S T F P

"Simple Timeslot/Frequency/Power" Protocol

A Communication Protocol for Application Messaging with a TDMA Radio

Version 0.9-4

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GE MDS

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Latest Version Information

For the latest version of this document, please visit the following link:
http://supportcentral.ge.com/products/sup_products.asp?prod_id=181796

Document version numbers will be in the format X.Y-Z where X and Z are reflected in messages sent and received using this protocol and Z will be used to indicate different versions of the document that do not impact messaging. For example, document version 1.A-2 will be represented as 0x1a in payload data.

Introduction

It has become apparent that it would be beneficial to create a dividing line between Media Access Control "Top" and "Bottom" layers. This concept allows a family of MACs to exist over the same generic TDMA implementation via an abstraction layer. Following this model, exact TDMA implementation does not have to be specified for MAC development to proceed.

Definition of Terms

MAC Top

The functions of the MAC Top Layer are as follows:

1. Decide what Timeslot and Frequency to transmit on and what Power Output level to employ.
2. Decide exactly what payload data is to be placed in each transmission (with the exception of framing required for modem operation).
3. Allocate, assign, or select the Timeslot, and Frequency for each base, fixed station, or mobile transmission.
4. Set the Timeslot, Frequency, and Power Output for each transmission within a frame structure defined in this document.
5. React to timing markers delivered by the MAC Bottom by sending transmit messages in a timely fashion.

MAC Bottom

The functions of the MAC Bottom Layer are as follows:

1. Maintain timing accuracy sufficient to accommodate users within RF propagation range with the required key up/down time between Timeslots.
2. Send timing markers to the MAC Top that demark Timeslot boundaries to trigger the MAC Top to deliver transmit messages.
3. Accept Timeslot, Frequency, and Power Output settings for each transmission.
4. Appropriately place transmitted messages in the requested Timeslot on the requested Frequency and at the requested Power Output level.
5. Deliver messages received over the air to the wire-side application including the Timeslot, Frequency, and Signal Strength for the received message.
6. Allow configuration of Timeslots per Epoch and Default Frequency and Power Output via a side mechanism not within the payload data stream.

Radio Messages

Each message exchanged between the MAC Top and MAC Bottom is to be encapsulated within a UDP message with a multicast address and port number specified outside of this protocol. The UDP message payload is to be fully described within this document.

Radio Clusters

It may prove to be helpful to group several radios into a Radio Cluster. This way, several radios can operate in parallel, perhaps for different frequency bands, or even on the same band to allow simultaneous transmit and/or receive. Each Radio within the Cluster maintains a unique Radio ID to allow the MAC Top to discriminate outgoing and incoming messages based upon the ID of the Radio that transmits or receives each message.

Timeslot

Each multi-second epoch is divided into a number of Timeslots to partition the available time into a TDMA "frame". The number of bytes that can be supported by each Timeslot within the frame structure depends on the effective over the air data rate, any overhead needed for the modem used, and a speed of light allowance to ensure multiple users maintain time separation between transmissions. Not within the scope of this protocol is whether or not each Timeslot is of uniform size or whether the size is variable. Timeslot numbers begin with 0 and continue to N-1, where N is the number of Timeslots in the Epoch.

Epoch

It is exceedingly likely that although each second could be split into several Timeslots, the number of Timeslots per second may not be enough to support a large enough number of users. Therefore a multi-second Epoch is defined to multiply the total effective number of Timeslots within a unit of time allocation.

Timing Markers

The MAC Bottom sends Timing Marker Messages for each Timeslot. This permits the MAC Top to be triggered to deliver messages for transmission in a timely fashion.

Frame Formats

The following message types are defined as part of the STFP protocol.

Type	Description	Payload	Config /Status
0x00	STFP Radio Transmit and Radio Configuration Message	Included	Included
0x01	STFP Radio Transmit Message*	Included	
0x02	STFP Radio Configuration Message		Included
0x02-0x7f	Reserved		
0x80	STFP Radio Receive Message with Radio Status Record	Included	Included
0x81	STFP Radio Receive Message without Radio Status Record*	Included	
0x82	STFP Errored Radio Receive Message		Included
0x83-0xfe	Reserved		
0xff	STFP Start of Timeslot Marker Message	N/A	N/A

* This message type is currently not implemented.

0x00-0x02 Transmit/Configuration Message Format

The STFP Transmit Format is shown in the following table.

ID	Description	Bits	Bytes	Default Value
1000	Message Type	8	1	0x00
1010	Message Version	8	1	0x00
1020	Radio ID	32	4	0x00000000
1030	Radio Configuration Tag***	8	1	0x00
1040*	Radio Configuration Record	176	22	See below
1050**	Payload Length	32	4	Various
1060**	Payload Data	Various	Various	Various
1070	Message Integrity	32	4	Various

* The Radio Configuration Record is excluded for message types denoting such.
** Payload Length is zero and Payload Data is omitted entirely for message types denoting such.
*** The Radio Configuration Tag field is not currently implemented and is included as a placeholder.

1000 Message Type

This field indicates what type of STFP message this is. The default is 0x00 for STFP Transmit Message with Radio Configuration Record. See the table above for currently permitted types. Additional types may be defined in the future.

1010 Message Version

This field indicates the version of STFP in use. Messages sent into the radio will be ignored unless they contain the version number the radio expects.

1020 Radio ID

The Radio ID is a value that is programmed into each radio that shares the same UDP multicast address and port to uniquely identify the radio path that the MAC Top intends to use for a given transmission. This way, all radios within the same radio cluster can be set up with the same UDP multicast address and port number, yet can still be uniquely identified by the MAC Top. This field is included for all message types.

1030 Radio Configuration Tag (Placeholder – Not Yet Implemented)

This field is a number to associate with the radio configuration parameters to follow. Think of it as a channel number. If the Radio Configuration Record is not specified but has been previously associated with a Radio Configuration Record Tag, the same Tag can be used as shorthand for the full configuration.

1040 Radio Configuration Record*

The format of the Radio Configuration Record is shown in the table in the "1040 Radio Configuration Record" section. *This field is not included for message types denoting its exclusion.

1050 Payload Length**

The Payload Length field indicates the number of Bytes included in the Payload Data portion of the message only. **For type 0x02 messages, this field is zero. Note that the TD220MAX radio does NOT support a value of zero for message type 0x00.

1060 Payload Data**

The Payload Data field contains the data to be transmitted over the air exactly as received by the radio. **For type 0x02 messages, this field is omitted.

1070 Message Integrity

The Message Integrity field is a CRC to protect only the interface between the MAC Top and Bottom layers. It is not transmitted over the air. It operates on the entire message, from Message Type to the end of the Payload Data or Payload Length for type 0x02 messages.

1040 Radio Configuration Record

The format of the Radio Configuration Record is detailed in the following table.

ID	Description	Bits	Bytes	Default Value
3020	Timeslot Within Epoch	8	1	0x00
3030	TX Frequency in Hz	80	10	"0220106250"
3035	RX Frequency in Hz	80	10	"0220106250"
3040	Power Output in Watts	8	1	2

3020 Timeslot Within Epoch

The Timeslot within Epoch value specifies which Timeslot within the Epoch the message is to be transmitted in. Valid values are 0 through N-1, where N is the number of Timeslots in the Epoch.

3030 TX Frequency

The value specifies which Frequency the radio will transmit the message on. The value is specified in Hz as an ASCII string. For example, 220.10625 MHz is 0220106250 Hz, and is specified as 0x30, 0x32, 0x32, 0x30, 0x31, 0x30, 0x36, 0x32, 0x35, 0x30.

3030 RX Frequency

The value specifies which Frequency the radio will return to receive on following the indicated Timeslot. The value is specified in Hz as an ASCII string. For example, 220.10625 MHz is 0220106250 Hz, and is specified as 0x30, 0x32, 0x32, 0x30, 0x31, 0x30, 0x36, 0x32, 0x35, 0x30. Note that the RX Frequency change is set up during the specified Timeslot, but reception begins on the NEXT timeslot on the new frequency.

3040 Transmit Power Output

This value specifies the output power to use for transmission in Watts. Valid values are 2 to 25 Watts in 1-Watt steps. The setting takes effect upon the next transmission, i.e. not during any current transmission.

0x80-0x82 Receive Message Format

The STFP Receive Format is shown in the following table.

ID	Description	Bits	Bytes	Default Value
2000	Message Type	8	1	0x80
2010	Message Version	8	1	0x00
2020	Radio ID	32	4	0x00000000
2030*	Radio Status Record	176	22	See below
2040**	Payload Length	32	4	Various
2050**	Payload Data	Various	Various	Various
2060	Message Integrity	32	4	Various

* The Radio Status Record is excluded for message types denoting such.
** Payload Length is zero and Payload Data is omitted entirely for message types denoting such.

2000 Message Type

This field indicates what type of STFP message this is. The default is 0x80 for STFP Receive Message with Radio Status Record. See the table above for currently permitted types. Additional types may be defined in the future.

2010 Message Version

This field indicates the version of STFP in use. The radio will send the protocol version it expects to be included in transmit messages.

2020 Radio ID

The Radio ID is a value that is programmed into each radio that shares the same UDP multicast address and port to uniquely identify the radio path that the message took for a given reception. This way, all radios within the same radio cluster can be set up with the same UDP multicast address and port number, yet can still be uniquely identified by the MAC Top.

2030 Radio Status Record*

The format of the Radio Status Record is shown in the table in the "2030 Radio Status Record" section.
*This field is not included for message types denoting its exclusion.

2040 Payload Length**

The Payload Length field indicates the number of Bytes included in the Payload Data portion of the message only. **This value will be zero for messages of type 0x82.

2050 Payload Data**

The Payload Data field contains the data to be transmitted over the air exactly as received by the radio.
**This field will be omitted for messages of type 0x82.

2060 Message Integrity

The Message Integrity field is a CRC to protect only the interface between the MAC Top and Bottom layers. It is not transmitted over the air. It operates on the entire message, from Message Type to the end of the Payload Data (or Payload Length if payload is zero-length as for messages of type 0x82).

2030 Radio Status Record

The format of the Radio Status Record is detailed in the following table.

ID	Description	Bits	Bytes	Default Value
4020	Timeslot Within Epoch	8	1	0x00
4025	TX Frequency	80	10	"0220106250"
4030	RX Frequency	80	10	"0220106250"
4040	Received Signal Strength Indication (RSSI) in dBm	8	1	-120 (0x88)

4020 Timeslot Within Epoch

The Timeslot Within Epoch value specifies which Timeslot within the Epoch the message was received in. Values range from 0 to N-1, where N is the number of Timeslots in an Epoch.

4025 TX Frequency

The TX Frequency value indicates the current default TX Frequency the radio is set to. The value is specified in Hz as an ASCII string. For example, 220.10625 MHz is 0220106250 Hz, and is specified as 0x30, 0x32, 0x32, 0x30, 0x31, 0x30, 0x36, 0x32, 0x35, 0x30.

4030 RX Frequency

The RX Frequency value indicates which Frequency the radio received the message on. The value is specified in Hz as an ASCII string. For example, 220.10625 MHz is 0220106250 Hz, and is specified as 0x30, 0x32, 0x32, 0x30, 0x31, 0x30, 0x36, 0x32, 0x35, 0x30.

4040 Received Signal Strength Indication (RSSI)

The Received Signal Strength Indication (RSSI) reports what signal level the message was received at in dBm. The value is signed and the valid range is from –120 to –30 dBm.

0xff Start of Timeslot Marker Message

This message is sent by each radio to the external device to indicate the start of a timeslot so the external application is triggered to send the payload message for the appropriate future timeslot.

ID	Description	Bits	Bytes	Default Value
8000	Message Type	8	1	0xff
8010	Message Type Version	8	1	0x00
8020	Radio ID	32	4	0x00000000
8030	Radio Status Record	176	22	See below
8060	Message Integrity	32	4	Various

8000 Message Type

This field indicates what type of STFP message this is. The default is 0xff for STFP Start of Timeslot Marker Message with Radio Status Record. See the table above for currently permitted types. Additional types may be defined in the future.

8010 Message Type Version

This field indicates the version of the STFP Message Type. The default is 0x00, and this field is available to allow future support for additional versions of each message type.

8020 Radio ID

The Radio ID is a value that is programmed into each radio that shares the same UDP multicast address and port to uniquely identify the radio path that the message took for a given reception. This way, all radios within the same radio cluster can be set up with the same UDP multicast address and port number, yet can still be uniquely identified by the MAC Top.

8030 Radio Status Record

The format of the Radio Status Record is shown in the table in the "8030 Radio Configuration Record" section.

8030 Radio Configuration Record

The format of the Radio Configuration Record is detailed in the following table.

ID	Description	Bits	Bytes	Default Value
9010	Timeslot Within Epoch	8	1	0x00
9025	TX Frequency	80	10	"0220106250"
9030	RX Frequency	80	10	"0220106250"
9040	Power Output in Watts	8	1	2

9010 Timeslot Within Epoch

The Timeslot Within Epoch value indicates the Timeslot for which the radio is requesting data payload and/or configuration. Read this as the radio saying "I am ready for data payload and/or configuration for Timeslot X". The Timeslot value does not represent the currently active Timeslot. Timeslot values range from 0 to N-1, where N is the number of Timeslots in the Epoch.

9025 TX Frequency

The TX Frequency value indicates the current TX Frequency (default after boot up or last used via Radio Configuration Record). The value is specified in Hz as an ASCII string. For example, 220.10625 MHz is 0220106250 Hz, and is specified as 0x30, 0x32, 0x32, 0x30, 0x31, 0x30, 0x36, 0x32, 0x35, 0x30.

9030 RX Frequency

The RX Frequency value indicates the current RX Frequency to which the radio is tuned (default after boot up or last used via Radio Configuration Record). The value is specified in Hz as an ASCII string. For example, 220.10625 MHz is 0220106250 Hz, and is specified as 0x30, 0x32, 0x32, 0x30, 0x31, 0x30, 0x36, 0x32, 0x35, 0x30.

9040 Power Output in Watts

This value specifies the output power used for transmission in Watts (default after boot up or last used via Radio Configuration Record). Valid values are 2 to 25 Watts in 1-Watt steps.

Appendix 1 – UDP/IP Frame Format

The following table shows the UDP/IP Frame Format when sent via IPv4.

Offset	Bits 0-15		Bits 16-31
0	Source Address		
32	Destination Address		
64	Zeroes	Protocol = 0x11	UDP Length
96	Source Port*		Destination Port
128	Length		Checksum*
160	STFP Message		

Bits 0-95 are the IP Header
Bits 160 and on are the STFP Message

Appendix 2 – Change Log

Version	Date	Changes By	Details
0.2	4/2/09	T. Mayo	Clarified Epoch concept. Changed references to "UDP broadcast address" to "UDP multicast address." Added description of Timing Markers
0.3	12/2/09	T. Mayo	Minor cosmetic changes.
0.4	8/19/10	T. Mayo	Added information on where to obtain the latest version of this document.
0.5	10/8/10	T. Mayo	Added message types 0x82 and 0xff for Errored Receive Message and Start of Timeslot Marker respectively.
0.6	11/5/2010	T. Mayo	Added message type 0x02 for Radio Configuration Message (without transmit payload data). Removed concept of "Second Within Epoch." Epochs are now entirely broken down by Timeslot only.
0.7	12/7/2010	T. Mayo	Changed transmit power to be specified in Watts instead of dBm.
0.8	12/21/2010	T. Mayo	Changed Timeslot numbering from 1 to N to 0 to N-1.
0.9-1	3/2/2011	T. Mayo	Added complete Radio Configuration Record to Timeslot Marker Message. Added description of version numbering and filtering.
0.9-2	1/10/2012	T. Mayo	Corrected link to master document. Corrected length for Radio Configuration Record and Radio Status Record within Transmit/Configuration Message format. Corrected identifier for Radio Configuration Tag and Record.
0.9-3	6/6/16	K. Tuttle	Indicated that the STFP Radio Configuration (0x02) Message Type is implemented. Indicated that a zero length payload length is not valid for type 0x00 and 0x01 Messages.
0.9-4	6/10/16	K. Tuttle	Clarified that the TD220MAX does not support a message length of zero for the Type 0x00 message..