GE

Grid Solutions

MCP Firmware Release Notes

Firmware Release Notes

MIS-0109

Version 3.10 Revision 0

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Table of Contents

About this Document **12**

Purpose 12
Intended Audience 12
Additional Documentation 12

1. Version 1.00 (27-March-2019) **13**

Software Versions 13
Predix Edge OS and Other Firmware Versions 13
Key Features 13
Capability and Capacity 14
1.1 Standalone 15
1.1.1 Performance Test Levels 15
1.1.2 HMI Response time 16
1.2 Hot Standby Redundancy 16
1.3 Warm Standby Redundancy 17
Time Sync Accuracy (PTP/IRIG-B/NTP) 18
1.4 PTP Accuracy 18
1.4.1 Test Steps: 18
1.4.2 Test Results: 18
1.5 IRIG-B Accuracy 18
1.5.1 Test Setup: 18
1.5.2 Test Results: 18
1.6 NTP IN Accuracy 19
1.6.1 Test Setup: 19
1.6.2 Test Results: 19
1.7 NTP OUT Accuracy 19
1.7.1 Test Results: 19
Application List 19
Known Issues 21
1.7.2 Cyber Security 21
1.7.3 Clients 21
1.7.4 Servers 21
1.7.5 Automation 22
1.7.6 Configuration 22
1.7.7 HMI 22
1.7.8 Pass-through 23
1.7.9 System 23
1.7.10 Hardware 23

2. Version 1.10 (14-February-2020) **24**

Software Versions 24
Predix Edge OS and Other Firmware Versions 24
Key Functions and Changes 24
2.1 Enhancements 24
2.1.1 Cyber Security 24
2.1.2 Clients 25
2.1.3 Server 25

2.1.4 Automation....25
2.1.5 HMI....25
2.1.6 Passthrough/VPN....26
2.1.7 System....26
2.1.8 Hardware....26
2.1.9 Documentation....26
2.2 Fixed defects....27
2.2.1 Cyber Security....27
2.2.2 Clients....27
2.2.3 Automation....27
2.2.4 Configuration....28
2.2.5 HMI....28
2.2.6 Pass-through....28
2.2.7 System....28
2.2.8 Hardware....29
2.2.9 Known Issues....29
2.2.10 Cyber Security....29
2.2.11 Clients....29
2.2.12 Servers....29
2.2.13 Automation....30
2.2.14 Configuration/Settings....30
2.2.15 HMI....30
2.2.16 Pass-through....31
2.2.17 System....31
2.2.18 Documentation....32
2.2.19 Hardware....32
Capability and Capacity....33
2.3 Stand Alone....33
2.3.1 Performance Test Levels....33
2.3.2 HMI Response time....34
2.4 Hot Standby Redundancy....35
2.5 Warm Standby Redundancy....35
Time Sync Accuracy (PTP/IRIG-B/NTP)....36
Application List....37

3. Version 2.00 (27-May-2020)....39

Software Versions....39
Predix Edge OS and Other Firmware Versions....39
Key Functions and Changes....39
3.1 Enhancements....39
3.1.1 Cyber Security....39
3.1.2 Clients....39
3.1.3 Servers....40
3.1.4 Automation....40
3.1.5 Configuration/Settings....40
3.1.6 HMI....40
3.1.7 Pass-through....40
3.1.8 System....41
3.1.9 Documentation....41
3.1.10 Hardware....41
3.2 Fixed defects....41
3.2.1 Cyber Security....41
3.2.2 Clients....41
3.2.3 Server....41
3.2.4 Automation....42
3.2.5 Configuration/Settings....42
3.2.6 HMI....42
3.2.7 Pass-through....42

3.2.8 System 42
3.2.9 Documentation 43
3.2.10 Hardware 43
3.3 Known Issues 43
3.3.1 Cyber Security 43
3.3.2 Clients 43
3.3.3 Servers 43
3.3.4 Automation 44
3.3.5 Configuration/Settings 44
3.3.6 HMI 44
3.3.7 Pass-through 45
3.3.8 System 45
3.3.9 Documentation 45
3.3.10 Hardware 46
Capability and Capacity 46
3.4 Stand Alone 50
3.4.1 Performance Test Levels 50
3.4.2 HMI Response time 51
3.4.3 D.20 HDLC Performance Test levels 51
3.5 Hot Standby Redundancy 52
3.6 Warm Standby Redundancy 53
Time Sync Accuracy (PTP/IRIG-B/NTP) 53
Application List 54

4. Version 2.10 (9-Dec-2020) 56

Software Versions 56
Predix Edge OS and Other Firmware Versions 56
Key Functions and Changes 57
4.1 Enhancements 57
4.1.1 Cyber Security 57
4.1.2 Clients 57
4.1.3 Servers 57
4.1.4 Automation 57
4.1.5 Configuration/Settings 57
4.1.6 HMI 57
4.1.7 Pass-through 57
4.1.8 System 57
4.1.9 Documentation 57
4.1.10 Hardware 58
4.2 Fixed defects 58
4.2.1 Cyber Security 58
4.2.2 Clients 58
4.2.3 Server 58
4.2.4 Automation 58
4.2.5 Configuration/Settings 58
4.2.6 HMI 58
4.2.7 Pass-through 58
4.2.8 System 59
4.2.9 Documentation 59
4.2.10 Hardware 59
4.3 Known Issues 59
4.3.1 Cyber Security 59
4.3.2 Clients 59
4.3.3 Servers 59
4.3.4 Automation 60
4.3.5 Configuration/Settings 60
4.3.6 HMI 61
4.3.7 Pass-through 61

4.3.8 System 61
4.3.9 Documentation 62
4.3.10 Hardware 62
Capability and Capacity 62
4.4 Stand Alone 66
4.4.1 D.20 HDLC Performance Test levels 66
4.5 Hot Standby Redundancy 67
4.6 Warm Standby Redundancy 67
Time Sync Accuracy (PTP/IRIG-B/NTP) 67
Application List 68

5. Version 2.50 (18-Oct-2021) 70

Software Versions 70
Predix Edge OS and Other Firmware Versions 70
Key Functions and Changes 71
5.1 Enhancements 71
5.1.1 Cyber Security 71
5.1.2 Clients 71
5.1.3 Servers 71
5.1.4 Automation 71
5.1.5 Configuration/Settings 71
5.1.6 HMI 72
5.1.7 Pass-through 72
5.1.8 System 72
5.1.9 Documentation 72
5.1.10 Hardware 72
5.2 Fixed defects 72
5.2.1 Cyber Security 72
5.2.2 Clients 73
5.2.3 Server 73
5.2.4 Automation 73
5.2.5 Configuration/Settings 73
5.2.6 HMI 74
5.2.7 Pass-through 74
5.2.8 System 74
5.2.9 Documentation 74
5.2.10 Hardware 74
5.3 Known Issues 75
5.3.1 Cyber Security 75
5.3.2 Clients 75
5.3.3 Servers 75
5.3.4 Automation 75
5.3.5 Configuration/Settings 76
5.3.6 HMI 76
5.3.7 Pass-through 77
5.3.8 System 77
5.3.9 Documentation 77
5.3.10 Hardware 78
Capability and Capacity 78
5.4 Standalone (non-redundant) 82
5.5 Warm Standby Redundancy 82
5.6 Hot Standby Redundancy 82
5.7 Hot-Hot Redundancy 82
5.7.1 Performance Test Levels 83
5.7.2 Redundancy Fail Over Time 85
5.7.3 HMI Response Times 85
Time Sync Accuracy (PTP/IRIG-B/NTP) 85
Application List 85

6. Version 2.60 (17-Dec-2021) 88

Software Versions 88
Predix Edge OS and Other Firmware Versions 88
Key Functions and Changes 89
6.1 Enhancements 89
6.1.1 Cyber Security 89
6.1.2 Clients 89
6.1.3 Servers 89
6.1.4 Automation 89
6.1.5 Configuration/Settings 89
6.1.6 HMI 89
6.1.7 Pass-through 90
6.1.8 System 90
6.1.9 Documentation 90
6.1.10 Hardware 90
6.2 Fixed defects 90
6.2.1 Cyber Security 90
6.2.2 Clients 90
6.2.3 Server 90
6.2.4 Automation 90
6.2.5 Configuration/Settings 91
6.2.6 HMI 91
6.2.7 Pass-through 91
6.2.8 System 91
6.2.9 Documentation 91
6.2.10 Hardware 91
6.3 Known Issues 91
6.3.1 Cyber Security 91
6.3.2 Clients 91
6.3.3 Servers 92
6.3.4 Automation 92
6.3.5 Configuration/Settings 93
6.3.6 HMI 93
6.3.7 Pass-through 93
6.3.8 System 93
6.3.9 Documentation 94
6.3.10 Hardware 94
Capability and Capacity 95
6.4 Standalone (non-redundant) 95
6.5 Warm Standby Redundancy 95
6.6 Hot Standby Redundancy 95
6.7 Hot-Hot Redundancy 95
6.7.1 Performance Test Levels 95
6.7.2 Redundancy Fail Over Time 95
6.7.3 HMI Response Times 95
Time Sync Accuracy (PTP/IRIG-B/NTP) 95
Application List 95

7. Version 2.70 (04-Mar-2022) – Projects Only 98

Software Versions 98
Predix Edge OS and Other Firmware Versions 98
Key Functions and Changes 99
7.1 Enhancements 99
7.1.1 Cyber Security 99
7.1.2 Clients 99
7.1.3 Servers 99
7.1.4 Automation 99

7.1.5 Configuration/Settings 99
7.1.6 HMI 99
7.1.7 Pass-through 99
7.1.8 System 99
7.1.9 Documentation 100
7.1.10 Hardware 100
7.2 Fixed defects 100
7.2.1 Cyber Security 100
7.2.2 Clients 100
7.2.3 Server 100
7.2.4 Automation 100
7.2.5 Configuration/Settings 100
7.2.6 HMI 100
7.2.7 Pass-through 100
7.2.8 System 100
7.2.9 Documentation 101
7.2.10 Hardware 101
7.3 Known Issues 101
7.3.1 Cyber Security 101
7.3.2 Clients 101
7.3.3 Servers 101
7.3.4 Automation 102
7.3.5 Configuration/Settings 103
7.3.6 HMI 103
7.3.7 Pass-through 103
7.3.8 System 103
7.3.9 Documentation 104
7.3.10 Hardware 104
Capability and Capacity 105
7.4 Standalone (non-redundant) 110
7.4.1 Performance Test Levels 110
7.5 Warm Standby Redundancy 111
7.6 Hot Standby Redundancy 111
7.7 Hot-Hot Redundancy 111
7.7.1 Performance Test Levels 111
7.7.2 Redundancy Fail Over Time 113
7.7.3 HMI Response Times 113
Time Sync Accuracy (PTP/IRIG-B/NTP) 114
Application List 114

8. Version 2.80 (18-July-2022) 117

Software Versions 117
Predix Edge OS and Other Firmware Versions 117
Key Functions and Changes 118
8.1 Enhancements 118
8.1.1 Cyber Security 118
8.1.2 Clients 118
8.1.3 Servers 118
8.1.4 Automation 118
8.1.5 Configuration/Settings 118
8.1.6 HMI 119
8.1.7 Pass-through 119
8.1.8 System 119
8.1.9 Documentation 119
8.1.10 Hardware 119
8.2 Fixed defects 119
8.2.1 Cyber Security 119
8.2.2 Clients 120

8.2.3 Server 120
8.2.4 Automation 120
8.2.5 Configuration/Settings 120
8.2.6 HMI 121
8.2.7 Pass-through 121
8.2.8 System 121
8.2.9 Documentation 121
8.2.10 Hardware 121
8.3 Known Issues 121
8.3.1 Cyber Security 121
8.3.2 Clients 121
8.3.3 Servers 122
8.3.4 Automation 122
8.3.5 Configuration/Settings 123
8.3.6 HMI 123
8.3.7 Pass-through 123
8.3.8 System 123
8.3.9 Documentation 124
8.3.10 Hardware 124
Capability and Capacity 125
8.4 Standalone (non-redundant) 130
8.4.1 Performance Test Levels 130
8.5 Warm Standby Redundancy 132
8.6 Hot Standby Redundancy 132
8.7 Hot-Hot Redundancy 132
8.7.1 Performance Test Levels 132
8.7.2 Redundancy Fail Over Time 134
8.7.3 HMI Response Times 135
Time Sync Accuracy (PTP/IRIG-B/NTP) 135
Application List 135

9. Version 3.00 (28-April-2023) 138

Software Versions 138
Predix Edge OS and Other Firmware Versions 138
Key Functions and Changes 139
9.1 Enhancements 139
9.1.1 Cyber Security 139
9.1.2 Clients 139
9.1.3 Servers 139
9.1.4 Automation 139
9.1.5 Configuration/Settings 139
9.1.6 HMI 140
9.1.7 Pass-through 140
9.1.8 System 140
9.1.9 Documentation 140
9.1.10 Hardware 141
9.2 Fixed defects 141
9.2.1 Cyber Security 141
9.2.2 Clients 141
9.2.3 Servers 142
9.2.4 Automation 142
9.2.5 Configuration/Settings 142
9.2.6 HMI 143
9.2.7 Pass-through 143
9.2.8 System 143
9.2.9 Documentation 144
9.2.10 Hardware 144
9.3 Known Issues 144

9.3.1 Cyber Security....144
9.3.2 Clients....144
9.3.3 Servers....145
9.3.4 Automation....145
9.3.5 Configuration/Settings....146
9.3.6 HMI....146
9.3.7 Pass-through....146
9.3.8 System....147
9.3.9 Documentation....147
9.3.10 Hardware....147
Capability and Capacity for MCP....148
9.4 Performance Test Levels of MCP Devices....155
9.4.1 Performance Test Levels....155
9.4.2 Redundancy Fail Over Time....161
9.4.3 HMI Response Times....161
Time Sync Accuracy (PTP/IRIG-B/NTP)....162
Timestamp Accuracy....162
Application List....163

10. Version 3.10 (23-August-2023)....166

Software Versions....166
Predix Edge OS and Other Firmware Versions....166
Key Functions and Changes....167
10.1 Enhancements....167
10.1.1 Cyber Security....167
10.1.2 Clients....167
10.1.3 Servers....167
10.1.4 Automation....167
10.1.5 Configuration/Settings....167
10.1.6 HMI....167
10.1.7 Pass-through....167
10.1.8 System....168
10.1.9 Documentation....168
10.1.10 Hardware....168
10.2 Fixed defects....169
10.2.1 Cyber Security....169
10.2.2 Clients....169
10.2.3 Servers....169
10.2.4 Automation....170
10.2.5 Configuration/Settings....170
10.2.6 HMI....170
10.2.7 Pass-through....170
10.2.8 System....170
10.2.9 Documentation....170
10.2.10 Hardware....170
10.3 Known Issues....171
10.3.1 Cyber Security....171
10.3.2 Clients....171
10.3.3 Servers....171
10.3.4 Automation....172
10.3.5 Configuration/Settings....172
10.3.6 HMI....173
10.3.7 Pass-through....173
10.3.8 System....173
10.3.9 Documentation....174
10.3.10 Hardware....174
Capability and Capacity for MCP....175
10.4 Performance Test Levels of MCP Devices....182

10.4.1 Performance Test Levels 182
10.4.2 Redundancy Fail Over Time 188
10.4.3 HMI Response Times 188
Time Sync Accuracy (PTP/IRIG-B/NTP) 189
Timestamp Accuracy 189
Application List 190

Modification Record 193

About this Document

Purpose

The purpose of this document is to outline features, capabilities, and issues, known to exist within the MCP Substation Gateway at the time of release.

Intended Audience

This document is an external document intended for both GE Staff and Customers. It highlights the features and capabilities of the G500 / G100 firmware.

Additional Documentation

For further information about the MCP, refer to the following documents:

- *MCP Software Configuration Guide (SWM0101)*
- *G500 Substation Gateway Instruction Manual (994-0152)*
- *G100 Substation Gateway Instruction Manual (994-0155)*
- *G500 Quick Start Guide (SWM0106)*
- *G100 Quick Start Guide (SWM0116)*

For the most current version of the above documentation, please download a copy from:
http://www.gegridsolutions.com/app/ViewFiles.aspx?prod=g500&type=3

1. Version 1.00 (27-March-2019)

Software Versions

The following defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	1.0.652	G500 Firmware Version.
DS Agile MCP Studio	1.0.0	Supported DS Agile MCP Studio Software.
G500 HMI Viewer	1.0.653	Supported G500 HMI 64-bit Software.

Predix Edge OS and Other Firmware Versions

The following defines the firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v1.0.652.

Package/Firmware	Version	Notes
Predix Edge OS	2.2.1	Supported GE's Secured Linux Operating System Version.
FPGA	1.02.00	Supported FPGA Version of Multi-Function Controller Platform (MCP)
CPLD	1.2.1	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Features

G500 is part of the Multi-Function Controller Platform (MCP).

G500 is designed to provide a reliable and accurate collection of data (metering, status, events and faults) from serial or LAN based intelligent substation devices to master applications such as SCADA, EMS, DMS or other enterprise applications. With its modern and robust cyber security features, the G500 is designed for smooth integration into NERC CIP and Cyber Security environments while consolidating functions such as ethernet communications, time synchronization, HMI and SCADA applications.

G500 supports the following key features as part of v1.00.

Advanced Gateway : G500 collects operational and non-operational data from substation protection, control, monitoring, RTU, and intelligent devices, pre-processes the data and moves it up to EMS and DMS SCADA systems providing centralized substation management.

Advanced Automation : G500 provides the computing platform necessary to automate substation procedures, such that intricate processes are carried out safely and efficiently by creating advanced custom automation programs using IEC 61131 compliant tools and perform basic math functions on data points using the built-in calculator tool.

Datalogging and Alarm Management	:	G500 supports logging of analog and binary events, including alarm management. Users have access to view and extract logged data via Runtime HMI corresponding screens (Trending, SOE, Historical Data, Active Alarms).
Automated Records (files) Retrieval and Management (ARRM)	:	G500 supports automated extraction of data files from IEDs, such as digital fault recording (DFR) records, event files, device information files, etc. Acquired files can be securely pushed automatically to remote systems.
Secure Passthrough Remote Access and VPN	:	G500 allows users to securely access substation devices from remote locations through validated interactive sessions hosted by the G500.
User Authentication	:	G500 provides Role Based Access Control (RBAC) with Local Account Authentication.
Runtime HMI	:	G500 provides user interaction with Role Based Access Control via a portable Runtime HMI application that runs in the Local unit KVM interfaces, as well as Remote in Windows based computers. There is no requirement to install Java/JRE on the Windows computers.
Support for Predix Edge Connectivity	:	G500 uses GE's Hardened *Predix EDGE* Operating System (Linux Yocto based) and supports secured connectivity for enrolling the unit into Predix Edge Manager. Predix Edge Manager is a GE hosted Cloud Application that provides asset / fleet management of enrolled devices.
Hardware Based PRP/Redundant LAN Support	:	G500 supports up to 3 hardware based independent PRP or Redundant LAN through the rear ethernet ports.
Hardware Based IEEE 1588 PTP Master-Slave Support	:	G500 supports hardware based PTP Master-Slave support on the rear ethernet ports.
Hardware Based IRIG-B Input Support	:	G500 supports hardware based IRIG-B input.
Hardware Asset Management Application (HAMA)	:	G500 supports monitoring of the hardware parameters, e.g., network modes, serial port settings, temperatures, real time utilizations of various resources, etc. and presenting of these to the G500 System Point Database by means of Analog/Digital/Accumulator/Text Points.

Capability and Capacity

The G500 performance test levels are presented in this section.

G500 Hardware under test: 4 core CPU/ 16GB RAM variant.

NOTE: In the combined tables, numbers in brackets are for the G500 variant with 2 core CPU/8GB RAM.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 10,000 (5,000) DI – 100	All points changing twice in 2 secs
Number of connected IEDs to G500	500 (250)	500 (250)
G500 total RTDB Point count	200,000 (100,000)	200,000 (100,000)

Requirement	Steady State Loading	Avalanche Loading
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points (half for 2 core CPU/8GB RAM)	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger / Continuous reports	1000 (500) AI mapped / 100 (50) reports	1000 (500) AI mapped / 100 (50) reports
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs
Alarms	100 (50) / sec	100 / sec (for 2 seconds)

1.1 Standalone

G500 provides the following performance capabilities in Single (non-redundant) Mode.

1.1.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in Table 1.1: Standalone Performance test results.

Table 1.1: Standalone Performance test results

Activity	DNP	DNP	IEC 61850	IEC 61850
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	2 core / 8 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state
Protocol – CLIENT / SERVER	DNP / DNP	DNP / DNP	IEC 61850 / DNP	IEC 61850 / DNP
RTDB Point count	200,000	100,000	200,000	100,000
Total RCB configured / Simulation per sec	NA	NA	6000 1000	3000 500
Number of IEDs	500 (250)	500 (250)	500 (250)	500 (250)
Points / IED (AI + DI + AO + DO)	[AI-250, 150-DI, 20-DO, 20-AO, 10-ACC]	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports
Number of Master connections Point count / Server	8 DI – 9300, AI – 15500	4 DI – 4650, AI - 7750	8 DI – 9300, AI - 15500	4 DI – 4650, AI - 7750
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 1 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,50,92	80, 28, 95	56, 30, 95	46, 36, 75
Average Memory	2.4 GB	1.4 GB	3 GB	2 GB

Activity	DNP	DNP	IEC 61850	IEC 61850
Event latency in (msecs) Average, Min, Max	399,19,1.04sec	487,13,1.31	589, 5, 2200	330, 41, 652
Control latency in (msecs) Average, Min, Max	34,12,291	629,3,1.09	8, 6, 16	9, 3, 68

1.1.2 HMI Response time

Under heavy loading conditions, the G500 provides the HMI response times listed in Table 1.2: User Interface Response Time.

Table 1.2: User Interface Response Time

Activity	Normal	High
Screen Access (Point Summary)	< 2 s	< 2 s
Screen Access (One-Line Viewer)	5 to 7 s	5 to 7 s
System Logs	< 2s	2s
Alarm ACK Delay (Single Alarm)	< 1 s	< 1 s
Alarm ACK Delay (20,000 Alarms)	< 2 s	< 7 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s
Datalogger	<2s	<2s

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control every 5 seconds continuously from the Master station.

1.2 Hot Standby Redundancy

G500 provides the following performance capabilities in Hot Standby Redundancy Mode.

Configuration	DNP	IEC61850
Hardware (CPU /RAM)	4 core / 16 GB	4 core / 16 GB
Redundancy	Hot Standby	Hot Standby
Number of IEDs	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP
RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)
Datalogger / Continuous reports	NA	NA
ARRM	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec

Configuration	DNP	IEC61850
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,34,71	32,46,67
Average Memory	3.12 GB	4.3 GB
Event latency – Average, Min, Max (msec)	390,60,1sec	368,2.8,1sec
Control latency – Average, Min, Max (msec)	30,12,377	3,1,73

1.3 Warm Standby Redundancy

G500 provides the following performance capabilities in Warm Standby Redundancy Mode.

Protocol	DNP	IEC61850	IEC 104
Hardware CPU / RAM	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)
Redundancy Mode	Warm Standby	Warm Standby	Warm Standby
Number of IEDs	500 (250)	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP	IEC 104 / IEC 104
RTDB Point count	200,000 (100,000)	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)	NA
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) continuous reports
ARRM	Not configured	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	62,53,96	43,48,60	28,32,42
Average Memory	2.4 GB	3 GB	3.4 GB
Event latency – Average, Min, Max (msec)	437,26,1.06	683,323,1sec	221,107,380
Control latency – Average, Min, Max (msec)	44,11,240	3,1,85	30,10,331

NOTE: G500 Supports maximum of 4 simultaneous Runtime HMIs (Remote + Local) either in Standby or Redundancy Modes (Hot/Warm Redundancy).

Time Sync Accuracy (PTP/IRIG-B/NTP)

G500 supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

1.4 PTP Accuracy

1.4.1 Test Steps:

Below are setup details used for measuring PTP IN Time sync accuracy:

- Total number of samples considered ~250,000.
- Accuracy found to be < +/- 1ms for 99.86% of samples.
- Measured the accuracy for every second at the G500 CPU or Kernel.

1.4.2 Test Results:

Time Sync Input	Accuracy % of samples within (+/- 1 msec)
PTP IN	99.86% (samples within +/-1 ms)

NOTES:

- Accuracy is measured in a scenario where the hardware /FPGA is fully loaded.
- If IEDs are getting time synced using any of the client communication protocols, then the above accuracy cannot be guaranteed at the IED.

1.5 IRIG-B Accuracy

1.5.1 Test Setup:

Below are setup details used for measuring IRIG-B IN Time sync accuracy:

- Total number of samples considered ~50,000.
- Accuracy found to be < +/- 1ms for 99.8% of samples.
- Measured the accuracy for every second at the G500 CPU or Kernel.

1.5.2 Test Results:

Time Sync Input	Accuracy % of samples within (+/- 1 msec)
IRIG-B IN	99.8% (samples within +/-1 ms)

NOTES:

- Accuracy is measured in a scenario where the hardware /FPGA is fully loaded.
- If IEDs are getting time synced using any of the client communication protocols, then the above accuracy cannot be guaranteed at the IED.

1.6 NTP IN Accuracy

1.6.1 Test Setup:

Below are setup details used for measuring NTP IN Time sync accuracy:

- Total number of samples considered ~50,000.
- Accuracy found to be < +/- 10ms for 99.97% of samples.
- Measured the accuracy for every second at the G500 CPU or Kernel.

1.6.2 Test Results:

Time Sync Input	Accuracy % of samples within (+/- 10 msec)
NTP IN	99.97% (samples within +/-10 ms)

NOTES: If IEDs are getting time synced using any of the client communication protocols, then the above accuracy cannot be guaranteed at the IED.

1.7 NTP OUT Accuracy

Below are setup details used for measuring NTP OUT Time sync accuracy:

- Total number of samples considered ~50,000.
- Accuracy found to be < +/- 1 ms for 99.9% of samples.
- Measured the accuracy for every second at the IED.

1.7.1 Test Results:

Time Sync Output	Accuracy % of samples within (+/- 1 msec)
NTP OUT	99.9% (samples within +/- 1ms)

NOTES: If IEDs are getting time synced using any of the client communication protocols, then the above accuracy cannot be guaranteed at the IED.

Application List

The following applications comprise the G500 v1.00 released firmware version and build 1.0.652.

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available
System Library	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available
Calculator	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✗ Not Available

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
PTP/IRIG-B Time Sync	✓ Available	✓ Available
Modbus Client	✓ Available	✓ Available
Modbus-TCP/SSH Client	✓ Available * Not Available in Warm Standby	✗ Not Available
SEL® Binary Client	✓ Available	✗ Not Available
Analog Data Logger	✓ Available	✗ Not Available
Generic ASCII Client	✓ Available	✗ Not Available
Modbus Server	✓ Available	✗ Not Available
DNP 3.0 Server	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available
Database Server	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✗ Not Available
IEC 60870-5-101/104 Server	✓ Available	✗ Not Available
IEC 60870-5-103 Client	✓ Available	✗ Not Available
IEC 61850 Client	✓ Available	✓ Available
IEC 60870-5-101/104 Client	✓ Available	✗ Not Available
Event Logger	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✗ Not Available
Control Lockout Manager	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available
SNMP Client	✓ Available	✗ Not Available
Automated Record Retrieval Manager	✓ Available	✗ Not Available

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
Software Licensing Subsystem	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available
Firewall	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available
Genconn	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available
Analog Report Generator	✓ Available	✘ Not Available
OpenVPN	✓ Available	✓ Available

Known Issues

1.7.2 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

1.7.3 Clients

GE Internal Reference #	Summary	Impact
D-05002	Cannot perform file transfer from GENASCII devices.	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.

1.7.4 Servers

GE Internal Reference #	Summary	Impact
B-11968	No support for events in NVRAM in DNP3 Server.	Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11967	No support for events in NVRAM in IEC101/104 Server.	Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

1.7.5 Automation

GE Internal Reference #	Summary	Impact
D-05877	No warning message when storage space is reduced in datalogger configuration.	Currently datalogger application re-adjusts the storage space(increase/decrease) based on the newly allocated settings. In this case users might not be aware of the deletion of the records if the newly allocated storage space is smaller than the previous allocated one.
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters.	DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
D-05462	Load shedding: Persistent storage of Zone Assignments is not working.	There is no persistency of zone assignments across power restarts when user sets the zones through Analog Setpoint commands.
B-11969	No support for events in NVRAM for DEM.	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
D-07025	Alarm/SOE Database corruption when abrupt G500 power failure happens & Events are simultaneously generated.	This is a remote case and if the database corruption happens the SQL server will not be started.

1.7.6 Configuration

GE Internal Reference #	Summary	Impact
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change.	No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.

1.7.7 HMI

GE Internal Reference #	Summary	Impact
D-05802	Local HMI shows exception errors when screens are open and video resolution is changed lower than the current size of HMI frames.	Occurs only when screen resolutions are changed, and the Local HMI has windows opened with a larger size than the new set resolution. User must close the Local HMI and re-open again.
D-05463	Point groups: Points are missing after deleting an active group.	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.

1.7.8 Pass-through

GE Internal Reference #	Summary	Impact
D-07084	Cannot access hosts inside Internal Zone unless hosts have custom routing configured.	Only hosts in internal zone that allow configuration of custom routes can be accessed via VPN server from external zone.

1.7.9 System

GE Internal Reference #	Summary	Impact
D-05714	Update of only Edge OS is not supported.	If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016	Enhancement. G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by a different time zone.	The timestamps of DI events come with wrong time zone in the SOE Logs or in DNP3. Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

1.7.10 Hardware

GE Internal Reference #	Summary	Impact
D-06232	IRIG-B Out is invalid during start-up.	IRIG-B OUT signal produces a 1970-01-01 signal for brief periods of time during G500 start-up.
D-06165	SFP Hot Plug in / Plug out detection.	No functional impact. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.
D-06458	Audio Output Port is not working.	User is unable to hear Alarm or any sounds from the Audio Output Port of G500.

2. Version 1.10 (14-February-2020)

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	1.1.457	G500 Firmware Version.
DS Agile MCP Studio	2.0.0.0.35611	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	1.1.458	Supported G500 HMI 64-bit Software.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v1.1.457.

Package/Firmware	Version	Notes
Predix Edge OS	2.2.1	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

2.1 Enhancements

This G500 version adds the following new features compared to V1.00:

2.1.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

2.1.2 Clients

GE Internal Reference #	Summary	Resolution
B-12826	Modbus TCP/SSH Client Support for Warm/Hot Standby.	Added Warm & Hot Standby Redundancy Support for Modbus TCP/SSH Client application.
R-01137	DNP Data Link Retries in G500 to be more like D20.	Added support for DNP Data Link Retries enable/disable option for Direct Operate controls.

2.1.3 Server

GE Internal Reference #	Summary	Resolution
R-01185	IEC101/104 Server support for NG implementation.	Added support for different link address to Backup Serial port in IEC101 DPA.
E-03739	Configurable DNP DPA Abs/Rel time for Binary Input Change Events.	Added support for Binary Input Change Events in DNP3 DPA to report with either Absolute timestamp or Relative timestamp.

2.1.4 Automation

GE Internal Reference #	Summary	Resolution
E-03776	Increase in DTA Application Limits.	Added support to increase the Application Limits fo the following Automation applications. *Calculator* ▪ Evaluation Expressions from 2,(to 10,000 ▪ Digital Assignments from 2,000 10,000 *System Poin Manager* ▪ Local groups from 256 to 1,000 ▪ Input Point Suppression groups from 256 to 10,000 ▪ Redundant IO groups from 256 10,000.
R-01186	Remote Control Lockout Group Enhancements.	Added support for manual group ownership in Remote Control Lockout functionality by explicitly acquiring the lock using a Group pseudo DO point.

2.1.5 HMI

GE Internal Reference #	Summary	Resolution
E-03446	Support for Setting GUI in addition to mcpcfg.	Added web-based Setting GUI in addition to command line mcpcfg for configuring G500 settings.

2.1.6 Passthrough/VPN

GE Internal Reference #	Summary	Resolution
R-01113	Improve GUI of VPN Server Routing and Whitelisting.	Enhancements are implemented in the VPN Server Routing List and Whitelisting drop-down options in GUI.

2.1.7 System

GE Internal Reference #	Summary	Resolution
B-13018	Secure Tunnel between Active & Standby G500s.	Added support for secure tunnel framework for data/command exchange between Active and Standby G500s in Hot & Warm Standby Redundancy modes.
B-12766	Hardware Asset Management Application (HAMA) Enhancements.	Added the support to show information/status of additional PCIe expansion cards (serial and D.20 when available).
B-12663	SOE and Alarm functions in HMI.	Enhanced speed and efficiency of SOE and Alarm functions.

2.1.8 Hardware

GE Internal Reference #	Summary	Resolution
B-12575	Hardware Based IRIG-B Output Support.	Added support for hardware based IRIG-B output to existing IRIG-B input.
R-01184	Added Fiber Optic Single Mode GB SFP as order option “L”.	Added support for Fiber Optic Single Mode GB SFP as order option “L” in the Ordering Guide.

2.1.9 Documentation

GE Internal Reference #	Summary	Resolution
R-01164	Add Note/description to Software Configuration Guide to clarify that Double Point functionality is only for Alarms.	Updated the Software Configuration Guide to clarify the support for Double Point Alarms as available only for Double Points in G500.
B-12696	Improve Documentation for Warm Standby Redundancy functionality.	Improved documentation for configuring Warm Standby Redundancy workflow in Software Configuration Guide.

2.2 Fixed defects

This version of G500 has the fixes for the following defects compared to V1.00:

2.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

2.2.2 Clients

GE Internal Reference #	Summary	Resolution
D-09785	DNP DCA memory usage increase when 10 controls/sec are simulated continuously.	Fixed the memory leak issue in DNP Client when more than 10 controls/sec are simulated continuously.

2.2.3 Automation

GE Internal Reference #	Summary	Resolution
D-07611	Sync To operation from DSAS "Overrides" Sync Manager Users.	DSAS excludes the Sync Manager configuration and users while doing Sync To operation to the G500.
D-05603	ARRM TFTP File retrieval is not working with 8-Series relays.	Fixed the issue of supporting file retrieval from 8-series relays through TFTP.
D-08328	ARRM FTP functionality is not working while restoring the snapshot to G500.	Fixed the issues with the decryption of FTP Password in the ARRM configuration files while restoring the configuration from the other G500 device.
D-07603	ARRM cannot read files from SEL via FTP.	Fixed the issues with the decryption of FTP Passwords from SEL relays while reading the files through ARRM.
D-08361	ARRM Directory path not updated after save and commit changes.	Fixed an issue where ARRM Change in Directory Path in File set Template was not propagating correctly after configuration save and commit.
D-08080	Redundant IO doesn't start unless there is at least one AI mapped.	Fixed an issue where Redundant IO doesn't start unless there is at least one AI being mapped, now works without any AI mapped.
D-05877	No warning message when storage space is reduced in datalogger configuration.	If the new configured datalogger file size is smaller than the current datalogger file size, pop up a confirmation dialog with the warning msg shown below: "The new requested size for this report is smaller than the current size of the data in the report. This operation will delete old/new/all data in the report. Do you want to continue?" Only saving datalogger configure when user clicks the 'yes' button

GE Internal Reference #	Summary	Resolution
D-07025	Alarm/SOE Database corruption when abrupt G500 power failure happens & Events are simultaneously generated.	After EdgeOS 2.2 upgrade timestamps off by random number of hours in MariaDB. By purging the database (apps automatically restarted), the issue was resolved.

2.2.4 Configuration

GE Internal Reference #	Summary	Resolution
D-08357	ARRM FTP/SFTP/TFTP default timeout increase to 10 sec.	Updated the default timeout for FTP/SFTP/TFTP from 2 secs to 10 secs.

2.2.5 HMI

GE Internal Reference #	Summary	Resolution
D-08521	G500 Buzzer should be disabled by default.	The default state of the G500 Buzzer after the firmware is installed is OFF.
D-09979	Manual forced accumulator values not supporting full range.	Fixed the issue with accumulators for not supporting max value of 2^63-1.
D-10185	Saving of Datalogger reports in Local HMI.	Fixed the issue in saving the datalogger reports in Local HMI.
D-10233	Local HMI allows admin and operator users to copy private keys to USB.	Fixed the issue in Local HMI File Explorer to copy the private keys to USB for all users.
D-05802	Local HMI shows exception errors when screens are open and video resolution is changed lower than the current size of HMI frames.	Fixed.

2.2.6 Pass-through

GE Internal Reference #	Summary	Resolution
D-07084	Cannot access hosts inside VPN Internal Zone unless hosts have custom routing configured.	Fixed.

2.2.7 System

GE Internal Reference #	Summary	Resolution
B-13055	Password Encryption/Decryption getting failed for Snapshot/Restore of one G500 to another G500.	Fixed the issue with failure of Password Encryption/Decryptions while using the Snapshot and Restore functionalities across the G500s.
D-09906	Missing SOEs during SOE Export.	Fixed the issue of missing of SOEs in the export file while DI events are being simulated and deletion is in progress.

2.2.8 Hardware

GE Internal Reference #	Summary	Resolution
D-06232	IRIG-B Out is invalid during start-up.	IRIG-B OUT signal produces a 1970-01-01 signal for brief periods of time during G500 start-up.
D-06458	Audio Output Port is not working.	Fixed the issues with audio output port of G500.

2.2.9 Known Issues

This G500 version has the following known issues:

2.2.10 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

2.2.11 Clients

GE Internal Reference #	Summary	Impact
D-09916	SEL Binary Client application restarts when configured to communicate with SEL 351S relay.	SEL Binary Client fails to communicate to the SEL 351S relay when the relay is connected through G500's Virtual Serial Ports.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.

2.2.12 Servers

GE Internal Reference #	Description
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

2.2.13 Automation

GE Internal Reference #	Summary	Impact
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters.	DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
D-05462	Load shedding: Persistent storage of Zone Assignments is not working.	There is no persistency of zone assignments across power restarts when user sets the zones through Analog Setpoint commands.
B-11969	No support for events in NVRAM for DEM.	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

2.2.14 Configuration/Settings

GE Internal Reference #	Summary	Impact
D-10345	mcpcfg settings must be reconfigured while upgrading the G500 from v1.0 to v1.1.	As part of upgrading the G500 from v1.0 to v1.1, the configuration settings must be reconfigured using mcpcfg or settings GUI after upgrading to v1.1.
D-10346	PTP-1588 IN and IRIG-B IN cannot be enabled at the same time in G500 v1.1.	G500 v1.1 does not support both PTP IN and IRIG-B IN to be enabled at the same time. Also, by default these Time Sync Input sources are disabled and user can enable either of them using mcpcfg or settings GUI.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change.	No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.

2.2.15 HMI

GE Internal Reference #	Summary	Impact
D-09695	Operator User in Active G500 gets Observer Group privileges sometimes after multiple switch-over or fail-overs in Hot or Warm Standby Redundancy.	Runtime HMI needs to be logged out and logged in if this case happens.
D-09915	G500 HMI "Internal Access Error" after SEL DCA is configured and then crashes.	Runtime HMI cannot be logged in and it displays “Internal Access” error even after rebooting the G500. However, once SEL Binary Client Configuration is deleted from the configuration then this issue will not be observed.

GE Internal Reference #	Summary	Impact
D-09944	Internationalization: Settings and messages in the Powerbar in Runtime HMI are not changing to specified language.	No Functional Impact. However, the messages/settings in the Powerbar in Runtime HMI continue to be seen in English.
D-10324	"The configuration has been modified. Unsaved changes will be discarded. Do you want to discard the changes?" this message is getting displayed even though any changes made are already committed. This applies to the Access tab in the local HMI viewer.	No Functional Impact. However, the message creates inconvenience to the user.
D-10325	After saving the changes in the Access tab of the local HMI viewer and navigating to other tab without committing the changes, then Local HMI viewer is not accessible.	Impact: Loss of access to the Local HMI viewer. However, can be recovered by committing or discarding the changes from DSAS.
D-05463	Point groups: Points are missing after deleting an active group.	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.

2.2.16 Pass-through

None.

2.2.17 System

GE Internal Reference #	Summary	Impact
E-03371	No method to restore a G500 after all admin local logons lost/forgotten.	G500 cannot be logged in using SSH/HMI/ Front Serial Port. However, users can use the Single Image installer through USB and restore the Factory Default firmware and the configuration.
D-08036	Avoid not applicable errors displayed during G500 bootup process.	No Functional Impact. However, during reboot of G500, some not applicable error messages are displayed on the console connected to the display port.
D-10254	Double Quote (" ") are not allowed to use in the password field for FTP in Sync Manager.	Double quotes (" ") cannot be used in password field of FTP in the Sync Manager configuration.

GE Internal Reference #	Summary	Impact
D-05714	Update of only Edge OS is not supported.	If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016	Enhancement. G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by a different time zone.	The timestamps of DI events come with wrong time zone in the SOE Logs or in DNP3. Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

2.2.18 Documentation

GE Internal Reference #	Summary	Impact
D-09783	G500 sync to UTC-(UTC_OFFSET) instead of UTC after fall back from PTP to IRIG-B - a reboot is required to fix the offset problem.	Dynamic failover at runtime between PTP and IRIG-B will not happen. Documentation does not capture this.
D-10131	Missing information about syslog file in the G500 SW Configuration Guide.	No Functional Impact. However, the examples that show the format of rsyslog file output are not available in the Software Configuration Guide.

2.2.19 Hardware

GE Internal Reference #	Summary	Impact
D-06165	SFP Hot Plug in / Plug out detection.	No functional impact. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

The G500 v1.10 meets below performance test level requirements of G500 v1.00.

NOTES:

- G500 Hardware under test: 4 core CPU/ 16GB RAM variant.
- In the below table, numbers inside the brackets are for the G500 variant with 2 core CPU/8GB RAM.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 10,000 (5,000) DI – 100	All points changing twice in 2 secs
Number of connected IEDs to G500	500 (250)	500 (250)
G500 total RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points (half for 2 core CPU/8GB RAM)	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger / Continuous reports	1000 (500) AI mapped / 100 (50) reports	1000 (500) AI mapped / 100 (50) reports
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs
Alarms	100 (50) / sec	100 / sec (for 2 seconds)

2.3 Stand Alone

G500 provides the following performance capabilities in Single (non-redundant) Mode.

2.3.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in Table 2.1: Standalone Performance test results.

Table 2.1: Standalone Performance test results

Activity	DNP	DNP	IEC 61850	IEC 61850
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	2 core / 8 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state
Protocol – CLIENT / SERVER	DNP / DNP	DNP / DNP	IEC 61850 / DNP	IEC 61850 / DNP

Activity	DNP	DNP	IEC 61850	IEC 61850
RTDB Point count	200,000	100,000	200,000	100,000
Total RCB configured / Simulation per sec	NA	NA	6000 1000	3000 500
Number of IEDs	500 (250)	500 (250)	500 (250)	500 (250)
Points / IED (AI + DI + AO + DO)	[AI-250, 150-DI, 20-DO, 20-AO, 10-ACC]	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports
Number of Master connections Point count / Server	8 DI – 9300, AI – 15500	4 DI – 4650, AI - 7750	8 DI – 9300, AI - 15500	4 DI – 4650, AI - 7750
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 1 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,50,92	80, 28, 95	56, 30, 95	46, 36, 75
Average Memory	2.4 GB	1.4 GB	3 GB	2 GB
Event latency in (msecs) Average, Min, Max	399,19,1.04sec	487,13,1.31	589, 5, 2200	330, 41, 652
Control latency in (msecs) Average, Min, Max	34,12,291	629,3,1.09	8, 6, 16	9, 3, 68

2.3.2 HMI Response time

Under heavy loading conditions, the G500 provides the HMI response times listed in Table 2.2: User Interface Response Time.

Table 2.2: User Interface Response Time

Activity	Normal	High
Screen Access (Point Summary)	< 2 s	< 2 s
Screen Access (One-Line Viewer)	5 to 7 s	5 to 7 s
System Logs	< 2s	2s
Alarm ACK Delay (Single Alarm)	< 1 s	< 1 s
Alarm ACK Delay (20,000 Alarms)	< 2 s	< 7 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

2.4 Hot Standby Redundancy

G500 provides the following performance capabilities in Hot Standby Redundancy Mode.

Configuration	DNP	IEC61850
Hardware (CPU /RAM)	4 core / 16 GB	4 core / 16 GB
Redundancy	Hot Standby	Hot Standby
Number of IEDs	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP
RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)
Datalogger / Continuous reports	NA	NA
ARRM	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,34,71	32,46,67
Average Memory	3.12 GB	4.3 GB
Event latency – Average, Min, Max (msec)	390,60,1sec	368,2.8,1sec
Control latency – Average, Min, Max (msec)	30,12,377	3,1,73

2.5 Warm Standby Redundancy

G500 provides the following performance capabilities in Warm Standby Redundancy Mode.

Protocol	DNP	IEC61850	IEC 104
Hardware CPU / RAM	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)
Redundancy Mode	Warm Standby	Warm Standby	Warm Standby
Number of IEDs	500 (250)	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP	IEC 104 / IEC 104
RTDB Point count	200,000 (100,000)	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI	150 DI, 250 AI

Protocol	DNP	IEC61850	IEC 104
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)	NA
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) continuous reports
ARRM	Not configured	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	62,53,96	43,48,60	28,32,42
Average Memory	2.4 GB	3 GB	3.4 GB
Event latency – Average, Min, Max (msec)	437,26,1.06	683,323,1sec	221,107,380
Control latency – Average, Min, Max (msec)	44,11,240	3,1,85	30,10,331

NOTE: G500 Supports maximum of 4 simultaneous Runtime HMIs (Remote + Local) either in Standby or Redundancy Modes (Hot/Warm Redundancy).

Time Sync Accuracy (PTP/IRIG-B/NTP)

G500 supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

The current version does not support runtime dynamic failover across different time sources.

Time Sync Input	Accuracy
PTP IN	100% samples within +/-121 microseconds
IRIG-B IN	100% samples within +/-100 microseconds
NTP IN	99.97% samples within +/-10 ms
NTP OUT	99.9% samples within +/- 1ms

NOTES:

- PTP and IRIG-B time accuracy is measured in a scenario where the hardware /FPGA is fully loaded and applies to G500 only.
- If IEDs are getting time synced using any of the client communication protocols (e.g., DNP3), then the above accuracy cannot be guaranteed at the IED.

Application List

The following applications comprise the G500 v1.10 released firmware version and build 1.1.457.

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available
System Library	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available
Calculator	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✗ Not available
PTP/IRIG-B Time Sync	✓ Available	✓ Available
Modbus Client	✓ Available	✓ Available
Modbus-TCP/SSH Client	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✗ Not Available
Analog Data Logger	✓ Available	✗ Not Available
Generic ASCII Client	✓ Available	✗ Not Available
Modbus Server	✓ Available	✗ Not Available
DNP 3.0 Server	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available
Database Server	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✗ Not Available
IEC 60870-5-101/104 Server	✓ Available	✗ Not Available
IEC 60870-5-103 Client	✓ Available	✗ Not Available
IEC 61850 Client	✓ Available	✓ Available
IEC 60870-5-101/104 Client	✓ Available	✗ Not Available
Event Logger	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✗ Not Available

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
Control Lockout Manager	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available
SNMP Client	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✖ Not Available
Software Licensing Subsystem	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available
Firewall	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available
Genconn	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available
Analog Report Generator	✓ Available	✖ Not Available
OpenVPN	✓ Available	✓ Available

3. Version 2.00 (27-May-2020)

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	2.0.159	G500 Firmware Version.
DS Agile MCP Studio	2.1.0	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	2.0.159	Supported G500 HMI 64-bit Software.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v2.0.0.

Package/Firmware	Version	Notes
Predix Edge OS	2.2.1	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

3.1 Enhancements

This G500 version adds the following new features compared to previous versions:

3.1.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

3.1.2 Clients

GE Internal Reference #	Description
E-03038	Added D.20 client (single instance) support to connect to D.20 IO peripherals.

3.1.3 Servers

None.

3.1.4 Automation

None.

3.1.5 Configuration/Settings

GE Internal Reference #	Description
E-03397	Allow import of full D.20 DCA configuration (IO peripherals and communication) from B003 (D2x) to G500.
B-13469	Added support to restore snapshots when Remote Authentication mode is enabled. After restore operation is completed, the device is in Local Authentication Mode. All Remote Authentication configuration parameters are retained after snapshot restoration and the user would need to reselect the Authentication mode to Remote (LDAP/TACACS+) from the Runtime HMI.
B-13418	Snapshots and configuration archives which contain internally configured passwords for IED, ARRM, Synch Manager, LDAP, TACAS+ are now portable across different G500 units of same or newer version (in previous versions this was possible only on the exact same unit).
B-13498	Added Encrypted MCPCloneSnapshot type. These may also be used for Firmware Upgrade operations.
B-13500	In redundant units, the serial port settings are configured separately in unit A and B and are not synchronized across to accommodate different serial port allocation between units A and B (required mainly for RS485 loops).
D-10254	Allow Double Quotes ("") when configuring passwords for FTP in Sync Manager.
D-09947	Ability to Save Changes of LDAP Server Settings without activating it (unit remains in Local Authentication mode).
B-13075	Added support for selecting the colors used to indicate errors in configuration. See Systemwide > GUI > Conditional Formatting.

3.1.6 HMI

GE Internal Reference #	Description
E-03784	In redundant devices: improved user experience and robustness for Local HMI during failover.
D-10576	Added support to view the existing emergency access code and forcing to generate a new emergency access code if needed.
D-10554	D.20 Traffic is not available to be visualized in Runtime HMI (this is an enforced rule, not a defect).
D-10577	When "mcpemergency" utility on local HMI is used to generate the emergency access code, is now possible to copy the code and paste it to the login prompt. Previously this had to be entered manually (the code is long and prone to make mistakes).

3.1.7 Pass-through

None.

3.1.8 System

GE Internal Reference #	Description
E-03629	Implemented Firmware Upgrade workflow using generic USB storage. External USB size must be between 8 – 32 GB in this release.
E-03371	Implemented a procedure to allow users to restore a G500 to Factory Default ("clean") configuration when all admin local logons have been lost (use USB storage method).

3.1.9 Documentation

GE Internal Reference #	Description
B-13504	Updated supported variants of Modbus Clients (Modbus RTU, Modbus TCP and Modbus TCP/SSH) and their support in warm and hot redundancy modes in the SWM0101 (Software Configuration Guide).
B-13513	Created Remote Authentication manuals for LDAP AD, Open LDAP, 389 DS.

3.1.10 Hardware

GE Internal Reference #	Description
E-03001	Added D.20 HDLC PCIe module as optional module, installable in PCIe slot 3. For additional details, please refer to "994-0152 G500 Substation Gateway Instruction Manual V200 R0".

3.2 Fixed defects

This version of G500 has the fixes for the following defects compared to V1.10:

3.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

3.2.2 Clients

GE Internal Reference #	Description
D-09916	SEL Binary Client was restarting abruptly when detected Double Precision Scaling Factors in a SEL relay (for e.g., SEL-351S). Now it logs a message into the diagnostic log and exits gracefully.
D-10226	An SNMP Disabled IED was enabled automatically after receiving a trap.

3.2.3 Server

GE Internal Reference #	Description
D-10392	AI and ACC parameters were not reported to DNP master based on the threshold settings in the DNP3 Server Mapfile.
D-07837	Modbus Server application failed to connect with message "killing modbusdpa application".

3.2.4 Automation

None.

3.2.5 Configuration/Settings

GE Internal Reference #	Description
D-10318	FTP in sync manager could not be configured from the Settings GUI.
D-10488	LDAP Remote Authentication configured settings (but not yet activated because "Enable" checkbox was not selected in the Settings tab) were not saved/persisted across reboots of G500.

3.2.6 HMI

GE Internal Reference #	Description
D-10378	HMI was occasionally displaying “Unsupported Value of Security Type”.
D-10574	Local HMI could not login sometimes using Emergency Access code during startup of G500.
D-09944	Internationalization: Settings and messages in the Powerbar in Runtime HMI were not changing to specified language.
D-10324	Fixed the message “The configuration has been modified. Unsaved changes will be discarded. Do you want to discard the changes?" that was displayed even though any changes made are already committed. This applies to the Access tab in the local HMI viewer.
D-10325	After saving the changes in the Access tab of the local HMI viewer and navigating to other tab without committing the changes, then Local HMI viewer was not accessible.

3.2.7 Pass-through

None.

3.2.8 System

GE Internal Reference #	Description
D-10081	Accumulator values were not synchronized between Active and Standby in Warm Standby Redundancy.
D-10373	Local HMI login prompt and Emergency access terminal were not available if LDAP server was not available during reboot.
D-10462	Pairing of redundancy failed after factory default settings was performed.
D-10479	The prompt "=> " was not returned during Secure Passthrough (SSH, Telnet, SSL/TLS) with SEL BIN.
D-10504	Multiple SSH sessions were not accessible in an LDAP enabled device.
D-10562	Datalogger Periodic Reports trending stopped/paused during long runs.
D-10563	SBO Controls were sometimes not accepted by RTDB if Control In Progress DTA was configured for the same DO Points or if control rate was >3 seconds in continuous/performance test scenarios.
D-10600	Active G500 was taking an additional ~1minute time to start when Standby G500 was powered off during start up.

3.2.9 Documentation

GE Internal Reference #	Description
D-09783	Only one-time source can be enabled at a time (PTP / IRIG-B); captured this in Software Configuration Guide.
D-10131	Added the format and details about Remote Syslogs of G500 in G500 Software Configuration Guide (SWM0101).

3.2.10 Hardware

None.

3.3 Known Issues

This G500 version has the following known issues:

3.3.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

3.3.2 Clients

GE Internal Reference #	Description
E-04038	D.20 Client is supported only in non-redundant systems in this release.
B-13475	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-09915	SEL IEDs with this configuration type are not supported (e.g., SEL-351S).
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.

3.3.3 Servers

GE Internal Reference #	Description
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

3.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
D-05462	Load shedding: There is no persistency of zone assignments across power restarts when user sets the zones through Analog Setpoint commands.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

3.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10343	Sync Manager Settings are not retained during upgrade from V1.0 to V1.1. User needs to re-enter these manually. Will not fix.
D-10345	mcpcfg settings must be reconfigured after upgrading G500 from 1.0 to 1.1. Will not fix.
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-10825	Online Editor / SNMP Agent Browser is not able to retrieve OID data if gathering data from target device takes more than 60 seconds. Workaround: configure the SNMP client offline, using OID from the end device (e.g., using a 3rd party MIB browser).

3.3.6 HMI

GE Internal Reference #	Description
D-10229	Gateway -A /-B designation is missing from local HMI banner sometimes
D-09695	Operator User in Active G500 gets Observer Group privileges sometimes after multiple switch-over or fail-overs in Hot or Warm Standby Redundancy. Runtime HMI needs to be logged out and logged in if this case happens.
D-05463	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.

3.3.7 Pass-through

None.

3.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10781	In redundant G500, if both units are (re)started at same time, the indications code and config out of sync are incorrect. Workaround: start one G500 at a time (wait for the first one to start) or restart one of the units while the other one runs.
D-10763	Communications stops on D.20 link in rare cases and doesn't recover. Current workaround: when stop condition is detected, the system will be automatically rebooted. If the system reboots to recover from this condition, the following message will be logged to the system event log: MsgID=70; INFO; Description=Last Reset Cause; Misc=Last reset caused by WDT_CARRIER.D20
D-10227	Email does not send messages when an alarm is activated.
D-08036	During start of G500, some not applicable error messages are displayed on the console connected to the display port. No Functional Impact.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by different time zone and resulting SOE timestamps have wrong time zone. Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

3.3.9 Documentation

None.

3.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

This G500 version supports the following application limits.

Application	Feature	Configuration Limits
Digital Event Manager	**Alarms**	
	Max Number of Alarm Groups	256
	Max number of members in an Alarm Group	1000
Calculator	**Expression Type:**	
	Evaluations	10000
	Timers	1000
	Analog Assignments	2000
	Digital Assignments	10000
	Quality Conversions	1000
	Type Conversions	1000
	Averages	1000
	Output to Input Conversions	1000
Load Shed DTA	**Number of Feeders and Zones**	
	Max Zones	50
	Max Feeders	100
Analog Reports DTA	Max Analog Reports	100
System Point Manager	Accumulator Freeze	100
	Analog Value Selection	100
	Control Lockout	
	• Remote Groups	8
	• Local Groups	10000
	Double Points	1000
	Input Point Suppression	10000
	Control in Progress	256
	Redundant I/O	10000
Analog Data Logger	Continuous Reports	1000
	Periodic Reports	1000
	Out of Range Reports	1000

Application	Feature	Configuration Limits
VPN Server	Number of VPN Clients	8
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IEDs**	
	DNP Multidrop	80
	DNP Multidrop (Modem)	80
	Generic ASCII	80
	SEL Binary IED	80
	IEC 60870-5-101 Multidrop	80
	IEC60870-5-103 Multidrop	80
	Modbus Multidrop	80
	D.20	1
	Network IEDs	
	DNP3 TCP	500
	Modbus TCP/Modbus TCP-SSH	500
	IEC60870-5 104	500
	IEC61850	500
	SNMP	1
	VPN Server	1
	Serial Masters	
	DNP3 Serial Master	8
	IEC 60870-5-101 Master	8
	Modbus Serial Master	8
	Network Masters	
	DNP3 Network Master	8
	IEC 60870-5-104 Master	8
	Modbus TCP Master	8
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**	
	IEC60870-5-103 Multidrop	255
	DNP3 Multidrop/Network	10
	Modbus Multidrop/TCP	20
	IEC60870-5 101 Multidrop	1000
	IEC60870-5 104	10
	SNMP Client	100
	GenASCII Client	120
	IEC61850 Client	60
	SEL Binary Client	1
	D.20 Client	120

Application	Feature		Configuration Limits
	Serial /Network Masters		
	DNP3 Serial Master		32
	Modbus Serial Master		32
	IEC60870-1 101 Master		32
	DNP3 TCP Master		1
	Modbus TCP Master		1
	IEC60870-1 104 Master		1
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs		1000
	Modbus Multi-Drop/Network IEDs		1000
	GenASCII IED		1000
	SNMP IED		1000
	IEC60870-1 103 Multi-Drop		1000
	IEC60870-1 101/104 Multi-Drop		
	• Bitstream		32
	• Double Command		1000
	• Integrate Total		1000
	• Measurand		1000
	• Packed Single Point		16
	• Regulating Step Command		1000
	• Set Point Command		1000
	• Single Point		1000
	• Step Position		1000
	SEL Binary IED		
	• Fast Meter Analog Input		32
	• Demand Analog Input		32
	• Peak Demand Analog Input		32
	• SER Digital Input		1000
	D.20 Peripheral Client		
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs
	D.20 K Card		32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs

Application	Feature		Configuration Limits
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master		DI -10000 AI -15000 DO -5000 ACC – 3000
	Modbus Serial/TCP Master		DI -10000 AI -15000 DO -5000 ACC -3000
	IEC60870-1 101/104 Master		DI -10000 AI -15000 DO -5000 ACC - 3000

This G500 version meets the following performance test levels (same as G500 v1.10).

NOTES:

- G500 Hardware under test: 4 core CPU/ 16GB RAM variant.
- In the following table(s), numbers inside the brackets are for the G500 variant with 2 core CPU/8GB RAM.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 10,000 (5,000) DI – 100	All points changing twice in 2 secs
Number of connected IEDs to G500	500 (250)	500 (250)
G500 total RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points (half for 2 core CPU/8GB RAM)	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger /	1000 (500) AI mapped /	1000 (500) AI mapped /

Requirement	Steady State Loading	Avalanche Loading
Continuous reports	100 (50) reports	100 (50) reports
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs
Alarms	100 (50) / sec	100 / sec (for 2 seconds)

3.4 Stand Alone

This G500 version provides the following performance capabilities in Single (non-redundant) Mode.

3.4.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in Table 3.1: Standalone Performance test results.

Table 3.1: Standalone Performance test results

Activity	DNP	DNP	IEC 61850	IEC 61850
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	2 core / 8 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state
Protocol – CLIENT / SERVER	DNP / DNP	DNP / DNP	IEC 61850 / DNP	IEC 61850 / DNP
RTDB Point count	200,000	100,000	200,000	100,000
Total RCB configured / Simulation per sec	NA	NA	6000 1000	3000 500
Number of IEDs	500 (250)	500 (250)	500 (250)	500 (250)
Points / IED (AI + DI + AO + DO)	[AI-250, 150-DI, 20-DO, 20-AO, 10-ACC]	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports
Number of Master connections Point count / Server	8 DI – 9300, AI – 15500	4 DI – 4650, AI - 7750	8 DI – 9300, AI - 15500	4 DI – 4650, AI - 7750
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 1 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,46,97	80, 28, 95	56, 30, 95	46, 36, 75
Average Memory	2.9 GB	1.4 GB	3 GB	2 GB
Event latency in (msecs) Average, Min, Max	398,19,1.04sec	487,13,1.31	589, 5, 2200	330, 41, 652
Control latency in (msecs) Average, Min, Max	30,12,291	629,3,1.09	8, 6, 16	9, 3, 68

3.4.2 HMI Response time

Under heavy loading conditions, the G500 provides the HMI response times listed in Table 3.2: User Interface Response Time.

Table 3.2: User Interface Response Time

Activity	Normal	High
Screen Access (Point Summary)	< 2 s	< 2 s
Screen Access (One-Line Viewer)	5 to 7 s	5 to 7 s
System Logs	< 2s	2s
Alarm ACK Delay (Single Alarm)	< 1 s	< 1 s
Alarm ACK Delay (20,000 Alarms)	< 2 s	< 7 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

3.4.3 D.20 HDLC Performance Test levels

The performance of G500 with D.20 HDLC card is tested with different scenarios listed in Table 3.3.

Table 3.3: D.20 HDLC Performance test results

Activity	Multi-Protocol	Multi-Protocol
Hardware (CPU / RAM)	2 core / 8 GB	4 core / 16 GB
Loading Condition	Steady state	Steady state
Protocol – CLIENT / SERVER	DNP, IEC 103, IEC 104, Modbus, IEC 61850 / DNP, Modbus, IEC 104	DNP / DNP
RTDB Point count	8244	200,000
Total RCB configured / Simulation per sec	NA	NA
Number of IEDs	101x D.20 peripherals + 42 other protocol IEDs	101x D.20 peripherals + 400 DNP IEDs
Points / IED (AI + DI + AO + DO)	Total = AI (1935) + DI (5056) + AO (154) + DO (993) + ACC (106)	[AI-250, 150-DI, 20-DO, 20-AO, 10-ACC]
Datalogger reports	NA	100
Number of Master connections Point count / Server	7	8 DI – 9300, AI – 15500
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg (%)	35.8	58.20
Average Memory	2.4 GB	2.52 GB

Activity	Multi-Protocol	Multi-Protocol
Event latency in (msecs) Average, Min, Max	696, 51, 1.97 sec	-
Control latency in (msecs) Average, Min, Max	72, 49, 254	-

3.5 Hot Standby Redundancy

This G500 version provides the following performance capabilities in Hot Standby Redundancy Mode.

Configuration	DNP	IEC61850
Hardware (CPU /RAM)	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)
Redundancy	Hot Standby	Hot Standby
Number of IEDs	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP
RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)
Datalogger / Continuous reports	NA	NA
ARRM	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,34,71	32,46,67
Average Memory	3.12 GB	4.3 GB
Event latency – Average, Min, Max (msec)	390,60,1sec	368,2.8,1sec
Control latency – Average, Min, Max (msec)	30,12,377	3,1,73

3.6 Warm Standby Redundancy

This G500 version provides the following performance capabilities in Warm Standby Redundancy Mode.

Protocol	DNP	IEC61850	IEC 104
Hardware CPU / RAM	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)
Redundancy Mode	Warm Standby	Warm Standby	Warm Standby
Number of IEDs	500 (250)	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP	IEC 104 / IEC 104
RTDB Point count	200,000 (100,000)	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)	NA
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) continuous reports
ARRM	Not configured	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	62,53,96	43,48,60	28,32,42
Average Memory	2.4 GB	3 GB	3.4 GB
Event latency – Average, Min, Max (msec)	437,26,1.06	683,323,1sec	221,107,380
Control latency – Average, Min, Max (msec)	44,11,240	3,1,85	30,10,331

NOTE: G500 Supports maximum of 4 simultaneous Runtime HMIs (Remote + Local) either in Standby or Redundancy Modes (Hot/Warm Redundancy).

Time Sync Accuracy (PTP/IRIG-B/NTP)

This G500 version supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

This version does not support runtime dynamic failover across different time sources.

Time Sync Input	Accuracy
PTP IN	100% samples within +/-121 microseconds
IRIG-B IN	100% samples within +/-100 microseconds
NTP IN	99.97% samples within +/-10 ms
NTP OUT	99.9% samples within +/- 1ms

NOTES:

- PTP and IRIG-B time accuracy is measured in a scenario where the hardware /FPGA is fully loaded and applies to G500 only.
- If IEDs are getting time synced using any of the client communication protocols (e.g., DNP3), then the above accuracy cannot be guaranteed at the IED.

Application List

This G500 version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✗ Not available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✗ Not available	✗ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✗ Not Available
Analog Data Logger	✓ Available	✓ Available	✗ Not Available
Generic ASCII Client	✓ Available	✓ Available	✗ Not Available
Modbus Server	✓ Available	✓ Available	✗ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✗ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✗ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✗ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✗ Not Available

Application	Support in Standalone	Support in Warm Standby	Support in Hot Standby
Event Logger	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✗ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✗ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✗ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available
Analog Report Generator	✓ Available	✓ Available	✗ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available

4. Version 2.10 (9-Dec-2020)

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	2.1.47	G500 Firmware Version.
DS Agile MCP Studio	2.2.0	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	2.1.42	Supported G500 HMI 64-bit Software.
MCP Utilities	1.0.12	Minimum Supported MCP Firmware Upgrade Utilities

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v2.0.0.

Package/Firmware	Version	Notes
Predix Edge OS	2.2.1	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

4.1 Enhancements

This G500 version adds the following new features compared to previous versions:

4.1.1 Cyber Security

None.

4.1.2 Clients

GE Internal Reference #	Description
R-01289	IEC 60870-5-101 ed.2 Master DNV Certification (Balanced and Unbalanced) IEC 60870-5-104 ed.2 Master DNV Certification
R-01290	IEC61850 Ed.2 Client UCA Level B Certification

4.1.3 Servers

GE Internal Reference #	Description
R-01289	IEC 60870-5-101 ed.2 Slave DNV Certification (Balanced and Unbalanced) IEC 60870-5-104 ed.2 Slave DNV Certification

4.1.4 Automation

None.

4.1.5 Configuration/Settings

GE Internal Reference #	Description
B-13679	Added SNMP Template for Reason LAN Switch S2024.

4.1.6 HMI

None.

4.1.7 Pass-through

None.

4.1.8 System

None.

4.1.9 Documentation

None.

4.1.10 Hardware

None.

4.2 Fixed defects

This version of G500 has the fixes for the following defects compared to V2.00:

4.2.1 Cyber Security

None.

4.2.2 Clients

GE Internal Reference #	Description
GS-02329341, D-11629	Fixed an issue where D.20 stops communicating with all the peripherals which then would be flashing in fault mode, and a manual reset is required for the G500 to recover.
D-10763	Fixed an issue where communications stop on D.20 link in rare cases and doesn't recover.
GS-02010744, D-09804	Fixed an issue where G500 61850 client cannot communicate with F650 ed.2 Server.

4.2.3 Server

GE Internal Reference #	Description
D-11483	Fixed an issue where RTS/CTS do not operate correctly in G500 DNP3 DPA over serial connection.

4.2.4 Automation

None.

4.2.5 Configuration/Settings

GE Internal Reference #	Description
GS-02223597, D-10928	Fixed an issue, where cannot upgrade G500 V1.0 to 2.0 due to not being able to load snapshot.

4.2.6 HMI

None.

4.2.7 Pass-through

None.

4.2.8 System

GE Internal Reference #	Description
D-10906	Fixed an issue where Enabled NTP time sync caused increasing zombies and then caused the system reboot eventually.

4.2.9 Documentation

GE Internal Reference #	Description
GS-02312730, D-11532	Fixed an issue where G500 SW Manual "Chassis Intrusion State" point was incorrect described.

4.2.10 Hardware

None.

4.3 Known Issues

This G500 version has the following known issues:

4.3.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

4.3.2 Clients

GE Internal Reference #	Description
E-04038	D.20 Client is supported only in non-redundant systems in this release.
B-13475, D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
R-01498, GS-02706688, DCSSUP-21882	G500 is not communicating with Modbus IED devices if the least significant group of the IP address has 3 digits.

4.3.3 Servers

GE Internal Reference #	Description
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

GE Internal Reference #	Description
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

4.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
D-05462	Load shedding: There is no persistency of zone assignments across power restarts when user sets the zones through Analog Setpoint commands.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948, D-11999	Initial value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).
DCSSUP-19948, D-12000	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).

4.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10343	Sync Manager Settings are not retained during upgrade from V1.0 to V1.1. User needs to re-enter these manually. Will not fix.
D-10345	mcpcfg settings must be reconfigured after upgrading G500 from 1.0 to 1.1. Will not fix.
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-10825	Online Editor / SNMP Agent Browser is not able to retrieve OID data if gathering data from target device takes more than 60 seconds. Workaround: configure the SNMP client offline, using OID from the end device (e.g., using a 3rd party MIB browser).

4.3.6 HMI

GE Internal Reference #	Description
D-10229	Gateway -A /-B designation is missing from local HMI banner sometimes
D-09695	Operator User in Active G500 gets Observer Group privileges sometimes after multiple switch-over or fail-overs in Hot or Warm Standby Redundancy. Runtime HMI needs to be logged out and logged in if this case happens.
D-05463	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.

4.3.7 Pass-through

None.

4.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10781	In redundant G500, if both units are (re)started at same time, the indications code and config out of sync are incorrect. Workaround: start one G500 at a time (wait for the first one to start) or restart one of the units while the other one runs.
D-10227	Email does not send messages when an alarm is activated.
D-08036	During start of G500, some not applicable error messages are displayed on the console connected to the display port. No Functional Impact.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-11689	Control Lockout: Incorrect behavior when IED DO point is mapped to both Local and Remote Group with Manual Ownership, and the issuer of the command had both RG and LG ownership, later after having RG ownership removed – will still execute the DO point mapped to the LG.
D-12039	After clearing logs from either mcpcfg, or sudo mcpcfg, or Settings GUI – the G500 must be rebooted to re-initialize the HMI server.

GE Internal Reference #	Description
D-11904	Soft reboot command fails in rare occasions. Performing a hardware reboot is successful, no functional impact.
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by different time zone and resulting SOE timestamps have wrong time zone Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

4.3.9 Documentation

None.

4.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

This G500 version supports the following application limits.

Application	Feature	Configuration Limits
Digital Event Manager	**Alarms**	
	Max Number of Alarm Groups	256
	Max number of members in an Alarm Group	1000
Calculator	**Expression Type:**	
	Evaluations	10000
	Timers	1000
	Analog Assignments	2000
	Digital Assignments	10000
	Quality Conversions	1000
	Type Conversions	1000
	Averages	1000
	Output to Input Conversions	1000
Load Shed DTA	**Number of Feeders and Zones**	
	Max Zones	50
	Max Feeders	100
Analog Reports DTA	Max Analog Reports	100
System Point Manager	Accumulator Freeze	100
	Analog Value Selection	100

Application	Feature	Configuration Limits
	Control Lockout	
	• Remote Groups	8
	• Local Groups	10000
	Double Points	1000
	Input Point Suppression	10000
	Control in Progress	256
	Redundant I/O	10000
Analog Data Logger	Continuous Reports	1000
	Periodic Reports	1000
	Out of Range Reports	1000
VPN Server	Number of VPN Clients	8
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IEDs**	
	DNP Multidrop	80
	DNP Multidrop (Modem)	80
	Generic ASCII	80
	SEL Binary IED	80
	IEC 60870-5-101 Multidrop	80
	IEC60870-5-103 Multidrop	80
	Modbus Multidrop	80
	D.20	1
	Network IEDs	
	DNP3 TCP	500
	Modbus TCP/Modbus TCP-SSH	500
	IEC60870-5 104	500
	IEC61850	500
	SNMP	1
	VPN Server	1
	Serial Masters	
	DNP3 Serial Master	8
	IEC 60870-5-101 Master	8
	Modbus Serial Master	8
	Network Masters	
	DNP3 Network Master	8
	IEC 60870-5-104 Master	8
	Modbus TCP Master	8

Application	Feature	Configuration Limits
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**	
	IEC60870-5-103 Multidrop	255
	DNP3 Multidrop/Network	10
	Modbus Multidrop/TCP	20
	IEC60870-5 101 Multidrop	1000
	IEC60870-5 104	10
	SNMP Client	100
	GenASCII Client	120
	IEC61850 Client	60
	SEL Binary Client	1
	D.20 Client	120
	Serial /Network Masters	
	DNP3 Serial Master	32
	Modbus Serial Master	32
	IEC60870-1 101 Master	32
	DNP3 TCP Master	1
	Modbus TCP Master	1
	IEC60870-1 104 Master	1
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs	1000
	Modbus Multi-Drop/Network IEDs	1000
	GenASCII IED	1000
	SNMP IED	1000
	IEC60870-1 103 Multi-Drop	1000
	IEC60870-1 101/104 Multi-Drop	
	• Bitstream	32
	• Double Command	1000
	• Integrate Total	1000
	• Measurand	1000
	• Packed Single Point	16
	• Regulating Step Command	1000
	• Set Point Command	1000
	• Single Point	1000
	• Step Position	1000
	SEL Binary IED	
	• Fast Meter Analog Input	32

Application	Feature		Configuration Limits
	• Demand Analog Input		32
	• Peak Demand Analog Input		32
	• SER Digital Input		1000
	D.20 Peripheral Client		
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs
	D.20 K Card		32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master		DI -10000 AI -15000 DO -5000 ACC – 3000
	Modbus Serial/TCP Master		DI -10000 AI -15000 DO -5000 ACC -3000
	IEC60870-1 101/104 Master		DI -10000 AI -15000 DO -5000 ACC - 3000

This G500 version meets the following performance test levels (same as G500 v1.10).

NOTES:

- G500 Hardware under test: 4 core CPU/ 16GB RAM variant.
- In the following table(s), numbers inside the brackets are for the G500 variant with 2 core CPU/8GB RAM.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 10,000 (5,000) DI – 100	All points changing twice in 2 secs
Number of connected IEDs to G500	500 (250)	500 (250)
G500 total RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points (half for 2 core CPU/8GB RAM)	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4	DI = 18750 i.e., =150*500/4 AI = 31250 i.e., =250*500/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger / Continuous reports	1000 (500) AI mapped / 100 (50) reports	1000 (500) AI mapped / 100 (50) reports
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs
Alarms	100 (50) / sec	100 / sec (for 2 seconds)

4.4 Stand Alone

NOTE: This G500 version provides the performance capabilities of G500 version 2.00. In addition to that, the following D.20 HDLC performance scenarios are tested in Single (non-redundant) Mode.

4.4.1 D.20 HDLC Performance Test levels

The performance of G500 with D.20 HDLC card is tested with different scenarios listed in Table 4.1.

Table 4.1: D.20 HDLC Performance test results

Activity	Multi-Protocol	Multi-Protocol
Hardware (CPU / RAM)	2 core / 8 GB	4 core / 16 GB
Loading Condition	Steady state	Steady state
Protocol – CLIENT / SERVER	DNP, IEC 103, IEC 104, Modbus, IEC 61850 / DNP, Modbus, IEC 104	DNP / DNP
RTDB Point count	8244	30,400
Total RCB configured / Simulation per sec	NA	NA
Number of IEDs	101x D.20 peripherals + 42 other protocol IEDs	94x D.20 peripherals + 60 DNP IEDs

Activity	Multi-Protocol	Multi-Protocol
Points / IED (AI + DI + AO + DO)	Total = AI (1935) + DI (5056) + AO (154) + DO (993) + ACC (106)	[AI-250, 150-DI, 20-DO, 20-AO, 10-ACC]
Datalogger reports	NA	NA
Number of Master connections Point count / Server	7	8 DI – 9300, AI – 15500
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg (%)	35.8	58.20
Average Memory	2.4 GB	2.52 GB
Event latency in (msecs) Average, Min, Max	696, 51, 1.97 sec	479,143,920
Control latency in (msecs) Average, Min, Max	72, 49, 254	23,14,54

4.5 Hot Standby Redundancy

NOTE: This G500 version provides the performance capabilities of G500 version 2.00 in Hot Standby Redundancy Mode.

4.6 Warm Standby Redundancy

NOTE: This G500 version provides the performance capabilities of G500 version 2.00 in Warm Standby Redundancy Mode.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This G500 version supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

This version does not support runtime dynamic failover across different time sources.

Time Sync Input	Accuracy
PTP IN	100% samples within +/-121 microseconds
IRIG-B IN	100% samples within +/-100 microseconds
NTP IN	99.97% samples within +/-10 ms
NTP OUT	99.9% samples within +/- 1ms

NOTES:

- PTP and IRIG-B time accuracy is measured in a scenario where the hardware /FPGA is fully loaded and applies to G500 only.
- If IEDs are getting time synced using any of the client communication protocols (e.g., DNP3), then the above accuracy cannot be guaranteed at the IED.

Application List

This G500 version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✗ Not available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✗ Not available	✗ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✗ Not Available
Analog Data Logger	✓ Available	✓ Available	✗ Not Available
Generic ASCII Client	✓ Available	✓ Available	✗ Not Available
Modbus Server	✓ Available	✓ Available	✗ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✗ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✗ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✗ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✗ Not Available
Event Logger	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Warm Standby	Support in Hot Standby
System Point Manager	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✗ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✗ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✗ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available
Analog Report Generator	✓ Available	✓ Available	✗ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available

5. Version 2.50 (18-Oct-2021)

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	2.5.114	G500 Firmware Version.
DS Agile MCP Studio	2.5.0	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	2.5.112	Supported G500 HMI 64-bit Software.
MCP Utilities	1.1.10	Minimum Supported MCP Firmware Upgrade Utilities.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v2.5.0.

Package/Firmware	Version	Notes
Predix Edge OS	2.6.0	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

5.1 Enhancements

This G500 version adds the following new features compared to previous versions:

5.1.1 Cyber Security

None.

5.1.2 Clients

GE Internal Reference #	Description
E-04038	Added support for D.20 client redundancy to connect to D.20 IO with redundant G500 devices.
E-04255	Added support for IEC 62351-14 syslog client in G500.

5.1.3 Servers

GE Internal Reference #	Description
E-04361	Added support in DNP3 DPA to assign Analog/Digital Input event change notifications through Class 0.
E-04362	Enhanced the support in DNP3 DPA for incrementing the sequence number when all the application layer retries are exhausted.
E-04363	Enhanced the support in DNP3 DPA for reporting local IIN flag/bit when a digital output point goes offline.
E-04364	Enhanced the support in DNP3 DPA for updating the retry value of unsolicited messages based on the value of the application layer retry count.
E-04365	Added support in DNP3 DPA to increase the RTS modem control pre-transmission delay from 400ms to 2000ms.
E-04366	Added support in DNP3 DPA to read the DCD status while establishing the serial connections with the SCADA Master.

5.1.4 Automation

GE Internal Reference #	Description
R-01432, GS-02538028	Added support for increasing the Analog Value Selection (AVS) groups to 250.
B-15358	Added support for increasing the Accumulator Freeze (AF) groups to 250.

5.1.5 Configuration/Settings

GE Internal Reference #	Description
E-04146	G500 One-Line Designer: allow copy and paste of instantiated symbols including source data.
E-04147	G500 One-Line Designer: during design, display only a small placeholder for the flags.

5.1.6 HMI

GE Internal Reference #	Description
E-04480	Runtime HMI Point Details and Connection pages show the source of data for IEDs and mode of operation of G500 for Masters in the system level hot-hot redundancy.
E-04257	Updated Runtime HMI Point Details/Point Forcing pages with all the supported G500 quality mnemonics.
E-03006	Quality Flag Symbol in SLD screens can now be TEXT in addition to Images

5.1.7 Pass-through

None.

5.1.8 System

GE Internal Reference #	Description
E-03935 R-01264	Added support for Hot-Hot/Hybrid redundancy in G500.
E-04170 E-04283	Implemented DI indications when configuration was accessed, or configuration changed in G500.
E-04000	Changed the name of the network interface/port from Maintenance IP to Adapter IP.
E-04322	Upgrade G500 to Edge OS 2.6.0.
E-04527	Implemented G500 front panel LED1 and LED2 status colors to represent the different redundancy/system states.
B-15418	Added support for resetting the user accounts of Predix Edge Technician Console (PETC) to recover access to the PETC after user lost/forgot the PETC Login credentials.

5.1.9 Documentation

GE Internal Reference #	Description
B-15403	Created a new instruction manual 994-0169 for Rear Serial Termination Assembly Panel.

5.1.10 Hardware

None.

5.2 Fixed defects

This version of G500 has the fixes for the following defects compared to V2.50:

5.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

5.2.2 Clients

GE Internal Reference #	Description
D-12835	Fixed the issue of SEL Binary Client could not process the interleaved responses when unsolicited and poll messages came simultaneously from SEL relays.
D-12986	Fixed the issue of wrong state description for "Enable test Flag in Controls" Digital Output pseudo point in IEC61850 client.
B-15424	Fixed the issue of removing the non-ascii/invalid characters from the point references of SEL auto-discovery files.
B-14232	Fixed the issue of SNMP Client could not communicate with Kyland SICOM3024P switch.
D-11870	Fixed the issue of SNMP client was not communicating with Power Supervisory Module Device - Enatel Power SM34.
D-13079	Fixed the issue of DO command status takes time sometimes to update the Real Time Database (RTDB).
R-01388 D-12308	Fixed the issue in G500 Modbus Serial Client did not receive the response from IED for AO and DO commands.

5.2.3 Server

GE Internal Reference #	Description
D-12965	Fixed the issue of Modbus Server reports parity errors while communicating with the Modbus Master through the serial expansion card ports.
D-12568	Fixed the issue of MODBUS Serial Server responding to invalid requests from the Modbus Master.

5.2.4 Automation

GE Internal Reference #	Description
D-05462 D-12666	Load Shedding: Fixed the issue of persistency of zone assignments across power restarts when user sets the zones through Analog Setpoint commands.
DCSSUP-19948, D-11999	Fixed the issue of initial value for variables configured in LogicLinx wizard did not work at runtime (starts at 0 always).
D-13014	Fixed the issue of Logiclinx Operate block cannot perform transient controls on D.20 DO points.
D-12972	Fixed the issue of DI self-triggered Calculator DTA timer expressions stopped updating if manual force was applied and removed later.
D-12662	Fixed the issue of file retrieval from SEL Binary /SEL ASCII relays was failed when they were configured with virtual serial port.

5.2.5 Configuration/Settings

GE Internal Reference #	Description
D-10825	Fixed the issue of Online Editor / SNMP Agent Browser was not able to retrieve OID data if the reading of the data from target device took more than 60 seconds.
DCSSUP-19634 / D-11665	Fixed the issue where LDAP client does not support "-" (hyphen) character in the DN name in LDAP Settings.

GE Internal Reference #	Description
DCSSUP-21099, GS-02579781	Fixed the issue of configuration sync to G500 not working if LDAP Remote Authentication is configured.

5.2.6 HMI

GE Internal Reference #	Description
D-10229	Fixed the issue of Gateway A /B designation was missing from local HMI banner sometimes.

5.2.7 Pass-through

None.

5.2.8 System

GE Internal Reference #	Description
D-10781	Fixed the issue in redundant G500 that if both units were (re)started at same time, the DI indications for code and config out of sync were incorrect.
E-03919	Fixed the issue of "StandbyGatewayUnavailable" pseudo DI point to reset to zero after the standby G500 completed its initialization instead of fixed timeout of 3 minutes in Hot Standby and Hot-Hot Redundancy modes.
D-13030	Fixed the issues of applications were not initialized properly sometimes after reboot of G500.
D-08036	Fixed issue of error messages was displayed on the console during boot up of G500.
D-11689 B-14315	Fixed the issue of incorrect behavior in control lockout i.e., When IED DO point was mapped to both Local and Remote Group with Manual Ownership, the priority should be given to the Remote Groups first and then to Local Control Groups.
D-12039	Fixed the issue that after clearing logs from either mcpcfg, or sudo mcpcfg, or Settings GUI – the G500 must be rebooted to re-initialize the HMI server.
D-11904	Fixed the issue of soft reboot command failed in rare occasions.
D-12892 D-12924	Fixed the issue of G500 was not communicating correctly in Redundant LAN mode.

5.2.9 Documentation

GE Internal Reference #	Description
D-12199	Corrected the discrepancies about the point descriptions of Modbus Server in the Software Configuration Manual.

5.2.10 Hardware

None.

5.3 Known Issues

This G500 version has the following known issues:

5.3.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

5.3.2 Clients

GE Internal Reference #	Description
B-13475 D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
D-12900	Alarm inhibit tag & Scan inhibit tags on DI point of D20 peripheral (S-card) is getting removed after failover in redundancy.
D-12834	Modbus Client could not process PRF events comes from SR 369 relay.
D-11261	IEC 61850 DCA transactions with IED are failing (reducing the efficiency) sometimes while issuing controls from LogicLinx DTA.
D-13075	D20A card in bad state can cause false behavior/functionality when it is configured in warm or hot-hot redundancy.
R-01498, GS-02706688, DCSSUP-21882	G500 is not communicating with Modbus IED devices if the least significant group of the IP address has 3 digits.

5.3.3 Servers

GE Internal Reference #	Description
D-12889	DNP DPA/Server takes high CPU if more than 5000 Analog Inputs are configured in Unbuffered mode.
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

5.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.

GE Internal Reference #	Description
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948, D-12000	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).
R-01422, DCSSUP-20715	Automatic Record Retrieval Manager (ARRM) DTA locks up/failed to retrieve the large size files from UR relay over SFTP.

5.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10343	Sync Manager Settings are not retained during upgrade from V1.0 to V1.1. User needs to re-enter these manually. Will not fix.
D-10345	mcpcfg settings must be reconfigured after upgrading G500 from 1.0 to 1.1. Will not fix.
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-11620	Abruptly disconnecting a session of mcpcfg locks it out the user till the completion of inactivity timeout duration.
D-12969	Adaptor IP is not getting removed completely for Net-1 interface in G500 after doing 'Remove Configuration and Reboot' from Settings GUI.
D-13028	Add more protection for memory leaks in Apache webserver settings.
D-13084	Need to remove unwanted text message displayed on the console when user tries to open mcpcfg/Settings GUI simultaneously in a particular scenario.
D-13088	Sometimes incorrect time zone is coming in the command prompt/shell, mcpcfg and settings GUI when IRIG-B/B006 is configured as time sync source from settings GUI. **Note:** Time zone is displaying correctly in Remote and Local HMI.
B-15613	The configuration through Bulk Editor is not supported for G500 after v2.10.

5.3.6 HMI

GE Internal Reference #	Description
D-12981	Issues in Runtime HMI if 8 Active Alarm Viewers are opened during performance characterization of G500.

5.3.7 Pass-through

GE Internal Reference #	Description
D-12990	In LDAP authentication, after passthrough connection is timed out, auto logout event is not generated into user activity log by IEC 103 Client.

5.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10227	Email does not send messages when an alarm is activated.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-12984	Daisy chained secondary monitor shows always duplicate monitor, but it does not show the extended desktop.
D-13083	Add support for progress bar to be displayed during "Applying update" procedure through Predix Edge Technician Console (PETC).
D-13039	When both G500's are power cycled at the same time and if switch panel configured as a master, then one of the G500 can go to the failed state. **Note:** If switch panel is configured as Master and one of the G500 is power cycled with a delay then this issue will not be observed.
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by different time zone and resulting SOE timestamps have wrong time zone Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

5.3.9 Documentation

None.

5.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

This G500 version supports the following application limits.

The maximum number of IEDs or Masters is total across all Connections.

The maximum size of the system is given by whichever limit comes first (groups vs members, number of Connections vs IEDs, number of Master instances vs LRUs in the Master etc.). User is responsible to ensure resource usage limits are not exceeded at runtime.

The 4 cores system has a maximum of 500 IEDs, 200k points and 8 Masters (LRUs).

The 2 cores system has a maximum of 250 IEDs, 100k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

Application	Feature	Configuration Limits
Digital Event Manager	**Alarms**	
	Max Number of Alarm Groups	256
	Max number of members in an Alarm Group	1000
Calculator	**Expression Type:**	
	Evaluations	10000
	Timers	1000
	Analog Assignments	2000
	Digital Assignments	10000
	Quality Conversions	1000
	Type Conversions	1000
	Averages	1000
	Output to Input Conversions	1000
Load Shed DTA	**Number of Feeders and Zones**	
	Max Zones	50
	Max Feeders	100
Analog Reports DTA	Max Analog Reports	256
System Point Manager	Accumulator Freeze	250
	Analog Value Selection	250
	Control Lockout	
	• Remote Groups	8
	• Local Groups	10000

Application	Feature	Configuration Limits
	Double Points	1000
	Input Point Suppression	10000
	Control in Progress	256
	Redundant I/O	10000
Analog Data Logger	Continuous Reports	1000
	Periodic Reports	1000
	Out of Range Reports	1000
VPN Server	Number of VPN Clients	8
	Number of VPN Server Instances	1
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IED Connections** (Note: Total number of connections are limited by maximum number of physical and virtual serial ports)	
	DNP Multidrop	80
	DNP Multidrop (Modem)	80
	Generic ASCII	80
	SEL Binary IED	80
	IEC 60870-5-101 Multidrop	80
	IEC 60870-5-103 Multidrop	80
	Modbus Multidrop	80
	D.20	1
	Network IED Connections	
	DNP3 TCP	50
	Modbus TCP/Modbus TCP-SSH	50
	IEC 60870-5 104	50
	IEC 61850	Calculated by Loader based on system size
	SNMP	1
	Serial Master Connections	
	DNP3 Serial Master	8
	IEC 60870-5-101 Master	8
	Modbus Serial Master	8
	Network Master Connections	
	DNP3 Network Master	8
	IEC 60870-5-104 Master	8
	Modbus Network Master	8

Application	Feature	Configuration Limits
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**	
	IEC 60870-5-103 Multidrop	255
	DNP3 Multidrop/Network	10
	Modbus Multidrop/TCP	20
	IEC 60870-5 101 Multidrop	1000
	IEC 60870-5 104	10
	SNMP Client	100
	GenASCII Client	120
	IEC 61850 Client	Calculated by Loader based on system size (maximum 500 in total)
	SEL Binary Client	1
	D.20 Client	120
	Serial/Network Masters	
	DNP3 Serial Master	8
	Modbus Serial Master	8
	IEC 60870-1 101 Master	8
	DNP3 TCP Master	1
	Modbus TCP Master	1
	IEC 60870-1 104 Master	1
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs	Limited by protocol
	Modbus Multi-Drop/Network IEDs	Limited by protocol
	GenASCII IED	1000
	SNMP IED	1000
	IEC60870-1 103 Multi-Drop	Limited by protocol
	IEC60870-1 101/104 Multi-Drop	
	• Bitstream	Limited by protocol
	• Double Command	Limited by protocol
	• Integrate Total	Limited by protocol
	• Measurand	Limited by protocol
	• Packed Single Point	Limited by protocol
	• Regulating Step Command	Limited by protocol
	• Set Point Command	Limited by protocol
	• Single Point	Limited by protocol
	• Step Position	Limited by protocol
	SEL Binary IED	

Application	Feature		Configuration Limits
	• Fast Meter Analog Input		Limited by IED
	• Demand Analog Input		Limited by IED
	• Peak Demand Analog Input		Limited by IED
	• SER Digital Input		Limited by IED
	D.20 Peripheral Client		
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs
	D.20 K Card		32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master		DI - 10000 AI - 15000 DO - 5000 AO - 5000 ACC – 3000
	Modbus Serial/TCP Master		DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	IEC 60870-1 101/104 Master		DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000

This G500 version meets the following performance test levels.

- G500 Hardware under test: 4 core CPU/ 16GB RAM variant.
- In the following table(s), numbers inside the brackets are for the G500 variant with 2 core CPU/8GB RAM, if the loading levels are smaller, then the total number of IEDs and RTDB points can increase but no more than specified limits under Capability and Capacity section above.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 5,000 (1,200) DI – 100 (50)	DI – 63,000 (18,900) AI – 113,000 (33,600)
Number of connected IEDs to G500	500 (150)	500 (150)
G500 total RTDB Point count	200,000 (60,000)	200,000 (60,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points	4 core: DI = 9375 i.e., =150*500/8 AI = 15625 i.e., =250*500/8 2 core: DI = 5625 i.e., =150*150/4 AI = 9375 i.e., =250*150/4	4 core: DI = 9375 i.e., =150*500/8 AI = 15625 i.e., =250*500/8 2 core: DI = 5625 i.e., =150*150/4 AI = 9375 i.e., =250*150/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger - Periodic reports/sec	4 core: 1000 AI mapped	4 core: 1000 AI mapped
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs
Alarms	100 (50) / sec	100 (50) / sec

5.4 Standalone (non-redundant)

The performance capabilities of Standalone are same as that of Hot-Hot redundancy mode in this version of G500.

5.5 Warm Standby Redundancy

The performance capabilities of Warm Standby Redundancy are same as that of Hot-Hot redundancy mode in this version of G500.

5.6 Hot Standby Redundancy

The performance capabilities of Hot Standby Redundancy (for the supported applications) are same as that of Hot-Hot redundancy mode in this version of G500.

5.7 Hot-Hot Redundancy

This G500 version provides the following performance capabilities in Hot-Hot/Hybrid redundancy mode.

5.7.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in **Table 5.1: Hot-Hot Performance Test Results**.

Table 5.1: Hot-Hot Performance Test Results

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	4 core / 16 GB	4 core / 16 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state	Steady state
Protocol – Client /Server	DNP / DNP	DNP / DNP	DNP + D2.0/DNP	IEC 61850+DNP/ DNP	IEC 104 + MODBUS + DNP + IEC 101 + SEL Binary/ IEC 104
RTDB Point count	200,000	60,000	200,000	200,000	200,000
Total RCB configured DI & AI Simulation/Sec	NA 100 DI/Sec, 5000 AI/Sec	NA 48 DI/Sec, 1200 AI/Sec	NA 100 DI/Sec, 5000 AI/Sec	250 100 DI/Sec, 5000 AI/Sec	NA 103 DI/Sec, 5000 AI/Sec
Number of IEDs	400-Hot-Hot, 100-Hot Standby	140 -Hot-Hot, 10-Hot Standby	101 x D.20 peripherals + 400 DNP IEDs	500	500
Points / IED (AI + DI + AO + DO)	[AI-225, DI -125, DO -20, AO -20, ACC -10]	[AI-225, DI - 125-DI, DO - 20, AO-20, ACC-10]	**DNP:** [AI- 225, DI -125, DO - 20, AO-20, ACC-10]	[AI-225, DI -125, DO -20, AO -20, ACC -10]	**IEC 104:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **MODBUS:** [AI-210, DI-150, DO-15, AO-15]

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
					DNP: [AI-225, DI-125, DO-20, AO-20, ACC-10] **IEC 101:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **SEL Binary:** [AI-75, DI-806, DO-101]
Datalogger reports	100 Periodic reports	No reports	100 Periodic reports	100 Periodic reports	100 Periodic reports
Number of Master connections Point Count / Server	8 DI – 7750, AI – 13950	4 DI – 4625, AI - 8325	8 DI – 7750, AI – 13950	8 DI – 7750, AI - 13950	8 DI – 11160 AI – 9920
Remote / Local HMI connections	8 Remote / 1 Local HMI	4 Remote / 0 Local HMI	1 Remote	8 Remote / 1 Local HMI	8 Remote / 1 Local HMI
CPU utilization (%) Min, Max, Median	16, 98, 72.9	54.2, 100, 86.1	71.8, 99.9, 81.4	33, 99.2,79.4	82.73, 31.90, 100
Average Used Memory (GB) Min, Max, Median	2.83, 3.19, 3.05	1.61, 1.74, 1.68	2.395, 2.646, 2.587	2.56 2.77 2.70	3.45, 4.03, 3.88
Event latency in (msecs) Min, Max, Median	59.4, 2480, 1272.2	35.2, 1760, 556	243, 2431,720	12.23, 1301.6,585.3	94,1215, 204
Control latency in (msecs) Min, Max, Median	21.7, 163, 92	21.9, 542, 282	<1, 426, 9	4.195, 1986.72,72.02	20, 1204, 63

5.7.2 Redundancy Fail Over Time

This G500 version supports below fail-over times (i.e., when Active G500 is power cycled) in the Hot-Hot/Hybrid Redundancy with the default 300ms heart-beat rate and with default 3 retries.

Table 5.2: Redundancy Fail Over Times

Hot-Hot Redundancy/D.20 Configuration	Maximum Fail-Over Time (msec)
D.20 is not configured	1250
D.20 is configured	1450

5.7.3 HMI Response Times

Under steady state loading conditions, this version of G500 provides the HMI response times listed in the below **Table 5.3: User Interface Response Times – Steady State Normal Conditions**.

Table 5.3: User Interface Response Times – Steady State Normal Conditions

Activity	Minimum	Maximum	Median
Screen Access (Point Summary)	1.44 s	2.39 s	1.88 s
Screen Access (One-Line Viewer)	NA	NA	NA
System Logs	2.42 s	3.08 s	2.60 s
Alarm ACK Delay (Single Alarm)	400 msec	550 msec	450 msec
Alarm ACK Delay (20,000 Alarms)	< 1 s	< 1 s	< 1 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s	< 1 s

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This G500 version supports the time sync accuracy results similar to G500 version 210, see: *Time Sync Accuracy (PTP/IRIG-B/NTP)*.

Application List

This G500 version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available	✓ Available
One Line Viewer	✓ Available	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✓ Available	✓ Available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✓ Available	✓ Available	✖ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Analog Data Logger	✓ Available	✓ Available	✓ Available	✖ Not Available
Generic ASCII Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Modbus Server	✓ Available	✓ Available	✓ Available	✖ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available	✓ Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Event Logger	✓ Available	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✓ Available	✖ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Software Watchdog	✓ Available	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✓ Available	✖ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available	✓ Available
Analog Report Generator	✓ Available	✓ Available	✓ Available	✖ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available	✓ Available

6. Version 2.60 (17-Dec-2021)

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	2.6.90	G500 Firmware Version.
DS Agile MCP Studio	2.6.0	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	2.6.90	Supported G500 HMI 64-bit Software.
MCP Utilities	1.1.11	Minimum Supported MCP Firmware Upgrade Utilities.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v2.6.0.

Package/Firmware	Version	Notes
Predix Edge OS	2.6.0	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

6.1 Enhancements

This G500 version adds the following new features compared to previous versions:

6.1.1 Cyber Security

None.

6.1.2 Clients

GE Internal Reference #	Description
R-01448/ CCR#219884396	Added support for Double Bit Binary in DNP3 Client in G500.
B-15569	Added support in D.20 client for syncing of Transition counters and Form C counters to the standby D.20 client in the hot-hot/hybrid redundancy.

6.1.3 Servers

GE Internal Reference #	Description
R-01448/ CCR#219884396	Added support for Double Bit Binary in DNP3 Server in G500.
R-01379	Upgraded IEC101-104 Server with the TMW protocol library version (3.29).

6.1.4 Automation

None.

6.1.5 Configuration/Settings

GE Internal Reference #	Description
B-15555	Added support of single group inherited for both points of a Double Bit Binary Inputs in the DNP3/ IEC101-104/IEC 103 Client Mapfiles.
B-15567	Added support for trimming of point descriptions that were greater than 128 characters in Digital Event Manager/Alarm configurations.
B-15550	Added support for automatic ON point selection in the Double Point DI configuration of DNP3/IEC101-104 Server Map Editor.

6.1.6 HMI

GE Internal Reference #	Description
R-01463, DCSSUP-21251	Added support for not to display the tooltip message in the One-Line Viewer (OLV) through the configuration option in the One-Line Designer (OLD).

6.1.7 Pass-through

None.

6.1.8 System

None.

6.1.9 Documentation

None.

6.1.10 Hardware

None.

6.2 Fixed defects

This version of G500 has the fixes for the following defects compared to G500 version 250:

6.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

6.2.2 Clients

None.

6.2.3 Server

GE Internal Reference #	Description
D-13101	Fixed the issue of RTS pre-amble timeout was not adding to the data link timeout in DNP3 Serial Server.
D-13182	Fixed the issue of IEC101 DPA event time stamp jumped by an hour when short time tag (CP24) was used, and the event timestamp was not within the range of the last clock sync hour.

6.2.4 Automation

GE Internal Reference #	Description
D-13111	Fixed the issue of Accumulator freeze functionality was not working for the delta-based copy value policy when the same point was mapped to the different groups and different freeze intervals were configured.
D-13123	Fixed the issue of Accumulator freeze functionality was not working for Logiclinx DTA accumulator pseudo points.
D-13124	Fixed the issue of Accumulator freeze functionality was not working for Loadshed DTA accumulator pseudo points.

6.2.5 Configuration/Settings

GE Internal Reference #	Description
D-13206	Fixed the issue of validation of server certificate was failed while configuring the OpenVPN in G500.

6.2.6 HMI

None.

6.2.7 Pass-through

None.

6.2.8 System

GE Internal Reference #	Description
R-01459, DCSSUP-21250	Fixed the issue of SOEs were not updating when point description had more than 70 unicode characters.

6.2.9 Documentation

None.

6.2.10 Hardware

None.

6.3 Known Issues

This G500 version has the following known issues:

6.3.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

6.3.2 Clients

GE Internal Reference #	Description
B-13475 D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
D-12900	Alarm inhibit tag & Scan inhibit tags on DI point of D20 peripheral (S-card) is getting removed after failover in redundancy.
D-12834	Modbus Client could not process PRF events comes from SR 369 relay.
D-11261	IEC 61850 DCA transactions with IED are failing (reducing the efficiency) sometimes while issuing controls from LogicLinx DTA.

GE Internal Reference #	Description
D-13075	D20A card in bad state can cause false behavior/functionality when it is configured in warm or hot-hot redundancy.
D-13214	DNP3 Client doesn't support object types 31 and 33 for Frozen Analog Inputs (all variations).
R-01498, GS-02706688, DCSSUP-21882	G500 is not communicating with Modbus IED devices if the least significant group of the IP address has 3 digits.

6.3.3 Servers

GE Internal Reference #	Description
D-12889	DNP DPA/Server takes high CPU if more than 5000 Analog Inputs are configured in Unbuffered mode.
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
D-13134/ D-13135	RTS Post-amble time is not added to the data link confirm timeout or application timeout in DNP3 Serial Server.
D-12566	IEC101 DPA/Server in unbalanced mode sometimes reports duplicate Digital Input events to the Master if the event happens at exactly the same time as General Interrogation response.

6.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948, D-12000	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).
R-01422, DCSSUP-20715	Automatic Record Retrieval Manager (ARRM) DTA locks up/failed to retrieve the large size files from UR relay over SFTP.

6.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-11620	Abruptly disconnecting a session of mcpcfg locks it out the user till the completion of inactivity timeout duration.
D-12969	Adaptor IP is not getting removed completely for Net-1 interface in G500 after doing 'Remove Configuration and Reboot' from Settings GUI.
D-13028	Add more protection for memory leaks in Apache webserver settings.
D-13084	Need to remove unwanted text message displayed on the console when user tries to open mcpcfg/Settings GUI simultaneously in a particular scenario.
D-13088	Sometimes incorrect time zone is coming in the command prompt/shell, mcpcfg and settings GUI when IRIG-B/B006 is configured as time sync source from settings GUI. **Note:** Time zone is displaying correctly in Remote and Local HMI.
B-15613	The configuration through Bulk Editor is not supported for G500 after v2.10.

6.3.6 HMI

GE Internal Reference #	Description
D-12981	Issues in Runtime HMI if 8 Active Alarm Viewers are opened during performance characterization of G500.
B-15650	The following features of the Analog Report Viewer are not available: • View online reports • Save and view offline reports

6.3.7 Pass-through

GE Internal Reference #	Description
D-12990	In LDAP authentication, after passthrough connection is timed out, auto logout event is not generated into user activity log by IEC 103 Client.

6.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.

GE Internal Reference #	Description
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10227	Email does not send messages when an alarm is activated.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-12984	Daisy chained secondary monitor shows always duplicate monitor, but it does not show the extended desktop.
D-13083	Add support for progress bar to be displayed during "Applying update" procedure through Predix Edge Technician Console (PETC).
D-13039	When both G500's are power cycled at the same time and if switch panel configured as a master, then one of the G500 can go to the failed state. **Note:** If switch panel is configured as Master and one of the G500 is power cycled with a delay then this issue will not be observed.
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by different time zone and resulting SOE timestamps have wrong time zone. Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

6.3.9 Documentation

None.

6.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

This G500 version supports the application limits similar to G500 version 250, except Analog Reports HMI Viewer is no longer supported.

6.4 Standalone (non-redundant)

The performance capabilities of this G500 version in Standalone are similar to G500 version 250.

6.5 Warm Standby Redundancy

The performance capabilities of this G500 version in Warm Standby Redundancy are similar to G500 version 250.

6.6 Hot Standby Redundancy

The performance capabilities of this G500 version in Hot Standby Redundancy are similar to G500 version 250.

6.7 Hot-Hot Redundancy

The performance capabilities of this G500 version in Hot-Hot Redundancy are similar to G500 version 250.

6.7.1 Performance Test Levels

The performance test levels of this G500 version are similar to G500 version 250.

6.7.2 Redundancy Fail Over Time

This G500 version supports the Redundancy fail over times similar to G500 version 250.

6.7.3 HMI Response Times

This G500 version supports the Runtime HMI response times similar to G500 version 250.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This G500 version supports the time sync accuracy results similar to G500 version 210, see: *Time Sync Accuracy (PTP/IRIG-B/NTP).*

Application List

This G500 version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Connection Parser	✓ Available	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✓ Available	✓ Available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✓ Available	✓ Available	✖ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Analog Data Logger	✓ Available	✓ Available	✓ Available	✖ Not Available
Generic ASCII Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Modbus Server	✓ Available	✓ Available	✓ Available	✖ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available	✓ Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Event Logger	✓ Available	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Load Shedding and Curtailment	✓ Available	✓ Available	✓ Available	✖ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✓ Available	✖ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available	✓ Available
Analog Report Generator	✖ Not Available	✖ Not Available	✖ Not Available	✖ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available	✓ Available

7. Version 2.70 (04-Mar-2022) – Projects Only

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	2.7.69	G500 Firmware Version.
DS Agile MCP Studio	2.7.0	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	2.7.69	Supported G500 HMI 64-bit Software.
MCP Utilities	1.1.12	Minimum Supported MCP Firmware Upgrade Utilities.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v2.7.0.

Package/Firmware	Version	Notes
Predix Edge OS	2.6.0	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

7.1 Enhancements

G500 version 2.70 is **Projects targeted**, which adds IEC 61850 Server **as Special Order**.

All other features are identical as G500 v2.60.

7.1.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

7.1.2 Clients

None.

7.1.3 Servers

GE Internal Reference #	Description
E-04668	Added support for IEC 61850 Ed.2 MMS Server with Agency as micro-service and enabled with a specific license option.

7.1.4 Automation

None.

7.1.5 Configuration/Settings

GE Internal Reference #	Description
E-04757	Added support for creation of IEC 61850 “cid” and server mapfiles using a custom “cid” creation tool to be delivered upon request to Projects teams.
E-03009	Added support for configurable decimal points for Analog Input displayed values in MCP One Line Designer screens (OLD).

7.1.6 HMI

None.

7.1.7 Pass-through

None.

7.1.8 System

None.

7.1.9 Documentation

GE Internal Reference #	Description
E-04720	Created "SWM0124 IEC 61850 Server User Guide V100 R0" for configuring the IEC 61850 Ed2 server.
B-15832	Updated document [994-0152] G500 Substation Gateway Instruction Manual with Ordering Codes for IEC 61850 Server (Projects only).

7.1.10 Hardware

None.

7.2 Fixed defects

This version of G500 has the fixes for the following defects compared to G500 version 260:

7.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

7.2.2 Clients

None.

7.2.3 Server

None.

7.2.4 Automation

None.

7.2.5 Configuration/Settings

None.

7.2.6 HMI

None.

7.2.7 Pass-through

None.

7.2.8 System

GE Internal Reference #	Description
B-15994	Increased the default value of maximum RTDB initialization/startup time to 540 secs to start the communication with the IEDs and Masters with larger system configurations.

7.2.9 Documentation

GE Internal Reference #	Description
B-15990/ B-15989	Updated document [994-0152] G500 Substation Gateway Instruction Manual for D.20 fuse rating to 2.5 A and added clarification about IRIG-B Input Invalid signal.

7.2.10 Hardware

None.

7.3 Known Issues

This G500 version has the following known issues:

7.3.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

7.3.2 Clients

GE Internal Reference #	Description
B-13475 D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
D-12900	Alarm inhibit tag & Scan inhibit tags on DI point of D20 peripheral (S-card) is getting removed after failover in redundancy.
D-12834	Modbus Client could not process PRF events comes from SR 369 relay.
D-11261	IEC 61850 DCA transactions with IED are failing (reducing the efficiency) sometimes while issuing controls from LogicLinx DTA.
D-13075	D20A card in bad state can cause false behavior/functionality when it is configured in warm or hot-hot redundancy.
D-13214	DNP3 Client doesn't support object types 31 and 33 for Frozen Analog Inputs (all variations).
D-13357	IEC 101 client ignores the Double Bit and Measurand objects when the IED sends unrequested events (i.e., events with invalid/bad object addresses) during the General or Group Interrogation period. **Workaround:** Ensure the configuration parameter "ignoreUnrequestedGIData" in the IEC 101 Application parameter settings to "Disabled".
R-01498, GS-02706688, DCSSUP-21882	G500 is not communicating with Modbus IED devices if the least significant group of the IP address has 3 digits.

7.3.3 Servers

GE Internal Reference #	Description
D-12889	DNP DPA/Server takes high CPU if more than 5000 Analog Inputs are configured in Unbuffered mode.

GE Internal Reference #	Description
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
D-13134/ D-13135	RTS Post-amble time is not added to the data link confirm timeout or application timeout in DNP3 Serial Server.
D-12566	IEC101 DPA/Server in unbalanced mode sometimes reports duplicate Digital Input events to the Master if the event happens at exactly the same time as General Interrogation response.
D-13332	Text points values (e.g., Bay ID, Device ID, Line ID, PRF TEXT etc.) are not updating from IEC 61850 server to the master properly.
D-13363	IEC 61850 Server is out of sync with the IED data when the system wide setting parameter "Event Queue Full Action**"** is configured as "LoseNewestEvents". Workaround: Ensure **"**Event Queue Full Action" is configured as "DoNotLoseEvents" always.
D-13359	IEC 61850 Server is not updating qualities of the GenASCII IED pseudo DI points to the master properly.

7.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948, D-12000	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).
R-01422, DCSSUP-20715	Automatic Record Retrieval Manager (ARRM) DTA locks up/failed to retrieve the large size files from UR relay over SFTP.

7.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-11620	Abruptly disconnecting a session of mcpcfg locks it out the user till the completion of inactivity timeout duration.
D-12969	Adaptor IP is not getting removed completely for Net-1 interface in G500 after doing 'Remove Configuration and Reboot' from Settings GUI.
D-13028	Add more protection for memory leaks in Apache webserver settings.
D-13084	Need to remove unwanted text message displayed on the console when user tries to open mcpcfg/Settings GUI simultaneously in a particular scenario.
D-13088	Sometimes incorrect time zone is coming in the command prompt/shell, mcpcfg and settings GUI when IRIG-B/B006 is configured as time sync source from settings GUI. **Note:** Time zone is displaying correctly in Remote and Local HMI.
B-15613	The configuration through Bulk Editor is not supported for G500 after v2.10.

7.3.6 HMI

GE Internal Reference #	Description
D-12981	Issues in Runtime HMI if 8 Active Alarm Viewers are opened during performance characterization of G500.
B-15650	The following features of the Analog Report Viewer are not available: • View online reports • Save and view offline reports

7.3.7 Pass-through

GE Internal Reference #	Description
D-12990	In LDAP authentication, after passthrough connection is timed out, auto logout event is not generated into user activity log by IEC 103 Client.

7.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.

GE Internal Reference #	Description
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10227	Email does not send messages when an alarm is activated.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-12984	Daisy chained secondary monitor shows always duplicate monitor, but it does not show the extended desktop.
D-13083	Add support for progress bar to be displayed during "Applying update" procedure through Predix Edge Technician Console (PETC).
D-13039	When both G500's are power cycled at the same time and if switch panel configured as a master, then one of the G500 can go to the failed state. **Note:** If switch panel is configured as Master and one of the G500 is power cycled with a delay then this issue will not be observed.
D-13365	Config Sync fails the standby G500 if switch panel is wrongly wired, and switch-panel mode is configured as “slave” in the redundancy configuration.
GS-02709884 /D-13470	Sometimes UTC time zone is getting overwritten by different time zone and resulting SOE timestamps have wrong time zone. Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

7.3.9 Documentation

None.

7.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

This G500 version supports the following application limits.

The maximum number of IEDs or Masters is total across all Connections.

The maximum size of the system is given by whichever limit comes first (groups vs members, number of Connections vs IEDs, number of Master instances vs LRUs in the Master etc.). User is responsible to ensure resource usage limits are not exceeded at runtime.

The 4 cores system has a maximum of 500 IEDs, 200k points and 8 Masters (LRUs).

The 2 cores system has a maximum of 250 IEDs, 100k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

Application	Feature	Configuration Limits
Digital Event Manager	**Alarms**	
	Max Number of Alarm Groups	256
	Max number of members in an Alarm Group	1000
Calculator	**Expression Type:**	
	Evaluations	10000
	Timers	1000
	Analog Assignments	2000
	Digital Assignments	10000
	Quality Conversions	1000
	Type Conversions	1000
	Averages	1000
	Output to Input Conversions	1000
Load Shed DTA	**Number of Feeders and Zones**	
	Max Zones	50
	Max Feeders	100
Analog Reports DTA	Not available starting with MCP V2.6 and newer.	None
System Point Manager	Accumulator Freeze	250
	Analog Value Selection	250
	Control Lockout	
	• Remote Groups	8
	• Local Groups	10000
	Double Points	1000
	Input Point Suppression	10000
	Control in Progress	256
	Redundant I/O	10000

Application	Feature	Configuration Limits
Analog Data Logger	Continuous Reports	1000
	Periodic Reports	1000
	Out of Range Reports	1000
VPN Server	Number of VPN Clients	8
	Number of VPN Server Instances	1
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IED Connections** (**Note**: Total number of serial connections are limited by maximum number of physical and virtual serial ports)	
	DNP Multidrop	80
	DNP Multidrop (Modem)	80
	Generic ASCII	80
	SEL Binary IED	80
	IEC 60870-5-101 Multidrop	80
	IEC60870-5-103 Multidrop	80
	Modbus Multidrop	80
	D.20	1
	Network IED Connections	
	DNP3 TCP	50
	Modbus TCP/Modbus TCP-SSH	50
	IEC60870-5 104	50
	IEC61850	Calculated by Loader based on system size
	SNMP	1
	Serial Master Connections	
	DNP3 Serial Master	8
	IEC 60870-5-101 Master	8
	Modbus Serial Master	8
	Network Master Connections	
	DNP3 Network Master	8
	IEC 60870-5-104 Master	8
	Modbus Network Master	8
	IEC 61850 Server	8 (2 for 2 cores)
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**	
	IEC60870-5-103 Multidrop	255
	DNP3 Multidrop/Network	10
	Modbus Multidrop/TCP	20

Application	Feature	Configuration Limits
	IEC60870-5 101 Multidrop	1000
	IEC60870-5 104	10
	SNMP Client	100
	GenASCII Client	120
	IEC61850 Client	Calculated by Loader based on system size (maximum 500 in total)
	SEL Binary Client	1
	D.20 Client	120
	Serial/Network Masters	
	DNP3 Serial Master	8
	Modbus Serial Master	8
	IEC 60870-1 101 Master	8
	DNP3 TCP Master	1
	Modbus TCP Master	1
	IEC 60870-1 104 Master	1
	IEC 61850 Server (This is number of maximum concurrent IEC 61850 Clients for same Server Instance / LRU in CID file)	3
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs	Limited by protocol
	Modbus Multi-Drop/Network IEDs	Limited by protocol
	GenASCII IED	1000
	SNMP IED	1000
	IEC 60870-1 103 Multi-Drop	Limited by protocol
	IEC 60870-1 101/104 Multi-Drop	
	• Bitstream	Limited by protocol
	• Double Command	Limited by protocol
	• Integrate Total	Limited by protocol
	• Measurand	Limited by protocol
	• Packed Single Point	Limited by protocol
	• Regulating Step Command	Limited by protocol
	• Set Point Command	Limited by protocol
	• Single Point	Limited by protocol
	• Step Position	Limited by protocol
	SEL Binary IED	
	• Fast Meter Analog Input	Limited by IED

Application	Feature		Configuration Limits
	• Demand Analog Input		Limited by IED
	• Peak Demand Analog Input		Limited by IED
	• SER Digital Input		Limited by IED
	D.20 Peripheral Client		
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs
	D.20 K Card		32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master		DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000
	Modbus Serial/TCP Master		DI - 10000 AI - 15000 DO - 5000 AO - 5000 ACC - 3000
	IEC 60870-1 101/104 Master		DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000
	IEC 61850 Server CID **Note**: when configured to maximum size it may take up to 10 minutes for the IEC 61850 Server Instance (LRU) to complete initialization.		DI - 10000 AI - 15000 DO - 5000 AO - 5000 ACC – 3000

This G500 version meets the following performance test levels.

- G500 Hardware under test: 4 core CPU/ 16GB RAM variant.
- In the following table(s), numbers inside the brackets are for the G500 variant with 2 core CPU/8GB RAM, if the loading levels are smaller, then the total number of IEDs and RTDB points can increase but no more than specified limits under the Capability and Capacity section above.

Requirement	**Steady State Loading**	**Avalanche Loading**
Loading Signal changes (continuously / sec)	AI - 5,000 (1,200) DI – 100 (50)	DI – 63,000 (18,900) AI – 113,000 (33,600)
Number of connected IEDs to G500	500 (150)	500 (150)
G500 total RTDB Point count	200,000 (60,000)	200,000 (60,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points	4 core: DI = 9375 i.e., =150*500/8 AI = 15625 i.e., =250*500/8 2 core: DI = 5625 i.e., =150*150/4 AI = 9375 i.e., =250*150/4	4 core: DI = 9375 i.e., =150*500/8 AI = 15625 i.e., =250*500/8 2 core: DI = 5625 i.e., =150*150/4 AI = 9375 i.e., =250*150/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger - Periodic reports/sec	4 core: 1000 AI mapped	4 core: 1000 AI mapped
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs
Alarms	100 (50) / sec	100 (50) / sec

7.4 Standalone (non-redundant)

The performance capabilities of Standalone are same as that of Hot-Hot redundancy mode in this version of G500- with the exception of IEC61850 Server, as shown below.

7.4.1 Performance Test Levels

The performance test levels of G500 version with IEC61850 server in the stand-alone mode is tested using the activity levels and disturbance scenarios presented next.

Table 7.1: IEC 61850 Server Standalone Performance Test Results

Activity	IEC 61850 Server (4 Core)	IEC61850 Server (2Core)
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB
Loading Condition	Steady state	Steady state
Protocol – Client /Server	DNP / IEC61850	DNP / IEC61850
RTDB Point count	200,000	60,000
Number of IEC61850 Server instances/Logical Remote Units (LRU)	6	2
Simultaneous IEC61850 Client connections for each LRU	1	1
Total number of IEDs in the system & Points per each IED	500 DNP3 IEDs [AI-225, DI -125, DO -20, AO -20, ACC -10]	160 DNP3 IEDs [AI-225, DI - 125-DI, DO - 20, AO-20, ACC-10]
Total DI & AI simulation/Sec	5000 – AI/sec 100 – DI/sec	480 – AI/sec 50 – DI/sec
Number of RTDB points mapped to each LRU	25000	25000
Total number of Logical Devices (LDs) in the system	2000 (4 * 500 i.e., 4 LDs for each IED)	640 (4 * 160 i.e., 4 LDs for each IED)
Datasets configured per each LRU	254 for each LRU	254 for each LRU
RCBs configured per each LRU	159 URCB for each LRU 95 BRCB for each LRU	159 URCB for each LRU 95 BRCB for each LRU
Datalogger reports	75 Periodic reports	48 Periodic Reports
Alarms/sec	100 On update Alarms	48 On update Alarms

Activity	IEC 61850 Server (4 Core)	IEC61850 Server (2Core)
Remote / Local HMI connections	4 Remote / 1 Local HMI	1 Remote / 0 Local HMI
CPU utilization (%) Min, Max, Median	77, 100, 88	41, 100, 63
Average Used Memory (GB) Min, Max, Median	5.1962, 5.6131, 5.3079	3.87, 4.16, 3.92
Event latency in (msecs) Min, Max, Median	59.4, 2480, 1272.2	35.2, 1760, 556
Control latency in (msecs) Min, Max, Median	21.7, 163, 92	21.9, 542, 282

7.5 Warm Standby Redundancy

The performance capabilities of Warm Standby Redundancy are same as that of Hot-Hot redundancy mode in this version of G500.

7.6 Hot Standby Redundancy

The performance capabilities of Hot Standby Redundancy are same as that of Hot-Hot redundancy mode in this version of G500.

7.7 Hot-Hot Redundancy

This G500 version provides the following performance capabilities in Hot-Hot/Hybrid redundancy mode.

7.7.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in **Table** 5.1: Hot-Hot Performance Test **Results**.

Table 7.2: Hot-Hot Performance Test Results

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	4 core / 16 GB	4 core / 16 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state	Steady state
Protocol – Client /Server	DNP / DNP	DNP / DNP	DNP + D2.0/DNP	IEC 61850+DNP/ DNP	IEC 104 + MODBUS + DNP + IEC 101 + SEL Binary/ IEC 104

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
RTDB Point count	200,000	60,000	200,000	200,000	200,000
Total RCB configured DI & AI Simulation/Sec	NA 100 DI/Sec, 5000 AI/Sec	NA 48 DI/Sec, 1200 AI/Sec	NA 100 DI/Sec, 5000 AI/Sec	250 100 DI/Sec, 5000 AI/Sec	NA 103 DI/Sec, 5000 AI/Sec
Number of IEDs	400-Hot-Hot, 100-Hot Standby	140 -Hot-Hot, 10-Hot Standby	101 x D.20 peripherals + 400 DNP IEDs	500	500
Points / IED (AI + DI + AO + DO)	[AI-225, DI -125, DO -20, AO -20, ACC -10]	[AI-225, DI - 125-DI, DO - 20, AO-20, ACC-10]	**DNP:** [AI- 225, DI -125, DO - 20, AO-20, ACC-10]	[AI-225, DI -125, DO -20, AO -20, ACC -10]	**IEC 104:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **MODBUS:** [AI-210, DI-150, DO-15, AO-15] **DNP:** [AI-225, DI-125, DO-20, AO-20, ACC-10] **IEC 101:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **SEL Binary:** [AI-75, DI-806, DO-101]

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
Datalogger reports	100 Periodic reports	No reports	100 Periodic reports	100 Periodic reports	100 Periodic reports
Number of Master connections Point Count / Server	8 DI – 7750, AI – 13950	4 DI – 4625, AI - 8325	8 DI – 7750, AI – 13950	8 DI – 7750, AI - 13950	8 DI – 11160 AI – 9920
Remote / Local HMI connections	8 Remote / 1 Local HMI	4 Remote / 0 Local HMI	1 Remote	8 Remote / 1 Local HMI	8 Remote / 1 Local HMI
CPU utilization (%) Min, Max, Median	16, 98, 72.9	54.2, 100, 86.1	71.8, 99.9, 81.4	33, 99.2,79.4	82.73, 31.90, 100
Average Used Memory (GB) Min, Max, Median	2.83, 3.19, 3.05	1.61, 1.74, 1.68	2.395, 2.646, 2.587	2.56 2.77 2.70	3.45, 4.03, 3.88
Event latency in (msecs) Min, Max, Median	59.4, 2480, 1272.2	35.2, 1760, 556	243, 2431,720	12.23, 1301.6,585.3	94,1215, 204
Control latency in (msecs) Min, Max, Median	21.7, 163, 92	21.9, 542, 282	<1, 426, 9	4.195, 1986.72,72.02	20, 1204, 63

7.7.2 Redundancy Fail Over Time

This G500 version supports below fail-over times (i.e., when Active G500 is power cycled) in the Hot-Hot/Hybrid Redundancy with the default 300ms heart-beat rate and with default 3 retries.

Table 7.3: Redundancy Fail Over Times

Hot-Hot Redundancy/D.20 Configuration	Maximum Fail-Over Time (msec)
D.20 is not configured	1250
D.20 is configured	1450

7.7.3 HMI Response Times

Under steady state loading conditions, this version of G500 provides the HMI response times listed in the below **Table 7.4: User Interface Response Times – Steady State Normal Conditions**.

Table 7.4: User Interface Response Times – Steady State Normal Conditions

Activity	Minimum	Maximum	Median
Screen Access (Point Summary)	1.44 s	2.39 s	1.88 s
Screen Access (One-Line Viewer)	NA	NA	NA

Activity	Minimum	Maximum	Median
System Logs	2.42 s	3.08 s	2.60 s
Alarm ACK Delay (Single Alarm)	400 msec	550 msec	450 msec
Alarm ACK Delay (20,000 Alarms)	< 1 s	< 1 s	< 1 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s	< 1 s

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This G500 version supports the time sync accuracy results similar to G500 version 210, see: *Time Sync Accuracy (PTP/IRIG-B/NTP).*

Application List

This G500 version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✓ Available	✓ Available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✓ Available	✓ Available	✖ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Analog Data Logger	✓ Available	✓ Available	✓ Available	✖ Not Available
Generic ASCII Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Modbus Server	✓ Available	✓ Available	✓ Available	✖ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
DNP 3.0 Client	✓ Available	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available	✓ Available
IEC 61850 Server	✓ Available	✖ Not Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Event Logger	✓ Available	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✓ Available	✖ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✓ Available	✖ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Third-party components	✓ Available	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available	✓ Available
Analog Report Generator	✖ Not Available	✖ Not Available	✖ Not Available	✖ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available	✓ Available

8. Version 2.80 (18-July-2022)

Software Versions

The following table defines the software versions required for interaction with the G500.

Package	Version	Notes
G500 Firmware	2.8.189	G500 Firmware Version.
DS Agile MCP Studio	2.8.0	Minimum Supported DS Agile MCP Studio Software.
G500 HMI Viewer	2.8.189	Supported G500 HMI 64-bit Software.
MCP Utilities	1.1.13	Minimum Supported MCP Firmware Upgrade Utilities.
IEC61850 CID Tool	6.0.2	Minimum Supported CID configuration tool for automatically creating IEC 61850 Server map files.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the G500 v2.80.

Package/Firmware	Version	Notes
Predix Edge OS	2.6.0	Supported GE's Secured Linux Operating System Version.
FPGA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	1.2.2	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

8.1 Enhancements

8.1.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

8.1.2 Clients

GE Internal Reference #	Description
B-16268	Added configuration option for DNP3 class order in DNP3 client application parameters to communicate with custom IEDs e.g., EPM9450 meters.
B-16152, B-16148	Added support for clearing the Frozen values in DNP3 client and D.20 client applications.

8.1.3 Servers

GE Internal Reference #	Description
E-04671	Added support for Tejas V Server when enabled with D2x Legacy license.
E-04668	Added support for IEC 61850 Ed.2 MMS Server with Agency as micro-service and enabled with IEC 61850 Server license.

8.1.4 Automation

GE Internal Reference #	Description
E-04670	Added support to enable a pseudo Digital Input point for each accumulator group that will pulse when a freeze operation has been performed on any of the mapped Accumulators in the group.
E-04671	Added support to enable a pseudo Digital Output point for each accumulator group that will freeze the group when a PULSE ON, LATCH ON or CLOSE command is operated on that point.
E-04669	Added support in Accumulator Freeze DTA to support all possible freeze combinations. i.e., timer based freeze, DI trigger based freeze and Group DO based freeze operations.

8.1.5 Configuration/Settings

GE Internal Reference #	Description
E-04671	Added support for Tejas V Server in DSAS Online and Offline Editor, when enabled with D2x Legacy license.
E-04820	Added support for IEC 61850 Server automatic configuration using the CID Tool as general distribution, when enabled with IEC 61850 Server license.
E-03009	Added support for configurable decimal points for Analog Input displayed values in MCP One Line Designer screens (OLD).
E-04234	Added support for sorting in lexicographic order and filter for Line/Bay/Device ID in G500 One Line Designer screens (OLD) Data Source selection.

8.1.6 HMI

None.

8.1.7 Pass-through

None.

8.1.8 System

GE Internal Reference #	Description
DCSSUP-21532	Adjusted log messages severity to be more appropriate to the message classes.
B-16207	Added support for new operation type "Clear Running and Frozen" for the accumulator freeze and clear commands in G500 control log
B-16206	Added support to append "With_Clear" to the control type for control commands in G500 control log.
R-01519/ E-03688	Added support for Predix Edge Technician Console (PETC) based firmware deployment (without USB) in G500.

8.1.9 Documentation

GE Internal Reference #	Description
E-04773	Updated document SWM0106 G500 Quick Start Guide to make content consistent with SWM0116 G100 Quick Start Guide.
E-04626	Updated document G500 Instruction Manual (994-0152) with ordering code and licensing options for Tejas V Server and removed Special Order option for the IEC61850 Server.
E-04720	Updated "SWM0124 IEC 61850 Server User Guide" for configuring the IEC 61850 Ed2 server.
B-15927	Updated Software Configuration Guide SWM0101 for Tejas V Server, added informational appendix for Logs in MCP.
E-04631	Updated Secure Deployment Guide SWM0105 to add a note for User Role recommendation for DSAS offline editor, strong security recommendations for the use of SFTP instead of FTP/TFTP and strong physical security recommendations to protect MCP inside a locked cabinet.
E-04730	Updated the list of supported MCP versions in the Analog Reports User Guide (SWM0102)

8.1.10 Hardware

None.

8.2 Fixed defects

This version of G500 has the fixes for the following defects compared to G500 version 270:

8.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

8.2.2 Clients

GE Internal Reference #	Description
R-01498, GS-02706688, DCSSUP-21882	Fixed the issue of G500 not communicating with Modbus IED devices if the least significant group of the IP address has 3 digits.
DCSSUP-21911, R-01507	Fixed an issue with time sync in DNP3 client not working with some IEDs.

8.2.3 Server

GE Internal Reference #	Description
D-13332	Fixed the issue of Text points values (e.g., Bay ID, Device ID, Line ID, PRF TEXT etc.) not updating from IEC 61850 server to the master properly.
D-13363	Fixed the issue of IEC 61850 Server out of sync with the IED data when the system wide setting parameter "Event Queue Full Action" is configured as "LoseNewestEvents" as the default value in "DoNotLoseEvents" always.
D-13359	Fixed the issue of IEC 61850 Server not updating qualities of the GenASCII IED pseudo DI points to the master properly.
DCSSUP-21466, R-01494	Fixed the issue of IEC104 Master not connecting to the G500 after failover in a redundant system.
D-13630	Fixed the issue of IEC 61850 Server restarts during switch/fail-overs in a warm standby redundant system.

8.2.4 Automation

GE Internal Reference #	Description
R-01422, DCSSUP-20715	Fixed the issue of Automatic Record Retrieval Manager (ARRM) DTA locked up or failed to retrieve the large size files from UR relay over SFTP.
D-13565/ D-13566/ D-13567	Fixed issues in Control Lockout functionality with IEC101 DPA multiple LRUs configurations.
D-13517/ D-13530	Fixed issues in Control Lockout functionality with Select Before Operate (SBO) commands from the Masters.

8.2.5 Configuration/Settings

GE Internal Reference #	Description
D-11620	Fixed the issue of abruptly disconnecting a session of mcpcfg locks out the user until completion of inactivity timeout duration.
DCSSUP-22093/ GS-02741036	Fixed the issue where after synch of configuration from DSAS to G500 - the ConfigSeqNumber gets set to "2" instead of having the value from DSAS.

8.2.6 HMI

GE Internal Reference #	Description
D-13536	Fixed the issue of G500 runtime HMI showing wrong serial port for IEC 103 Client.
D-13576	Fixed the issue of G500 runtime HMI failed to create the VPN Client configuration file while doing the Save & Commit.
D-13564	Fixed the issue where ARRM Runtime HMI continuously shows connection status as disconnected if the descriptions of the file sets contain Unicode/UTF-8 characters.

8.2.7 Pass-through

None.

8.2.8 System

GE Internal Reference #	Description
D-13365	Fixed the issue of Config Sync fails the standby G500 if switch panel is wrongly wired, and switch-panel mode is configured as “slave” in the redundancy configuration.

8.2.9 Documentation

None.

8.2.10 Hardware

None.

8.3 Known Issues

This G500 version has the following known issues:

8.3.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

8.3.2 Clients

GE Internal Reference #	Description
B-13475 D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
D-12900	Alarm inhibit tag & Scan inhibit tags on DI point of D20 peripheral (S-card) is getting removed after failover in redundancy.
D-12834	Modbus Client could not process PRF events comes from SR 369 relay.
D-11261	IEC 61850 DCA transactions with IED are failing (reducing the efficiency) sometimes while issuing controls from LogicLinx DTA.
D-13075	D20A card in bad state can cause false behavior/functionality when it is configured in warm or hot-hot redundancy.

GE Internal Reference #	Description
D-13214	DNP3 Client doesn't support object types 31 and 33 for Frozen Analog Inputs (all variations).
D-13357	IEC 101 client ignores the Double Bit and Measurand objects when the IED sends unrequested events (i.e., events with invalid/bad object addresses) during the General or Group Interrogation period. **Workaround:** Ensure the configuration parameter "ignoreUnrequestedGIData" in the IEC 101 Application parameter settings to "Disabled".
D-13592	DNP3 client does not support Clear command when Remote Accumulators parameter is set to False.

8.3.3 Servers

GE Internal Reference #	Description
D-12889	DNP DPA/Server takes high CPU if more than 5000 Analog Inputs are configured in Unbuffered mode.
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
D-13134/ D-13135	RTS Post-amble time is not added to the data link confirm timeout or application timeout in DNP3 Serial Server.
D-12566	IEC101 DPA/Server in unbalanced mode sometimes reports duplicate Digital Input events to the Master if the event happens at the same time as General Interrogation response.

8.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948, D-12000	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).

8.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-12969	Adaptor IP is not getting removed completely for Net-1 interface in G500 after doing 'Remove Configuration and Reboot' from Settings GUI.
D-13028	Add more protection for memory leaks in Apache webserver settings.
D-13084	Need to remove unwanted text message displayed on the console when user tries to open mcpcfg/Settings GUI simultaneously in a particular scenario.
D-13088	Sometimes incorrect time zone is coming in the command prompt/shell, mcpcfg and settings GUI when IRIG-B/B006 is configured as time sync source from settings GUI. **Note:** Time zone is displaying correctly in Remote and Local HMI.
B-15613	The configuration through Bulk Editor is not supported for G500 after v2.10.

8.3.6 HMI

GE Internal Reference #	Description
D-12981	Issues in Runtime HMI if 8 Active Alarm Viewers are opened during performance characterization of G500.
B-15650	The following features of the Analog Report Viewer are not available: • View online reports • Save and view offline reports

8.3.7 Pass-through

GE Internal Reference #	Description
D-12990	In LDAP authentication, after passthrough connection is timed out, auto logout event is not generated into user activity log by IEC 103 Client.

8.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.

GE Internal Reference #	Description
D-10227	Email does not send messages when an alarm is activated.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-12984	Daisy chained secondary monitor shows always duplicate monitor, but it does not show the extended desktop.
D-13083	Add support for progress bar to be displayed during "Applying update" procedure through Predix Edge Technician Console (PETC).
D-13039	When both G500's are power cycled at the same time and if switch panel configured as a master, then one of the G500 can go to the failed state. **Note:** If switch panel is configured as Master and one of the G500 is power cycled with a delay then this issue will not be observed.
GS-02709884 / D-13470	Sometimes UTC time zone is getting overwritten by different time zone and resulting SOE timestamps have wrong time zone. Workaround: Configure GMT instead of UTC in DNP3 client and server configurations both in serial and ethernet modes.

8.3.9 Documentation

None.

8.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity

This G500 version supports the following application limits.

The maximum number of IEDs or Masters is total across all connections.

The maximum size of the system is given by whichever limit comes first (groups vs members, number of Connections vs IEDs, number of Master instances vs LRUs in the Master etc.). User is responsible to ensure resource usage limits are not exceeded at runtime.

The 4 cores system has a maximum of 500 IEDs, 200k points and 8 Masters (LRUs).

The 2 cores system has a maximum of 250 IEDs, 100k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

Tejas V Master/LRU instances are not counted as part of 8 Masters or LRUs calculations, both for 4 core and 2 core G500s.

Application	Feature	Configuration Limits
Digital Event Manager	**Alarms**	
	Max Number of Alarm Groups	256
	Max number of members in an Alarm Group	1000
Calculator	**Expression Type:**	
	Evaluations	10000
	Timers	1000
	Analog Assignments	2000
	Digital Assignments	10000
	Quality Conversions	1000
	Type Conversions	1000
	Averages	1000
	Output to Input Conversions	1000
Load Shed DTA	**Number of Feeders and Zones**	
	Max Zones	50
	Max Feeders	100
Analog Reports DTA	Not available starting with MCP V2.6 and newer.	None
System Point Manager	Accumulator Freeze	250
	Analog Value Selection	250
	Control Lockout	
	• Remote Groups	8
	• Local Groups	10000
	Double Points	1000
	Input Point Suppression	10000
	Control in Progress	256
	Redundant I/O	10000

Application	Feature	Configuration Limits
Analog Data Logger	Continuous Reports	1000
	Periodic Reports	1000
	Out of Range Reports	1000
VPN Server	Number of VPN Clients	8
	Number of VPN Server Instances	1
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IED Connections** (**Note**: Total number of serial connections are limited by maximum number of physical and virtual serial ports)	
	DNP Multidrop	80
	DNP Multidrop (Modem)	80
	Generic ASCII	80
	SEL Binary IED	80
	IEC 60870-5-101 Multidrop	80
	IEC60870-5-103 Multidrop	80
	Modbus Multidrop	80
	D.20	1
	Network IED Connections	
	DNP3 TCP	50
	Modbus TCP/Modbus TCP-SSH	50
	IEC60870-5 104	50
	IEC61850	Calculated by Loader based on system size
	SNMP	1
	Serial Master Connections	
	DNP3 Serial Master	8
	IEC 60870-5-101 Master	8
	Modbus Serial Master	8
	Network Master Connections	
	DNP3 Network Master	8
	IEC 60870-5-104 Master	8
	Modbus Network Master	8
	IEC 61850 Server	8 (2 for 2 cores)
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**	
	IEC60870-5-103 Multidrop	255
	DNP3 Multidrop/Network	10
	Modbus Multidrop/TCP	20

Application	Feature	Configuration Limits
	IEC60870-5 101 Multidrop	1000
	IEC60870-5 104	10
	SNMP Client	100
	GenASCII Client	120
	IEC61850 Client	Calculated by Loader based on system size (maximum 500 in total)
	SEL Binary Client	1
	D.20 Client	120
	Serial/Network Masters	
	DNP3 Serial Master	8
	Modbus Serial Master	8
	IEC 60870-1 101 Master	8
	Tejas V Master	The maximum number of LRUs is 99 per serial port, regardless of 2/4 cores.
	DNP3 TCP Master	1
	Modbus TCP Master	1
	IEC 60870-1 104 Master	1
	IEC 61850 Server (This is number of maximum concurrent IEC 61850 Clients for same Server Instance / LRU in CID file)	3
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs	Limited by protocol
	Modbus Multi-Drop/Network IEDs	Limited by protocol
	GenASCII IED	1000
	SNMP IED	1000
	IEC 60870-1 103 Multi-Drop	Limited by protocol
	IEC 60870-1 101/104 Multi-Drop	
	• Bitstream	Limited by protocol
	• Double Command	Limited by protocol
	• Integrate Total	Limited by protocol
	• Measurand	Limited by protocol
	• Packed Single Point	Limited by protocol
	• Regulating Step Command	Limited by protocol
	• Set Point Command	Limited by protocol
	• Single Point	Limited by protocol
	• Step Position	Limited by protocol

Application	Feature		Configuration Limits
	SEL Binary IED		
	• Fast Meter Analog Input		Limited by IED
	• Demand Analog Input		Limited by IED
	• Peak Demand Analog Input		Limited by IED
	• SER Digital Input		Limited by IED
	D.20 Peripheral Client		
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs
	D.20 K Card		32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master		DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000
	Modbus Serial/TCP Master		DI - 10000 AI - 15000 DO - 5000 AO - 5000 ACC - 3000
	IEC 60870-1 101/104 Master		DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000
	IEC 61850 Server CID **Note**: when configured to maximum size it may take up to 10 minutes for the IEC 61850 Server Instance (LRU) to complete initialization.		DI - 10000 AI - 15000 DO - 5000 AO - 5000 ACC – 3000

Application	Feature	Configuration Limits
	Tejas V Master	DI -256 AI -510 DO -256 AO – 64 ACC -510 3 control groups, each group with 1 raise and 1 lower DO point. Optional DI indication for local / remote status. Optional DI indication for accumulator freeze indication.

This G500 version meets the following performance test levels.

- G500 Hardware under test: 4 core CPU/ 16GB RAM variant.
- In the following table(s), numbers inside the brackets are for the G500 variant with 2 core CPU/8GB RAM, if the loading levels are smaller, then the total number of IEDs and RTDB points can increase but no more than specified limits under the Capability and Capacity section above.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 5,000 (1,200) DI – 100 (50)	DI – 63,000 (18,900) AI – 113,000 (33,600)
Number of connected IEDs to G500	500 (150)	500 (150)
G500 total RTDB Point count	200,000 (60,000)	200,000 (60,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points	4 core: DI = 9375 i.e., =150*500/8 AI = 15625 i.e., =250*500/8 2 core: DI = 5625 i.e., =150*150/4 AI = 9375 i.e., =250*150/4	4 core: DI = 9375 i.e., =150*500/8 AI = 15625 i.e., =250*500/8 2 core: DI = 5625 i.e., =150*150/4 AI = 9375 i.e., =250*150/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger - Periodic reports/sec	4 core: 1000 AI mapped	4 core: 1000 AI mapped
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs

Requirement	Steady State Loading	Avalanche Loading
Alarms	100 (50) / sec	100 (50) / sec

8.4 Standalone (non-redundant)

The performance capabilities of this G500 version in Standalone are same as that of Hot-Hot redundancy mode in this version of G500 – with the exception of IEC 61850 Server and Tejas V Server, presented below.

8.4.1 Performance Test Levels

The performance test levels of G500 version with IEC61850 server in the stand-alone mode is tested using the activity levels and disturbance scenarios presented next.

Table 8.1: IEC 61850 Server Standalone Performance Test Results

Activity	IEC 61850 Server (4 Core)	IEC61850 Server (2Core)
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB
Loading Condition	Steady state	Steady state
Protocol – Client /Server	DNP / IEC61850	DNP / IEC61850
RTDB Point count	200,000	60,000
Number of IEC61850 Server instances/Logical Remote Units (LRU)	6	2
Simultaneous IEC61850 Client connections for each LRU	1	1
Total number of IEDs in the system & Points per each IED	500 DNP3 IEDs [AI-225, DI -125, DO -20, AO -20, ACC -10]	160 DNP3 IEDs [AI-225, DI - 125-DI, DO - 20, AO-20, ACC-10]
Total DI & AI simulation/Sec	5000 – AI/sec 100 – DI/sec	480 – AI/sec 50 – DI/sec
Number of RTDB points mapped to each LRU	25000	25000
Total number of Logical Devices (LDs) in the system	2000 (4 * 500 i.e., 4 LDs for each IED)	640 (4 * 160 i.e., 4 LDs for each IED)
Datasets configured per each LRU	254 for each LRU	254 for each LRU
RCBs configured per each LRU	159 URCB for each LRU 95 BRCB for each LRU	159 URCB for each LRU 95 BRCB for each LRU

Activity	IEC 61850 Server (4 Core)	IEC61850 Server (2Core)
Datalogger reports	75 Periodic reports	48 Periodic Reports
Alarms/sec	100 On update Alarms	48 On update Alarms
Remote / Local HMI connections	4 Remote / 1 Local HMI	1 Remote / 0 Local HMI
CPU utilization (%) Min, Max, Median	77, 100, 88	41, 100, 63
Average Used Memory (GB) Min, Max, Median	5.1962, 5.6131, 5.3079	3.87, 4.16, 3.92
Event latency in (msecs) Min, Max, Median	59.4, 2480, 1272.2	35.2, 1760, 556
Control latency in (msecs) Min, Max, Median	21.7, 163, 92	21.9, 542, 282

The performance test levels of G500 version with Tejas server in the stand-alone mode is tested using the activity levels presented next **IEC 61850 Server.**

Table 8.2: Tejas V Server Standalone Performance Test Results

Activity	Tejas V Server (2 Core)
Hardware (CPU / RAM)	2 core / 8 GB
Loading Condition	Steady state
Protocol – Client /Server	DNP3 / Tejas V
Number of Tejas V instances/Logical Remote Units (LRU)	10
Total number of IEDs in the system & Points per each IED	60 DNP3 IEDs [AI-225, DI -125, DO -20, AO -20, ACC -10]
Points to mapped to each Tejas V Master	[AI-225, DI -125, DO -20, AO -20, ACC -10]
Total DI & AI simulation/Sec	840 – AI/sec 50 – DI/sec

Activity	Tejas V Server (2 Core)
Datalogger reports	12 Periodic reports and each report with 10 AI/sec
Remote/Local HMI connections	1 Remote / 0 Local HMI
Alarms/sec	50 Deviation Alarms
CPU utilization (%) Min, Max, Median	48, 100, 82
Average Used Memory (GB) Min, Max, Median	1.27,1.4,1.34
Event latency in (msecs) Min, Max, Median	221, 812,700
Control latency in (msecs) Min, Max, Median	75, 81, 78

8.5 Warm Standby Redundancy

The performance capabilities of Warm Standby Redundancy are same as that of Hot-Hot redundancy mode in this version of G500.

8.6 Hot Standby Redundancy

The performance capabilities of Hot Standby Redundancy are same as that of Hot-Hot redundancy mode in this version of G500.

8.7 Hot-Hot Redundancy

This G500 version provides the following performance capabilities in Hot-Hot/Hybrid redundancy mode.

8.7.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in **Table 9.1: Performance Test Results**.

Table 8.3: Hot-Hot Performance Test Results

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	4 core / 16 GB	4 core / 16 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state	Steady state
Protocol – Client /Server	DNP / DNP	DNP / DNP	DNP + D2.0/DNP	IEC 61850+DNP/ DNP	IEC 104 + MODBUS + DNP +

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
					IEC 101 + SEL Binary/ IEC 104
RTDB Point count	200,000	60,000	200,000	200,000	200,000
Total RCB configured DI & AI Simulation/Sec	NA 100 DI/Sec, 5000 AI/Sec	NA 48 DI/Sec, 1200 AI/Sec	NA 100 DI/Sec, 5000 AI/Sec	250 100 DI/Sec, 5000 AI/Sec	NA 103 DI/Sec, 5000 AI/Sec
Number of IEDs	400-Hot-Hot, 100-Hot Standby	140 -Hot-Hot, 10-Hot Standby	101 x D.20 peripherals + 400 DNP IEDs	500	500
Points / IED (AI + DI + AO + DO)	[AI-225, DI -125, DO -20, AO -20, ACC -10]	[AI-225, DI - 125-DI, DO - 20, AO-20, ACC-10]	**DNP:** [AI- 225, DI -125, DO - 20, AO-20, ACC-10]	[AI-225, DI -125, DO -20, AO -20, ACC -10]	**IEC 104:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **MODBUS:** [AI-210, DI-150, DO-15, AO-15] **DNP:** [AI-225, DI-125, DO-20, AO-20, ACC-10] **IEC 101:** [AI-160, DI-160, DO-40, AO-20, ACC-20)

Activity	DNP (4 Core)	DNP (2Core)	DNP + D.20	IEC 61850	Multi-Protocol
					SEL Binary: [AI-75, DI-806, DO-101]
Datalogger reports	100 Periodic reports	No reports	100 Periodic reports	100 Periodic reports	100 Periodic reports
Number of Master connections Point Count / Server	8 DI – 7750, AI – 13950	4 DI – 4625, AI - 8325	8 DI – 7750, AI – 13950	8 DI – 7750, AI - 13950	8 DI – 11160 AI – 9920
Remote / Local HMI connections	8 Remote / 1 Local HMI	4 Remote / 0 Local HMI	1 Remote	8 Remote / 1 Local HMI	8 Remote / 1 Local HMI
CPU utilization (%) Min, Max, Median	16, 98, 72.9	54.2, 100, 86.1	71.8, 99.9, 81.4	33, 99.2,79.4	82.73, 31.90, 100
Average Used Memory (GB) Min, Max, Median	2.83, 3.19, 3.05	1.61, 1.74, 1.68	2.395, 2.646, 2.587	2.56 2.77 2.70	3.45, 4.03, 3.88
Event latency in (msecs) Min, Max, Median	59.4, 2480, 1272.2	35.2, 1760, 556	243, 2431,720	12.23, 1301.6,585.3	94,1215, 204
Control latency in (msecs) Min, Max, Median	21.7, 163, 92	21.9, 542, 282	<1, 426, 9	4.195, 1986.72,72.02	20, 1204, 63

8.7.2 Redundancy Fail Over Time

This G500 version supports below fail-over times (i.e., when active G500 is power cycled) in the Hot-Hot/Hybrid Redundancy with the default 300ms heart-beat rate and with default 3 retries.

Table 8.4: Redundancy Fail Over Times

Hot-Hot Redundancy/D.20 Configuration	Maximum Fail-Over Time (msec)
D.20 is not configured	1250
D.20 is configured	1450

8.7.3 HMI Response Times

Under steady state loading conditions, this version of G500 provides the HMI response times listed in the below **Table 9.4: User Interface Response Times – Steady State Normal Conditions**.

Table 8.5: User Interface Response Times – Steady State Normal Conditions

Activity	Minimum	Maximum	Median
Screen Access (Point Summary)	1.44 s	2.39 s	1.88 s
Screen Access (One-Line Viewer)	NA	NA	NA
System Logs	2.42 s	3.08 s	2.60 s
Alarm ACK Delay (Single Alarm)	400 msec	550 msec	450 msec
Alarm ACK Delay (20,000 Alarms)	< 1 s	< 1 s	< 1 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s	< 1 s

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This G500 version supports the time sync accuracy results similar to G500 version 210, see: *Time Sync Accuracy (PTP/IRIG-B/NTP)*.

Application List

This G500 version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✓ Available	✓ Available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✓ Available	✓ Available	✖ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Analog Data Logger	✓ Available	✓ Available	✓ Available	✖ Not Available
Generic ASCII Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Modbus Server	✓ Available	✓ Available	✓ Available	✖ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available	✓ Available
IEC 61850 Server	✓ Available	✖ Not Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Tejas V Server	✓ Available	✓ Available	✓ Available	✖ Not Available
Event Logger	✓ Available	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✓ Available	✖ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
System Status Manager	✓ Available	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✓ Available	✖ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available	✓ Available
Analog Report Generator	✖ Not Available	✖ Not Available	✖ Not Available	✖ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available	✓ Available

9. Version 3.00 (28-April-2023)

Software Versions

The following table defines the software versions required for interaction with the MCP.

Package	Version	Notes
G500 Firmware	3.0.2528	G500 Firmware Version.
G100 Firmware	3.0.2528	G100 Firmware Version.
DS Agile MCP Studio	3.0.0	Minimum Supported DS Agile MCP Studio Software.
MCP HMI Viewer	3.0.2528	Supported MCP HMI 64-bit Software.
MCP Utilities	1.1.13	Minimum Supported MCP Firmware Upgrade Utilities.
IEC61850 CID Tool	8.0.7	Minimum Supported CID configuration tool for automatically creating IEC 61850 Server map files.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the MCP v3.00.

Package/Firmware	G100 Version	G500 Version	Notes
Predix Edge OS	2.7.0	2.7.0	Supported GE's Secured Linux Operating System Version.
FPGA	NA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	NA	1.2.3	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	FLEBG100A00006V107	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	NA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

9.1 Enhancements

9.1.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

9.1.2 Clients

GE Internal Reference #	Description
E-04750	Added separate default DNP DCA application parameters for serial and network connections.
E-04001	Changed SEL auto discovery to be a manually initiated process.
E-04942	Added support for clearing communication statistics for D.20 DCA.
E-03661	Made visible in editor the "autodiscovery" files for SELBIN (Offline & online editors).

9.1.3 Servers

GE Internal Reference #	Description
E-04940	Added support in IEC 61850 server to support SBO Normal Security via CID Tool setting.
E-04204	Added support in IEC 61850 server to operate as hot-hot or warm standby modes when G500 is configured in Hot-Hot redundant mode.
E-04367	Implemented DNP3 DPA set time only when other clock sources failed.

9.1.4 Automation

None.

9.1.5 Configuration/Settings

GE Internal Reference #	Description
E-04879	Starting with V3.00 - redundancy with an RS232 Switch Panel always uses the assigned A and B designation from mcpcfg / Settings GUI, instead of the CTS signal. This simplifies redundancy wiring by using same watchdog cable. Upgrading from a previous G500 version does not require cable changes, however the A and B designation assignment is now mandatory.
E-05010 E-05020 E-05021	Enhanced DSAS Miscellaneous > Updates to download new artefacts: MCP Firmware PETC, MCP Applications PETC, Remote HMI Installers.

9.1.6 HMI

GE Internal Reference #	Description
E-04511	Added runtime HMI dashboard that shows status of configured applications.
E-03570	Added support in Point Details / AI tab to show both value and AI Text Enumeration at runtime.
E-03364	Added support to open Active Alarms already filtered by group, by calling the Active Alarms window using a "group" parameter when configuring the "open" action from OLD.
R-01471	Added Remote Desktop Server functionality which allows connection to the Local HMI using Microsoft Windows Remote Desktop client.
R-01605 / E-05015	Added runtime HMI feature to open multiple User Screens with one single action.

9.1.7 Pass-through

None.

9.1.8 System

GE Internal Reference #	Description
E-04495	Added support for Hot-Hot/Hybrid redundancy in G100.

9.1.9 Documentation

GE Internal Reference #	Description
E-04736	Updated MCP Runtime HMI Help file with System Status and Redundancy in G100.
E-04600	Update Help file content on the configuration changes needed for IEC 61850 Server in DSAS offline/online editor.
E-04869	Updated document [SWM0111] Configuring the MCP for Centralized LDAP Authentication using Windows AD Installation and Configuration Guide (V3.00 R0) to add a note for Distinguished Name tables, updated XCA certificate Signature Algorithm references to SHA-256.
E-04875	Updated document [SWM0106] G500 Quick Start Guide (V3.00 R0).
E-04627	Updated document [SWM0116] G100 Quick Start Guide (V3.00 R0).
E-04734	Updated document [SWM0105] G500 Secure Deployment User Guide (V3.00 R0).
E-04936	Updated document [SWM0123] G100 Secure Deployment User Guide (V3.00 R0).
E-04599	Updated document [SWM0101] MCP Software Configuration Guide (V3.20 R0).
R-01525	Added 517-0169 Westerm D20 C Type 1 Version 1 to compatibility list in document [994-0155] G100 Instruction Manual (V3.00 R0).
E-04872	Updated document [994-0152] G500 Substation Gateway Instruction Manual (V3.00 R0).
E-04877	Updated document [994-0155] G100 Substation Gateway Instruction Manual (V3.00 R0).
E-04873	Updated document [SWM0124] IEC 61850 Server User Guide (V3.00 R0).
E-04874	Updated document [PRBT-0429] MCP NERC CIP5 Response (V4.10 R0).

GE Internal Reference #	Description
E-04871	Updated document [TN0116] MCP Firmware Upgrade and Restore to Defaults Workflows (V3.00 R6).
E-04876	Updated document [TN0125] MCP Firmware Upgrade via PETC (V3.00 R0).
E-04318	Updated document [MIS-0109] MCP Firmware Release Notes (V3.00 R0).
E-05026	Created document [994-0153] MCP Binder and ISO Image (V3.00 R0).

9.1.10 Hardware

GE Internal Reference #	Description
B-16456	Created new MCP Watchdog cable (977-0568).
B-16831	Created new Redundancy Kit MCP-REDN.

9.2 Fixed defects

This version of MCP has the fixes for the following defects compared to G500 version 280.

9.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

9.2.2 Clients

GE Internal Reference #	Description
D-13592	Fixed the issue in DNP3 Client to support Clear command when Remote Accumulators parameter is set to False.
D-13321	Added a fix in DNP Client to recover itself and starts polling in case if the polling gets stuck at the transport layer.
R-01572 DCSSUP-22808 DCSSUP-22855	Fixed the IEC61850 Client Restarts issue after a refused command (by IED in Local).
R-01570, R-01556/ DCSSUP-22614, DCSSUP-22833	Fixed the issue of IEC-60870-104 Client getting frozen randomly after few days of operation (once in a month).
R-01542/ DCSSUP-22403	Fixed an issue where IEC 608705-103 Client keeps restarting with large values of “Max confirm Idle timeout” and “Respond Idle timeout”.
D-14006	Fixed the issue of Peak demand data misinterpretation by adding Demand and Peak Demand readings in Double Floating Point format only.
D-14078	Fixed the IEC61850 client restart issue when issuing command to CDC=DPC when status is in intermediate state (0 0).
D-12853	Fixed the issue of Local GPIO DCA Command Failed Accum Pseudo Point not getting to increment on TTL failure.
DCSSUP-20185, GS-02402538 / R-01388	Fixed the issue where Modbus Client Serial Communications, AO orders, do not receive response back from slave.

9.2.3 Servers

GE Internal Reference #	Description
R-01539 / DCSSUP-22426	Fixed the issue that third party IEC 61850 communication is taking more time to report in A-View.
D-13722	Fixed the issue of IEC61850 Server not working when more than 50 LDs are being configured in 61850 LRU.
D-12931	Fixed the issue of G500 is not getting time synced from DNP master when primary time sync source IRIG-B is enabled but in failed condition.

9.2.4 Automation

GE Internal Reference #	Description
D-14003	Fixed the issue of Event Logger (Elog) failing to persist PRF events to mSQL database.
D-13127	Fixed the issue of LogicLinx failing to run post upgrade of configuration from v2.1 to v2.5.
D-13248	Fixed the LogicLinx memory corruption issue when system point not mapped.
D-13613	Fixed the issue in HAMA application where the last cause of reboot is being shown as "Reset WDT Carrier", no matter how the unit is rebooted.

9.2.5 Configuration/Settings

GE Internal Reference #	Description
D-12969	Fixed the issue of Adaptor IP being removed completely from Net1 interface in G500 after doing 'Remove Configuration and Reboot' from Settings GUI.
D-13088	Fixed the issue of incorrect time zone being displayed sometimes in the command prompt/shell, mcpcfg and settings GUI when IRIG-B/B006 is configured as time sync source from settings GUI.
D-13868	Fixed the issue of serial ports mode configuration (RS485 4w) being available in Settings GUI despite not being supported by G100.
D-14057	Fixed an issue where upgrade of snapshots or configurations fails if containing one or more malformed SEL DCA self-description files.
D-13713	Fixed the issue of mandatory configuration for secondary IP when using settings GUI to configure RM with single LAN.
D-14099	Fixed the issue of no 'Point Description' being displayed in the 'Online Trends' when the point description character length is more than 128 characters.
D-13797	Fixed the issue in Web GUI where eth0 and eth1 are being displayed as available network interfaces in firewall rules of G100.
DCSSUP-23243/ R-01593	Fixed the issue of G500 Losing 104 Devices Reference when Convert Settings to v2.7 or Higher.
D-12810	The order in which pseudo points appear in the offline editor of is different when compared to the online editor for the applications Modbus DCA, D.20 DCA and SNMP DCA.

9.2.6 HMI

GE Internal Reference #	Description
R-01549, DCSSUP-22543	Fixed the issue of G500 HMI Tag being lost when navigated to different screen and back.
D-12981	Fixed the issue in Runtime HMI if 8 Active Alarm Viewers are opened during performance characterization of G500.
D-13845	Fixed the issue of MCP Runtime HMI (in Windows) being installed only for current user.
D-13900	Fixed the issue of MCP login Security Banner not accepting some of the ASCII characters like- @ # $ % & ; :
D-13841	Fixed the issue of MCP login security banner not accepting the foreign languages.
D-13976	Fixed the issue of Autologin settings not being saved, when modified and saved from the runtime HMI.
D-13947	Fixed the issue of Failing to Export Trending database from runtime HMI, if the configured datalogger report point has a comma(,) in the point reference.

9.2.7 Pass-through

None.

9.2.8 System

GE Internal Reference #	Description
GS-02709884 / D-13470	Fixed issue of UTC time zone getting overwritten by different time zone and resulting SOE timestamps have wrong time zone.
D-13904	Fixed the issue of passthrough and terminal server functionalities not working properly when LDAP is configured.
DCSSUP-22261 / R-01529	Fixed the issue of G500 NTP Signal Present Input via NTP from GPS clock server RT430 not always working when GPS clock is powered off.
DCASUP-22556 / R-01552	Fixed the issue of Firewall rules for DNP/TCP rules not taking effect when configured from web settings GUI and works properly when configured from mcpcfg.
D-13819	Fixed the issue of duplicate firewall rules getting added in firewall rule table when two DNP servers are configured on the same port.
D-13823	Fixed an issue where firewall rules for were not added for NTP client.
D-13832	Fixed the issue of MQTT_Outbound rule getting displayed in firewall settings though it is used only internally.
D-13792	Fixed a race condition in NTP which is preventing the MCP unit from time syncing.
D-13709	Fixed the issue of G100 DHCP client failing to set default gateway on Net2 after reboot.
D-13663	Fixed the issue of hostname not being automatically updated in the list of hosts which is resulting in nuisance errors while trying to connect as a root user.
D-13560	Fixed an issue when G500 locks and becomes unresponsive after multiple SW WDOG events.
GS-02683392 / D-13811	Fixed the issue causing Permission Denied message in NTP Log.
D-12140	Merged fix from D400: Calculator stops evaluating averaging expressions.
D-13835	Fixed the issue of NTP IN pseudo point taking very long time (around 9 minutes) to update when NTP signal is in.

GE Internal Reference #	Description
D-12887	G100 GPIO input_overrun warning messages are logged periodically (~30 s) in the kernel log on loaded systems. The impact is that the MCP support bundle will not be able to retrieve a kernel log event older than approximately 22 days on a busy system, so ensure MCP support bundle is created, if necessary, soon after a kernel event that may need to be investigated.

9.2.9 Documentation

GE Internal Reference #	Description
D-13906	Removed the print button from local HMI help.
D-09928	Corrected described procedure for Sync Manger SFTP Key transfer in SWM0101 MCP Software Configuration Guide (V3.20 R0).

9.2.10 Hardware

None.

9.3 Known Issues

This G500 version has the following known issues:

9.3.1 Cyber Security

GE Internal Reference #	Description
D-14069	The MCP Settings GUI does not automatically log off after the inactivity timeout. It requires that the user click into the web page or hit refresh after the timeout occurs to trigger the Settings GUI to close the session. The mcpcfg utility will be locked out from use while the MCP Settings GUI session is open. If MCP Settings GUI was left open after the inactivity timeout has expired (maliciously or unintentionally), as a workaround, you can login and logout of the MCP Settings GUI in another browser to release the lockout of the mcpcfg utility.

For any additional known issues, please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

9.3.2 Clients

GE Internal Reference #	Description
B-13475 D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
D-12900	Alarm inhibits tag & Scan inhibit tags on DI point of D20 peripheral (S-card) is getting removed after failover in redundancy.
D-12834	Modbus Client could not process PRF events comes from SR 369 relay.
D-13075	D20A card in bad state can cause false behaviour/functionality when it is configured in warm or hot-hot redundancy.

GE Internal Reference #	Description
D-13214	DNP3 Client doesn't support object types 31 and 33 for Frozen Analog Inputs (all variations).
D-14111	Cold Reboot Required DI (1) based on HDLC card faulty state will be reset on warm reboot also.

9.3.3 Servers

GE Internal Reference #	Description
D-12889	DNP DPA/Server takes high CPU if more than 5000 Analog Inputs are configured in Unbuffered mode.
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
D-13134/ D-13135	RTS Post-amble time is not added to the data link confirm timeout or application timeout in DNP3 Serial Server.
D-12566	IEC101 DPA/Server in unbalanced mode sometimes reports duplicate Digital Input events to the Master if the event happens at the same time as General Interrogation response.
D-13996	IEC101/104 DPA buffer overflow DI events will be lost when set as discard newest
D-13383	IEC 61850 Server does not report correct point values when both the digital points (Bit-1 and Bit-2) are 'ON' and will not recover until a new event occurs.
D-12567	The time sync accuracy of G100 when IEC101 Server (Unbalanced/Balanced) is used as a time sync source is > +/- 4 msec.

9.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948, D-12000	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).

GE Internal Reference #	Description
D-14100	In MCP Runtime HMI, data points in 'Online Trends' do not display 'underscore (_)' in Point description even though it is there in the configuration.
D-13941	Control in progress DI pseudo point for GPIO DCA DO point is not getting high till pulse on +pulse off time when control command is getting executed on GPIO DCA DO point

9.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-13028	Add more protection for memory leaks in Apache webserver settings.
D-13084	Need to remove unwanted text message displayed on the console when user tries to open mcpcfg/Settings GUI simultaneously in a particular scenario.
B-15613	The configuration through Bulk Editor is not supported for G500 after v2.10.

9.3.6 HMI

GE Internal Reference #	Description
B-15650	The following features of the Analog Report Viewer are not available: • View online reports • Save and view offline reports
B-14982	The product references in the Runtime (Local/Remote) HMI logs need to be changed as "MCP".
D-05463	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.

9.3.7 Pass-through

GE Internal Reference #	Description
D-12990	In LDAP authentication, after passthrough connection is timed out, auto logout event is not generated into user activity log by IEC 103 Client.

9.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10227	Email does not send messages when an alarm is activated.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-12984	Daisy chained secondary monitor shows always duplicate monitor, but it does not show the extended desktop.
D-13083	Add support for progress bar to be displayed during "Applying update" procedure through Predix Edge Technician Console (PETC).
D-13039	When both G500's are power cycled at the same time and if switch panel configured as a master, then one of the G500 can go to the failed state. **Note:** If switch panel is configured as Master and one of the G500 is power cycled with a delay then this issue will not be observed.
B-14973	The software licensing application reports core license 012 as “G500 Core”, it should be “MCP Core”. There is no functional impact.

9.3.9 Documentation

None.

9.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity for MCP

This MCP version supports the following application limits.

The maximum number of IEDs or Masters is total across all connections.

The maximum size of the system is given by whichever limit comes first (groups vs members, number of Connections vs IEDs, number of Master instances vs LRUs in the Master etc.). User is responsible to ensure resource usage limits are not exceeded at runtime. For tested performance levels, refer to **Table 9.1** and **Table 9.2**.

The G500 4 cores system has a maximum of 500 IEDs, 200k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

The G500 2 cores system has a maximum of 250 IEDs, 100k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

The G100 system has a maximum of 120 IEDs, 24k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

Tejas V Master/LRU instances are not counted as part of 8 Masters or LRUs calculations, both for 4 core and 2 core G500s and for G100.

Application	Feature	Configuration Limits	
		G500	G100
Digital Event Manager	**Alarms**		
	Max Number of Alarm Groups	256	256
	Max number of members in an Alarm Group	1000	1000
Calculator	**Expression Type**		
	Evaluations	10000	10000
	Timers	1000	1000
	Analog Assignments	2000	2000
	Digital Assignments	10000	10000
	Quality Conversions	1000	1000
	Type Conversions	1000	1000
	Averages	1000	1000
	Output to Input Conversions	1000	1000
Load Shed DTA	**Number of Feeders and Zones**		
	Max Zones	50	50
	Max Feeders	100	100
Analog Reports DTA	Analog Reports are not available starting with MCP V2.6 and newer	None	None
System Point Manager	Accumulator Freeze	250	250
	Analog Value Selection	250	250
	Control Lockout		
	• Remote Groups	8	8
	• Local Groups	10000	10000

Application	Feature	Configuration Limits	
		G500	G100
	Double Points	1000	1000
	Input Point Suppression	10000	10000
	Control in Progress	256	256
	Redundant I/O	10000	10000
Analog Data Logger	Continuous Reports	1000	1000
	Periodic Reports	1000	1000
	Out of Range Reports	1000	1000
VPN Server	Number of VPN Clients	8	8
	Number of VPN Server Instances	1	1
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IED Connections** [**Note**: Total number of serial connections are limited by maximum number of physical and virtual serial ports (150)]		
	DNP Multidrop	80	80
	DNP Multidrop (Modem)	80	80
	Generic ASCII	80	80
	SEL Binary IED	80	80
	IEC 60870-5-101 Multidrop	80	80
	IEC60870-5-103 Multidrop	80	80
	Modbus Multidrop	80	80
	D.20	1	1
	Network IED Connections		
	DNP3 TCP	50	50
	Modbus TCP/Modbus TCP-SSH	50	50
	IEC60870-5 104	50	50
	IEC61850	Calculated by Loader based on system size	Calculated by Loader based on system size
	SNMP	1	1
	Serial Master Connections		
	DNP3 Serial Master	8	8
	IEC 60870-5-101 Master	8	8
	Modbus Serial Master	8	8
	Network Master Connections		
	DNP3 Network Master	8	8
	IEC 60870-5-104 Master	8	8
	Modbus Network Master	8	8

Application	Feature	Configuration Limits	
		G500	**G100**
	IEC 61850 Server	8	8
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**		
	IEC60870-5-103 Multidrop	255	255
	DNP3 Multidrop/Network	10 **(Note 1)**	10 **(Note 1)**
	Modbus Multidrop/TCP	20 **(Note 1)**	20 **(Note 1)**
	IEC60870-5 101 Multidrop	1000	1000
	IEC60870-5 104	10 **(Note 1)**	10 **(Note 1)**
	SNMP Client	100	100
	GenASCII Client	120	120
	IEC61850 Client	Calculated by Loader based on system size (maximum 500 in total)	Calculated by Loader based on system size (maximum 120 in total)
	SEL Binary Client	1	1
	D.20 Client	120	120
	Serial/Network Masters		
	DNP3 Serial Master	8	8
	Modbus Serial Master	8	8
	IEC 60870-1 101 Master	8	8
	Tejas V Master	The maximum number of LRUs is 99 per serial port, regardless of 2/4 cores.	The maximum number of LRUs is 99 per serial port
	DNP3 TCP Master	1	1
	Modbus TCP Master	1	1
	IEC 60870-1 104 Master	1	1
	IEC 61850 Server (This is number of maximum concurrent IEC 61850 Clients for same Server Instance / LRU in CID file)	3	3
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs	Limited by protocol	Limited by protocol
	Modbus Multi-Drop/Network IEDs	Limited by protocol	Limited by protocol
	GenASCII IED	1000	1000
	SNMP IED	1000	1000
	IEC 60870-1 103 Multi-Drop	Limited by protocol	Limited by protocol

Application	Feature		Configuration Limits	
			G500	G100
	IEC 60870-1 101/104 Multi-Drop			
	• Bitstream		Limited by protocol	Limited by protocol
	• Double Command		Limited by protocol	Limited by protocol
	• Integrate Total		Limited by protocol	Limited by protocol
	• Measurand		Limited by protocol	Limited by protocol
	• Packed Single Point		Limited by protocol	Limited by protocol
	• Regulating Step Command		Limited by protocol	Limited by protocol
	• Set Point Command		Limited by protocol	Limited by protocol
	• Single Point		Limited by protocol	Limited by protocol
	• Step Position		Limited by protocol	Limited by protocol
	SEL Binary IED			
	• Fast Meter Analog Input		Limited by IED	Limited by IED
	• Demand Analog Input		Limited by IED	Limited by IED
	• Peak Demand Analog Input		Limited by IED	Limited by IED
	• Digital Output		Limited by IED	Limited by IED
	• SER Digital Input		Limited by IED	Limited by IED
	D.20 Peripheral Client			
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters	64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs	32 Analog Inputs
	D.20 K Card		32 Digital Outputs	32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs	16 Digital Inputs 8 Digital Outputs
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs

Application	Feature	Configuration Limits	
		G500	**G100**
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000
	Modbus Serial/TCP Master	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	IEC 60870-1 101/104 Master	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	IEC 61850 Server CID **Note**: when configured to maximum size it may take up to 10 minutes for the IEC 61850 Server Instance (LRU) to complete initialization.	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	Tejas V Master	DI -256 AI -510 DO -256 AO – 64 ACC -510 3 control groups, each group with 1 raise and 1 lower DO point. Optional DI indication for local / remote status. Optional DI indication for accumulator freeze indication.	DI -256 AI -510 DO -256 AO – 64 ACC -510 3 control groups, each group with 1 raise and 1 lower DO point. Optional DI indication for local / remote status. Optional DI indication for accumulator freeze indication.

Note 1: Indicates recommended value which can be exceeded with an increased level of event latency.

This MCP version meets the following performance test levels.

- MCP Hardware under test:
  - G500 4 core CPU/ 16GB RAM.
  - G500 2 core CPU/8GB RAM
  - G100 8GB RAM
- The following table(s) indicate the G500 4 core , G500 2 core and G100 values in different loading conditions.
- If the loading levels are lower, then the total number of IEDs and RTDB points can increase but no more than specified limits under the Capability and Capacity section above.

Requirement	Steady State Loading			Avalanche Loading		
	G500 (4 Core)	**G500 (2 Core)**	**G100**	**G500 (4 Core)**	**G500 (2 Core)**	**G100**
Loading Signal changes(continuously / sec)	AI - 5,000 DI – 100	AI – 1200 DI - 50	AI - 1200 DI – 12	DI – 62500 AI – 112500	DI – 18750 AI - 33750	All points changing twice in 2 secs
Number of connected IEDs	500	150	120	500	150	120
Total RTDB Point count	200,000	60, 000	24000	200,000	60,000	24000
Points / IED DI/AI/DO/AO/ACC	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225- AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED
Each Server has points	4 core: DI = 7812 i.e., = (125*500)/8 AI = 14063 i.e., = (225*500)/8 DO = 1250 i.e., (20*500)/8	2 core: DI = 4687 i.e., = (125*150)/4 AI = 8437 i.e., = (225150)/4 DO = 750 i.e., (20*150)/4	4 DI = 1875 i.e., = 125 * 60 /4 AI = 3375 i.e., = 225 * 60 /4 AO = 300 i.e., = 20 * 60 / 4	4 core: DI = 7812 i.e., = (125*500)/8 AI = 14063 i.e., = (225*500)/8 DO =1250 i.e., (20*500)/8	2 core: DI = 4687 i.e., = 125*150)/4 AI = 8437 i.e., = (225*150)/4 DO = 750 i.e., (20*150)/4	4 DI = 1875 i.e., = 125 * 60 /4 AI = 3375 i.e., = 225 * 60 /4 AO = 300 i.e., = 20 * 60 / 4

Requirement	Steady State Loading			Avalanche Loading		
	G500 (4 Core)	G500 (2 Core)	G100	G500 (4 Core)	G500 (2 Core)	G100
	AO = 1250 i.e., (20*500)/8 Acc = 625 i.e., (10*500)/8	AO = 750 i.e., (20*150)/4 Acc = 375 i.e., (10*150)/4	AO = 300 i.e., = 20 * 60 / 4 ACC = 150 i.e., = 10 * 60/ 4	AO =1250 i.e., (20*500)/8 Acc = 625 i.e., (10*500)/8	AO = 750 i.e., (20*150)/4 Acc = 375 i.e., (10*150)/4	AO = 300 i.e., = 20 * 60 / 4 ACC = 150 i.e., = 10 * 60/ 4
Remote HMI connections	4 Simultaneous connections	2 Simultaneous connections	2 Simultaneous connections	4 Simultaneous connections	2 Simultaneous connections	2 Simultaneous connections
Local HMI connections	1 connection (multiple displays)	1 connection (multiple displays)	1 connection (single displays)	1 connection (multiple displays)	1 connection (multiple displays)	1 connection (single displays)
Datalogger - Periodic reports/sec	100 Reports each with 5 AI points. Total 500 AI point mapped	50 Reports each with 10 AI points. Total 500 AI point mapped	120 AI mapped / 12 reports	100 Reports each with 5 AI points. Total 500 AI point mapped	50 Reports each with 10 AI points. Total 500 AI point mapped	120 AI mapped / 12 reports
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs	12 / sec	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs	12 / sec (twice within 2 secs)
Alarms	100/sec	50/sec	12	100/ sec	50/sec	12/sec

9.4 Performance Test Levels of MCP Devices

This MCP version provides the following performance capabilities when configured in different modes (Standalone / Hot-Hot Redundancy/ Hot Standby Redundancy / Warm Standby Redundancy).

9.4.1 Performance Test Levels

The performance of MCP is tested using the activity levels and disturbance scenarios presented next:

Notes:

- The performance tests results in Table 9.1 were determined in Hot-Hot redundancy mode. The results apply to Warm Standby, Hot Standby and Standalone modes.
- The Tejas V Server performance tests results in Table 9.2 were determined in Standalone mode. The results apply to Warm Standby, Hot Standby and Hot-Hot redundancy modes, if a 4 core G500 is used.

Table 9.1: Performance Test Results

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
Protocol – Client /Server	DNP3 / DNP3	DNP3 / DNP3	(DNP3 + D.2.0) / DNP3	(IEC 61850+DNP) / DNP	(IEC 61850+DNP) / IEC61850	(IEC 104 + MODBUS + DNP + IEC 101 + SEL Binary) / IEC 104	(IEC 61850+DNP) / IEC61850
RTDB Point count	200,000	60,000	200,000	200,000	200,000	200,000	24,000

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
DI & AI Simulation/Sec	100 DI/Sec, 5000 AI/Sec	48 DI/Sec, 1200 AI/Sec	100 DI/Sec, 5000 AI/Sec	100 DI/Sec, 5000 AI/Sec	50 DI/Sec, 2500 AI/Sec	103 DI/Sec, 5000 AI/Sec	8 DI/Sec, 320 AI/Sec
Number of IEDs	400-Hot-Hot, 100-Hot Standby	140 -Hot-Hot, 10-Hot Standby	101 x D.20 peripherals + 400 DNP IEDs	500	400-Hot-Hot, 100-Hot Standby	500	30-Hot-Hot, 30-Hot Standby
Points / IED (AI + DI + AO + DO + ACC)	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	400 [AI-225, DI - 125, DO - 20, AO-20, ACC-10]	400 [AI- 225, DI -125, DO - 20, AO-20, ACC-10]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	**IEC 104:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **MODBUS:** [AI-210, DI-150, DO-15, AO-15, ACC-0]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	DNP3 (Client / Server)	DNP3 (Client / Server)	DNP3 (Client / Server) + D.20 (Client)	IEC 61850 Client	IEC 61850 Server	Multi-Protocol	IEC 61850 Server
Hardware	G500 (4 Core)	G500 (2 Core)	G500 (4 Core)	G500 (4 Core)	G500 (4 Core)	G500 (4 Core)	G100
						DNP: [AI-225, DI-125, DO-20, AO-20, ACC-10] **IEC 101:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **SEL Binary:** [AI-75, DI-806, DO-101 AO-0 ACC-0]	

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
Number of RTDB points mapped to each LRU	25000	25000	25000	25000	25000	25000	6000
Number of Master connections Point Count / Server	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	4 DI – 7812, AI – 14063 DO – 1250 AO -1250 ACC - 625	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	4 DI – 7812, AI – 14063 DO – 1250 AO -1250 ACC - 625	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	2 DI – 1875, AI – 3375 DO – 300 AO -300 ACC - 150
Total number of Server Logical Devices (LDs) in the system	NA	NA	NA	NA	1008 (252 LD mapped in each LRU. So, 252*4=1008LD)	NA	120 (60 LD mapped in each LRU. So, 60*2= 120LD)
Datasets configured in each LRU	NA	NA	NA	NA	254 Datasets mapped in each LRU	NA	61 Datasets mapped in each LRU
RCBs configured in each LRU	NA	NA	NA	NA	172 URCB for each LRU 82 BRCB for each LRU	NA	36 URCB for each LRU 19 BRCB for each LRU
Datalogger reports updated per sec	100 Periodic reports each with 5 AI points	No reports	100 Periodic reports	100 Periodic reports each with 5 AI points	50 Periodic reports each with 10 AI points	100 Periodic reports	12 Periodic reports each with 10 AI points

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
Remote / Local HMI connections	4 Remote / 1 Local HMI	4 Remote / 0 Local HMI	1 Remote	8 Remote / 1 Local HMI	4 Remote / 1 Local HMI	8 Remote / 1 Local HMI	2 Remote / 1 Local HMI
CPU utilization (%) Min, Max, Median	56, 95, 66	54, 100, 86	72, 100, 81	33, 100, 79	50, 100, 69	32, 100, 83	30, 100, 77
Used Memory (GB) Min, Max, Median	2.79, 3.097, 3.039	1.61, 1.74, 1.68	2.395, 2.646, 2.587	2.56 2.77 2.70	4.004, 4.318, 4.206	3.45, 4.03, 3.88	1.854, 2.113, 2.018
Event latency in (msecs) Min, Max, Median	61, 1026, 508	35, 1760, 556	243, 2431, 720	12, 1301, 585	10, 287, 111	94, 1215, 204	12, 228, 113
Control latency in (msecs) Min, Max, Median	12, 104, 28	22, 542, 282	1, 426, 9	4, 1987, 72	6, 468, 14	20, 1204, 63	9, 85, 16

Table 9.2: Performance Test Results in Standalone mode

Results taken from Firmware Version	**G500 V2.8**	**G100 V2.3**
Activity	**Tejas V Server**	**DNP3 +D.20 /DNP3**
Hardware	**G500 (2 Core)**	**G100**
Protocol – Client /Server	DNP3 / Tejas V	DNP3 + D.20 / DNP3
RTDB Point count	24,000	24,000
DI & AI Simulation/Sec	840 – AI/sec 50 – DI/sec	1200 – AI/sec 12– DI/sec
Number of IEDs	60	120
Points / IED (AI + DI + AO + DO + ACC)	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10] + D.20 points from 60 peripherals
Number of RTDB points mapped to each LRU	400	6000
Number of Master connections Point Count / Server	10 Number of Tejas V instances/ Logical Remote Units (LRU) 400	4 DI = 1875 i.e., = 125 * 60 /4 AI = 3375 i.e., = 225 * 60 /4 AO = 300 i.e., = 20 * 60 / 4 AO = 300 i.e., = 20 * 60 / 4 ACC = 150 i.e., = 10 * 60/ 4
Datalogger reports per sec	12 Periodic reports and each report with 10 AI	12 Periodic reports and each report with 10 AI
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 1 Local HMI
CPU utilization (%) Min, Median, Max	48, 100, 82	35, 75, 100
Used Memory (GB) Min, Median, Max	1.27,1.4,1.34	<1, 1.201, 1.261

Results taken from Firmware Version	G500 V2.8	G100 V2.3
Activity	Tejas V Server	DNP3 +D.20 /DNP3
Hardware	G500 (2 Core)	G100
Event latency in (msecs) Min, Median, Max	221, 812,700	172, 518, 2595
Control latency in (msecs) Min, Median, Max	75, 81, 78	12, 25, 254

9.4.2 Redundancy Fail Over Time

This MCP version supports below fail-over times (i.e., when active G500 / G100 is power cycled) in the Hot-Hot/Hybrid Redundancy with the default 300ms heart-beat rate and with default 3 retries.

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Table 9.3: Hot-Hot Redundancy Fail Over Times

Hot-Hot Redundancy/D.20 Configuration	Maximum Fail-Over Time (msec)	
	G500	G100
D.20 is not configured	1250	1780
D.20 is configured	1450	1940

9.4.3 HMI Response Times

Under steady state loading conditions, this version of G500 provides the HMI response times listed in the below **Table 9.4: User Interface Response Times – Steady State Normal Conditions**.

Table 9.4: User Interface Response Times – Steady State Normal Conditions

Activity	G500 (4 Core)	G500 (2 Core)	G100
Screen Access (Point Summary) (Min, Max, Median) sec	2, 2.6, 2.1 sec	1.5, 5.3, 1.9 sec	0.9, 1.7, 1.4 sec
Screen Access (One-Line Viewer) (Min, Max, Median) sec	9 sec	54 sec	14 sec
System Logs) (Min, Max, Median) sec	1.9, 2.7, 1.9 sec	4.9, 12.1, 5.9 sec	3.1, 3.9, 3.1 sec
Alarm ACK Delay (Single Alarm)	3 sec	<1 sec	<1 sec
Alarm ACK Delay (20,000 Alarms)	< 1 sec	16 sec	6 sec
DI/AI Update to Point Summary Screen	< 1 sec	< 1 sec	< 1 sec

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

Screen Access time was measured in heavy loading condition.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This MCP version supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

This version does not support runtime dynamic failover across different time sources.

Time Sync Input	Accuracy	
	G500	G100
IRIG-B IN	• 100% samples within 945 microseconds with an average of 39 microseconds and standard deviation of 28 microseconds • Total number of samples considered ~3507	• 100% samples within 866 microseconds with an average of 90 microseconds and standard deviation of 76 microseconds • Total number of samples considered ~3758
PTP IN	• 100% samples within 693 microseconds with an average of 40 microseconds and standard deviation of 31 microseconds • Total number of samples considered ~3457	NA
NTP IN	• 100% samples within 1065 microseconds with an average of 437 microseconds and standard deviation of 216 microseconds • Total number of samples considered ~3614	• 100% samples within 867 microseconds with an average of 92 microseconds and standard deviation of 81 microseconds • Total number of samples considered ~3259

NOTES:

- IRIG-B/ PTP time accuracy is measured in a scenario where the hardware is fully loaded.

Timestamp Accuracy

This MCP version provides the following Timestamp Accuracy.

Protocol	Accuracy % @ N = **%** of samples within +/- **N** milliseconds	
	G500	G100
D.20 HDLC	• 99.92% @ 1 ms • 100% @ 2 ms • Total number of samples considered ~18,000 • Measured the accuracy for every five seconds at a D.20 S peripheral	• 98.32% @ 1 ms • 99.96% @ 2 ms • 100% @ 3 ms • Total number of samples considered ~33,000 • Measured the accuracy for every five seconds at a D.20 S peripheral
GPIO	NA	• 96.5% @ 1 ms • 99.92% @ 2 ms • 100% @ 3 ms • Total number of samples considered ~33,000 • Measured the accuracy for every five seconds at the GPIO

Protocol	Accuracy % @ N = **%** of samples within +/- **N** milliseconds	
	G500	**G100**
DNP I/O	• 83.33% @ 1 ms • 99.82% @ 2 ms • 99.86% @ 3 ms • 100% @ 4 ms • Total number of samples considered ~16476 • Measured the accuracy for every five seconds at a DNP I/O S peripheral	• 3.4% @ 1 ms • 80.14% @ 2 ms • 96.15% @ 3ms • 99.16% @ 4 ms • 99.88% @ 5 ms • 100% @ 6 ms • Total number of samples considered ~11790 • Measured the accuracy for every five seconds at a DNP I/O S peripheral

Application List

This MCP version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✓ Available	✓ Available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✓ Available	✓ Available	✖ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Analog Data Logger	✓ Available	✓ Available	✓ Available	✖ Not Available
Generic ASCII Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Modbus Server	✓ Available	✓ Available	✓ Available	✖ Not Available
DNP 3.0 Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Digital Event Manager	✓ Available	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available	✓ Available
GPIO/Local Client(Available in G100 only)	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Tejas V Server	✓ Available	✓ Available	✓ Available	✖ Not Available
Event Logger	✓ Available	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✓ Available	✖ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available	✓ Available
Virtual Serial Ports	✓ Available	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✓ Available	✖ Not Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available	✓ Available
Analog Report Generator	✖ Not Available	✖ Not Available	✖ Not Available	✖ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available	✓ Available

10. Version 3.10 (23-August-2023)

Software Versions

The following table defines the software versions required for interaction with the MCP.

Package	Version	Notes
G500 Firmware	3.1.153	G500 Firmware Version.
G100 Firmware	3.1.153	G100 Firmware Version.
DS Agile MCP Studio	3.1.0	Minimum Supported DS Agile MCP Studio Software.
MCP HMI Viewer	3.1.153	Supported MCP HMI 64-bit Software.
MCP Utilities	1.1.13	Minimum Supported MCP Firmware Upgrade Utilities.
IEC61850 CID Tool	8.0.8	Minimum Supported CID configuration tool for automatically creating IEC 61850 Server map files.

Predix Edge OS and Other Firmware Versions

The following table defines the package/firmware versions supported for Predix Edge Linux OS, FPGA, CPLD, UEFI and BCOM FPGA in the MCP v3.10.

Package/Firmware	G100 Version	G500 Version	Notes
Predix Edge OS	2.7.0	2.7.0	Supported GE's Secured Linux Operating System Version.
FPGA	NA	1.03.00	Supported FPGA Version of Multi-Function Controller Platform (MCP).
CPLD	NA	1.2.3	Supported CPLD Version of Multi-Function Controller Platform (MCP).
UEFI	FLEBG100A00006V107	VX5D0007.C01	Supported UEFI Version of Multi-Function Controller Platform (MCP).
BCOM FPGA	NA	2.3.0	Supported COM's Module FPGA Version of Multi-Function Controller Platform (MCP).

Key Functions and Changes

10.1 Enhancements

10.1.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

10.1.2 Clients

GE Internal Reference #	Description
R-01598 / E-05035	Add a parameter to control the logic type of "Enable/Disable Device" in the MCP DNP3 Client Map file.
R-01599 / E-05036	Add a parameter to control the logic type of "Enable/Disable Polling" in the MCP DNP3 Client Map file.
R-01600 / E-05037	Implement DNP3 Client quality flags behavior when devices are disabled at runtime, as a new Client Map parameter "Device Disable Sets Remote Force and Offline".

10.1.3 Servers

GE Internal Reference #	Description
R-01601 / E-05038	Implement DNP3 Server runtime behavior based on quality flags, as a new DNP3 DPA LRU Application Parameter "Report Remote Forced and Offline Points".
B-17119	Add support for time sync rejection based on time quality to IEC 101/104 DPA.

10.1.4 Automation

None.

10.1.5 Configuration/Settings

GE Internal Reference #	Description
B-17274	Removed support for 110 Baud rate from all serial protocols in the connection configuration GUI.
R-01542 / DCSSUP-22403	Updated default values for IEC 60870-5-103 Application Parameters.

10.1.6 HMI

None.

10.1.7 Pass-through

None.

10.1.8 System

GE Internal Reference #	Description
B-14973	Implement the change needed to show "MCP Core" for license 012 which currently shows up as "G500 Core".
B-17229	Make serial port FIFO trigger level in G100 to be same as G500 at baud rates below 115200.

10.1.9 Documentation

GE Internal Reference #	Description
E-05118	Updated document [SWM0101] MCP Software Configuration Guide (V321 R0) including enhancements in DNP Serial and Network Master sections, IEC 101/104 Application Parameters, IEC 103 Client and Application default values, One Line Designer tool tip options, merging and deleting redundant tables, removing “slave” references where applicable.
E-05123	Updated help file content in DSAS online/offline editor and Runtime HMI including enhancements in DNP Serial and Network Master sections, IEC 101/104 Application Parameters, IEC 103 Client and Application default values, One Line Designer tool tip options, merging and deleting redundant tables, removing “slave” references where applicable.
E-05128	Updated document [SWM0103] Integration of MCP with OpenVPN Client (V200 R3).
E-05143	Updated document [SWM0122] Configuring UEFI Settings on G100 User Guide (V200 R0).
E-05117	Updated document [SWM0124] IEC 61850 Server User Guide (V310 R0) to include new added DNP Pseudo Points.
B-17156	Updated document [MIS–0109] MCP Firmware Release Notes (V310 R0) with Time Sync Accuracy and Timestamp Accuracy.
B-17242	Updated document [MIS-0110] Open Source License Information (V310 R0).
D-15231	Updated document [SWM0109] Secure Integration of SCADA Third Party Equipment with MCP (V200 R3) with stunnel software download link.
E-05137	Updated document [TN0116] MCP Firmware Upgrade and Restore to Defaults Workflows (V300 R7).
E-05188	Updated document [994-0152] G500 Substation Gateway Instruction Manual for V310 release (V310 R0).
E-05187	Updated document [994-0155] G100 Substation Gateway Instruction Manual for V310 release (V310 R0).
E-05165	Created document [994-0153] MCP Binder and ISO Image (V3.10 R0).

10.1.10 Hardware

None.

10.2 Fixed defects

This version of MCP has the fixes for the following defects compared to MCP version 300.

10.2.1 Cyber Security

Please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

10.2.2 Clients

GE Internal Reference #	Description
R-01620 / DCSSUP-23567	Fixed the issue in G100 where GPIO will not refresh.
D-15247	Fixed the issue of incorrect current time calculation in Modbus DCA (the key rotation may be too fast or too slow).
R-01609 / DCSSUP-23393 / DCSSUP-23574 / DCSSUP-23649	Fixed the data update issue with MODUS RTU DCA (Serial).
R-01542 / DCSSUP-22403	Fixed multiple issues in IEC 60870-5-103 DCA: - Diagnostic Log was flooded with "Call b032_producer_update_quality fail -60" messages when IEC103 IED went offline - An empty message was logged when IED reported “COT: RESTART or POWERON” after being initialized - Parity or Framing errors stopped application layer and caused devices to go offline - One IED failure could take other IEDs to offline - One or more IEDs would go offline after sometime - Improved Telemetry time updates
D-15220	Fixed the issue in G100 GPIO DCA, where DO point is looped back to DI point, after 'Save and Commit changes, the DI point status persists to '1' but DO point status becomes '0'.
D-15132	Fixed the issue in D.20 FPGA where Rx is not disabled when switching to dormant mode.
D-15268	Fixed the issue in Modbus DCA that the device remains online when DCA receives a message with invalid CRC.
D-15280	Fixed the issue in Modbus DCA that DO command exception responses are not triggering protocol errors in HMI.
D-15269	Fixed the issue in Modbus DCA that HMI does not show protocol errors when invalid CRC DO/AO response received.
D-15256	Fixed the issue in Modbus DCA that Write Single Coil/Write Single Register Response Comm Errors Masked when first byte of address is 0,1 or 2, and Write Multiple Register results in false failure if first byte of "Starting Address" is not 0.

10.2.3 Servers

None.

10.2.4 Automation

None.

10.2.5 Configuration/Settings

None.

10.2.6 HMI

None.

10.2.7 Pass-through

None.

10.2.8 System

GE Internal Reference #	Description
D-15169	Fixed the issue in a case where Hot-hot system with HDLC configured is not handling the HDLC driver's FAULTY state (device remains online and transactions are frozen, points are not offline).
D-15179	Fixed the issue in Hot-hot system where HDLC driver falls into faulty mode after switchovers.
D-15124	Fixed the issue in Standalone system with HDLC configured, which is not handling the HDLC driver's FAULTY state.
D-15127	Fixed the issue of incorrect diagnostic log message in case of HDLC card fault requiring cold reboot occurs.

10.2.9 Documentation

GE Internal Reference #	Description
D-15227/ R-01626	Corrected document [994-0155] G100 Instruction Manual (V300 R1) to indicate that the DP port requires active DP to HDMI or active DP to DVI-D adapters. Passive adapters are not supported.

10.2.10 Hardware

None.

10.3 Known Issues

This MCP version has the following known issues:

10.3.1 Cyber Security

GE Internal Reference #	Description
D-14069	The MCP Settings GUI does not automatically log off after the inactivity timeout. It requires that the user click into the web page or hit refresh after the timeout occurs to trigger the Settings GUI to close the session. The mcpcfg utility will be locked out from use while the MCP Settings GUI session is open. If MCP Settings GUI was left open after the inactivity timeout has expired (maliciously or unintentionally), as a workaround, you can login and logout of the MCP Settings GUI in another browser to release the lockout of the mcpcfg utility.

For any additional known issues, please refer to Product & Cyber Security Advisories on the GE Grid Solutions web site.

10.3.2 Clients

GE Internal Reference #	Description
B-13475 D-09915	SEL Binary Client doesn't support Double Precision Scaling Factors.
D-05002	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible.
D-12900	Alarm inhibits tag & Scan inhibit tags on DI point of D20 peripheral (S-card) is getting removed after failover in redundancy.
D-12834	Modbus Client could not process PRF events comes from SR 369 relay.
D-13075	D20A card in bad state can cause false behaviour/functionality when it is configured in warm or hot-hot redundancy.
D-13214	DNP3 Client doesn't support object types 31 and 33 for Frozen Analog Inputs (all variations).
D-14111	Cold Reboot Required DI (1) based on HDLC card faulty state will be reset on warm reboot also.

10.3.3 Servers

GE Internal Reference #	Description
D-12889 / B-16203	DNP DPA/Server takes high CPU if more than 5000 Analog Inputs are configured in Unbuffered mode.
B-11967	No support for events in NVRAM in IEC101/104 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

GE Internal Reference #	Description
B-11968	No support for events in NVRAM in DNP3 Server. Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
D-13134 / D-13135	RTS Post-amble time is not added to the data link confirm timeout or application timeout in DNP3 Serial Server.
D-12566	IEC101 DPA/Server in unbalanced mode sometimes reports duplicate Digital Input events to the Master if the event happens at the same time as General Interrogation response.
D-13996	IEC101/104 DPA buffer overflow DI events will be lost when set as discard newest.
D-13383	IEC 61850 Server does not report correct point values when both the digital points (Bit-1 and Bit-2) are 'ON' and will not recover until a new event occurs.
D-12567	The time sync accuracy of G100 when IEC101 Server (Unbalanced/Balanced) is used as a time sync source is > +/- 4 msec.

10.3.4 Automation

GE Internal Reference #	Description
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters. DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
B-11969	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
DCSSUP-19948 / D-12000 / R-01430	Restore the last value for variables configured in LogicLinx wizard does not work at runtime (starts at 0 always).
D-14100	In MCP Runtime HMI, data points in 'Online Trends' do not display 'underscore (_)' in Point description even though it is there in the configuration.
D-13941	Control in progress DI pseudo point for GPIO DCA DO point is not getting high till pulse on +pulse off time when control command is getting executed on GPIO DCA DO point.

10.3.5 Configuration/Settings

GE Internal Reference #	Description
D-10502	NOT A DEFECT. If client applications are configured in non-redundant mode and later the device properties are switched to a redundant mode where some applications are not enabled - their respective points are still available to be mapped, but at runtime will be offline. This is to retain the mappings in case the user decides to switch later back to single mode and the client applications are active again, as previously configured.
D-10388	TACACS+ remote authentication can be enabled and activated even if the TACACS+ Server is not available in that moment. This will conduct to a device that can only be accessed using Emergency Access process, if TACACS+ server is not available.

GE Internal Reference #	Description
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change. No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.
D-13028	Add more protection for memory leaks in Apache webserver settings.
D-13084	Need to remove unwanted text message displayed on the console when user tries to open mcpcfg/Settings GUI simultaneously in a particular scenario.
B-15613	The configuration through Bulk Editor is not supported for G500 after v2.10.

10.3.6 HMI

GE Internal Reference #	Description
B-15650	The following features of the Analog Report Viewer are not available: • View online reports • Save and view offline reports
B-14982	The product references in the Runtime (Local/Remote) HMI logs need to be changed as "MCP".
D-05463	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.

10.3.7 Pass-through

GE Internal Reference #	Description
D-12990	In LDAP authentication, after passthrough connection is timed out, auto logout event is not generated into user activity log by IEC 103 Client.

10.3.8 System

GE Internal Reference #	Description
E-04130	The USB FLASH drive used for the Firmware Upgrade must be FAT32 format. As a result of this, only USB FLASH drives of maximum 32 GB can be used. The minimum size, imposed by storage requirements, is 8 GB.
E-03041 D-10346	Input time source selection (PTP / IRIG-B / NTP) does not support dynamic failover between time sources at runtime. Only the configured time source is active at a time.
D-10227	Email does not send messages when an alarm is activated.
D-05714	Update of only Edge OS is not supported. If only Edge OS updates are required, the complete G500 firmware image needs to be updated.

GE Internal Reference #	Description
D-06167	Full support for latest PTP power profiles: • IEEE C37.238-2017 • IEC61850-9-3 Ed.1 2016 Enhancement: G500 supports the following PTP profiles: • IEEE 1588-2008 J4 Peer-to-Peer Profile • IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile.
D-12984	Daisy chained secondary monitor shows always duplicate monitor, but it does not show the extended desktop.
D-13083	Add support for progress bar to be displayed during "Applying update" procedure through Predix Edge Technician Console (PETC).
D-13039	When both G500's are power cycled at the same time and if switch panel configured as a master, then one of the G500 can go to the failed state. **Note:** If switch panel is configured as Master and one of the G500 is power cycled with a delay then this issue will not be observed.

10.3.9 Documentation

None.

10.3.10 Hardware

GE Internal Reference #	Description
D-06165	No functional impact. SFP Hot Plug in / Plug out detection. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

Capability and Capacity for MCP

This MCP version supports the following application limits.

The maximum number of IEDs or Masters is total across all connections.

The maximum size of the system is given by whichever limit comes first (groups vs members, number of Connections vs IEDs, number of Master instances vs LRUs in the Master etc.). User is responsible to ensure resource usage limits are not exceeded at runtime. For tested performance levels, refer to **Table 10.1** and **Table 10.2**.

The G500 4 cores system has a maximum of 500 IEDs, 200k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

The G500 2 cores system has a maximum of 250 IEDs, 100k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

The G100 system has a maximum of 120 IEDs, 24k points and 8 Masters (LRUs) unless otherwise restricted by system loading.

Tejas V Master/LRU instances are not counted as part of 8 Masters or LRUs calculations, both for 4 core and 2 core G500s and for G100.

Application	Feature	Configuration Limits	
		G500	G100
Digital Event Manager	**Alarms**		
	Max Number of Alarm Groups	256	256
	Max number of members in an Alarm Group	1000	1000
Calculator	**Expression Type**		
	Evaluations	10000	10000
	Timers	1000	1000
	Analog Assignments	2000	2000
	Digital Assignments	10000	10000
	Quality Conversions	1000	1000
	Type Conversions	1000	1000
	Averages	1000	1000
	Output to Input Conversions	1000	1000
Load Shed DTA	**Number of Feeders and Zones**		
	Max Zones	50	50
	Max Feeders	100	100
Analog Reports DTA	Analog Reports are not available starting with MCP V2.6 and newer	None	None
System Point Manager	Accumulator Freeze	250	250
	Analog Value Selection	250	250
	Control Lockout		
	• Remote Groups	8	8

Application	Feature	Configuration Limits	
		G500	**G100**
	• Local Groups	10000	10000
	Double Points	1000	1000
	Input Point Suppression	10000	10000
	Control in Progress	256	256
	Redundant I/O	10000	10000
Analog Data Logger	Continuous Reports	1000	1000
	Periodic Reports	1000	1000
	Out of Range Reports	1000	1000
VPN Server	Number of VPN Clients	8	8
	Number of VPN Server Instances	1	1
SCADA – No. of Client or Server connections (Serial/Network/D.20)	**Serial IED Connections** [**Note**: Total number of serial connections are limited by maximum number of physical and virtual serial ports (150)]		
	DNP Multidrop	80	80
	DNP Multidrop (Modem)	80	80
	Generic ASCII	80	80
	SEL Binary IED	80	80
	IEC 60870-5-101 Multidrop	80	80
	IEC60870-5-103 Multidrop	80	80
	Modbus Multidrop	80	80
	D.20	1	1
	Network IED Connections		
	DNP3 TCP	50	50
	Modbus TCP/Modbus TCP-SSH	50	50
	IEC60870-5 104	50	50
	IEC61850	Calculated by Loader based on system size	Calculated by Loader based on system size
	SNMP	1	1
	Serial Master Connections		
	DNP3 Serial Master	8	8
	IEC 60870-5-101 Master	8	8
	Modbus Serial Master	8	8
	Network Master Connections		
	DNP3 Network Master	8	8
	IEC 60870-5-104 Master	8	8

Application	Feature	Configuration Limits	
		G500	G100
	Modbus Network Master	8	8
	IEC 61850 Server	8	8
SCADA - No. of IEDs or Master station LRUs in each connection	**Serial /Network IEDs**		
	IEC60870-5-103 Multidrop	255	255
	DNP3 Multidrop/Network	10 (Note 1)	10 (Note 1)
	Modbus Multidrop/TCP	20 (Note 1)	20 (Note 1)
	IEC60870-5 101 Multidrop	1000	1000
	IEC60870-5 104	10 (Note 1)	10 (Note 1)
	SNMP Client	100	100
	GenASCII Client	120	120
	IEC61850 Client	Calculated by Loader based on system size (maximum 500 in total)	Calculated by Loader based on system size (maximum 120 in total)
	SEL Binary Client	1	1
	D.20 Client	120	120
	Serial/Network Masters		
	DNP3 Serial Master	8	8
	Modbus Serial Master	8	8
	IEC 60870-1 101 Master	8	8
	Tejas V Master	The maximum number of LRUs is 99 per serial port, regardless of 2/4 cores.	The maximum number of LRUs is 99 per serial port
	DNP3 TCP Master	1	1
	Modbus TCP Master	1	1
	IEC 60870-1 104 Master	1	1
	IEC 61850 Server (This is number of maximum concurrent IEC 61850 Clients for same Server Instance / LRU in CID file)	3	3
SCADA - No. of points configured in each IED/Peripheral mapfile	DNP3 Multi-Drop/Network IEDs	Limited by protocol	Limited by protocol
	Modbus Multi-Drop/Network IEDs	Limited by protocol	Limited by protocol
	GenASCII IED	1000	1000
	SNMP IED	1000	1000
	IEC 60870-1 103 Multi-Drop	Limited by protocol	Limited by protocol

Application	Feature		Configuration Limits	
			G500	G100
	IEC 60870-1 101/104 Multi-Drop			
	• Bitstream		Limited by protocol	Limited by protocol
	• Double Command		Limited by protocol	Limited by protocol
	• Integrate Total		Limited by protocol	Limited by protocol
	• Measurand		Limited by protocol	Limited by protocol
	• Packed Single Point		Limited by protocol	Limited by protocol
	• Regulating Step Command		Limited by protocol	Limited by protocol
	• Set Point Command		Limited by protocol	Limited by protocol
	• Single Point		Limited by protocol	Limited by protocol
	• Step Position		Limited by protocol	Limited by protocol
	SEL Binary IED			
	• Fast Meter Analog Input		Limited by IED	Limited by IED
	• Demand Analog Input		Limited by IED	Limited by IED
	• Peak Demand Analog Input		Limited by IED	Limited by IED
	• Digital Output		Limited by IED	Limited by IED
	• SER Digital Input		Limited by IED	Limited by IED
	D.20 Peripheral Client			
	D.20 S Card		64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters	64 Digital Inputs, or 32 Double Point Inputs, or 64 Transition Counters, or 32 Form C Counters
	D.20 A Card		32 Analog Inputs	32 Analog Inputs
	D.20 K Card		32 Digital Outputs	32 Digital Outputs
	D.20 C Card	C0	16 Digital Inputs 8 Digital Outputs	16 Digital Inputs 8 Digital Outputs
		C1	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs	16 Digital Inputs 8 Digital Outputs 16 Analog Inputs
		C2	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs	16 Digital Inputs 8 Digital Outputs 8 Analog Inputs 8 Analog Outputs

Application	Feature	Configuration Limits	
		G500	**G100**
SCADA - No. of points mapped into server mapfile	DNP3 Serial/TCP Master	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000
	Modbus Serial/TCP Master	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	IEC 60870-1 101/104 Master	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	IEC 61850 Server CID **Note**: when configured to maximum size it may take up to 10 minutes for the IEC 61850 Server Instance (LRU) to complete initialization.	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC – 3000	DI - 10000 AI - 15000 DO – 5000 AO - 5000 ACC - 3000
	Tejas V Master	DI -256 AI -510 DO -256 AO – 64 ACC -510 3 control groups, each group with 1 raise and 1 lower DO point. Optional DI indication for local / remote status. Optional DI indication for accumulator freeze indication.	DI -256 AI -510 DO -256 AO – 64 ACC -510 3 control groups, each group with 1 raise and 1 lower DO point. Optional DI indication for local / remote status. Optional DI indication for accumulator freeze indication.

Note 1: Indicates recommended value which can be exceeded with an increased level of event latency.

This MCP version meets the following performance test levels.

- MCP Hardware under test:
  - G500 4 core CPU/ 16GB RAM.
  - G500 2 core CPU/8GB RAM
  - G100 8GB RAM
- The following table(s) indicate the G500 4 core , G500 2 core and G100 values in different loading conditions.
- If the loading levels are lower, then the total number of IEDs and RTDB points can increase but no more than specified limits under the Capability and Capacity section above.

Requirement	**Steady State Loading**			**Avalanche Loading**		
	G500 (4 Core)	**G500 (2 Core)**	**G100**	**G500 (4 Core)**	**G500 (2 Core)**	**G100**
Loading Signal changes (continuously / sec)	AI - 5,000 DI – 100	AI – 1200 DI - 50	AI - 1200 DI – 12	DI – 62500 AI – 112500	DI – 18750 AI - 33750	All points changing twice in 2 secs
Number of connected IEDs	500	150	120	500	150	120
Total RTDB Point count	200,000	60, 000	24000	200,000	60,000	24000
Points / IED DI/AI/DO/AO/ACC	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225- AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED	400 125-DI, 225-AI, 20-DO, 20-AO & 10-Acc per IED
Each Server has points	4 core: DI = 7812 i.e., = (125*500)/8 AI = 14063 i.e., = (225*500)/8 DO = 1250 i.e., (20*500)/8	2 core: DI = 4687 i.e., = (125*150)/4 AI = 8437 i.e., = (225150)/4 DO = 750 i.e., (20*150)/4	4 DI = 1875 i.e., = 125 * 60 /4 AI = 3375 i.e., = 225 * 60 /4 AO = 300 i.e., = 20 * 60 / 4	4 core: DI = 7812 i.e., = (125*500)/8 AI = 14063 i.e., = (225*500)/8 DO =1250 i.e., (20*500)/8	2 core: DI = 4687 i.e., = 125*150)/4 AI = 8437 i.e., = (225*150)/4 DO = 750 i.e., (20*150)/4	4 DI = 1875 i.e., = 125 * 60 /4 AI = 3375 i.e., = 225 * 60 /4 AO = 300 i.e., = 20 * 60 / 4

Requirement	Steady State Loading			Avalanche Loading		
	G500 (4 Core)	G500 (2 Core)	G100	G500 (4 Core)	G500 (2 Core)	G100
	AO = 1250 i.e., (20*500)/8 Acc = 625 i.e., (10*500)/8	AO = 750 i.e., (20*150)/4 Acc = 375 i.e., (10*150)/4	AO = 300 i.e., = 20 * 60 / 4 ACC = 150 i.e., = 10 * 60/ 4	AO =1250 i.e., (20*500)/8 Acc = 625 i.e., (10*500)/8	AO = 750 i.e., (20*150)/4 Acc = 375 i.e., (10*150)/4	AO = 300 i.e., = 20 * 60 / 4 ACC = 150 i.e., = 10 * 60/ 4
Remote HMI connections	4 Simultaneous connections	2 Simultaneous connections	2 Simultaneous connections	4 Simultaneous connections	2 Simultaneous connections	2 Simultaneous connections
Local HMI connections	1 connection (multiple displays)	1 connection (multiple displays)	1 connection (single displays)	1 connection (multiple displays)	1 connection (multiple displays)	1 connection (single displays)
Datalogger - Periodic reports/sec	100 Reports each with 5 AI points. Total 500 AI point mapped	50 Reports each with 10 AI points. Total 500 AI point mapped	120 AI mapped / 12 reports	100 Reports each with 5 AI points. Total 500 AI point mapped	50 Reports each with 10 AI points. Total 500 AI point mapped	120 AI mapped / 12 reports
ARRM	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs	12 / sec	Maximum 240 file sets across all IEDs	Maximum 240 file sets across all IEDs	12 / sec (twice within 2 secs)
Alarms	100/sec	50/sec	12	100/ sec	50/sec	12/sec

10.4 Performance Test Levels of MCP Devices

This MCP version provides the following performance capabilities when configured in different modes (Standalone / Hot-Hot Redundancy/ Hot Standby Redundancy / Warm Standby Redundancy).

10.4.1 Performance Test Levels

The performance of MCP is tested using the activity levels and disturbance scenarios presented next:

Notes:

- The performance tests results in Table 9.1 were determined in Hot-Hot redundancy mode. The results apply to Warm Standby, Hot Standby and Standalone modes.
- The Tejas V Server performance tests results in Table 9.2 were determined in Standalone mode. The results apply to Warm Standby, Hot Standby and Hot-Hot redundancy modes, if a 4 core G500 is used.

Table 10.1: Performance Test Results

Results taken from Firmware Version	**G500 V3.0**	**G500 V2.5**	**G500 V2.5**	**G500 V2.5**	**G500 V3.0**	**G500 V2.5**	**G100 V3.0**
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
Protocol – Client /Server	DNP3 / DNP3	DNP3 / DNP3	(DNP3 + D.2.0) / DNP3	(IEC 61850+DNP) / DNP	(IEC 61850+DNP) / IEC61850	(IEC 104 + MODBUS + DNP + IEC 101 + SEL Binary) / IEC 104	(IEC 61850+DNP) / IEC61850
RTDB Point count	200,000	60,000	200,000	200,000	200,000	200,000	24,000

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
DI & AI Simulation/Sec	100 DI/Sec, 5000 AI/Sec	48 DI/Sec, 1200 AI/Sec	100 DI/Sec, 5000 AI/Sec	100 DI/Sec, 5000 AI/Sec	50 DI/Sec, 2500 AI/Sec	103 DI/Sec, 5000 AI/Sec	8 DI/Sec, 320 AI/Sec
Number of IEDs	400-Hot-Hot, 100-Hot Standby	140 -Hot-Hot, 10-Hot Standby	101 x D.20 peripherals + 400 DNP IEDs	500	400-Hot-Hot, 100-Hot Standby	500	30-Hot-Hot, 30-Hot Standby
Points / IED (AI + DI + AO + DO + ACC)	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	400 [AI-225, DI - 125, DO - 20, AO-20, ACC-10]	400 [AI- 225, DI -125, DO - 20, AO-20, ACC-10]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	**IEC 104:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **MODBUS:** [AI-210, DI-150, DO-15, AO-15, ACC-0]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	DNP3 (Client / Server)	DNP3 (Client / Server)	DNP3 (Client / Server) + D.20 (Client)	IEC 61850 Client	IEC 61850 Server	Multi-Protocol	IEC 61850 Server
Hardware	G500 (4 Core)	G500 (2 Core)	G500 (4 Core)	G500 (4 Core)	G500 (4 Core)	G500 (4 Core)	G100
						DNP: [AI-225, DI-125, DO-20, AO-20, ACC-10] **IEC 101:** [AI-160, DI-160, DO-40, AO-20, ACC-20) **SEL Binary:** [AI-75, DI-806, DO-101 AO-0 ACC-0]	

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
Number of RTDB points mapped to each LRU	25000	25000	25000	25000	25000	25000	6000
Number of Master connections Point Count / Server	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	4 DI – 7812, AI – 14063 DO – 1250 AO -1250 ACC - 625	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	4 DI – 7812, AI – 14063 DO – 1250 AO -1250 ACC - 625	8 DI – 7812, AI – 14063 DO -1250 AO -1250 ACC - 625	2 DI – 1875, AI – 3375 DO – 300 AO -300 ACC - 150
Total number of Server Logical Devices (LDs) in the system	NA	NA	NA	NA	1008 (252 LD mapped in each LRU. So, 252*4=1008LD)	NA	120 (60 LD mapped in each LRU. So, 60*2= 120LD)
Datasets configured in each LRU	NA	NA	NA	NA	254 Datasets mapped in each LRU	NA	61 Datasets mapped in each LRU
RCBs configured in each LRU	NA	NA	NA	NA	172 URCB for each LRU 82 BRCB for each LRU	NA	36 URCB for each LRU 19 BRCB for each LRU
Datalogger reports updated per sec	100 Periodic reports each with 5 AI points	No reports	100 Periodic reports	100 Periodic reports each with 5 AI points	50 Periodic reports each with 10 AI points	100 Periodic reports	12 Periodic reports each with 10 AI points

Results taken from Firmware Version	G500 V3.0	G500 V2.5	G500 V2.5	G500 V2.5	G500 V3.0	G500 V2.5	G100 V3.0
Activity	**DNP3 (Client / Server)**	**DNP3 (Client / Server)**	**DNP3 (Client / Server) + D.20 (Client)**	**IEC 61850 Client**	**IEC 61850 Server**	**Multi-Protocol**	**IEC 61850 Server**
Hardware	**G500 (4 Core)**	**G500 (2 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G500 (4 Core)**	**G100**
Remote / Local HMI connections	4 Remote / 1 Local HMI	4 Remote / 0 Local HMI	1 Remote	8 Remote / 1 Local HMI	4 Remote / 1 Local HMI	8 Remote / 1 Local HMI	2 Remote / 1 Local HMI
CPU utilization (%) Min, Max, Median	56, 95, 66	54, 100, 86	72, 100, 81	33, 100, 79	50, 100, 69	32, 100, 83	30, 100, 77
Used Memory (GB) Min, Max, Median	2.79, 3.097, 3.039	1.61, 1.74, 1.68	2.395, 2.646, 2.587	2.56 2.77 2.70	4.004, 4.318, 4.206	3.45, 4.03, 3.88	1.854, 2.113, 2.018
Event latency in (msecs) Min, Max, Median	61, 1026, 508	35, 1760, 556	243, 2431, 720	12, 1301, 585	10, 287, 111	94, 1215, 204	12, 228, 113
Control latency in (msecs) Min, Max, Median	12, 104, 28	22, 542, 282	1, 426, 9	4, 1987, 72	6, 468, 14	20, 1204, 63	9, 85, 16

Table 10.2: Performance Test Results in Standalone mode

Results taken from Firmware Version	**G500 V2.8**	**G100 V2.3**
Activity	**Tejas V Server**	**DNP3 +D.20 /DNP3**
Hardware	**G500 (2 Core)**	**G100**
Protocol – Client /Server	DNP3 / Tejas V	DNP3 + D.20 / DNP3
RTDB Point count	24,000	24,000
DI & AI Simulation/Sec	840 – AI/sec 50 – DI/sec	1200 – AI/sec 12– DI/sec
Number of IEDs	60	120
Points / IED (AI + DI + AO + DO + ACC)	400 [AI-225, DI -125, DO -20, AO -20, ACC -10]	400 [AI-225, DI -125, DO -20, AO -20, ACC -10] + D.20 points from 60 peripherals
Number of RTDB points mapped to each LRU	400	6000
Number of Master connections Point Count / Server	10 Number of Tejas V instances/ Logical Remote Units (LRU) 400	4 DI = 1875 i.e., = 125 * 60 /4 AI = 3375 i.e., = 225 * 60 /4 AO = 300 i.e., = 20 * 60 / 4 AO = 300 i.e., = 20 * 60 / 4 ACC = 150 i.e., = 10 * 60/ 4
Datalogger reports per sec	12 Periodic reports and each report with 10 AI	12 Periodic reports and each report with 10 AI
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 1 Local HMI
CPU utilization (%) Min, Median, Max	48, 100, 82	35, 75, 100

Results taken from Firmware Version	G500 V2.8	G100 V2.3
Activity	**Tejas V Server**	**DNP3 +D.20 /DNP3**
Hardware	**G500 (2 Core)**	**G100**
Used Memory (GB) Min, Median, Max	1.27,1.4,1.34	<1, 1.201, 1.261
Event latency in (msecs) Min, Median, Max	221, 812,700	172, 518, 2595
Control latency in (msecs) Min, Median, Max	75, 81, 78	12, 25, 254

10.4.2 Redundancy Fail Over Time

This MCP version supports below fail-over times (i.e., when active G500 / G100 is power cycled) in the Hot-Hot/Hybrid Redundancy with the default 300ms heart-beat rate and with default 3 retries.

Table 10.3: Hot-Hot Redundancy Fail Over Times

Hot-Hot Redundancy/D.20 Configuration	Maximum Fail-Over Time (msec)	
	G500	G100
D.20 is not configured	1250	1780
D.20 is configured	1450	1940

10.4.3 HMI Response Times

Under steady state loading conditions, this version of G500 provides the HMI response times listed in the below **Table 9.4: User Interface Response Times – Steady State Normal Conditions**.

Table 10.4: User Interface Response Times – Steady State Normal Conditions

Activity	G500 (4 Core)	G500 (2 Core)	G100
Screen Access (Point Summary) (Min, Max, Median) sec	2, 2.6, 2.1 sec	1.5, 5.3, 1.9 sec	0.9, 1.7, 1.4 sec
Screen Access (One-Line Viewer) (Min, Max, Median) sec	9 sec	54 sec	14 sec
System Logs) (Min, Max, Median) sec	1.9, 2.7, 1.9 sec	4.9, 12.1, 5.9 sec	3.1, 3.9, 3.1 sec
Alarm ACK Delay (Single Alarm)	3 sec	<1 sec	<1 sec
Alarm ACK Delay (20,000 Alarms)	< 1 sec	16 sec	6 sec
DI/AI Update to Point Summary Screen	< 1 sec	< 1 sec	< 1 sec

NOTE: Under heavy loading conditions, the control latency was measured by simulating one control in every 5 seconds continuously from the Master station.

Screen Access time was measured in heavy loading condition.

Time Sync Accuracy (PTP/IRIG-B/NTP)

This MCP version supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

This version does not support runtime dynamic failover across different time sources.

Time Sync Input	Accuracy	
	G500	G100
IRIG-B IN	• 100% samples within 945 microseconds with an average of 39 microseconds and standard deviation of 28 microseconds • Total number of samples considered ~3507	• 100% samples within 866 microseconds with an average of 90 microseconds and standard deviation of 76 microseconds • Total number of samples considered ~3758
PTP IN	• 100% samples within 693 microseconds with an average of 40 microseconds and standard deviation of 31 microseconds • Total number of samples considered ~3457	NA
NTP IN	• 100% samples within 1065 microseconds with an average of 437 microseconds and standard deviation of 216 microseconds • Total number of samples considered ~3614	• 100% samples within 867 microseconds with an average of 92 microseconds and standard deviation of 81 microseconds • Total number of samples considered ~3259

NOTES:

- IRIG-B/ PTP time accuracy is measured in a scenario where the hardware is fully loaded.

Timestamp Accuracy

This MCP version provides the following Timestamp Accuracy.

Protocol	Accuracy % @ N = **%** of samples within +/- **N** milliseconds	
	G500	G100
D.20 HDLC	• 99.92% @ 1 ms • 100% @ 2 ms • Total number of samples considered ~18,000 • Measured the accuracy for every five seconds at a D.20 S peripheral	• 98.32% @ 1 ms • 99.96% @ 2 ms • 100% @ 3 ms • Total number of samples considered ~33,000 • Measured the accuracy for every five seconds at a D.20 S peripheral
GPIO	NA	• 96.5% @ 1 ms • 99.92% @ 2 ms • 100% @ 3 ms • Total number of samples considered ~33,000 • Measured the accuracy for every five seconds at the GPIO

Protocol	Accuracy % @ N = **%** of samples within +/- **N** milliseconds	
	G500	**G100**
DNP I/O	• 83.33% @ 1 ms • 99.82% @ 2 ms • 99.86% @ 3 ms • 100% @ 4 ms • Total number of samples considered ~16476 • Measured the accuracy for every five seconds at a DNP I/O S peripheral	• 3.4% @ 1 ms • 80.14% @ 2 ms • 96.15% @ 3ms • 99.16% @ 4 ms • 99.88% @ 5 ms • 100% @ 6 ms • Total number of samples considered ~11790 • Measured the accuracy for every five seconds at a DNP I/O S peripheral

Application List

This MCP version has the following applications available depending on configured redundancy mode.

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Runtime HMI	✓ Available	✓ Available	✓ Available	✓ Available
One-Line Viewer	✓ Available	✓ Available	✓ Available	✓ Available
Config GUI / Schemas	✓ Available	✓ Available	✓ Available	✓ Available
System Library	✓ Available	✓ Available	✓ Available	✓ Available
C++ System Library	✓ Available	✓ Available	✓ Available	✓ Available
Connection Parser	✓ Available	✓ Available	✓ Available	✓ Available
Calculator	✓ Available	✓ Available	✓ Available	✓ Available
Hardware Asset Management Application (HAMA)	✓ Available	✓ Available	✓ Available	✓ Available
PTP/IRIG-B Time Sync	✓ Available	✓ Available	✓ Available	✓ Available
D.20 Client	✓ Available	✓ Available	✓ Available	✖ Not available
Modbus RTU/Multi-drop Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP Client	✓ Available	✓ Available	✓ Available	✓ Available
Modbus - TCP/SSH Client	✓ Available	✓ Available	✓ Available	✓ Available
SEL® Binary Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Analog Data Logger	✓ Available	✓ Available	✓ Available	✖ Not Available
Generic ASCII Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Modbus Server	✓ Available	✓ Available	✓ Available	✖ Not Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
DNP 3.0 Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Client	✓ Available	✓ Available	✓ Available	✓ Available
Digital Event Manager	✓ Available	✓ Available	✓ Available	✓ Available
Database Server	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 TCP/IP Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 Server Serial Transport Layer	✓ Available	✓ Available	✓ Available	✓ Available
DNP 3.0 DIDO	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-103 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Client	✓ Available	✓ Available	✓ Available	✓ Available
GPIO/Local Client(Available in G100 only)	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 61850 Server	✓ Available	✓ Available	✓ Available	✖ Not Available
IEC 60870-5-101/104 Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Tejas V Server	✓ Available	✓ Available	✓ Available	✖ Not Available
Event Logger	✓ Available	✓ Available	✓ Available	✓ Available
Real-Time Database	✓ Available	✓ Available	✓ Available	✓ Available
LogicLinx IEC 61131-3 Soft Logic	✓ Available	✓ Available	✓ Available	✓ Available
Redundancy Manager	✓ Available	✓ Available	✓ Available	✓ Available
System Point Manager	✓ Available	✓ Available	✓ Available	✓ Available
Load Shedding and Curtailment	✓ Available	✓ Available	✓ Available	✖ Not Available
Control Lockout Manager	✓ Available	✓ Available	✓ Available	✓ Available
Software Watchdog	✓ Available	✓ Available	✓ Available	✓ Available
Configuration Manager	✓ Available	✓ Available	✓ Available	✓ Available
IP Changer	✓ Available	✓ Available	✓ Available	✓ Available
MD5SUM Builder	✓ Available	✓ Available	✓ Available	✓ Available
System Status Manager	✓ Available	✓ Available	✓ Available	✓ Available

Application	Support in Standalone	Support in Hot-Hot/Hybrid	Support in Warm Standby	Support in Hot Standby
Virtual Serial Ports	✓ Available	✓ Available	✓ Available	✓ Available
SNMP Client	✓ Available	✓ Available	✓ Available	✖ Not Available
Automated Record Retrieval Manager	✓ Available	✓ Available	✓ Available	✖ Not Available
Software Licensing Subsystem	✓ Available	✓ Available	✓ Available	✓ Available
Third-party components	✓ Available	✓ Available	✓ Available	✓ Available
Terminal Services	✓ Available	✓ Available	✓ Available	✓ Available
mcpcfg utility	✓ Available	✓ Available	✓ Available	✓ Available
E-mail Utility	✓ Available	✓ Available	✓ Available	✓ Available
IO Traffic Monitor	✓ Available	✓ Available	✓ Available	✓ Available
Firewall	✓ Available	✓ Available	✓ Available	✓ Available
Edge OS & Drivers	✓ Available	✓ Available	✓ Available	✓ Available
Secure Enterprise Connectivity	✓ Available	✓ Available	✓ Available	✓ Available
Genconn	✓ Available	✓ Available	✓ Available	✓ Available
HMI Access Manager	✓ Available	✓ Available	✓ Available	✓ Available
Sync Service Library	✓ Available	✓ Available	✓ Available	✓ Available
Sync Server Application	✓ Available	✓ Available	✓ Available	✓ Available
Analog Report Generator	✖ Not Available	✖ Not Available	✖ Not Available	✖ Not Available
OpenVPN	✓ Available	✓ Available	✓ Available	✓ Available

Modification Record

Version	Rev.	Date	Change description
1.00	0	27th February, 2019	Created for G500 Firmware Version 1.00.
	1	31st May, 2019	Updated for Defect D-06458: Audio Output Port is not working.
1.10	0	06th March, 2020	Updated for G500 Firmware Version 1.10.
2.00	0	27th May, 2020	Updated for G500 Firmware Version 2.00. Updated and removed feature requests from known issues and document sub-sections throughout for consistency.
2.10	0	14th Dec, 2020	Updated for G500 Firmware Version 2.10. Updated with D.20 HDLC Perf Test Capabilities.
	1	27th Jan, 2021	Updated Key features (Hardware Based IRIG-B Input Support) section for G500 Firmware Version 1.00.
	2	10th May, 2022	Added D-10906.
2.50	0	18th Oct, 2021	Updated for G500 Firmware Version 2.50.
2.60	0	17th Dec, 2021	Updated for G500 Firmware Version 2.60.
2.70	0	4th Mar, 2022	Updated for G500 Firmware Version 2.70 (projects release).
	1	10th May, 2022	Added D-10906.
2.80	0	18th July, 2022	Updated for G500 Firmware Version 2.80.
3.00	0	28th April, 2023	Updated for MCP Firmware Version 3.00.
3.10	0	23rd August, 2023	Updated for MCP Firmware Version 3.10.