File Hash

The following example shows the use of a request to get the system configuration hash:

```
admin@(none) 22:09:59> request services vpn ipsec get-config-hash hash-algo sha384 hash
  e60429aa127cb2f23e10ae00b6c1553fa9d1f598b2a206926ad0dcdf9a758622eec77ad559b32f
  85ceea9013a961041f
[ok][2013-01-18 22:10:15]
```

This hash can then be loaded in IMA database.

7.3 Monitoring

The current attestation status of the IMA connection is displayed using same command as used to display regular VPN data connection status. The example on the following page shows that the IMA connection succeeded but the IMA Evaluation was "non-compliant" and IMA recommendation was "Quarantined". This will happen is the system configuration file hash loaded in IMA does not match the actual hash of the current system configuration, indicating that system configuration was changed since last time the hash was loaded in the IMA database.

```
> show services vpn
services vpn ipsec ipsec-status connections connection IMA-CONN-1
 state             disconnected
 failure-reason    none
 last-timestamp    2013-01-18T21:24:26+00:00
 ima-evaluation    "non-compliant major"
 ima-recommendation Quarantined
```

Once it is determined through event logs that the configuration was changed by authorized user, the current configuration hash can be loaded in the IMA and then the Orbit can be instructed to re-attest with IMA server, as shown below.

```
> request service-vpn-ipsec-attest-with-ima conn-name IMA-CONN-1
```

The IMA status can then be checked again periodically for new attestation result:

```
> show services vpn
services vpn ipsec ipsec-status connections connection IMA
 state           disconnected
 failure-reason     none
 last-timestamp     2013-01-18T22:19:02+00:00
 ima-evaluation     compliant
 ima-recommendation "Access Allowed"
```

7.4 IMA Troubleshooting

Follow the troubleshooting steps described in VPN section on troubleshooting IMA connection failure. Note that an IMA connection failure means that unit was unable to communicate or attest with IMA. It does not mean there was an IMA evaluation failure.

8.0 APPENDIX C – Common Event Expression (CEE)

Events will be categorized using a taxonomy based on the Common Event Expression (CEE) event profile (1). These events will be encoded using JavaScript Object Notation (JSON), and placed into the standard message body of a syslog message.

From the CEE website:

Common Event Expression (CEE™) improves the audit process and the ability of users to effectively interpret and analyze event log and audit data. This is accomplished by defining an extensible unified event structure, which users and developers can leverage to describe, encode, and exchange their CEE Event Records (2).

CEE defines the structure of event messages via an XML schema referred to as the CEE Core Profile. The Core Profile consists of 3 reusable components: (2)

- **Event Taxonomy** — provides a listing of Event Tags that can be used to classify and identify events. The taxonomy supports common event categorization methods and identification of records that pertain to similar types of events.
- **Field Dictionary** — a listing of event record fields and field value types used to represent common event data. Selected fields and value types become associated with properties of a specific event instance.
- **CEE Event Schema** — defines the structure of an event record, including the minimum set of required fields. Event Extensions provide a mechanism for capturing additional data about an event.

One of the key features of the CEE Core Profile is that it can be extended by an organization so that they can add additional taxonomy categories and fields that describe vendor specific events.

8.1 Event Taxonomy

The CEE Core Profile defines the following taxonomy categories:

- **Action** — The primary type of action that was undertaken as part of the event. The status or result of the action should be detailed in the status field.
- **Domain** — The environment or domain of the event. Typical event domains include network (net), operating system (os), and application (app).
- **Object** — The type of object that is targeted or otherwise affected by the event
- **Service** — The service the event involves. The service field value provides context to the event action or more precision to the event domain.
- **Status** — The end result or status of the event action identified by the action field.
- **Subject** — The type of object that initiated or started the event action identified by the action field.

With the exception of 'subject', the Core Profile defines valid values for each of these categories, some examples of the values include "access, copy, clone, encrypt" for action values, and "error, failure, ongoing, success" for status values.

All taxonomy fields are optional, however if given they *must* contain exactly one non-null value.

8.2 Event Field Dictionary

The Core Profile defines a selection of common fields that may be used in event logs. Like the taxonomy categories, this dictionary can be extended by vendors by using a custom profile. All of the defined fields are optional with the exception of the following 3 mandatory fields that must be in every logged event:

- host – Hostname of the event source.
- pname – Process name that generated the event.

- time – Event start time

It may appear that having the time field is redundant, as the time is already in the syslog message; this is false for 2 reasons:

1. RFC 3164 (3) Syslog timestamps do not contain the year, and only have second resolution, whereas the CEE timestamps have microsecond resolution with full year. RFC 5424 (4) Syslog messages do include the year and support for microsecond resolution
2. Syslog timestamps reflect the time that the event was sent to syslog, not necessarily the time that the event occurred. Depending on the situation, these times may be different

8.3 Event Encoding & Transport

CEE defines two different methods for encoding events for transport and storage, XML and JSON. CEE also explicitly defines how CEE messages are to be transported over syslog (5). The following requirements are stated:

- Syslog Header – The standard Syslog header MUST be used.
- Syslog Body – The CEE Event MUST be represented using the CLS (CEE common Log Syntax) JSON Encoding.
- CEE Event Flag – The beginning of the encoded CEE Event MUST be identified by the CEE Event Flag. Within Syslog, the CEE Event Flag is @cee:
- Character Encoding – If the syslog implementation is only 7-bit, all characters not in the ASCII character set MUST be escaped.

8.3.1 Examples

A valid CEE JSON Event Record embedded within an RFC5424 Syslog transport:

```
<165>1 2011-12-20T12:38:06Z 10.10.0.1 process - example-event-1
  @cee:{"pname":"auth","host":"system.example.com","time":"2011-12-20T12:38:05.123456-
  05:00"}
```

A valid CEE JSON Event Record used with a “legacy” Syslog transport:

```
<0>Dec 20 12:42:20 syslog-relay process[35]: @cee:
  {"crit":123,"id":"abc","appname":"application","pname":"auth","pid":123,"host":"system.exam
  ple.com","pri":10,"time":"2011-12-20T12:38:05.123456-
  05:00","action":"login","domain":"app","object":"account","service":"web","status":"success"}
```

The following example shows a series of events that may be generated by a host requesting an IP for its eth0 interface from a DHCP server (Syslog header left off for brevity, and formatted for clarity):

DHCP Request sent to the server:

```
@cee: {
"host":"stout",
"pname":" my_appname ",
"time":"2012-08-22T11:20:10.559227-04:00",
"action":"request",
"domain":"net",
"object":"interface",
"service":"dhcp_client",
"status":"ongoing",
"event":"dhcp_client",
"interface_name":"eth0",
"profile":"http://gemds.com/cee_profile/1.0beta1.xsd"
}
```

DHCP Response from server, assigning the IP 192.168.2.3:

@cee: {
"host":"stout",
"pname":"my_appname",
"time":"2012-08-22T11:20:10.559748-04:00",
"action":"request",
"domain":"net",
"object":"interface",
"service":"dhcp_client",
"status":"success",
"ipv4":"192.168.2.3",
"event":"dhcp_client",
"interface_name":"eth0",
"profile":"http://gemds.com/cee_profile/1.0beta1.xsd"
}

The body of syslog messages of type “alert” is specified using RFC 5425 type key/value pairs. A few additional fields are also present.

8.3.2 syslog PRIVAL

The “PRIVAL” field of the syslog “HEADER” shall to be set to 113 for alerts and between 104 and 111 for editable events.

8.3.3 syslog APP-NAME

The “APP-NAME” field of the “HEADER” specified in the syslog RFC shall be set to “csmgr”.

RFC5424 states: “The APP-NAME field SHOULD identify the device or application that originated the message.” The semantics of the field have changed from the application that originated the event, to the application who should receive the event.

8.3.4 syslog MSG

For events of type audit, the msg is vendor specific, whereas events of type alert must be in a specified format which contains a GUID, level and message. Using the CEE approach all of the requested information would be present in all messages.

Example of message using format

Jun 7 11:10:22 ccc99 csmgr[27417]: Source=’ ABCDEF0123456789AB00000000000099’ Level=’5’ Message=’Date/Time Changed by User’

Example of message using CEE format

Jun 7 11:10:22 ccc99 systemmgr[33212]: @cee: {"host":"ccc99",”guid”:” ABCDEF0123456789AB00000000000099”,”syslog_priority”:5, "pname":"systemmgr","time":"2012-08-23T09:16:21.335592-04:00","action":"modify","domain":"os","object":"datetime”, “status":"success","event":"date_time_from_user","profile":"http://gemds.com/cee_profile/1.0beta1.xsd"}

8.4 Configuring

The following shows how to configure the unit with a server to which events will be sent:

% set logging syslog server my_syslog_server **ip** 192.168.1.1 **port** 1999 **protocol tls version** RFC5424 **tls-options tls-ca-certificate** my_ca_cert **tls-client-certificate** my_client_cert **tls-client-key** my_client_key

The following shows how to configure an event that will be logged locally, via syslog, and via netconf-notifications:

```
% set logging event-rules cell_connected syslog true local true netconf-notification true
```

8.5 Monitoring

Ensure the CLI is in operational mode. Follow the example below to view the state and statistics:

```
% show logging event-rules cell_connected
   description          "cell connection established";
   local                true;
   priority             notice;
   syslog-facility      user;
   syslog               true;
   snmp-notification    true;
   netconf-notification true;

% show logging event-rules cell_disconnected
   description          "cell connection disconnected";
   local                true;
   priority             notice;
   syslog-facility      user;
   syslog               true;
   snmp-notification    true;
   netconf-notification true;
```

8.6 Event List

A comprehensive summary list of Orbit events is provided here:

```
FIPS                         - FIPS 140-2 Operational Compliance
OneTimePassword              - One-Time-Password activity
OneTimePassword_Unset        - One-Time-Password Unset
card_insertion               - A new module was inserted into the chassis.
card_removal                 - A module was removed from the chassis.
cell_connected               - cell connection established
cell_disconnected            - cell connection disconnected
cell_recovery                - cell recovery initiated
cell_roaming_change          - cell roaming state changed
cell_service_change          - cell service state changed
cell_sim_change              - cell sim state changed
console_login                -
console_logout               -
date_time_from_gps           -
date_time_from_ntp           -
date_time_from_user          -
date_time_not_set            -
ddns_update                  - DDNS update
debug                        - Internal debugging events
dhcp_client                  -
dns_resolution_failure       - A DNS lookup failed
event_log_cleared            - The event log was cleared by a user
eventlog_full                - System eventlog is full
eventlog_high_water          - System eventlog has reached the high-water mark
hardware_error               -
image_copy                   -
image_corrupt                -
info                         - Internal information events
internal_software_error      - Internal software error
internal_software_warning    - Internal software warning
invalid_configuration        - Invalid configuration
io_pin                       - I/O Pin Value Changes
ipsec_vpn_connection         - ipsec vpn connection event
link_down                    -
link_up                      -
ln_auth                      - LN Authentication event
ln_cal                       - NIC calibration alert
ln_connection                - LN connection
ln_evm_error                 - LN has too many out of specification EVM values
ln_frequency                 - Bad LN frequency
ln_host_activity             - LN hasn't received messages from the host card
ln_provision                 - NIC provisioning
ln_retry_error               - The nic has had too many transmit retries
ln_rssi_error                - LN has too many out of specification RSSI values
ln_temp                      - NIC temperature alert
ln_vswr                      - NIC VSWR alert
```

```
lw_auth                    - LW Authentication event
lw_cal                     - NIC calibration alert
lw_connection              - LW connection
lw_frequency               - Bad LW frequency
lw_provision               - NIC provisioning
lw_retry_error             - The nic has had too many transmit retries
lw_rssi_error              - LW has too many out of specification RSSI values
lw_temp                    - NIC temprature alert
netconf_confirmed_commit   - A NETCONF confirmed commit event
netconf_login              -
netconf_logout             -
netmon_state               - netmon operation state
nic_reprogram              - Module reprogramming
nx_auth                    - NX Authentication event
nx_cal                     - NIC calibration alert
nx_connection              - NX connection
nx_encrypt_error           - NX Encryption Error Event
nx_encrypt_warning         - NX Encryption Warning Event
nx_provision               - NIC provisioning
nx_retry_error             - NX has had too many transmit retries
nx_rssi_error              - NX has too many out of specification RSSI values
nx_temp                    - NIC temperature alert
nx_vswr                    - NIC VSWR alert
openvpn-bad-ca             - OpenVPN CA certificate is not valid
openvpn-bad-cert           - OpenVPN certificate is not valid
openvpn_state              - OpenVPN operation state
os_error                   -
password_changed           - A local user's password was changed.
poor_vswr                  - Poor VSWR. Check antenna connection.
radius_server_failure      - Failed to connect to a RADIUS server
reboot_by_user             -
reprogram                  -
settings_change            - System configuration has changed
sfp_interface_error        - SFP Interface Error
sfp_interface_link_loss    - SFP Interface Link Loss
slab_memory_warning        - Slab Memory Warning
ssh_login                  -
ssh_logout                 -
stale_firmware_warning     - Stale Firmware Warning
system_boot                -
system_boot_error          - Boot Error
tacacsplus_server_failure  - Failed to connect to a TACACS+ server
tamper_detected            -
terminal_server_connect    -
test_alarm                 - Test Alarm
vrrp_router_change         - An interface has changed VRRP router state.
web_login                  -
web_logout                 -
```

```
web_proxy_login          -
web_proxy_logout         -
wifi_station_connect     - station connected to access point
wifi_station_disconnect  - station disconnected from access point
ztp_registration         - ZTP registration
```

9.0 APPENDIX D – Managing Signed Firmware

The MDS code signing tool (CST) is a command line program that can be run on Windows or Linux. Running the CST and passing the "--help" argument will print the following usage info:

```
pkgsigner --help

GEMDS Firmware Packaging Signing Utility (pkgsigner) 06-6671A01 Rev. 0.3.0
Built: Jan 7 2013 11:25:34

Usage:
To verify and sign a package:
  pkgsigner -v verifycert -k privkey -P password -p pubcert -f infile -o outfile

  where:  verifycert = The filepath a public certificate to be used to verify the
                       signature of the infile if and the infile has been
                       previously signed.
             privkey = The filepath for the private key to be used to create
                       a signed package.
            password = The optional password, if the private key is encrypted
             pubcert = The filepath for the public certificate corresponding to
                       the privkey. This is used to store a hash of the certificate
                       information, to aide lookup of the appropriate public key
                       during signature verification
              infile = The filepath for package file (input)
             outfile = The filepath for signed package file (output)

To display package info and verification status:
  pkgsigner -l -v verifycert -f infile
  where:  verifycert = The filepath a public certificate to be used to verify the
                       signature of the infile if and the infile has been
                       previously signed.
              infile = The filepath for package file (input)
```

Users can verify that a firmware package file came from GE Vernova MDS by using the CST. The following example shows how to verify a signed firmware package file came from GE Vernova MDS by using the firmware file ge_signed_package.mpk and by using the MDS provided public certificate ge_pubcert.pem.

```
./pkgsigner -l -v ge_pubcert.pem -f ge_signed_package.mpk
Processing file: 'ge_signed_package.mpk'
Package ID: 20121101
NumImages: 4
NumSignatures: 1
Image #0 : Bootloader version 2012.07-g644d99
Image #1 :     Kernel version 3.0.15-mds-gc00
Image #2 :     RootFS version 0.0.4
Image #3 :     CompFS version 0.0.0
Package version: 0.0.4

Signature #1 validation was successful.
```

Signing a MDS firmware package is an optional step for users and is not required. Users may wish to sign a firmware package to ensure that only user-approved firmware package revisions from GE Vernova MDS can be loaded into a unit. An example of signing a firmware package is shown below:

```
./pkgsigner -v ge_pubcert.pem -k user_key.pem -P "mypass" -p user_pubcert.pem -f
   ge_signed_package.mpk -o user_signed_package.mpk

Processing file: 'ge_signed_package.mpk'
Package ID: 20121101
NumImages: 4
NumSignatures: 1
Image #0 : Bootloader version 2012.07-g644d99
Image #1 :    Kernel version 3.0.15-mds-gc00
Image #2 :    RootFS version 0.0.4
Image #3 :    CompFS version 0.0.0
Package version: 0.0.4

Signature #1 validation was successful.

Packed file created in 'user_signed_package.mpk'.
```

Where:

- ge_signed_package.mpk is the firmware package provided by GE Vernova MDS that was signed by GE Vernova MDS. Firmware packages will typically be downloaded by users from MDS product websites.
- ge_pubcert.pem is the public certificate provided by GE Vernova MDS that is used to verify that the signed packaged is authentic. The GE Vernova MDS public certificate will typically be downloaded by users from the MDS product website.
- user_key.pem is a private key provided by the user.
- mypass is the password used to decrypt *user_key.pem*, assuming the key is password protected. If the key is not password protected, then the –P option may be omitted.
- user_pubcert.pem is the public certificate corresponding to *user_key.pem*.
- user_signed_package.mpk the file that will be created that contains the GE Vernova MDS signature and the newly appended user signature.

When verifying a user-signed package, both the MDS public certificate and the user's public certificate must be provided to the CST:

```
./pkgsigner -l -v ge_pubcert.pem -v user_pubcert.pem -f user_signed_package.mpk

Processing file: 'user_signed_package.mpk'
Package ID: 20121101
NumImages: 4
NumSignatures: 2
Image #0 : Bootloader version 2012.07-g644d99
Image #1 :    Kernel version 3.0.15-mds-gc00
Image #2 :    RootFS version 0.0.4
Image #3 :    CompFS version 0.0.0
Package version: 0.0.4

Signature #2 validation was successful.
Signature #1 validation was successful.
```

10.0 APPENDIX E – Obtaining Provisioned 4G/LTE Service (Verizon)

10.1 Understanding

The MDS Orbit requires a mini SIM card (2FF type) provisioned for 4G cell operation. The unit's cellular interface will not function without a valid SIM card installed.

GE Venova MDS does not provide SIM cards. Service can be obtained by contacting Verizon and requesting a provisioned SIM card for the appropriate M2M service plan.

Description of the SIM port and how to insert a SIM card is provided in Figure 3-23. Steps for Inserting SIM Card on Page 77.

10.2 Before Contacting Verizon

To enable service, Verizon will typically require the IMEI (International Mobile Equipment Identity) of the equipment in which the SIM card will be used.

The IMEI can be found by logging into the device and entering the following command:

```
> show interfaces-state interface Cell cell-status imei
cell-status imei 991000947608727
```

If MEID (Mobile Equipment Identifier) is needed, this is equal to the IMEI value *minus the last digit.*

NOTE Do not run the command above unless a provisioned SIM card is installed in the unit. If an un-provisioned card is used, the cell-status may return an error code beginning with 0x instead of the proper IMEI value.

10.3 Establishing a Cell Service Plan

Verizon offers a variety of service plans. Determine your data needs and contact your Verizon Wireless Business Representative to obtain the appropriate provisioned SIM cards.

Verizon provides the following link to assist in finding a service representative based on customer attributes and needs: https://www.findmyrep.vzw.com/

11.0APPENDIX F – NX915 Module Frequencies

The NX915 module is a Frequency-Hopping Spread Spectrum (FHSS) radio that can be configured to operate in a subset of all available frequencies for a particular modem mode (125kbps, 250kbps, 500kbps, etc). The radio frequency will change at the "Dwell Time" rate, a default of 50ms.

The table below illustrates the discrete frequencies (or channels) that can be user configured. The selected “hop-set” defines the specific channels of radio operation.

NOTE The module may be configured for by the factory to disallow operation in specific frequencies to meet country specific regulatory requirements. These settings can NOT be changed or modified by the user.

When specific hop-set can be user configured that defines a specific collection of radio operation.

The following table show the number of discrete frequencies (or channels) available for each modem type based on the selected hop set

		Modem-Mode					
Channel	**Frequency**	**125**	**250**	**500**	**1000**	**1000W**	**1250**
0	902.700000	A	A	A			
1	903.007500	A	A	B	B	B	
2	903.315000	A	A	C	C	C	C
3	903.622500	A	A	A	D	D	D
4	903.930000	A	A	B	A	E	E
5	904.237500	A	A	C	B	A	F
6	904.545000	A	A	A	C	B	A
7	904.852500	A	A	B	D	C	B
8	905.160000	A	A	C	A	D	C
9	905.467500	A	A	A	B	E	D
10	905.775000	A	A	B	C	A	E
11	906.082500	A	A	C	D	B	F
12	906.390000	A	A	A	A	C	A
13	906.697500	A	A	B	B	D	B
14	907.005000	A	A	C	C	E	C
15	907.312500	A	A	A	D	A	D
16	907.620000	A	A	B	A	B	E
17	907.927500	A	A	C	B	C	F
18	908.235000	A	A	A	C	D	A
19	908.542500	A	A	B	D	E	B
20	908.850000	A	A	C	A	A	C
21	909.157500	A	A	A	B	B	D
22	909.465000	A	A	B	C	C	E
23	909.772500	A	A	C	D	D	F
24	910.080000	A	A	A	A	E	A
25	910.387500	A	A	B	B	A	B
26	910.695000	A	A	C	C	B	C
27	911.002500	A	A	A	D	C	D

28	911.310000	A	A	B	A	D	E
29	911.617500	A	A	C	B	E	F
30	911.925000	A	A	A	C	A	A
31	912.232500	A	A	B	D	B	B
32	912.540000	A	A	C	A	C	C
33	912.847500	A	A	A	B	D	D
34	913.155000	A	A	B	C	E	E
35	913.462500	A	A	C	D	A	F
36	913.770000	A	A	A	A	B	A
37	914.077500	A	A	B	B	C	B
38	914.385000	A	A	C	C	D	C
39	914.692500	A	A	A	D	E	D
40	915.000000	A	A	B	A	A	E
41	915.307500	A	A	C	B	B	F
42	915.615000	A	A	A	C	C	A
43	915.922500	A	A	B	D	D	B
44	916.230000	A	A	C	A	E	C
45	916.537500	A	A	A	B	A	D
46	916.845000	A	A	B	C	B	E
47	917.152500	A	A	C	D	C	F
48	917.460000	A	A	A	A	D	A
49	917.767500	A	A	B	B	E	B
50	918.075000	A	A	C	C	A	C
51	918.382500	A	A	A	D	B	D
52	918.690000	A	A	B	A	C	E
53	918.997500	A	A	C	B	D	F
54	919.305000	A	A	A	C	E	A
55	919.612500	A	A	B	D	A	B
56	919.920000	Unused					
57	920.227500	A	A	A	B	C	D
58	920.535000	A	A	B	C	D	E
59	920.842500	A	A	C	D	E	F
60	921.150000	A	A	A	A	A	A
61	921.457500	A	A	B	B	B	B
62	921.765000	A	A	C	C	C	C
63	922.072500	A	A	A	D	D	D
64	922.380000	A	A	B	A	E	E
65	922.687500	A	A	C	B	A	F
66	922.995000	A	A	A	C	B	A
67	923.302500	A	A	B	D	C	B
68	923.610000	A	A	C	A	D	C
69	923.917500	A	A	A	B	E	D

70	924.225000	A	A	B	C	A	E
71	924.532500	A	A	C	D	B	F
72	924.840000	A	A	A	A	C	A
73	925.147500	A	A	B	B	D	B
74	925.455000	A	A	C	C	E	C
75	925.762500	A	A	A	D	A	D
76	926.070000	A	A	B	A	B	E
77	926.377500	A	A	C	B	C	F
78	926.685000	A	A	A	C	D	A
79	926.992500	A	A	B	D	E	
80	927.300000	A	A	C			

Channels/Hop Set

A	80	80	27	18	15	13
B	0	0	27	20	15	12
C	0	0	26	20	16	12
D	0	0	0	20	16	13
E	0	0	0	0	16	13
F	0	0	0	0	0	13

12.0APPENDIX G- VPN Configuration Examples

The commands listed in this section can be copy-n-pasted in the Orbit CLI (in configuration mode) followed by "commit" to save the changes. Please turn off CLI autowizard before pasting in the commands as shown below:

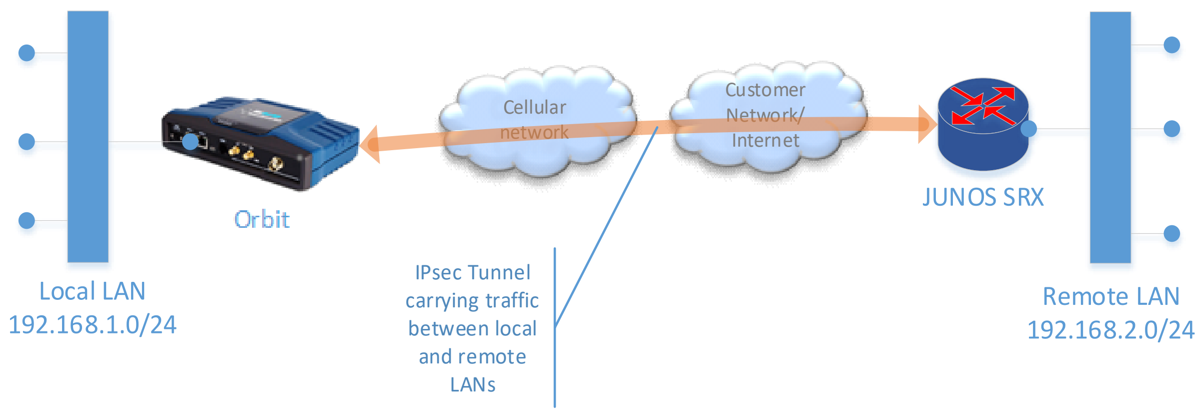
admin@(none) 18:26:51> config

admin@(none) 18:26:53% run set autowizard false

admin@(none) 18:27:03%

12.1 Policy-Based IPsec VPN with Juniper JUNOS

In this example we describe a sample configuration for a site-to-site policy based IPsec VPN setup between Orbit MCR (2E1S) and Juniper SRX240 JUNOS appliance with IKEv2 pre-shared key based authentication.



The WAN IP address of SRX240 is 172.18.175.40 and Orbit cell ip address is 172.18.175.138.

12.1.1 Orbit

12.1.1.1 Configuration

 # Bridge/LAN interface configuration

set interfaces interface Bridge type bridge

set interfaces interface Bridge ipv4 address 192.168.1.1 prefix-length 24

set interfaces interface Bridge filter input IN_TRUSTED

set interfaces interface Bridge filter output OUT_TRUSTED

set interfaces interface Bridge bridge-settings members port ETH1

set interfaces interface Bridge bridge-settings members port ETH2

 # Cell interface configuration

set interfaces interface Cell type cellular

set interfaces interface Cell enabled true

set interfaces interface Cell ipv4 dhcp point-to-point-connection true

set interfaces interface Cell filter input IN_UNTRUSTED

```
set interfaces interface Cell filter output OUT_UNTRUSTED
set interfaces interface Cell cell-config connection-profile PROFILE-1 bearer-config apn CUSTOMER-APN
```

 # IKE/IPsec configuration

```
set services vpn enabled true
set services vpn ike policy SRX240-IKE-POLICY auth-method pre-shared-key
set services vpn ike policy SRX240-IKE-POLICY pre-shared-key test123
set services vpn ike policy SRX240-IKE-POLICY ciphersuite CS1 encryption-algo aes128-cbc
set services vpn ike policy SRX240-IKE-POLICY ciphersuite CS1 mac-algo sha256-hmac
set services vpn ike policy SRX240-IKE-POLICY ciphersuite CS1 dh-group dh14
set services vpn ike peer SRX240-IKE-PEER ike-policy SRX240-IKE-POLICY
set services vpn ike peer SRX240-IKE-PEER local-identity default
set services vpn ike peer SRX240-IKE-PEER peer-endpoint address 172.18.175.40
set services vpn ike peer SRX240-IKE-PEER peer-identity default
set services vpn ike peer SRX240-IKE-PEER role initiator
set services vpn ipsec policy SRX240-IPSEC-POLICY ciphersuite CS1 encryption-algo aes128-cbc
set services vpn ipsec policy SRX240-IPSEC-POLICY ciphersuite CS1 mac-algo sha256-hmac
set services vpn ipsec policy SRX240-IPSEC-POLICY ciphersuite CS1 dh-group dh14
set services vpn ipsec connection SRX240 ike-peer SRX240-IKE-PEER
set services vpn ipsec connection SRX240 ipsec-policy SRX240-IPSEC-POLICY
set services vpn ipsec connection SRX240 local-ip-subnet 192.168.1.0/24
set services vpn ipsec connection SRX240 remote-ip-subnets [ 192.168.2.0/24 ]
set services vpn ipsec connection SRX240 filter input IN_TRUSTED
set services vpn ipsec connection SRX240 filter output OUT_TRUSTED
```

 # Firewall configuration

```
set services firewall enabled true
set services firewall address-set CELL-IP
set services firewall filter IN_TRUSTED rule 10 match protocol all
set services firewall filter IN_TRUSTED rule 10 actions
set services firewall filter IN_TRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp
set services firewall filter IN_UNTRUSTED rule 1 actions
set services firewall filter IN_UNTRUSTED rule 1 actions action accept
set services firewall filter IN_UNTRUSTED rule 2 match protocol udp
set services firewall filter IN_UNTRUSTED rule 2 match src-port
set services firewall filter IN_UNTRUSTED rule 2 match src-port services [ dns ]
set services firewall filter IN_UNTRUSTED rule 3 match protocol tcp
set services firewall filter IN_UNTRUSTED rule 3 match dst-port
set services firewall filter IN_UNTRUSTED rule 3 match dst-port services [ https netconf ssh ]
set services firewall filter IN_UNTRUSTED rule 10 match protocol udp
```

set services firewall filter IN_UNTRUSTED rule 10 match dst-port
set services firewall filter IN_UNTRUSTED rule 10 match dst-port services [ike ntp]
set services firewall filter IN_UNTRUSTED rule 10 actions
set services firewall filter IN_UNTRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 11 match protocol esp
set services firewall filter IN_UNTRUSTED rule 11 actions
set services firewall filter IN_UNTRUSTED rule 11 actions action accept
set services firewall filter IN_UNTRUSTED rule 12 match protocol all
set services firewall filter IN_UNTRUSTED rule 12 actions
set services firewall filter IN_UNTRUSTED rule 12 actions action drop
set services firewall filter OUT_TRUSTED rule 10 match protocol all
set services firewall filter OUT_TRUSTED rule 10 actions
set services firewall filter OUT_TRUSTED rule 10 actions action accept
set services firewall filter OUT_UNTRUSTED rule 1 match src-address
set services firewall filter OUT_UNTRUSTED rule 1 match src-address address-set CELL-IP
set services firewall filter OUT_UNTRUSTED rule 1 match src-address add-interface-address true
set services firewall filter OUT_UNTRUSTED rule 1 actions
set services firewall filter OUT_UNTRUSTED rule 1 actions action accept
set services firewall filter OUT_UNTRUSTED rule 2 match protocol all
set services firewall filter OUT_UNTRUSTED rule 2 actions
set services firewall filter OUT_UNTRUSTED rule 2 actions action drop

12.1.1.2 Status

> **show services vpn**

```
services vpn ike security-associations security-association 1
 name            SRX240
 state           ESTABLISHED
 local-host      172.18.175.138
 local-id        172.18.175.138
 remote-host     172.18.175.40
 remote-id       172.18.175.40
 initiator       true
 initiator-spi   6fae9c7ca839c195
 responder-spi   63568d4ca1c3d071
 ciphersuite     AES_CBC-128/HMAC_SHA2_256_128/PRF_HMAC_SHA2_256/MODP_2048
 established-time 1
 rekey-time      9899
 reauth-time     0
services vpn ipsec security-associations security-association 1
 name        SRX240
```

```
state        INSTALLED
mode         TUNNEL
udp-encap    false
in-spi       c4bfce67
out-spi      ef7c6bd3
ciphersuite  AES_CBC-128/HMAC_SHA2_256_128
in-bytes     0
in-packets   0
in-last-use  1619592
out-bytes    0
out-packets  0
out-last-use 0
rekey-time   2704
life-time    3599
install-time 1
local-ts     192.168.1.0/24
remote-ts    192.168.2.0/24
```

12.1.2 JUNOS

12.1.2.1 Configuration

The configuration below assumes that interface ge-0/0/0 is the external WAN interface and vlan.0 is the VLAN interface that includes all LAN ports.

```
# IKE/IPsec configuration
set security ike proposal IKE-PROP-PSK authentication-method pre-shared-keys
set security ike proposal IKE-PROP-PSK dh-group group14
set security ike proposal IKE-PROP-PSK authentication-algorithm sha-256
set security ike proposal IKE-PROP-PSK encryption-algorithm aes-128-cbc
set security ike policy IKE-POLICY-PSK proposals IKE-PROP-PSK
set security ike policy IKE-POLICY-PSK pre-shared-key ascii-text test123
set security ike gateway ORBIT138 ike-policy IKE-POLICY-PSK
set security ike gateway ORBIT138 address 172.18.175.138
set security ike gateway ORBIT138 local-identity inet 172.18.175.40
set security ike gateway ORBIT138 external-interface ge-0/0/0
set security ike gateway ORBIT138 version v2-only
set security ipsec proposal IPSEC-PROP protocol esp
set security ipsec proposal IPSEC-PROP authentication-algorithm hmac-sha-256-128
set security ipsec proposal IPSEC-PROP encryption-algorithm aes-128-cbc
set security ipsec policy IPSEC-POLICY perfect-forward-secrecy keys group14
set security ipsec policy IPSEC-POLICY proposals IPSEC-PROP
set security ipsec vpn ORBIT138 ike gateway ORBIT138
```

set security ipsec vpn ORBIT138 ike ipsec-policy

Security zone configuration

set security zones security-zone TRUST address-book address LOCAL-NET-1 192.168.2.0/24

set security zones security-zone TRUST host-inbound-traffic system-services all

set security zones security-zone TRUST interfaces vlan.0

set security zones security-zone UNTRUST address-book address ORBIT138-NET-1 192.168.1.0/24

set security zones security-zone UNTRUST host-inbound-traffic system-services ike

set security zones security-zone UNTRUST host-inbound-traffic system-services ping

set security zones security-zone UNTRUST host-inbound-traffic system-services ntp

set security zones security-zone UNTRUST interfaces ge-0/0/0.0

Security policies

set security policies from-zone TRUST to-zone UNTRUST policy ORBIT138-NET-1-SA match source-address LOCAL-NET-1

set security policies from-zone TRUST to-zone UNTRUST policy ORBIT138-NET-1-SA match destination-address ORBIT138-NET-1

set security policies from-zone TRUST to-zone UNTRUST policy ORBIT138-NET-1-SA match application any

set security policies from-zone TRUST to-zone UNTRUST policy ORBIT138-NET-1-SA then permit tunnel ipsec-vpn ORBIT138

set security policies from-zone UNTRUST to-zone TRUST policy ORBIT138-NET-1-SA match source-address ORBIT138-NET-1

set security policies from-zone UNTRUST to-zone TRUST policy ORBIT138-NET-1-SA match destination-address LOCAL-NET-1

set security policies from-zone UNTRUST to-zone TRUST policy ORBIT138-NET-1-SA match application any

set security policies from-zone UNTRUST to-zone TRUST policy ORBIT138-NET-1-SA then permit tunnel ipsec-vpn ORBIT138

12.1.2.2 Status

> show security ike security-associations

Index State Initiator cookie Responder cookie Mode Remote Address

1948863 UP 95c139a87c9cae6f 71d0c3a14c8d5663 IKEv2 172.18.175.138

> show security ipsec security-associations

Total active tunnels: 1

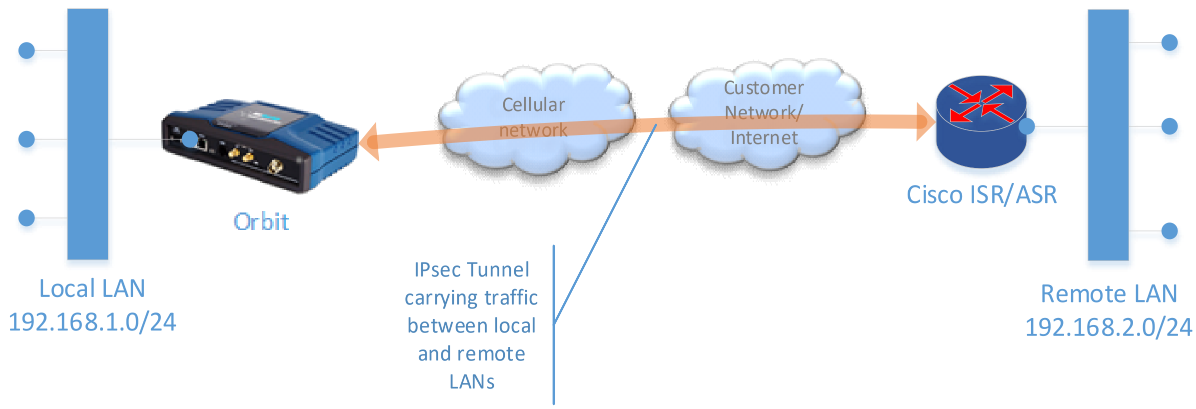
ID Algorithm SPI Life:sec/kb Mon vsys Port Gateway

<131074 ESP:aes-128/sha256 ef7c6bd3 3522/ unlim - root 500 172.18.175.138

>131074 ESP:aes-128/sha256 c4bfce67 3522/ unlim - root 500 172.18.175.138

12.2 Policy-Based IPsec VPN with Cisco IOS

Following shows a sample configuration for a site-to-site policy based IPsec VPN setup between Orbit and Cisco ISR/ASR router with IKEv2 pre-shared key based authentication.



The WAN IP address of Cisco ISR/ASR is 172.18.175.45 and Orbit cell ip address is 192.168.3.24.

12.2.1 Orbit

12.2.1.1 Configuration

 # Bridge/LAN interface configuration

set interfaces interface Bridge type bridge

set interfaces interface Bridge ipv4 address 192.168.1.1 prefix-length 24

set interfaces interface Bridge filter input IN_TRUSTED

set interfaces interface Bridge filter output OUT_TRUSTED

set interfaces interface Bridge bridge-settings members port ETH1

set interfaces interface Bridge bridge-settings members port ETH2

 # Cell interface configuration

set interfaces interface Cell type cellular

set interfaces interface Cell enabled true

set interfaces interface Cell ipv4 dhcp point-to-point-connection true

set interfaces interface Cell filter input IN_UNTRUSTED

set interfaces interface Cell filter output OUT_UNTRUSTED

set interfaces interface Cell cell-config connection-profile PROFILE-1 bearer-config apn **CUSTOMER-APN**

 # IKE/IPsec configuration

set services vpn enabled true

set services vpn ike policy IKE-POLICY auth-method pre-shared-key

set services vpn ike policy IKE-POLICY pre-shared-key test123

set services vpn ike policy IKE-POLICY ciphersuite CS1 encryption-algo aes128-cbc

set services vpn ike policy IKE-POLICY ciphersuite CS1 mac-algo sha256-hmac

set services vpn ike policy IKE-POLICY ciphersuite CS1 dh-group dh14

set services vpn ike peer IKE-PEER ike-policy IKE-POLICY

set services vpn ike peer IKE-PEER local-identity default

set services vpn ike peer IKE-PEER peer-endpoint address 172.18.175.45

set services vpn ike peer IKE-PEER peer-identity default set services vpn ike peer IKE-PEER role initiator

set services vpn ipsec policy IPSEC-POLICY ciphersuite CS1 encryption-algo aes128-cbc

set services vpn ipsec policy IPSEC-POLICY ciphersuite CS1 mac-algo sha256-hmac

set services vpn ipsec connection CISCO ike-peer IKE-PEER

set services vpn ipsec connection CISCO ipsec-policy IPSEC-POLICY

set services vpn ipsec connection CISCO local-ip-subnet 192.168.1.0/24

set services vpn ipsec connection CISCO remote-ip-subnets [192.168.2.0/24]

set services vpn ipsec connection CISCO filter input IN_TRUSTED

set services vpn ipsec connection CISCO filter output OUT_TRUSTED

Firewall configuration

set services firewall enabled true

set services firewall address-set CELL-IP

set services firewall filter IN_TRUSTED rule 10 match protocol all

set services firewall filter IN_TRUSTED rule 10 actions

set services firewall filter IN_TRUSTED rule 10 actions action accept

set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp

set services firewall filter IN_UNTRUSTED rule 1 actions

set services firewall filter IN_UNTRUSTED rule 1 actions action accept

set services firewall filter IN_UNTRUSTED rule 2 match protocol udp

set services firewall filter IN_UNTRUSTED rule 2 match src-port

set services firewall filter IN_UNTRUSTED rule 2 match src-port services [dns]

set services firewall filter IN_UNTRUSTED rule 3 match protocol tcp

set services firewall filter IN_UNTRUSTED rule 3 match dst-port

set services firewall filter IN_UNTRUSTED rule 3 match dst-port services [https netconf ssh]

set services firewall filter IN_UNTRUSTED rule 10 match protocol udp

set services firewall filter IN_UNTRUSTED rule 10 match dst-port

set services firewall filter IN_UNTRUSTED rule 10 match dst-port services [ike ntp]

set services firewall filter IN_UNTRUSTED rule 10 actions

set services firewall filter IN_UNTRUSTED rule 10 actions action accept

set services firewall filter IN_UNTRUSTED rule 11 match protocol esp

set services firewall filter IN_UNTRUSTED rule 11 actions

set services firewall filter IN_UNTRUSTED rule 11 actions action accept

set services firewall filter IN_UNTRUSTED rule 12 match protocol all

set services firewall filter IN_UNTRUSTED rule 12 actions

set services firewall filter IN_UNTRUSTED rule 12 actions action drop

set services firewall filter OUT_TRUSTED rule 10 match protocol all

set services firewall filter OUT_TRUSTED rule 10 actions

set services firewall filter OUT_TRUSTED rule 10 actions action accept

set services firewall filter OUT_UNTRUSTED rule 1 match src-address

```
set services firewall filter OUT_UNTRUSTED rule 1 match src-address address-set CELL-IP
set services firewall filter OUT_UNTRUSTED rule 1 match src-address add-interface-address true
set services firewall filter OUT_UNTRUSTED rule 1 actions
set services firewall filter OUT_UNTRUSTED rule 1 actions action accept
set services firewall filter OUT_UNTRUSTED rule 2 match protocol all
set services firewall filter OUT_UNTRUSTED rule 2 actions
set services firewall filter OUT_UNTRUSTED rule 2 actions action drop
```

12.2.1.2 Status

> show services vpn

```
services vpn ike security-associations security-association 194
 name            CISCO
 state           ESTABLISHED
 local-host      192.168.3.24
 local-id        192.168.3.24
 remote-host     172.18.175.45
 remote-id       172.18.175.45
 initiator       true
 initiator-spi   19ff75241329afca
 responder-spi   db8b71ddb5602c7a
 ciphersuite     AES_CBC-128/HMAC_SHA2_256_128/PRF_HMAC_SHA2_256/MODP_2048
 established-time 245
 rekey-time      9569
 reauth-time     1818307942
services vpn ipsec security-associations security-association 193
 name        CISCO_t1
 state       INSTALLED
 mode        TUNNEL
 udp-encap   false
 in-spi      c3eaf292
 out-spi     6029b7da
 ciphersuite AES_CBC-128/HMAC_SHA2_256_128
 in-bytes    0
 in-packets  0
 in-last-use 7
 out-bytes   0
 out-packets 0
 out-last-use 27732648
 rekey-time  2500
 life-time   3355
 install-time 245
 local-ts    172.16.23.24/32
 remote-ts   192.168.2.0/24
```

12.2.2 Cisco IOS

12.2.2.1 Configuration

The configuration below assumes that interface GigabitEthernet0/0 is the external WAN interface and the GigabitEthernet0/1 is the local LAN interface.

NOTE Please ensure that IPv4 MTU configured on external WAN interface is the same as the one assigned on Orbit's Cell interface (which is assigned by the cellular network).

```
crypto ikev2 proposal IKEV2-PROPOSAL
 encryption aes-cbc-128
 integrity sha256
 group 14
!
crypto ikev2 policy IKEV2-POLICY
 match fvrf any
 proposal IKEV2-PROPOSAL-1
!

crypto ikev2 keyring IKEV2-KEYS-24
 peer ORBIT-24
  address 192.168.3.24
  pre-shared-key local test123
  pre-shared-key remote test123

crypto ikev2 profile IKEV2-PROFILE-24
 match identity remote address 192.168.3.24 255.255.255.255
 authentication remote pre-share
 authentication local pre-share
 keyring local IKEV2-KEYS-24
!
crypto ipsec transform-set S2S-TUNNEL esp-aes esp-sha256-hmac
 mode tunnel

crypto map CMAP-24 10 ipsec-isakmp
 set peer 192.168.3.24
 set transform-set S2S-TUNNEL
 set ikev2-profile IKEV2-PROFILE-24
 match address CMAP-24
!

interface GigabitEthernet0/1
 ip address 192.168.2.1 255.255.255.0

interface GigabitEthernet0/0
 mtu 1428
 ip address 172.18.175.45 255.255.255.0
 crypto map CMAP-24

ip access-list extended CMAP-24
 permit ip 192.168.1.0 0.0.0.255 192.168.2.0 0.0.0.255
```

12.2.2.2 Status

#show crypto ikev2 sa remote 192.168.3.24

```
Tunnel-id Local              Remote              fvrf/ivrf          Status
1         172.18.175.45/4500    192.168.3.24/4500     none/none           READY
      Encr: AES-CBC, keysize: 128, Hash: SHA256, DH Grp:14, Auth sign: PSK, Auth verify: PSK
      Life/Active Time: 86400/1083 sec
```

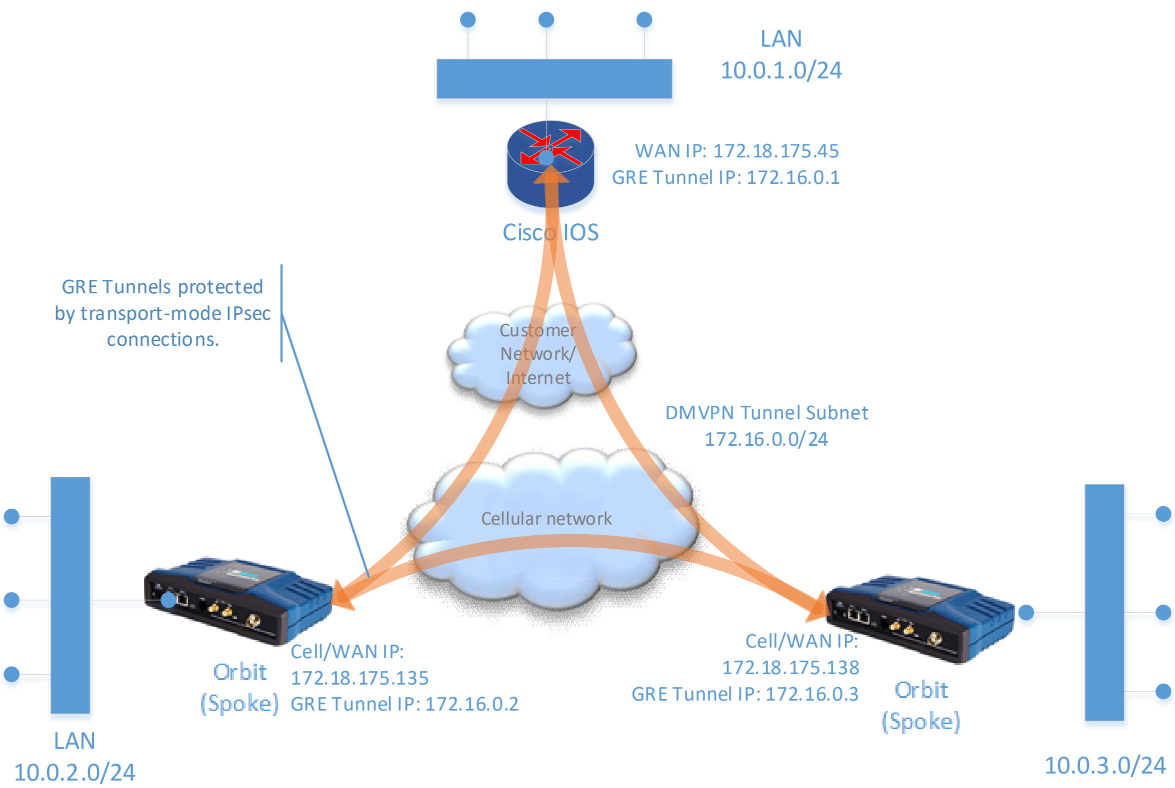
#show crypto ipsec sa peer 192.168.3.24

```
interface: GigabitEthernet0/0
    Crypto map tag: CMAP-24, local addr 172.18.175.45

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (192.168.2.0/255.255.255.0/0/0)
   remote ident (addr/mask/prot/port): (192.168.1.0/255.255.255.0/0/0)
```

```
current_peer 192.168.3.24 port 4500
  PERMIT, flags={origin_is_acl,}
 #pkts encaps: 0, #pkts encrypt: 0, #pkts digest: 0
 #pkts decaps: 0, #pkts decrypt: 0, #pkts verify: 0
 #pkts compressed: 0, #pkts decompressed: 0
 #pkts not compressed: 0, #pkts compr. failed: 0
 #pkts not decompressed: 0, #pkts decompress failed: 0
 #send errors 0, #recv errors 0

  local crypto endpt.: 172.18.175.45, remote crypto endpt.: 192.168.3.24
  path mtu 1428, ip mtu 1428, ip mtu idb GigabitEthernet0/0
  current outbound spi: 0xC3EAF292(3286954642)
  PFS (Y/N): N, DH group: none

  inbound esp sas:
   spi: 0x6029B7DA(1613346778)
     transform: esp-aes esp-sha256-hmac ,
     in use settings ={Tunnel, }
     conn id: 3395, flow_id: Onboard VPN:1395, sibling_flags 80000040, crypto map: CMAP-24
     sa timing: remaining key lifetime (k/sec): (4608000/2495)
     IV size: 16 bytes
     replay detection support: N
     Status: ACTIVE(ACTIVE)

  inbound ah sas:

  inbound pcp sas:

  outbound esp sas:
   spi: 0xC3EAF292(3286954642)
     transform: esp-aes esp-sha256-hmac ,
     in use settings ={Tunnel, }
     conn id: 3396, flow_id: Onboard VPN:1396, sibling_flags 80000040, crypto map: CMAP-24
     sa timing: remaining key lifetime (k/sec): (4608000/2495)
     IV size: 16 bytes
     replay detection support: N
     Status: ACTIVE(ACTIVE)

  outbound ah sas:

  outbound pcp sas:
```

12.3 DMVPN with Cisco IOS

In this example we describe a sample configuration for a DMVPN between Orbit MCR (2E1S) and Cisco ISR 1941 router with IKEv2 public-key based authentication using RSA certificates generated from 3-tier PKI. That is, there are 3 CAs- Root CA->Sub CA-1->Sub CA-2. The Orbit client certificate is issued by Sub CA-2.



In example below, we disable default route over Cell and instead setup BGP dynamic routing that advertises the local LAN network to the IOS router and received default route over the GRE tunnel form IOS router.

12.3.1 Orbit

12.3.1.1 Configuration

 # NTP configuration

set system ntp use-ntp true

set system ntp ntp-server 172.18.175.62

 # Bridge/LAN interface configuration

set interfaces interface Bridge type bridge

set interfaces interface Bridge ipv4 address 10.0.3.0 prefix-length 24

set interfaces interface Bridge filter input IN_TRUSTED

set interfaces interface Bridge filter output OUT_TRUSTED

set interfaces interface Bridge bridge-settings members port ETH1 set interfaces interface Bridge bridge-settings members port ETH2

 # Cell interface configuration

 # Ensure that the MTU configured on WAN interface of IOS router matches the cell interface MTU (default=1428).

set interfaces interface Cell type cellular

set interfaces interface Cell enabled true

 # Disable default route over Cell interface

set interfaces interface Cell ipv4 dhcp request-routers false

set interfaces interface Cell ipv4 dhcp point-to-point-connection true

set interfaces interface Cell filter input IN_UNTRUSTED

set interfaces interface Cell filter output OUT_UNTRUSTED

set interfaces interface Cell cell-config connection-profile PROFILE-1 bearer-config apn **CUSTOMER-APN**

 # IKE/IPsec Configuration

set services vpn enabled true

set services vpn ike policy DMVPN-CERT version ikev2

set services vpn ike policy DMVPN-CERT auth-method pub-key

set services vpn ike policy DMVPN-CERT pki cert-type rsa

 # Client certificate is installed as ID1

set services vpn ike policy DMVPN-CERT pki cert-id ID1

 # Client private key pair is generated as ID1

set services vpn ike policy DMVPN-CERT pki key-id ID1

 # Root CA certificate is installed as CA1

set services vpn ike policy DMVPN-CERT pki ca-cert-id CA1

 # Sub CA certificates are installed as SUBCA1 and SUBCA2.

set services vpn ike policy DMVPN-CERT pki sub-ca-cert-ids [SUBCA1 SUBCA2]

set services vpn ike policy DMVPN-CERT ciphersuite CS1 encryption-algo aes256-cbc

set services vpn ike policy DMVPN-CERT ciphersuite CS1 mac-algo sha1-hmac

set services vpn ike policy DMVPN-CERT ciphersuite CS1 dh-group dh5

set services vpn ike peer DMVPN ike-policy DMVPN-CERT

set services vpn ike peer DMVPN peer-endpoint any

set services vpn ike peer DMVPN role responder

set services vpn ipsec policy DMVPN ciphersuite CS1 encryption-algo aes256-cbc

set services vpn ipsec policy DMVPN ciphersuite CS1 mac-algo sha1-hmac

set services vpn ipsec connection DMVPN ike-peer DMVPN

set services vpn ipsec connection DMVPN ipsec-policy DMVPN

set services vpn ipsec connection DMVPN host-to-host

set services vpn ipsec connection DMVPN filter input IN_TRUSTED

set services vpn ipsec connection DMVPN filter output OUT_TRUSTED

 # Multipoint GRE tunnel configuration

set interfaces interface GRE1 type gre

set interfaces interface GRE1 enabled true

set interfaces interface GRE1 gre-config mode ip-over-gre

set interfaces interface GRE1 gre-config src-address 0.0.0.0

set interfaces interface GRE1 gre-config dst-address 0.0.0.0

 # Ensure that the key matches with one configured on GRE tunnel on IOS router.

set interfaces interface GRE1 gre-config key 10000

set interfaces interface GRE1 gre-config ipsec-connection DMVPN

 # Ensure that the MTU matches with one configured on GRE tunnel on IOS router.

set interfaces interface GRE1 ipv4 mtu 1346

set interfaces interface GRE1 ipv4 address 172.16.0.3 prefix-length 24

set interfaces interface GRE1 filter input IN_TRUSTED

set interfaces interface GRE1 filter output OUT_TRUSTED

 # NHRP service configuration

set services nhrp enabled true

set services nhrp interface Bridge shortcut-destination

set services nhrp interface GRE1 map HUB protocol-address 172.16.0.1

set services nhrp interface GRE1 map HUB protocol-netmask 255.255.255.0

set services nhrp interface GRE1 map HUB nbma-address 172.18.175.45

set services nhrp interface GRE1 map HUB register true

set services nhrp interface GRE1 map HUB cisco true

set services nhrp interface GRE1 authentication cisco123

set services nhrp interface GRE1 holding-time 300

 # BGP routing configuration

 # This configuration exports the local LAN network to the IOS router and imports default route over the GRE tunnel from the IOS router.

set routing router-id 172.16.0.3

set routing route-filter LOCAL-LAN rule 1 match outgoing-interface Bridge

set routing route-filter LOCAL-LAN rule 1 actions action accept

 # Following static route allows Orbit to reach the IOS router

set routing static-routes ipv4 route 1 outgoing-interface Cell

set routing static-routes ipv4 route 1 dest-prefix 172.18.175.0/24

set routing bgp neighbor PRIMARY-HUB peer-address 172.16.0.1

set routing bgp neighbor PRIMARY-HUB enabled true

 # Following export filter enables the local LAN subnet to be advertised to the IOS router

set routing bgp neighbor PRIMARY-HUB export-filter LOCAL-LAN

set routing bgp neighbor PRIMARY-HUB local-as 65550

set routing bgp neighbor PRIMARY-HUB peer-as 65500

```
set routing bgp neighbor PRIMARY-HUB hold-time 30
set routing bgp neighbor PRIMARY-HUB keepalive-time 10
```

 # Firewall configuration

```
set services firewall enabled true
set services firewall address-set CELL-IP
set services firewall filter IN_TRUSTED rule 10 match protocol all
set services firewall filter IN_TRUSTED rule 10 actions
set services firewall filter IN_TRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp
set services firewall filter IN_UNTRUSTED rule 1 actions
set services firewall filter IN_UNTRUSTED rule 1 actions action accept
set services firewall filter IN_UNTRUSTED rule 2 match protocol udp
set services firewall filter IN_UNTRUSTED rule 2 match src-port
set services firewall filter IN_UNTRUSTED rule 2 match src-port services [ dns ]
set services firewall filter IN_UNTRUSTED rule 3 match protocol tcp
set services firewall filter IN_UNTRUSTED rule 3 match dst-port
set services firewall filter IN_UNTRUSTED rule 3 match dst-port services [ https netconf ssh ]
set services firewall filter IN_UNTRUSTED rule 10 match protocol udp
set services firewall filter IN_UNTRUSTED rule 10 match dst-port
set services firewall filter IN_UNTRUSTED rule 10 match dst-port services [ ike ntp ]
set services firewall filter IN_UNTRUSTED rule 10 actions
set services firewall filter IN_UNTRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 11 match protocol esp
set services firewall filter IN_UNTRUSTED rule 11 actions
set services firewall filter IN_UNTRUSTED rule 11 actions action accept
set services firewall filter IN_UNTRUSTED rule 12 match protocol all
set services firewall filter IN_UNTRUSTED rule 12 actions
set services firewall filter IN_UNTRUSTED rule 12 actions action drop
set services firewall filter OUT_TRUSTED rule 10 match protocol all
set services firewall filter OUT_TRUSTED rule 10 actions
set services firewall filter OUT_TRUSTED rule 10 actions action accept
set services firewall filter OUT_UNTRUSTED rule 1 match src-address
set services firewall filter OUT_UNTRUSTED rule 1 match src-address address-set CELL-IP
set services firewall filter OUT_UNTRUSTED rule 1 match src-address add-interface-address true
set services firewall filter OUT_UNTRUSTED rule 1 actions
set services firewall filter OUT_UNTRUSTED rule 1 actions action accept
set services firewall filter OUT_UNTRUSTED rule 2 match protocol all
set services firewall filter OUT_UNTRUSTED rule 2 actions
set services firewall filter OUT_UNTRUSTED rule 2 actions action drop
```

12.3.1.2 Status

 # IKE/IPsec status

> show services vpn

```
services vpn ike security-associations security-association 5
 name            DMVPN
 state           ESTABLISHED
 local-host      172.18.175.138
 local-id        "C=US, ST=NY, L=Rochester, O=GE MDS, OU=ENGG, CN=VZW138.com"
 remote-host     172.18.175.45
 remote-id       "CN=DMVPN-HUB.com, OU=ENGG, O=GE MDS, L=Rochester, ST=NY, C=US,
unstructuredName=DMVPN-HUB.com"
 initiator       true
 initiator-spi   ba596984ff972043
 responder-spi   0c2e769cbc243bf3
 ciphersuite     AES_CBC-256/HMAC_SHA1_96/PRF_HMAC_SHA1/MODP_1536
 established-time 574
 rekey-time      9200
 reauth-time     2075232
services vpn ipsec security-associations security-association 4
 name        DMVPN
 state       INSTALLED
 mode        TRANSPORT
 udp-encap   false
 in-spi      c0b5d5d0
 out-spi     26c5d2f3
 ciphersuite AES_CBC-256/HMAC_SHA1_96
 in-bytes    34106
 in-packets  492
 in-last-use 1
 out-bytes   9094
 out-packets 140
 out-last-use 2
 rekey-time  2195
 life-time   3026
 install-time 575
 local-ts    172.18.175.138/32[gre]
 remote-ts   172.18.175.45/32[gre]
```

 # NHRP status

> show services nhrp

```
                                        EXPIRES
NBMA ADDRESS   PROTOCOL ADDRESS  STATE    TYPE    IN
-----------------------------------------------------------
0.0.0.0        192.168.1.255/32  up       local
0.0.0.0        192.168.1.11/32   up       local
0.0.0.0        192.168.1.0/32    up       local
0.0.0.0        192.168.1.0/24    up       local
0.0.0.0        172.16.0.3/32     up       local
172.18.175.45  172.16.0.1/24     used up  static
```

 # Routing status

 # The highlighted default route is received from the IOS router via BGP.

> show routing-state routes

```
                        OUTGOING
DEST PREFIX      NEXT HOP    INTERFACE   SOURCE
--------------------------------------------------
0.0.0.0/0        172.16.0.1  GRE1        dynamic
10.0.3.0/24      -           Bridge      kernel
172.16.0.0/24    -           GRE1        kernel
172.18.175.0/24  -           Cell        static
```

> show routing-state bgp

```
routing-state bgp neighbor PRIMARY-HUB
 routing-instance inet.main
 state           up
 preference      100
 import-filter   ACCEPT
 export-filter   LOCAL-LAN
 statistics import-updates-received 1
 statistics import-updates-rejected 0
 statistics import-updates-filtered 0
 statistics import-updates-ignored 0
 statistics import-updates-accepted 1
 statistics import-withdraws-received 0
 statistics import-withdraws-rejected 0
 statistics import-withdraws-ignored 0
 statistics import-withdraws-accepted 0
 statistics export-updates-received 8
 statistics export-updates-rejected 1
 statistics export-updates-filtered 6
 statistics export-updates-accepted 1
```

```
 statistics export-withdraws-received 0
 statistics export-withdraws-accepted 0
 local-state      established
 peer-address     172.16.0.1
 peer-as          65500
 peer-id          172.16.0.1
 local-address    172.16.0.3
 hold-time        18/30
 keepalive-time   9/10
```

12.3.2 Cisco IOS

12.3.2.1 Configuration

```
# NTP configuration
ntp server 172.18.175.62
!

# Local LAN network interface configuration
interface GigabitEthernet0/1
 ip address 10.0.1.0 255.255.255.0
 duplex auto
 speed auto
!

# WAN network interface configuration
interface GigabitEthernet0/0
# Ensure that the MTU configured matches the cell interface MTU (default=1428).
 mtu 1428
 ip address 172.18.175.45 255.255.255.0
 duplex auto
 speed auto
!

# Certificate configuration
crypto pki trustpoint DMVPN-3-TIER-SUBCA-2
 enrollment terminal pem
 subject-name C=US, ST=NY, L=Rochester, O=GE MDS, OU=ENGG, CN=DMVPN-HUB.com
 revocation-check none
 rsakeypair DMVPN-3-TIER-SUBCA-2 2048
!
```

```
# Below assumes that Orbit client certificates have 'orbit' string in the common name. This enables this ceritificate map to be used for all Orbits that connect to this router.
crypto pki certificate map ORBIT_CERT_MAP 1
 subject-name co cn = orbit
!
# NOTE: Only client certificate and SUB CA-2 certificate needs to be installed.
crypto pki certificate chain DMVPN-3-TIER-SUBCA-2
 certificate 0B
<CONTENTS REMOVED FOR BREVITY>
     quit
 certificate ca 02
<CONTENTS REMOVED FOR BREVITY>
     quit

# IKE/IPsec configuration
crypto ikev2 proposal DMVPN_IKEV2_PROPOSAL
 encryption aes-cbc-256
 integrity sha1
 group 5
!
crypto ikev2 policy DMVPN_IKEV2_POLICY
 match fvrf any
 proposal DMVPN_IKEV2_PROPOSAL
!
crypto ikev2 profile DMVPN_IKEV2_PROFILE
 match certificate ORBIT_CERT_MAP
 identity local dn
 authentication remote rsa-sig
 authentication local rsa-sig
 pki trustpoint DMVPN-3-TIER-SUBCA-2
 dpd 10 3 periodic
!
crypto ipsec transform-set DMVPN_TRANSFORM esp-aes 256 esp-sha-hmac
 mode transport
!
crypto ipsec profile DMVPN
 set transform-set DMVPN_TRANSFORM
 set ikev2-profile DMVPN_IKEV2_PROFILE
!

# Multipoint GRE tunnel configuration
interface Tunnel0
```

```
 description DMVPN NETWORK
 ip address 172.16.0.1 255.255.255.0
 no ip redirects
```

#Ensure that MTU matches one configured on the GRE interface on Orbit.

```
 ip mtu 1346
 ip nhrp authentication cisco123
 ip nhrp map multicast dynamic
 ip nhrp network-id 99
 ip nhrp holdtime 300
 ip nhrp shortcut
 ip nhrp redirect
 no ip split-horizon
 ip tcp adjust-mss 1300
tunnel source GigabitEthernet0/0
 tunnel mode gre multipoint
 tunnel key 10000
 tunnel protection ipsec profile DMVPN
!
```

 # BGP routing configuration

```
router bgp 65500
 bgp router-id 172.16.0.1
 bgp log-neighbor-changes
 # Ensure below limit accommodates the maximum number of spokes
 bgp listen limit 5000
 bgp listen range 172.16.0.0/24 peer-group DMVPN-SPOKE
 neighbor DMVPN-SPOKE peer-group
 neighbor DMVPN-SPOKE remote-as 65550
 neighbor DMVPN-SPOKE next-hop-self
 neighbor DMVPN-SPOKE default-originate
!
ip route 0.0.0.0 0.0.0.0 172.18.175.62
!
```

12.3.2.2 Status

#IKE/IPsec status

DMVPN-HUB#show crypto ikev2 sa

```
 IPv4 Crypto IKEv2  SA

Tunnel-id Local                 Remote                fvrf/ivrf         Status
1         172.18.175.45/4500    172.18.175.138/4500   none/none         READY
```

```
     Encr: AES-CBC, keysize: 256, Hash: SHA96, DH Grp:5, Auth sign: RSA, Auth verify: RSA
     Life/Active Time: 86400/1714 sec

 IPv6 Crypto IKEv2  SA
```

DMVPN-HUB#show crypto ipsec sa

```
interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 172.18.175.45

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (172.18.175.45/255.255.255.255/47/0)
   remote ident (addr/mask/prot/port): (172.18.175.138/255.255.255.255/47/0)
   current_peer 172.18.175.138 port 4500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 32660, #pkts encrypt: 32660, #pkts digest: 32660
    #pkts decaps: 13845, #pkts decrypt: 13845, #pkts verify: 13845
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0

     local crypto endpt.: 172.18.175.45, remote crypto endpt.: 172.18.175.138
     path mtu 1500, ip mtu 1500, ip mtu idb (none)
     current outbound spi: 0xCF3F2463(3477021795)
     PFS (Y/N): N, DH group: none

     inbound esp sas:
      spi: 0x1BB50496(464848022)
        transform: esp-256-aes esp-sha-hmac ,
        in use settings ={Transport, }
        conn id: 2681, flow_id: Onboard VPN:681, sibling_flags 80000000, crypto map: Tunnel0-head-0
        sa timing: remaining key lifetime (k/sec): (4255357/2041)
        IV size: 16 bytes
        replay detection support: N
        Status: ACTIVE(ACTIVE)

     inbound ah sas:

     inbound pcp sas:
```

```
    outbound esp sas:
     spi: 0xCF3F2463(3477021795)
       transform: esp-256-aes esp-sha-hmac ,
       in use settings ={Transport, }
       conn id: 2682, flow_id: Onboard VPN:682, sibling_flags 80000000, crypto map: Tunnel0-head-0
       sa timing: remaining key lifetime (k/sec): (4255276/2041)
       IV size: 16 bytes
       replay detection support: N
       Status: ACTIVE(ACTIVE)

    outbound ah sas:

    outbound pcp sas:
```

 # NHRP status

DMVPN-HUB#show dmvpn

```
Legend: Attrb --> S - Static, D - Dynamic, I - Incomplete
        N - NATed, L - Local, X - No Socket
        # Ent --> Number of NHRP entries with same NBMA peer
        NHS Status: E --> Expecting Replies, R --> Responding, W --> Waiting
        UpDn Time --> Up or Down Time for a Tunnel
==========================================================================

Interface: Tunnel0, IPv4 NHRP Details
Type:Hub, NHRP Peers:1,

 # Ent  Peer NBMA Addr Peer Tunnel Add State  UpDn Tm Attrb
 ----- --------------- --------------- ----- -------- -----
     1 172.18.175.138       172.16.0.3    UP 16:55:28     D
```

 # Routing status

 # The highlighted route is the LAN network route received from Orbit via BGP.

DMVPN-HUB#show ip route

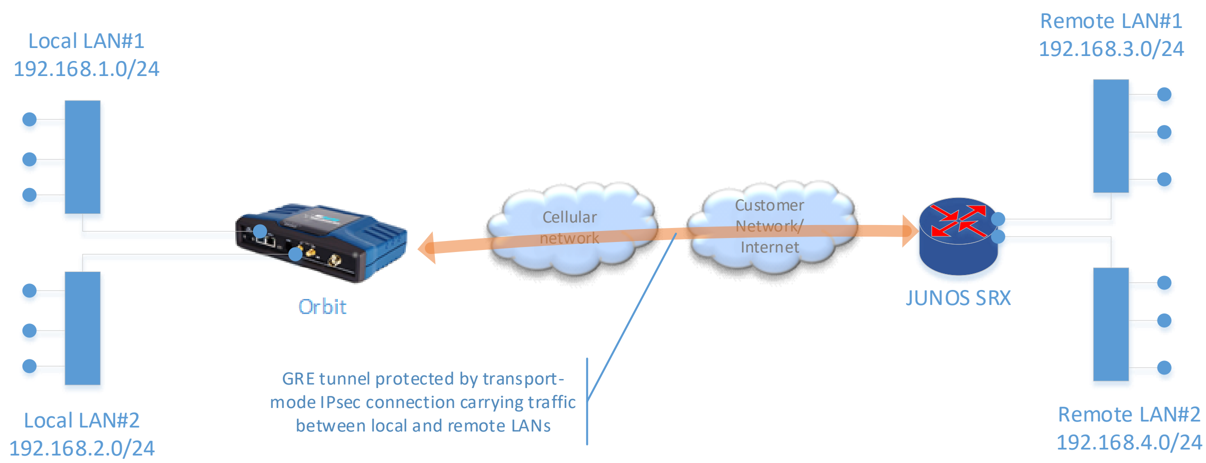
```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
```

```
    + - replicated route, % - next hop override

Gateway of last resort is 172.18.175.62 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 172.18.175.62
      10.0.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        10.0.1.0/24 is directly connected, GigabitEthernet0/1
L        10.0.1.1/32 is directly connected, GigabitEthernet0/1
         172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.0.0/24 is directly connected, Tunnel0
L        172.16.0.1/32 is directly connected, Tunnel0
      172.18.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.18.175.0/24 is directly connected, GigabitEthernet0/0
L        172.18.175.45/32 is directly connected, GigabitEthernet0/0
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
B        192.168.1.0/24 [20/0] via 172.16.0.3, 16:54:41
```

12.4 GRE/IPsec with Juniper JUNOS

In this example, we describe a sample configuration for a GRE/IPsec between Orbit MCR (2E1S) and Juniepr SRX240 with IKEv2 pre-shared key authentication.

NOTE The Juniper JUNOS based devices do not support IPsec transport mode for data traffic. Therefore, to protect GRE traffic one needs to setup IPsec tunnel instead of IPsec transport mode connection. This leads to double tunneling- GRE tunnel within IPsec tunnel. Also, GRE tunneling over IPsec tunnel is only supported for route-based tunnel setup.



12.4.1 Orbit

12.4.1.1 Configuration

 # Bridge/LAN#1 interface configuration

set interfaces interface Bridge type bridge

set interfaces interface Bridge ipv4 address 192.168.1.1 prefix-length 24

set interfaces interface Bridge filter input IN_TRUSTED

set interfaces interface Bridge filter output OUT_TRUSTED

set interfaces interface Bridge bridge-settings members port ETH1

Bridge/LAN#2 interface configuration

set interfaces interface Bridge2 type bridge

set interfaces interface Bridge2 ipv4 address 192.168.2.1 prefix-length 24

set interfaces interface Bridge2 filter input IN_TRUSTED

set interfaces interface Bridge2 filter output OUT_TRUSTED

set interfaces interface Bridge2 bridge-settings members port ETH1

Cell interface configuration

set interfaces interface Cell type cellular

set interfaces interface Cell enabled true

set interfaces interface Cell ipv4 dhcp point-to-point-connection true

set interfaces interface Cell filter input IN_UNTRUSTED

set interfaces interface Cell filter output OUT_UNTRUSTED

set interfaces interface Cell cell-config connection-profile PROFILE-1 bearer-config apn **CUSTOMER-APN**

Loopback interface used as source address for GRE tunnels towards JUNOS

This is required for GRE traffic to ride on IPsec tunnel

set interfaces interface LO-SRX240 type loopback

set interfaces interface LO-SRX240 ipv4 address 172.16.1.2 prefix-length 32

IKE/IPsec configuration

set services vpn enabled true

set services vpn ike policy SRX240-IKE-POLICY auth-method pre-shared-key

set services vpn ike policy SRX240-IKE-POLICY pre-shared-key test123

set services vpn ike policy SRX240-IKE-POLICY ciphersuite CS1 encryption-algo aes128-cbc

set services vpn ike policy SRX240-IKE-POLICY ciphersuite CS1 mac-algo sha256-hmac

set services vpn ike policy SRX240-IKE-POLICY ciphersuite CS1 dh-group dh14

set services vpn ike peer SRX240-IKE-PEER ike-policy SRX240-IKE-POLICY

set services vpn ike peer SRX240-IKE-PEER local-identity default

set services vpn ike peer SRX240-IKE-PEER peer-endpoint address 172.18.175.40

set services vpn ike peer SRX240-IKE-PEER peer-identity default

set services vpn ike peer SRX240-IKE-PEER role initiator

set services vpn ipsec policy SRX240-IPSEC-POLICY ciphersuite CS1 encryption-algo aes128-cbc

set services vpn ipsec policy SRX240-IPSEC-POLICY ciphersuite CS1 mac-algo sha256-hmac

set services vpn ipsec policy SRX240-IPSEC-POLICY ciphersuite CS1 dh-group dh14
set services vpn ipsec connection SRX240 ike-peer SRX240-IKE-PEER
set services vpn ipsec connection SRX240 ipsec-policy SRX240-IPSEC-POLICY
set services vpn ipsec connection SRX240 local-ip-subnet 172.16.1.2/32
set services vpn ipsec connection SRX240 remote-ip-subnets 172.16.1.1/32
set services vpn ipsec connection SRX240 filter input IN_TRUSTED
set services vpn ipsec connection SRX240 filter output OUT_TRUSTED

GRE interface configuration

set interfaces interface GRE-SRX240 type gre
set interfaces interface GRE-SRX240 gre-config mode ip-over-gre
set interfaces interface GRE-SRX240 gre-config src-address 172.16.1.2
set interfaces interface GRE-SRX240 gre-config dst-address 172.16.1.1
set interfaces interface GRE-SRX240 ipv4 mtu 1250
set interfaces interface GRE-SRX240 ipv4 address 10.1.1.2 prefix-length 30
set interfaces interface GRE-SRX240 filter input IN_TRUSTED
set interfaces interface GRE-SRX240 filter output OUT_TRUSTED

Routing configuration

set routing static-routes ipv4 route 1 dest-prefix 192.168.3.0/24
set routing static-routes ipv4 route 1 outgoing-interface GRE-SRX240
set routing static-routes ipv4 route 1 dest-prefix 192.168.4.0/24
set routing static-routes ipv4 route 1 outgoing-interface GRE-SRX240

Firewall configuration

set services firewall enabled true
set services firewall address-set CELL-IP
set services firewall filter IN_TRUSTED rule 10 match protocol all
set services firewall filter IN_TRUSTED rule 10 actions
set services firewall filter IN_TRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 1 match protocol icmp
set services firewall filter IN_UNTRUSTED rule 1 actions
set services firewall filter IN_UNTRUSTED rule 1 actions action accept
set services firewall filter IN_UNTRUSTED rule 2 match protocol udp
set services firewall filter IN_UNTRUSTED rule 2 match src-port
set services firewall filter IN_UNTRUSTED rule 2 match src-port services [dns]
set services firewall filter IN_UNTRUSTED rule 3 match protocol tcp
set services firewall filter IN_UNTRUSTED rule 3 match dst-port
set services firewall filter IN_UNTRUSTED rule 3 match dst-port services [https netconf ssh]
set services firewall filter IN_UNTRUSTED rule 10 match protocol udp
set services firewall filter IN_UNTRUSTED rule 10 match dst-port

```
set services firewall filter IN_UNTRUSTED rule 10 match dst-port services [ ike ntp ]
set services firewall filter IN_UNTRUSTED rule 10 actions
set services firewall filter IN_UNTRUSTED rule 10 actions action accept
set services firewall filter IN_UNTRUSTED rule 11 match protocol esp
set services firewall filter IN_UNTRUSTED rule 11 actions
set services firewall filter IN_UNTRUSTED rule 11 actions action accept
set services firewall filter IN_UNTRUSTED rule 12 match protocol all
set services firewall filter IN_UNTRUSTED rule 12 actions
set services firewall filter IN_UNTRUSTED rule 12 actions action drop
set services firewall filter OUT_TRUSTED rule 10 match protocol all
set services firewall filter OUT_TRUSTED rule 10 actions
set services firewall filter OUT_TRUSTED rule 10 actions action accept
set services firewall filter OUT_UNTRUSTED rule 1 match src-address
set services firewall filter OUT_UNTRUSTED rule 1 match src-address address-set CELL-IP
set services firewall filter OUT_UNTRUSTED rule 1 match src-address add-interface-address true
set services firewall filter OUT_UNTRUSTED rule 1 actions
set services firewall filter OUT_UNTRUSTED rule 1 actions action accept
set services firewall filter OUT_UNTRUSTED rule 2 match protocol all
set services firewall filter OUT_UNTRUSTED rule 2 actions
set services firewall filter OUT_UNTRUSTED rule 2 actions action drop
```

12.4.1.2 Status

#IKE/IPsec status

> show services vpn

```
services vpn ike security-associations security-association 54
 name            SRX240_SA
 state           ESTABLISHED
 local-host      172.18.175.135
 local-id        172.18.175.135
 remote-host     172.18.175.40
 remote-id       172.18.175.40
 initiator       true
 initiator-spi   78c786f79094ac55
 responder-spi   c5aa90f242499e8d
 ciphersuite     AES_CBC-128/HMAC_SHA2_256_128/PRF_HMAC_SHA2_256/MODP_2048
 established-time 694
 rekey-time      9143
 reauth-time     1852140901
services vpn ipsec security-associations security-association 196
 name        SRX240_SA
```

```
state        INSTALLED
mode         TUNNEL
udp-encap    false
in-spi       cce4cde5
out-spi      4c84f08c
ciphersuite  AES_CBC-128/HMAC_SHA2_256_128/MODP_2048
in-bytes     0
in-packets   0
in-last-use  1621200
out-bytes    0
out-packets  0
out-last-use 0
rekey-time   708
life-time    1590
install-time 2010
local-ts     172.16.1.2/32
remote-ts    172.16.1.1/32
```

 # Routing status

> show routing-state routes

```
                          OUTGOING
DEST PREFIX      NEXT HOP      INTERFACE     SOURCE
-----------------------------------------------------
0.0.0.0/0        -             Cell          kernel
10.1.1.0/30      -             GRE-SRX240    kernel
192.168.1.0/24   -             Bridge        kernel
192.168.2.0/24   -             Bridge2       kernel
172.16.1.1/32    172.18.175.40 Cell          static
```

12.4.2 JUNOS

12.4.2.1 Configuration

 # WAN external interface

 # NOTE: Ensure that MTU value matches that configured on Cell interface on Orbit (default=1428).

```
set interfaces ge-0/0/0 unit 0 family inet mtu 1428
set interfaces ge-0/0/0 unit 0 family inet address 172.18.175.40/26
```

 # Local LAN#1 interface

```
set interfaces vlan unit 0 family inet address 192.168.3.1/24
set interfaces ge-0/0/1 unit 0 family ethernet-switching vlan members vlan-trust-1
set vlans vlan-trust-1 vlan-id 1
set vlans vlan-trust l3-interface vlan.0
```

 # Local LAN#2 interface

set interfaces vlan unit 1 family inet address 192.168.4.1/24

set interfaces ge-0/0/2 unit 0 family ethernet-switching vlan members vlan-trust-2

set vlans vlan-trust-2 vlan-id 2

set vlans vlan-trust l3-interface vlan.1

 # Loopback interface used as source address for GRE tunnels towards Orbits

set interfaces lo0 unit 0 family inet address 172.16.1.1/32

 # Qos Traffic shaping (optional)

set interfaces gr-0/0/0 per-unit-scheduler

set chassis fpc 0 pic 0 tunnel-queuing

 # Common routing

set routing-options static route 0.0.0.0/0 next-hop 172.18.175.62

 # Common IKE

set security ike proposal IKE-PROP-PSK authentication-method pre-shared-keys

set security ike proposal IKE-PROP-PSK dh-group group14

set security ike proposal IKE-PROP-PSK authentication-algorithm sha-256

set security ike proposal IKE-PROP-PSK encryption-algorithm aes-128-cbc

set security ike policy IKE-POLICY-PSK proposals IKE-PROP-PSK

set security ike policy IKE-POLICY-PSK pre-shared-key ascii-text test123

 # Common IPsec

set security ipsec proposal IPSEC-PROP protocol esp

set security ipsec proposal IPSEC-PROP authentication-algorithm hmac-sha-256-128

set security ipsec proposal IPSEC-PROP encryption-algorithm aes-128-cbc

set security ipsec policy IPSEC-POLICY perfect-forward-secrecy keys group14

set security ipsec policy IPSEC-POLICY proposals IPSEC-PROP

 # Common Policies

set security policies from-zone TRUST to-zone TRUST policy TTT match source-address any

set security policies from-zone TRUST to-zone TRUST policy TTT match destination-address any

set security policies from-zone TRUST to-zone TRUST policy TTT match application any

set security policies from-zone TRUST to-zone TRUST policy TTT then permit

 # Common zones

set security zones security-zone TRUST address-book address LOCAL-NET-1 172.16.1.1/32 set security zones security-zone TRUST host-inbound-traffic system-services all

set security zones security-zone TRUST interfaces vlan.0

set security zones security-zone TRUST interfaces vlan.1

set security zones security-zone TRUST interfaces lo0.0

set security zones security-zone UNTRUST host-inbound-traffic system-services ike

set security zones security-zone UNTRUST host-inbound-traffic system-services ping

set security zones security-zone UNTRUST host-inbound-traffic system-services ntp

set security zones security-zone UNTRUST interfaces ge-0/0/0.0

 # Config for ORBIT135

 # IPsec tunnel interface

set interfaces st0 unit 0 family inet address 10.11.11.1/30

 # GRE tunnel interface

set interfaces gr-0/0/0 unit 0 tunnel source 172.16.1.1

set interfaces gr-0/0/0 unit 0 tunnel destination 172.16.1.2

set interfaces gr-0/0/0 unit 0 family inet mtu 1250

set interfaces gr-0/0/0 unit 0 family inet address 10.1.1.1/30

 # Rate limiting applied to GRE tunnel interface (optional)

set class-of-service interfaces gr-0/0/0 unit 0 shaping-rate 1m

 # IKE

set security ike gateway ORBIT135 ike-policy IKE-POLICY-PSK

set security ike gateway ORBIT135 address 172.18.175.135

set security ike gateway ORBIT135 local-identity inet 172.18.175.40

set security ike gateway ORBIT135 external-interface ge-0/0/0

set security ike gateway ORBIT135 version v2-only

 # IPsec

set security ipsec vpn ORBIT135 bind-interface st0.0

set security ipsec vpn ORBIT135 ike gateway ORBIT135

set security ipsec vpn ORBIT135 ike ipsec-policy IPSEC-POLICY

 # IPsec policies

set security policies from-zone TRUST to-zone VPN-ORBIT135 policy ORBIT135 match source-address LOCAL-NET-1

set security policies from-zone TRUST to-zone VPN-ORBIT135 policy ORBIT135 match destination-address ORBIT135-NET-1

set security policies from-zone TRUST to-zone VPN-ORBIT135 policy ORBIT135 match application any set security policies from-zone TRUST to-zone VPN-ORBIT135 policy ORBIT135 then permit

set security policies from-zone VPN-ORBIT135 to-zone TRUST policy ORBIT135 match source-address ORBIT135-NET-1

set security policies from-zone VPN-ORBIT135 to-zone TRUST policy ORBIT135 match destination-address LOCAL-NET-1

set security policies from-zone VPN-ORBIT135 to-zone TRUST policy ORBIT135 match application any

set security policies from-zone VPN-ORBIT135 to-zone TRUST policy ORBIT135 then permit

set security zones security-zone VPN-ORBIT135 address-book address ORBIT135-NET-1 176.16.1.2/32

set security zones security-zone VPN-ORBIT135 interfaces st0.0

set security zones security-zone TRUST interfaces gr-0/0/0.0

Routes to Orbit LAN networks

set routing-options static route 172.16.1.2/32 next-hop st0.0

set routing-options static route 192.168.1.0/24 next-hop gr-0/0/0.0

set routing-options static route 192.168.2.0/24 next-hop gr-0/0/0.0

12.4.2.2 Status

IKE/IPsec status

> show security ike security-associations

```
Index   State  Initiator cookie  Responder cookie  Mode        Remote Address
1948872 UP     55ac9490f786c778  8d9e4942f290aac5  IKEv2       172.18.175.135
```

> show security ipsec security-associations

```
  Total active tunnels: 1
  ID    Algorithm       SPI      Life:sec/kb  Mon vsys Port  Gateway
  <131073 ESP:aes-128/sha256 5e4fca36 3403/ unlim - root 500  172.18.175.135
  >131073 ESP:aes-128/sha256 cb6ed905 3403/ unlim - root 500  172.18.175.135
```

Routing status

> show route

```
0.0.0.0/0          *[Static/5] 1w5d 18:34:56
                    > to 172.18.175.62 via ge-0/0/0.0
10.1.1.0/30         *[Direct/0] 1w5d 18:35:02
                    > via gr-0/0/0.0
10.1.1.1/32         *[Local/0] 1w5d 18:35:02
                      Local via gr-0/0/0.0
10.11.11.0/30       *[Direct/0] 1w5d 20:14:32
                    > via st0.0
10.11.11.1/32       *[Local/0] 1w5d 20:14:32
                      Local via st0.0
```

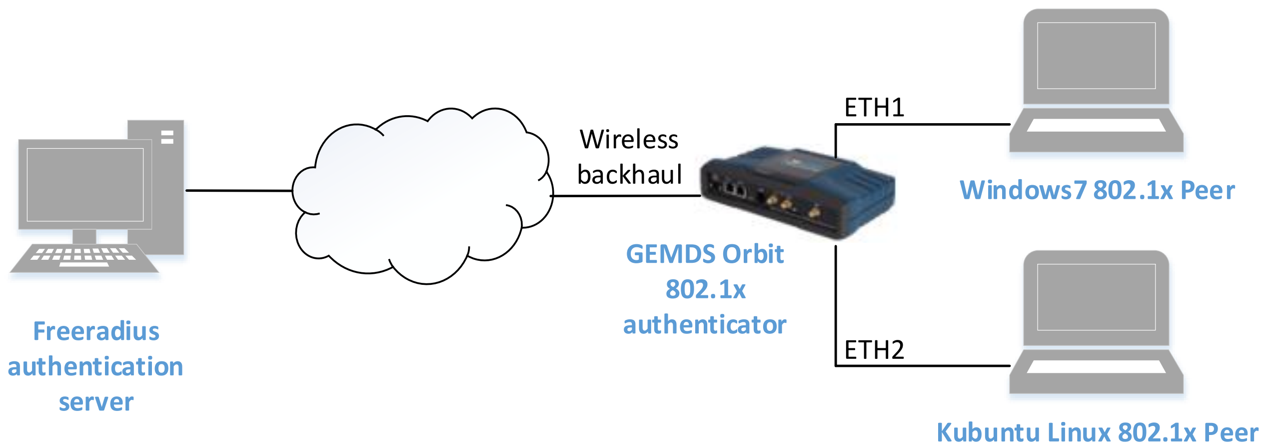
```
172.16.1.1/32      *[Direct/0] 1w5d 20:14:55
                   > via lo0.0
172.16.1.2/32      *[Static/5] 1w2d 20:03:32
                   > via st0.0
172.18.175.0/26    *[Direct/0] 1w5d 18:34:56
                   > via ge-0/0/0.0
172.18.175.40/32   *[Local/0] 1w5d 18:35:03
                     Local via ge-0/0/0.0
192.168.3.0/24     *[Direct/0] 1w5d 18:34:56
                   > via vlan.0
192.168.3.1/32     *[Local/0] 1w5d 20:14:32
                     Local via vlan.0
192.168.4.0/24     *[Direct/0] 1w5d 18:34:56
                   > via vlan.1
192.168.4.1/32     *[Local/0] 1w5d 20:14:32
                     Local via vlan.1
192.168.1.0/24   *[Static/5] 1w5d 18:35:02
                   > via gr-0/0/0.0
192.168.2.0/24   *[Static/5] 1w5d 18:35:02
                   > via gr-0/0/0.0
```

13.0APPENDIX H – 802.1x Port Authentication w/ EAP

13.1 Overview

The Orbit can act as an 802.1x port authenticator for its ETH1 and ETH2 interfaces. The following diagram depicts the Orbit 802.1x port authentication setup used throughout this document. Either EAP or MAB mode can be configured for ETH1 and ETH2. This document shows how to configure each component in the diagram for EAP authentication mode.

The Orbit blocks all traffic (except EAP frames) on the Ethernet port until it can authenticate the peer connected to that port. The Orbit must be able to communicate with the RADIUS authentication server through a non-authenticating Ethernet port or other backhaul network interface like the cellular modem.



13.2 Configuration Examples

13.2.1 Orbit Device

The following shows an example of port authentication configuration on the Orbit, using EAP mode on ETH1 and ETH2.

```
set system mds-radius servers ghost address 192.168.1.2
set system mds-radius servers ghost shared-secret password

set interfaces interface ETH1 security security-mode EAP
set interfaces interface ETH1 security radius-server ghost

set interfaces interface ETH2 security security-mode EAP
set interfaces interface ETH2 security radius-server ghost
```

The status of port authentication for all network interfaces on the Orbit can be viewed by issuing the following command. Although all interfaces are displayed, port authentication only applies to ETH1 and ETH2.

```
run show interfaces-state interface security
NAME     SECURITY
--------------------
Bridge   -
Cell     -
ETH1     pending
ETH2     authorized
NxRadio  -
```

13.2.2 FreeRADIUS

Setup FreeRADIUS with server and device certificates, users, and network clients. The following shows only a snippet of the configuration but has the most important sections listed.

/etc/freeradius/users

```
# Username/password example
joe Cleartext-Password := password

# MAC Authentication Bypass (MAB) examples
d89d67f4ffb6 Cleartext-Password := d89d67f4ffb6
0010186f8dfd Cleartext-Password := 0010186f8dfd
989096cbcd6e Cleartext-Password := 989096cbcd6e
00133b109b4c Cleartext-Password := 00133b109b4c
```

/etc/freeradius/eap.conf

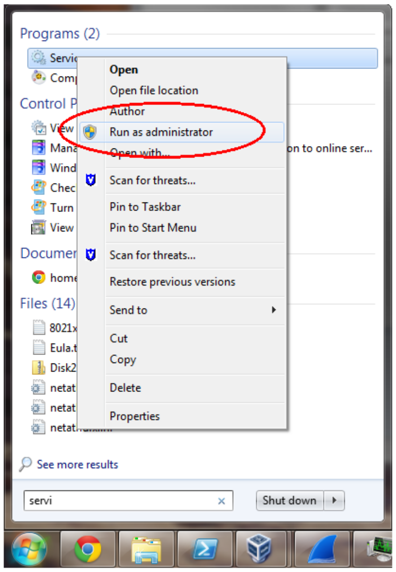
Setup tls { } section with your certificates, key and key password

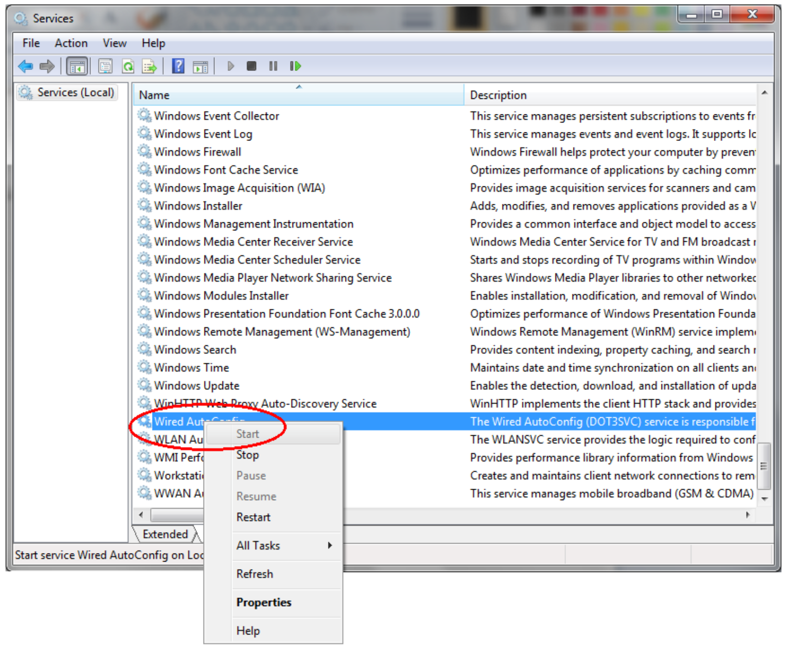
/etc/freeradius/clients.conf

```
# Allow connections from devices in this network
client 192.168.1.0/24 {
       secret         = password
       shortname      = ghost
}
```

13.2.3 Windows as 802.1x peer/supplicant – start WiredAutoConfig service

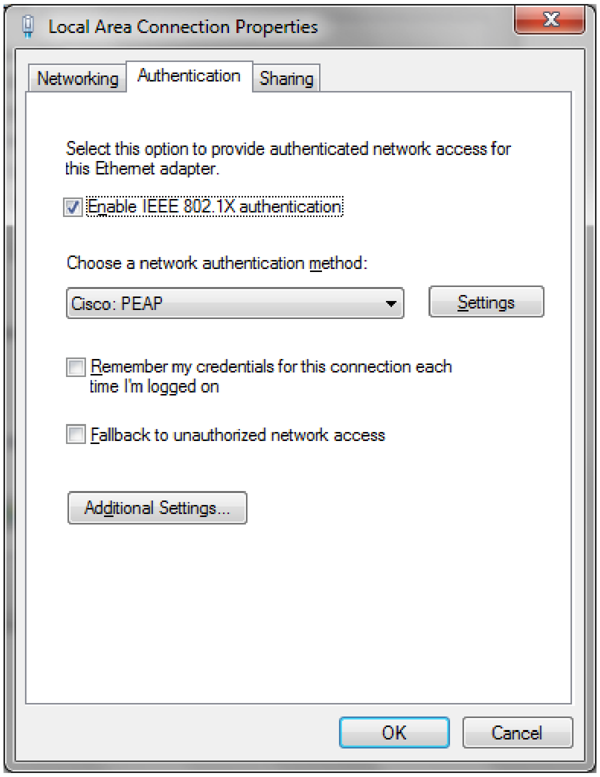
All EAP authentication modes on Windows require the following service to be started before configuring authentication on a wired network interface. When using EAP, the Orbit ETH port security mode must also be set to EAP. The Orbit is agnostic to the specific EAP method chosen. Examples in this document show Cisco PEAP and EAP-TLS methods being used.

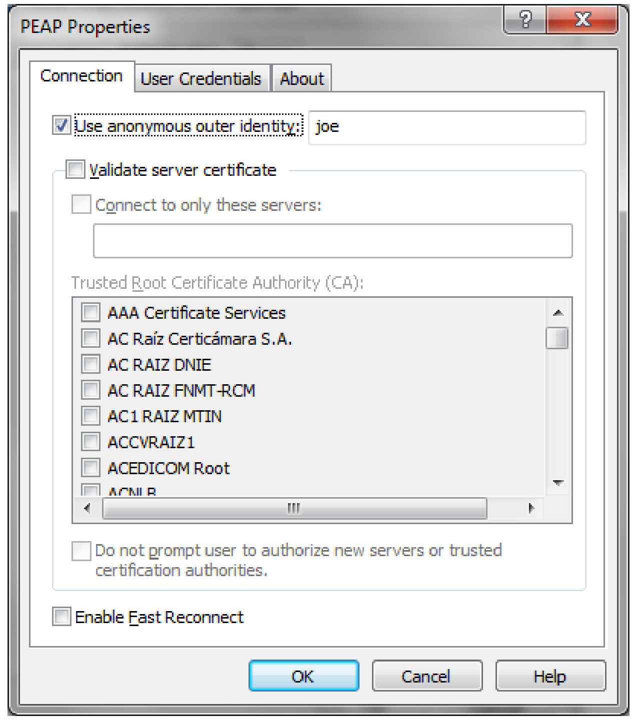


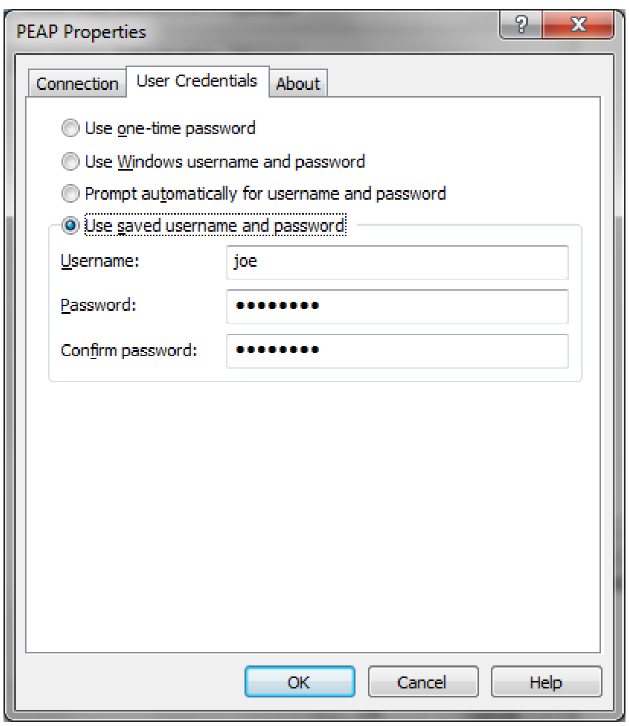


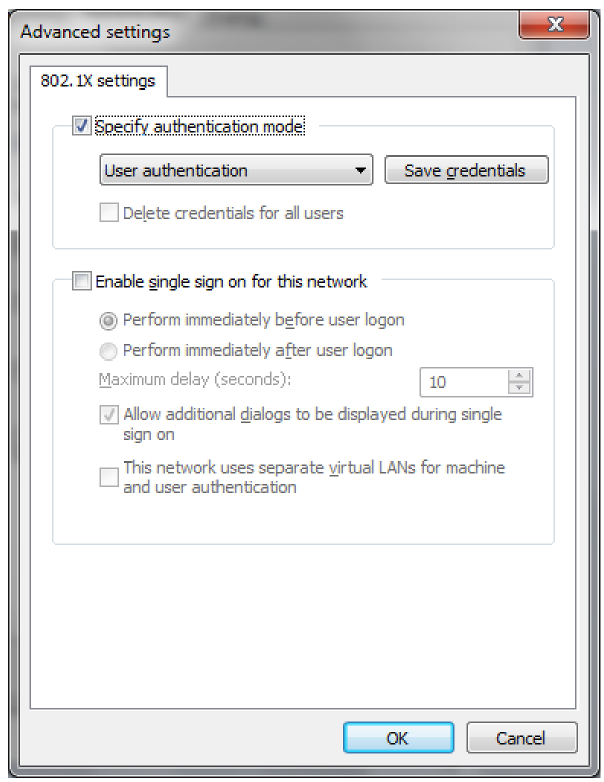
13.2.4 Windows configuration #1 - Cisco PEAP mode

Following shows the configuration used to test Cisco PEAP mode on Windows



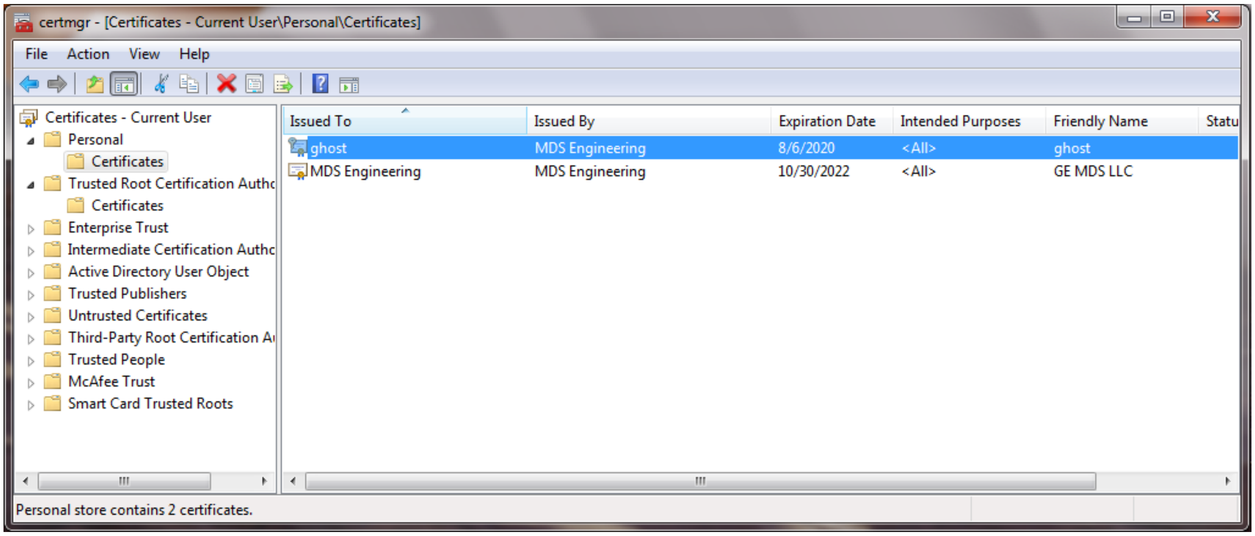




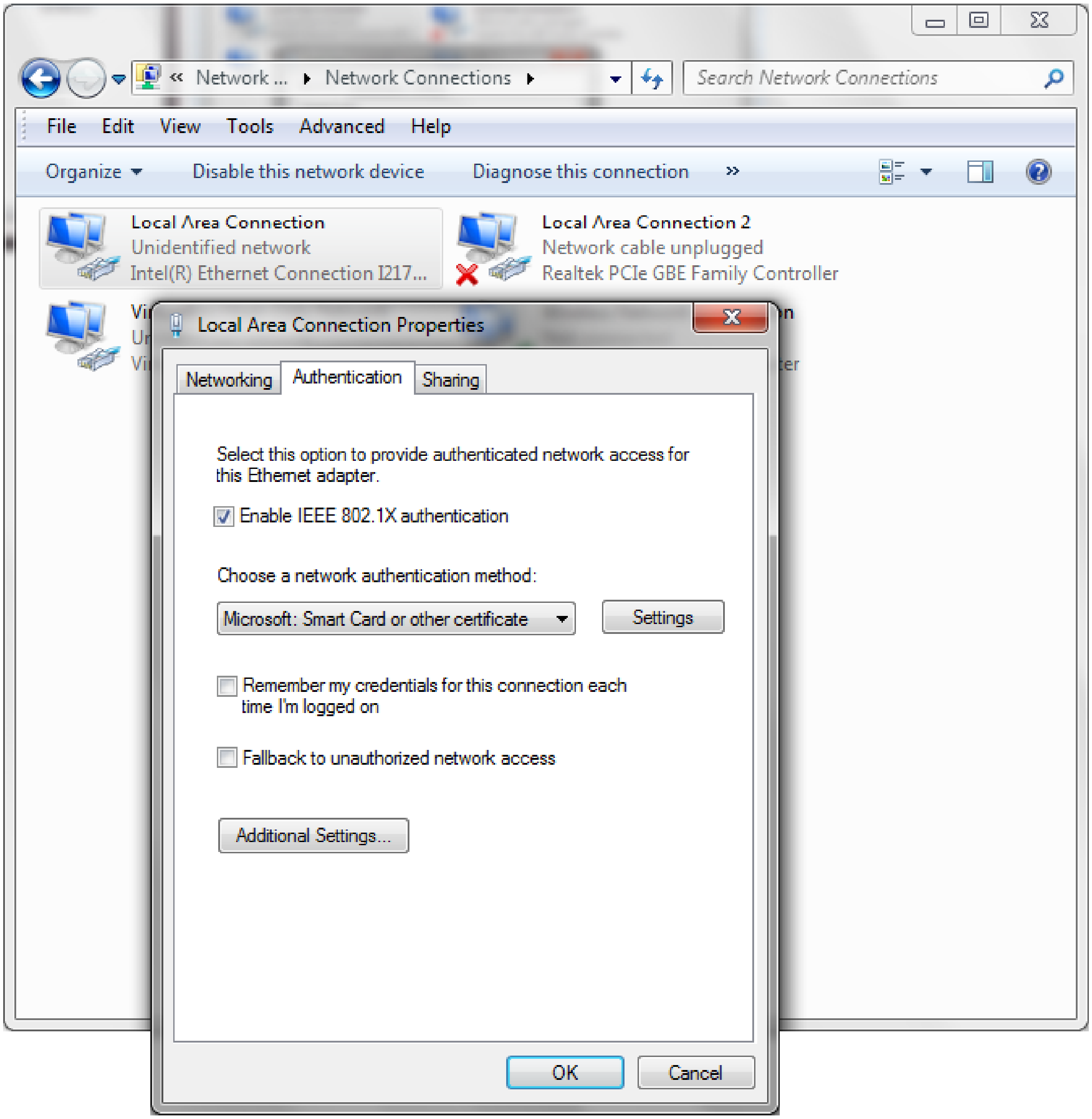


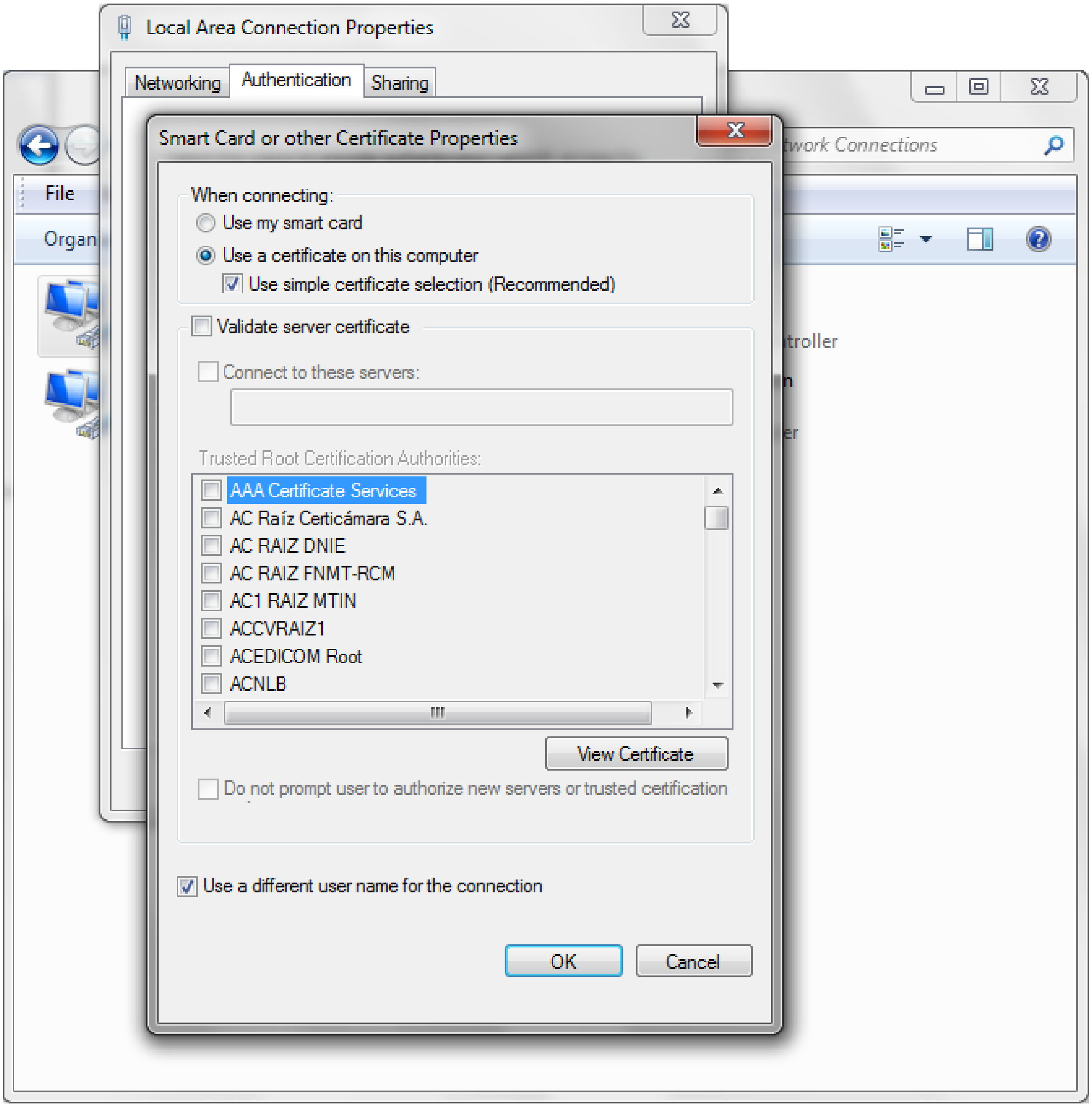
13.2.5 Windows configuration #2 - EAP-TLS mode

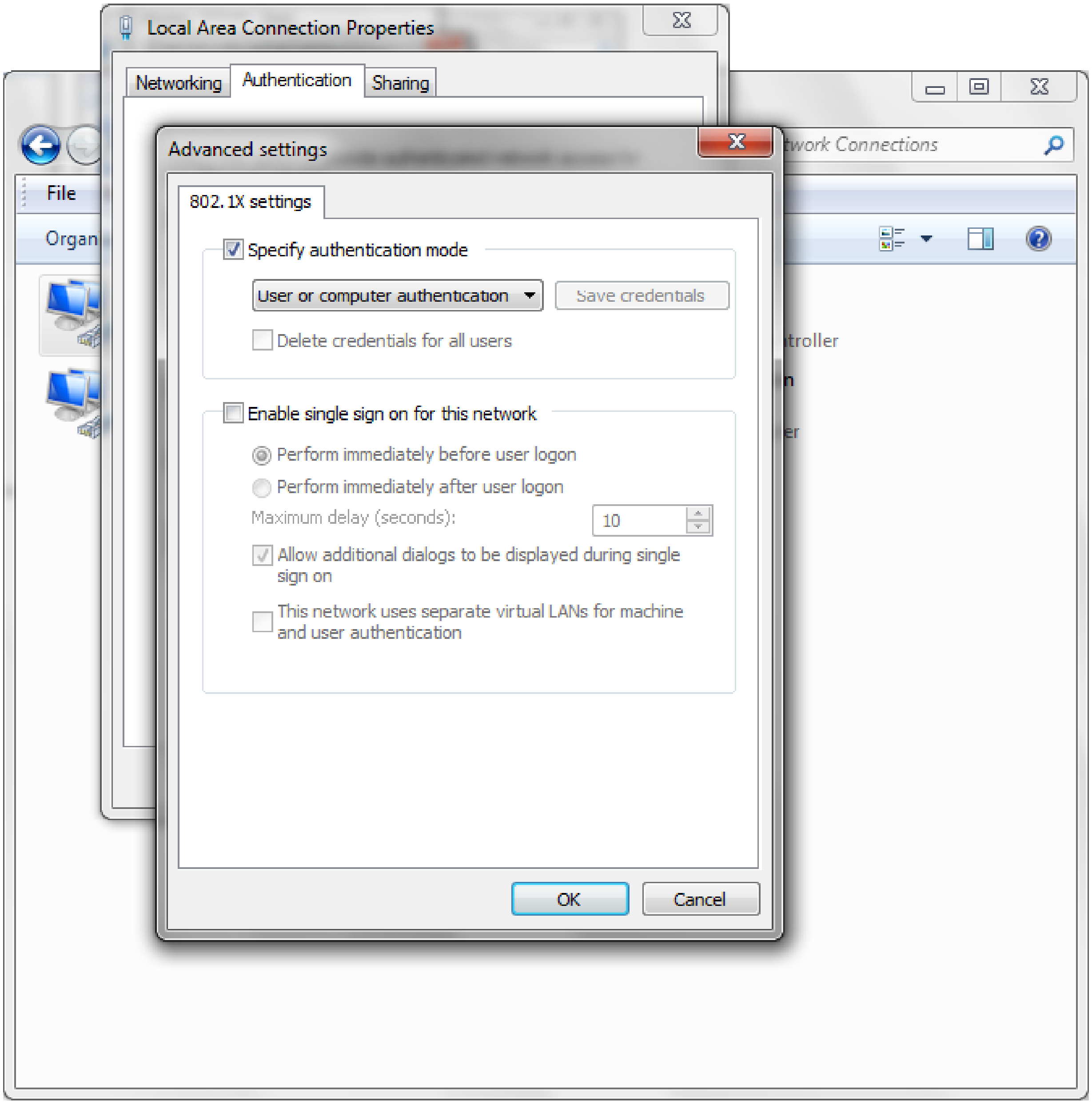
Following shows EAP-TLS mode on Windows with certificates. A certificate must be issued for the Windows peer. The client certificate and the issuing certificate can be imported using the **certmgr.msc** utility.



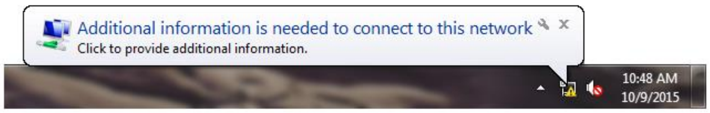
The wired interface is configured as shown in the next few diagrams on the following pages:

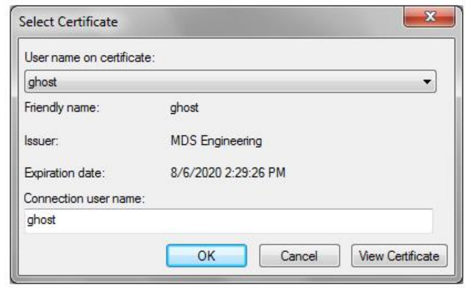

Network ... Network Connections
Search Network Connections
File Edit View Tools Advanced Help
Organize Disable this network device Diagnose this connection
Local Area Connection
Unidentified network
Intel(R) Ethernet Connection I217...
Local Area Connection 2
Network cable unplugged
Realtek PCIe GBE Family Controller
Local Area Connection Properties
Networking Authentication Sharing
Select this option to provide authenticated network access for this Ethernet adapter.
Enable IEEE 802.1X authentication
Choose a network authentication method:
Microsoft: Smart Card or other certificate
Settings
Remember my credentials for this connection each time I'm logged on
Fallback to unauthorized network access
Additional Settings...
OK
Cancel


Local Area Connection Properties
Networking
Authentication
Sharing
File
Organ
twork Connections
troller
Smart Card or other Certificate Properties
When connecting:
Use my smart card
Use a certificate on this computer
Use simple certificate selection (Recommended)
Validate server certificate
Connect to these servers:
Trusted Root Certification Authorities:
AAA Certificate Services
AC Raíz Certicámara S.A.
AC RAIZ DNIE
AC RAIZ FNMT-RCM
AC1 RAIZ MTIN
ACCVRAIZ1
ACEDICOM Root
ACNLB
View Certificate
Do not prompt user to authorize new servers or trusted certification
Use a different user name for the connection
OK
Cancel

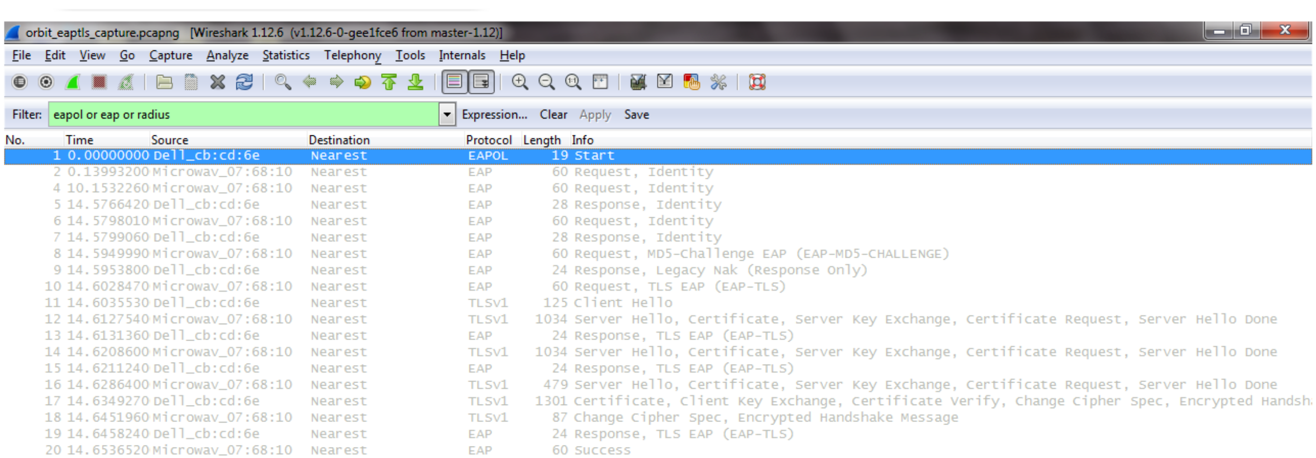

Local Area Connection Properties
Networking
Authentication
Sharing
Advanced settings
802.1X settings
Specify authentication mode
User or computer authentication
Save credentials
Delete credentials for all users
Enable single sign on for this network
Perform immediately before user logon
Perform immediately after user logon
Maximum delay (seconds):
10
Allow additional dialogs to be displayed during single sign on
This network uses separate virtual LANs for machine and user authentication
OK
Cancel
File
Organ
twork Connections
troller

Connecting the Ethernet cable between the Orbit authenticator and Windows peer presents the following notification on Windows. Clicking the notification presents the certificate selection box where the imported certificate can be chosen.



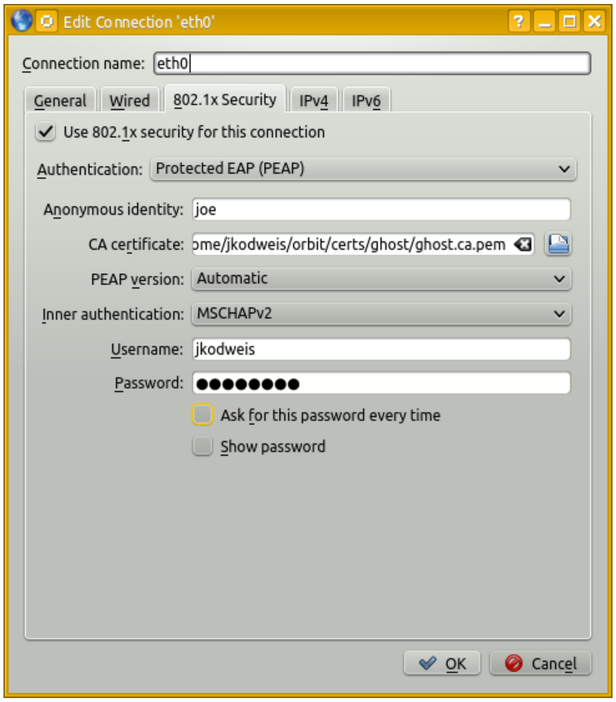


Running Wireshark in administrator mode on the Windows peer captures the EAP-TLS conversation between the Orbit and Windows. This tool can be used to diagnose communication errors on the peer.



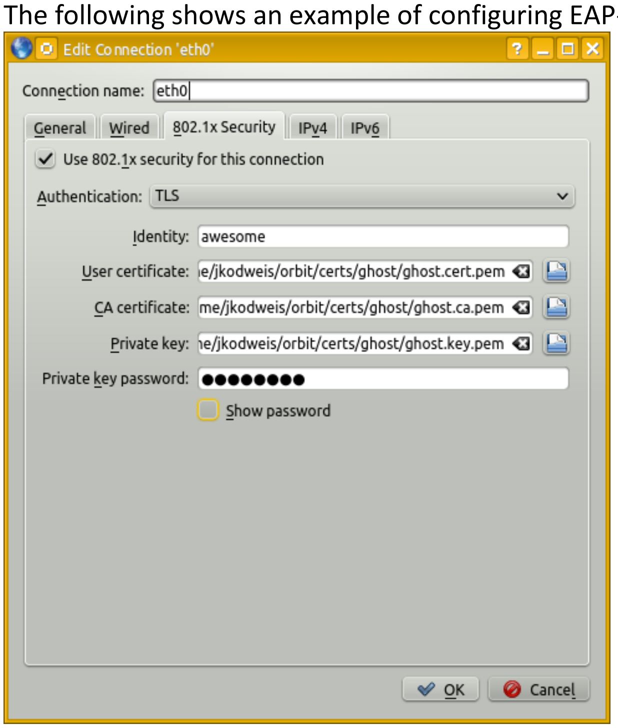
13.2.6 Kubuntu Linux configuration #1 – PEAP mode

The following shows an example of configuring PEAP mode on Kubuntu Linux. Unlike Windows, there is no need to start a service on this distribution. Also, this is no certificate import utility; the certificates can reside anywhere on the file system.



13.2.7 Kubuntu Linux configuration #2 – EAP-TLS mode

The following shows an example of configuring EAP-TLS mode on Kubuntu Linux.



13.2.8 Cisco switch as authenticator

The following configuration was used to evaluate behavior of another authenticator, ensuring the Orbit is compatible with established devices already being used in industry. A Cisco Catalyst 2960-S switch was used.

```
Switch#show configuration
Using 2061 out of 524288 bytes
!
version 12.2
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
hostname Switch
boot-start-marker
boot-end-marker
enable secret 5 $1$sP31$MR/SumVvQhHlirgeef3gY0
username login privilege 15 nopassword
aaa new-model
aaa authentication dot1x default group radius
aaa authorization network default group radius
aaa authorization network mylist none
aaa session-id common
switch 1 provision ws-c2960s-24ts-l
dot1x system-auth-control
spanning-tree mode pvst
spanning-tree extend system-id
vlan internal allocation policy ascending
interface FastEthernet0
no ip address
interface GigabitEthernet1/0/1
switchport mode access
interface GigabitEthernet1/0/2
switchport mode access
authentication order dot1x
authentication port-control auto
dot1x pae authenticator
interface GigabitEthernet1/0/3
….
interface Vlan1
ip address 192.168.1.100 255.255.0.0
interface Vlan2
no ip address
ip http server
ip http secure-server
radius-server host 192.168.1.200 auth-port 1812 acct-port 1646
radius-server key password
line con 0
line vty 0 4
password cisco
line vty 5 15
password cisco
end

Switch#
```

14.0 APPENDIX I – Licenses

14.1 Open Source License Declaration

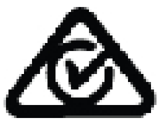
Orbit products include Open Source Software. Usage is governed by the corresponding licenses which are listed on the Ge Vernova Industrial Wireless website, under Orbit MCR Software/Firmware Downloads, Support Items and download license-declaration-n_n_n.txt.

Upon request, in accordance with certain software license terms, GE Vernova will make available a copy of Open Source code contained in this product. This code is provided to you on an "as is" basis, and GE Vernova makes no representations or warranties for the use of this code by you independent of any GE Vernova provided software or services. For more information please contact technical support.

15.0APPENDIX J – Country Specific Information

The table below identifies any country-specific installation requirements or warning required by the country for the Orbit. Operation of the unit must be in full compliance with all country and regional requirements.

Table 15-1. Country-Specific Installation Data

Country	Applicable Symbol(s)	Installation/Operating Requirements
Australia		For professional use only, not for sale to the general public. Hot surface—this product is only suitable for installation In restricted access locations.

16.0APPENDIX K – Orbit LN radio modes

The charts below provide a comparison of Orbit LN operating modes. The information is provided to be able to more accurately assess the benefits and tradeoffs to match the proper operating mode to a given target application. For more information contact your Sales representative or Technical Services.

Table 16-1. Orbit LN Radio Operating Modes for QAM operation

MODE NAME	Advanced	Advanced-Polling	Standard (DEFAULT MODE)	Store-and-Forward
Description	The latest evolution of Media Access Control for LN. Offers the best latency and throughput, and simplifies remote configuration. Supports low latency, non overlapping, single hop store and forward.	A variation of Advanced mode optimized for high density, polled networks. On-demand, pass phrase based authentication. Supports low latency, non overlapping, single hop store and forward.	Original LN Media Access Control. Highly Secure, packet-based router operation, with full association, authentication, and key rotation. Adaptive modulation up to 64QAM	Standard mode with added support for single-hop, overlapping, store and forward
When to use it	New or migrated Orbit LN networks of low to medium density* that support primarily IP or unsolicited traffic, require EAP-TLS authentication, or need low latency store and forward. * typically less than 50 remotes per AP	Orbit LN networks with medium to high density* of remotes per AP that are primarily polled with limited unsolicited traffic, or need low latency store and forward. Useful when migrating larger legacy networks to Orbit LN. * up to 250 remotes per AP	To maintain backward compatibility when adding to existing Orbit LN networks that are running Standard mode.	Orbit LN Networks that require overlapping store and forward coverage, or when adding to an existing network running Store-and-Forward mode.
Traffic Supported	Serial & IP traffic. Report by exception.	Serial Polling or IP (polling). Very limited report by exception.	Serial & IP traffic. Report by exception.	Serial & IP traffic. Report by exception.
Optimal System Size	20-50 for 12.5KHz channels.	50-250 estimate for 12.5KHz channels, based on limited IP traffic.	20-50 for 12.5KHz channels.	20-50 for 12.5KHz channels.
Min/Max Data Rate @12.5KHz	20/60kbps	20/60kbps	20/60kbps	20/60kbps
Modulation	QAM (Adaptive: QPSK, 16QAM, 32 QAM, 64QAM)	QAM (Adaptive: QPSK, 16QAM, 32QAM, 64QAM)	QAM (Adaptive: QPSK, 16QAM, 64QAM)	QAM (Adaptive: QPSK, 16QAM, 64QAM)
Store and Forward	YES Single hop, non-overlapping	YES Single hop, non-overlapping SAF not recommended for larger systems	NO	YES Single hop, overlapping
Forward Error Correction	YES	YES	YES	YES
Serial Pass Through	YES	YES	YES	YES
Terminal Server and IP/Payload	YES	YES	YES	YES
VRCs	YES	YES	YES	YES
Firewalls	YES	YES	YES	YES
Web Proxy	YES	NO	YES	YES
Connected Remotes table	YES Learned actively via Association Process. Doesn't require system to be polled.	YES Learned passively as traffic passes through the network.	YES Learned actively via Association Process. Doesn't require system to be polled.	YES Learned actively via Association Process. Doesn't require system to be polled.
DLINK Transition from Transparent Mode	YES	Limited PulseNET support; will need PulseNET updates.	YES	YES
Remote management via ssh	YES	YES	YES	YES
Association / Authentication	YES Automatic	YES. Passively on demand	YES	YES
Over-the-Air Reprogramming	YES multicast and TFTP	YES multicast and TFTP	YES multicast and TFTP	YES multicast and TFTP
Encryption	YES Full Orbit encryption options with key-rotation.	YES Some options not available.	YES Full Orbit encryption options with key-rotation.	YES Full Orbit encryption options with key-rotation.
Network Management	PulseNET support	Limited PulseNET support; will need PulseNET updates	PulseNET support	PulseNET support
Restrictions	Not interoperable with Standard mode (default for previously deployed units).	Not interoperable with Standard mode (default for previously deployed units).	Not interoperable with Store-and-Forward mode. Use Store-and-Forward or Advanced mode for networks with one or more store and forward device.	Use of Store-and-Forward mode reduces system throughput and capacity.

Table 16-2. Orbit LN Backward Compatible Radio Operating Modes

MODE NAME	Packet-with-Mac	Serial-Transparent
Description	Emulates an SD remote or store and forward running in packet with MAC mode. Does not include AP or repeater functionality.	Emulates an x710, or an SD running in transparent or x710 mode. Will work with a majority of x710 networks.
When to use it	When adding Orbit LN as a remote or store and forward device onto an existing SD network running packet with MAC mode. Used when migrating existing SD networks to Orbit LN.	When adding Orbit LN as a remote onto an existing x710 or transparent SD network. Used when migrating existing transparent legacy networks to Orbit LN.
Traffic Supported	Serial Polling. Limited IP (polling). Report by exception.	Serial Polling.
Optimal System Size	10-25 based on limited IP traffic. Bounded by user application.	Bounded only by user application.
Min/Max Data Rate @12.5KHz	9.6/19.2kbps	9.6/19.2kbps
Modulation	FSK (3 & 7 Level)	FSK (3 & 7 Level)
Store and Forward	YES SD-compatible SAF	NO
Forward Error Correction	NO	NO
Serial Pass Through	YES	YES
Terminal Server and IP/Payload	YES	YES (terminated locally)
VRCs	YES	NO
Firewalls	Limited	Limited
Web Proxy	NO	NO
Connected Remotes table	NO	NO
DLINK Transition from Transparent Mode	YES	N/A
Remote management via ssh	YES	NO
Association / Authentication	NO	NO
Over-the-Air Reprogramming	LIMITED TFTP only, slow update	NO
Encryption	YES Limited to fixed PSK AES128.	NO
Network Management	PulseNET running in Legacy mode. Also Field Network Manager & legacy Insite)	PulseNET running in Legacy mode. Also Field Network Manager & legacy Insite
Restrictions	AP capability not supported - use SD or SD Master Station. DLINK not supported on local interfaces (over the air only).	No locally connected DLINK. Local firmware update ONLY.

17.0APPENDIX L – Understanding ARP Cache

The Arp Cache feature is a powerful tool for reducing over-the-air-traffic on narrowand interfaces. The feature can be selected for NxRadio, LnRadio, and LwRadio interfaces.

There are two items to configure, the enable checkbox and the timeout value:

ARP Cache feature tries to limit ARPs from going over-the-air. This is not so much because the ARPs are large packets, but because the ARPs add contention to the channel for information that can be reasonably determined without sending data over-the-air.

When ARP cache is enabled, whenever an ARP reply or IPV4 packet arrives over-the-air Orbit will save the source mac address and the source IP address pair. This gives us a table of devices that Orbit expects to be on the other side of the radio link.

Next when an ARP request is going to go out over-the-air, Orbit will do a lookup in this table to see if the requested IP address is in the table. If it is not found, it goes over-the-air like any other packet. If it is found a spoofed reply is generated locally as if it came from the requested device and nothing is sent over-the-air.

Orbit also keeps a timestamp of the last time a message came from over-the-air that would update the table. Entries are removed from the table if they have been in there longer than the Arp Cache Timeout value.

The ARP cache is VLAN aware so VLAN tagged over-the-air traffic is tracked in its own table and appropriately used for outbound requests.

ARP cache is also enabled on remote-to-remote communication, so if a request is passed from a remote to the AP, before it is sent over-the-air the table lookup is done. This lets the request-reply only require 2 hops instead of 4.

ARP cache works well in most scenarios. A key scenario to avoid is swapping out a device and giving it the same IP address (when that device also does not initiate any over-the-air traffic). In this case any over-the-air traffic would need to wait the cache timeout (default 900 seconds/15 minutes) before it could communicate. This happens with wired systems as well, but recovery appears faster since most operating systems/devices ARP every 30-90 seconds. This constant stream of ARPs is what Orbit's ARP caching was implemented to avoid.

Summary:

- ARP Cache limits over-the-air traffic by keeping a local table of devices that that are marked as located remotely, so that replies to ARP requests can be generated locally without going over-the-air
- ARP Cache is simpler to configure than ARP proxy (which is *not* implemented in Orbit)
- ARP Cache will only stop ARP requests from going over-the-air. If a device generates excessive gratuitous ARPs (broadcast ARP replies that are unsolicited) this will NOT limit them.

NOTES

IN CASE OF DIFFICULTY...

Our products are designed for long life and trouble-free operation. However, this equipment, as with all electronic equipment, may have an occasional component failure. The following information will assist you in the event that servicing becomes necessary.

TECHNICAL ASSISTANCE

Technical assistance for MDS products is available from the GE Vernova Grid Automation Support team. Please provide the complete model number of the product, along with a description of the trouble/symptom(s) that you are experiencing. In many cases, problems can be resolved without the need for returning the unit to the factory.

For product support, please contact the GE Vernova support team as follows:

Region	E-mail	Telephone
Global Contact Centre	GA.support@gevernova.com	+44 1785 250070
Central, East Asia, Pacific	GA.supportCEAP@gevernova.com	+61 414 730 964
India	GA.supportIND@gevernova.com	+91 44 2264 8000
Middle East, North Africa, Turkey	GA.supportMENAT@gevernova.com	+971 4 375 6950
Europe, Russia, CIS, Sub-Saharan Africa	GA.supportERCIS@gevernova.com	+34 94 485 8854
North America	GA.supportNAM@gevernova.com	+1 877 605 6777
Latin America	GA.supportLAM@gevernova.com	+55 48 2108 0300

REPAIR SERVICE

Component level repair of this equipment is not recommended in the field. Many components are installed using surface mount technology, which requires specialized training and equipment for proper servicing. For this reason, the equipment should be returned to the factory for any PC board repairs. The factory is best equipped to diagnose, repair and align your unit to its proper operating specifications.

If return of the equipment is necessary, you must obtain a return authorization number before shipment. This number helps expedite the repair so that the equipment can be returned to you as quickly as possible. Please be sure to include the number on the outside of the shipping box, and on any correspondence relating to the repair. No equipment will be accepted for repair without an authorization number.

Contact Technical Support in your region to obtain an authorization number:

The radio must be properly packed for return to the factory. The original shipping container and packaging materials should be used whenever possible. All factory returns should be addressed to:

GE Vernova MDS LLC
Product Services Department
(Auth. No. XXXX)
175 Science Parkway
Rochester, NY 14620 USA

When repairs have been completed, the equipment will be returned to you by the same shipping method used to send it to the factory. Please specify if you wish to make different shipping arrangements.

REPLACEMENT PARTS

Many spare and replacement items are available for purchase by contacting your factory sales representative, or by visiting our online store at https://store.gegridsolutions.com .

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