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0.9	June 26, 2020	Maulin Lodhia	Cosmetic changes and changed default side LED color table

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Acronyms and Glossary

ABP............................ activation by personalization
ADR .... adaptive data rate
bps............................. bits per second
CRC .... cyclic redundancy check
DL .... downlink
EU .... European Union as an RF region for LoRaWAN
Flash memory .... Non-volatile memory located on the Home Sensor, which contains application and configuration settings.
FW .... firmware
ID .... identity / identifier
IoT .... Internet of things
ISM .... industrial, scientific, and medical
LoRa .... a patented "long-range" IoT technology acquired by Semtech
LoRAMAC .... LoRaWAN MAC
LoRaWAN .... LoRa wide area network (a network protocol based on LoRa)
LoRaWAN Commissioning
.... the unique device identifiers and encryption keys used for LoRaWAN communication (see LoRaWAN Specification [1] for more details).
LSB............................ least significant bit
LTC............................ lithium thionyl chloride (the chemistry of LTC batteries)
MAC........................... medium access control
MCU .... microcontroller unit
MRDT .... Meeting Room Display Tablet
ms.............................. millisecond(s)
MSB .... most significant bit
NA .... North America as an RF region for LoRaWAN
NS .... network server
OTA .... over-the-air
OTAA .... OTA activation
Reg .... register
RF .... radio frequency
RFU............................ reserved for future use
RO.............................. read-only
RTU............................ remote terminal unit
R/W .... read/write
Rx .... receiver

SW .... software
TRM .... technical reference manual
Tx .... transmitter
UL .... uplink

1 Overview

This TRM describes the configuration options supported by the Meeting Room Display Tablet (MRDT) Sensor. This document is intended for a technical audience, such as application developers, with an understanding of the NS and its command interfaces.

This TRM is only applicable to the MRDT Sensor modules listed in Table 1-1.

The MRDT Sensor is an all-purpose LoRaWAN IoT sensor run on four AA batteries and packed into a small casing. The MRDT Sensor features EPD screen, LCD controller, LED controller, accelerometer and battery monitor (Battery Gauge). The battery lifetime of the MRDT Sensor is estimated to be 1 year.[1] Table 1-1 presents the currently available MRDT Sensor models.

Table 1-1: Kona MRDT Sensor Models

Product Code & Revision	Description	RF Region
T0006086	MODULE, DIGITAL SIGNAGE, BATTERY POWERED	US 902-928 MHz (ISM band) & EU 863-870 MHz (ISM band)
T0006093	MODULE, DIGITAL SIGNAGE, EXTERNALLY POWERED	US 902-928 MHz (ISM band) & EU 863-870 MHz (ISM band)

Information streams currently supported by the SW are as follows:

- UL stream, i.e. from the Sensor
  - Readings obtained from on-board transducers (***sent on LoRaWAN port 10***)
  - Response to configuration and control commands from the NS (***sent on LoRaWAN port 100***)
- DL stream, i.e. data from the NS
  - Changing the state of the Sensor’s (digital) outputs, i.e. open/close them (***sent on LoRaWAN port 10***)
  - Configuration and control commands used to change the Sensor’s behavior (***sent on LoRaWAN port 100***)

The default configuration of the MRDT Sensor for reporting transducer readings includes the following:

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[1] [1] This is for status updates (LoRa Tx/Rx) every 10 minutes at room temperature, with4x AA LiFeS2 battery having a total capacity of 7 Ah. Variations to this estimate can occur depending on the ambient temperature, use case, battery capacity, and battery self-discharge rate. Estimate is based on typical use case: 10 hour work day with LoRa update every 10 mins and 10 different meetings displayed on tablet per day.

- Report the battery voltage every 1 (one) hour.
- For Class A mode operation query room status every 10 minutes.

The MRDT Sensor has a USB port used for firmware upgrade.

2 UL Payload Formats

The UL streams (from the Sensor to the NS) supported by the SW include,

- The readings obtained from on-board transducers (sent on LoRaWAN port 10); and are explained in Sections 2.1.
- Booking Application messages.

The above streams are explained in Section Sections 2.1.and 2.2.

2.1 Frame Payload to Report Transducers Data

Each data field from the Sensor is encoded in a frame format shown in Figure 2-1. A big-endian format (MSB first) is always followed.

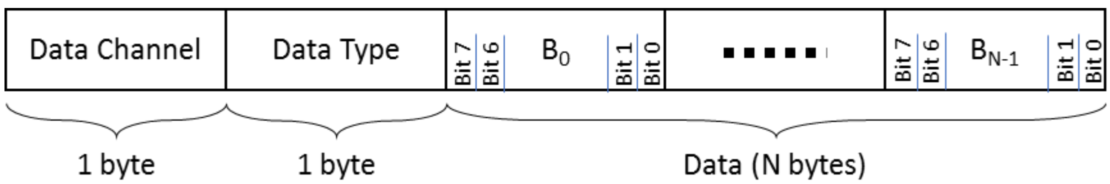

Figure 2-1: The UL frame payload format.

A Sensor message payload can include multiple transducer data frames. Frames can be arranged in any order. A single payload may include data from any given transducer. The MRDT Sensor frame payload values for transducers data are shown in Table 2-1. Transducers data in the UL are sent through ***LoRaWAN port 10***.

Table 2-1: UL Frame Payload Values for Transducers Data

Information Type	Data Channel	Data Type	Data Size [Bytes]	Data Type	Data Format
Battery Voltage	0x40	0xFF	2	Analog Input	Signed, 0.01 V/LSB
MCU Temperature	0x41	0x67	2	Temperature	0.1°C / LSB (signed)

2.1.1 Example Uplink Payloads

- 0x **40 FF** 01 2C **03 67** 00 0A
  - $0x\ \mathbf{40\ FF}$ (Battery Voltage) $= (0x\ 01\ 2C) \times 0.01\ V = 3.00\ V$
  - $0x\ \mathbf{42\ 67}$ (MCU Temperature) $= (0x\ 00\ 0A) \times 0.1°C = 1°C$

2.2 Frame Payload to Request Booking Application messages

Each data field from the Sensor is encoded in a frame format shown in Figure 2-12. A big-endian format (MSB first) is always followed.

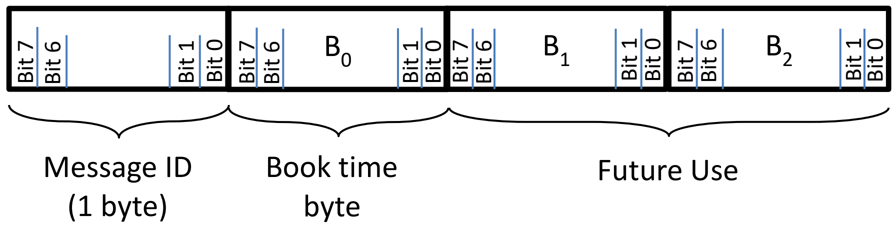

Figure 2-2 The UL frame payload format to request Booking App messages

The MRDT Sensor frame payload values for EPD soft button presses are shown in Table 2-12.

Table 2-2: UL Frame Payload Values request Booking App messages.

Information Type	Message ID	Data Size [Bytes]	Data Format
Room status request	0x33	0	
Book now request	0x34	3	Book meeting room for X minutes/hour Data value: • 0x1 = 15 minutes • 0x2 = 30 minutes • 0x3 = 45 minutes • 0x4 = 1 Hour
Extend meeting request	0x35	3	Book meeting room for X minutes/hour Data value: • 0x1 = 15 minutes • 0x2 = 30 minutes • 0x3 = 45 minutes
Book meeting in future request	0x36	3	Book meeting room for X minutes/hour Data value: • 0x1 = 30 minutes • 0x2 = 45 minutes • 0x3 = 1 Hour
Finish Meeting	0x37	0	
Room information request	0x38	0	
Room amenities status request	0x39	1	Request status of amenities in the room Data value: • Bit 0 – TV status • Bit 1 – Projector • Bit 2 – Web Camera • Bit 3 – White Board

3 DL Payload Formats

The DL streams (from the Sensor to the NS) supported by the SW include,

- Configuration and control commands used to change the Sensor's behavior (sent on LoRaWAN port 100); and are explained in sections 3.1.1 and 3.1.2

3.1 Configuration and Control Commands

A single DL configuration and control message can contain multiple command blocks, with a possible mix of read and write commands. Each message block is formatted as shown in Figure 3-1. A big-endian format (MSB first) is always followed.

The Command Field has a "register" address that is used to access various configuration parameters. These addresses are bound between 0x00 and 0x7F.

Bit 7 of the Command Field determines whether a read or write action is being performed. To write to a register, this bit must be set to 1 (one), but to read a register, it must be set to 0 (zero). All read commands are one-byte long. Data following a read access command will be interpreted as a new command block. Read commands are processed last. For example, in a single DL message, if there is a read command from a register and a write command to the same register, the write command is executed first.

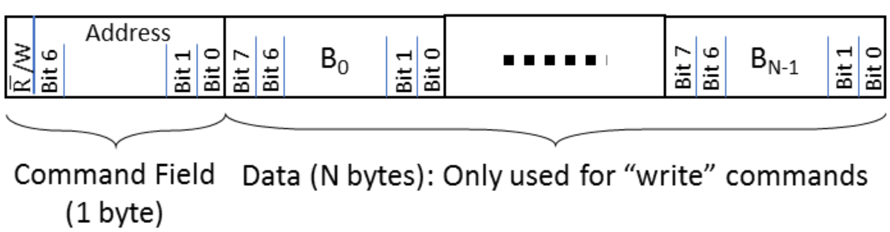

Figure 3-1: The format of a DL configuration and control message block.

All DL configuration and control commands are sent on ***LoRaWAN port 100***.

Examples:

In the following examples, the Command Field is boldfaced:

- Read Reg 0x00, 0x01, 0x02:
  - DL command: { 0x **00 01 02** }
- Read Reg 0x05 and write value 0x8000 to Reg 0x10:
  - DL command: { 0x **05 90** 80 00 }

When a write command is sent to the Sensor, the Sensor will immediately respond with a CRC32 of the entire DL payload as the first 4 bytes of the UL frame.

DL configuration and control commands fall into one of the following 4 (four) categories and are discussed in Sections 3.1.1, 3.1.2, 0, and 3.1.3.5, respectively:

- LoRaWAN Commissioning
- LoRaMAC Configuration
- Sensor Application Configuration
- Sensor Command and Control

3.1.1 LoRaWAN Commissioning

LoRaWAN commissioning values can be read back from the Sensor using DL commands. These registers are RO. See LoRaWAN 1.0.3 specification [1] for description of the values. Table 3-1 shows a list of these registers.

Table 3-1: LoRaWAN Commissioning Registers

Address	Access	Value	# Bytes
0x00	R	DevEUI	8
0x01	R	AppEUI	8
0x02	R	AppKey	16
0x03	R	DevAddr	4
0x04	R	NwkSKey	16
0x05	R	AppSKey	16

Note 1: Commissioning values need to be kept secure at all times.

Note 2: Registers 0x02, 0x04, 0x05 cannot be read back in some regions if the DR number is too small. For example, in the NA region, the maximum frame payload size with DR0 is 11 bytes.

3.1.2 LoRaMAC Configuration

LoRaMAC options can be configured using DL commands. These configuration options change the default MAC configuration that the Sensor loads on start-up. They can also change certain run-time parameters. Table 3-2 shows the MAC configuration registers. In this table, B_i refers to data byte indexed *i* as defined Figure 3-1.

Table 3-2: LoRaMAC Configuration Registers

Address	Access	Value	# Bytes	Description
0x10	R/W	Join Mode	2	B_0-bit 7: 0 = ABP, 1 = OTAA B_1: RFU
0x11	R/W	• Unconfirmed/Confirmed UL • Disable/Enable Duty Cycle • Disable/Enable ADR	2	B_0-bits 7–4: 0 = Class A, C = Class C B_1-bit 0: 0 = Unconfirmed UL, 1 = Confirmed UL

				B_1-bit 1 (RO): 0 = Private, 1 = Public Sync Word B_1-bit 2: 0 = Disable duty cycle, 1 = Enable duty cycle B_1-bit 3: 0 = Disable ADR, 1 = Enable ADR
0x12	R/W	• Default DR number • Default Tx Power number	2	B_0-bits 3–0: Default DR number [2] B_1-bits 3–0: Default Tx power number [2]
0x13	R/W	• Rx2 window DR number • Rx2 window channel frequency	5	B_0-B_1-B_2-B_3: Channel frequency in Hz for Rx2 B_4: DR for Rx2
0x19	R/W	Net ID MSBs	2	Bytes B_0-B_1 in the Net ID (B_0-B_1-B_2-B_3)
0x1A	R/W	Net ID LSBs	2	Bytes B_2-B_3 in the Net ID (B_0-B_1-B_2-B_3)

Note: Modifying these values only changes them in the Sensor device. Options for the Sensor in the NS also need to be changed in order to not strand a Sensor. Modifying configuration parameters in the NS is outside the scope of this document.

Examples:

In the following example payloads, the Command Field is boldfaced:

- Switch Device to ABP Mode:
  - DL payload: { 0x **90** 00 00 }
- Set ADR On, No Duty Cycle, and Confirmed UL Payloads:
  - DL payload: { 0x **91** 00 09 }
- Set default DR number to 1 and default Tx Power number to 2:
  - DL payload: { 0x **92** 01 02 }

3.1.2.1 Default Configuration

Table 3-3 and Table 3-5 list the default values for the LoRaMAC configuration registers (cf. [1], [2]).

Table 3-3: Default Values of LoRaMAC Configuration Registers

Address	Default Value
0x10	0x 80 00 (OTAA mode)
0x11	0x 00 0E (Class A, Unconfirmed UL, enabled duty cycle, enabled ADR)
0x12	0x 00 04 (DR0, Tx Power 0—max power, see Table 3-4)
0x13	As per Table 3-5.
0x19	0x 00 00

0x1A	0x 00 00

Table 3-4: Maximum Tx Power in Different Regions by Default

RF Region	Max Tx EIRP [dBm]
EU868	16
US915	30
AS923	16
AU915	30
IN865	30
CN470	19.15
KR920	14
RU864	16

Table 3-5: Default Values of Rx2 Channel Frequency and DR Number in Different Regions

RF Region	Default Value	Channel Frequency	DR Number
EU868	0x 33 D3 E6 08 00	869.525 MHz	DR0
NA915	0x 37 08 70 A0 08	923.3 MHz	DR8
AS923	0x 37 06 EA 00 02	923.2 MHz	DR2
AU915	0x 37 08 70 A0 08	923.3 MHz	DR8
IN865	0x 33 A6 80 F0 02	866.55 MHz	DR2
CN470	0x 1E 1E 44 20 00	505.3 MHz	DR0
KR920	0x 36 F3 13 E0 00	921.9 MHz	DR0
RU864	0x 33 CD 69 E0 00	869.1 MHz	DR0

3.1.3 MRDT Sensor Application Configuration

This section lists all possible Sensor application configurations (as part of DL configuration and control commands), like periodic Tx configuration.

Note: Care must be taken to avoid stranding the sensor during reconfiguration. If all sensing inputs are disabled, the device will not be able to be reconfigured.

3.1.3.1 Periodic Tx Configuration

All periodic sensor reporting is synchronized around “ticks”. A tick is simply a user configurable time-base that is used to schedule sensor measurements. For each transducer, the number of elapsed ticks before transmitting can be defined, as shown in Table 3-6.

Table 3-6: Ticks Configuration for Periodic Tx

Address	Access	Value	# Bytes	Description
0x20	R/W	Seconds in a Tick	4	Sets the core tick in seconds for periodic events (0 disables)

0x21	R/W	Ticks per Battery Tx	2	Ticks between battery reports (0 disables)
0x22	R/W	Ticks per MCU Temperature Tx	2	Ticks between MCU temperature reports (0 disables)
0x23	R/W	Ticks per get room status request	2	Ticks between get room status request (0 disables)

3.1.3.1.1 Seconds in a Tick

All periodic transmit events are schedule in "ticks". This allows for sensor reads to be synchronized, reducing the total number of uplinks required to transmit sensor data. The minimum seconds in a tick is 30 seconds and the maximum is 86400 seconds (i.e. a day). Values from 1 to 29 or above 86400 are RFU and will be ignored by the sensor.

If "Seconds in a Tick" is set to 0 (zero), ***all*** periodic reporting will be disabled regardless of individual sensor reporting configurations. Disabling all periodic based reporting is not recommended!

3.1.3.1.2 Ticks per <Transducer>

Sets the individual tick period for a transducer. Once the configured number of ticks has expired the Sensor will poll the specified transducer and report the data in an uplink message.

A setting of 0 (zero) will disable periodic reporting for the specified transducer. Disabling all periodic based reporting is not recommended!

3.1.3.1.3 Default Configuration

Seconds in a Tick	300 seconds (5 min)
Ticks per Battery Tx	12 (1 hour)
Ticks per MCU Temperature Tx	0 (disabled)
Ticks per Get room Status request	2 (10 min)

3.1.3.1.4 Example DL Messages

- Disable all periodic events:
  - 0x: A0 00 00 00 00 (Reg 20, write bit set to true) – Seconds in a Tick = 0 (disabled)
- Read the current "Seconds in a Tick" value:
  - 0x: 20 (Reg 20, write bit set to false)
- Write "Tick per MCU Temperature Tx" and "Ticks per get room status request":
  - 0x: A2 00 01 A3 00 02 (Reg 22 and Reg 23, write bit set to true)—set "Ticks per MCU Temperature Tx" to 1 (one) and "Ticks per get room status request" to 2 (two).

3.1.3.2 MRDT custom hardware configuration

MRDT is equipped with side LEDs and Front EPD screen light. The LED color can be custom configured based on available or occupied room status. The front EPD screen light intensity level can also be custom configured. Please note that these settings are only available

Table 3-7: MRDT hardware custom configuration

Address	Access	Value	# Bytes	Description
0x24	R/W	LED color setting for available room status	3	Available room status LED color setting (Red =0x00, Green = 0x00, Blue = 0x00 turns off LEDs) Each color/byte value ranges from 0x00 to 0xFF
0x25	R/W	LED color setting occupied room status	3	Occupied room status LED color(Red =0x00, Green = 0x00, Blue = 0x00 turns off LEDs) Each color/byte value ranges from 0x00 to 0xFF
0x26	R/W	Front light led intensity level	1	Front EPD screen light intensity level (0 disables, 100 Max Intensity) Valid Range: 0 - 100

3.1.3.2.1 Available/Occupied room status LED color

In externally powered MRDT the side LEDs are multi-colored and can be customized using red, green blue color combinations. In MRDT firmware users can customize LED color per room status (available or occupied).

The following the DL frame format for Available/Occupied room status LED color setting message.

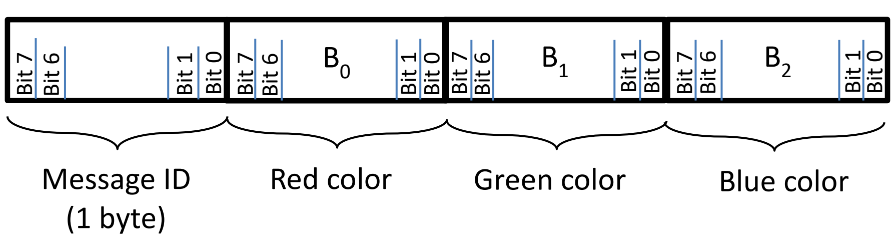

Figure 3-2: The format of Available/Occupied room status LED color setting

3.1.3.2.2 Front EPD screen light intensity level

Sets the front EPD screen light intensity level.

A setting of 100 will set the front EPD screen light intensity level to maximum level.

A setting of 0 (zero) will disable front EPD screen light.

3.1.3.2.3 Default Configuration

Available Room Status LED color	0x00 0x00 0x00 (OFF)
Occupied Room Status LED color	0xFF 0xA6 0x2C (White)
Front EPD screen intensity level	50

3.1.3.2.4 Example DL Messages

- Disable LED color:
    - 0x: A4 00 00 00 (Reg 24, write bit set to true) – Available room status LED color = 0x00 0x00 0x00 (disabled)
    - 0x: A5 00 00 00 (Reg 25, write bit set to true) – Occupied room status LED color = 0x00 0x00 0x00 (disabled)
- Read the current “Front EPD screen intensity level” value:
    - 0x: 26 (Reg 26, write bit set to false)
- Write “Available room status LED color” and “Occupied room status LED color”:
    - 0x: A4 FF A6 2C A5 00 00 FF (Reg 24 and Reg 25, write bit set to true)—set “Available room status LED color” to 0xFF 0xA6 0x2C (White) and “Occupied room status LED color” to 0x00 0x00 0xFF (Blue).

3.1.3.3 Booking application acknowledgements

The message ID field is the response for the message UL request (as described in Table 2-2).

The message block is formatted as shown in Figure 3-13. A big-endian format (MSB first) is always followed. All the booking application acknowledgments are sent on ***LoRaWAN port 101.***

NOTE: Each acknowledgement is followed by a room status response as described later section 3.1.3.3

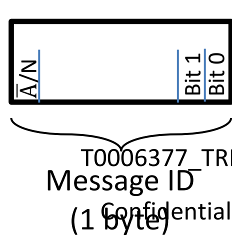

Figure 3-3: The format of a DL booking application acknowledgements

The following table describes the booking application downlink acknowledgments.

Table 3-8: DL Frame Booking Application acknowledgements.

Information Type	Message ID Field Value	Maximum DL Frame size (Bytes)	Number of DL messages per UL message request	Information
Book now response	0xB4	1	1	ACK
	0x34	1	1	NACK
Extend meeting response	0xB5	1	1	ACK
	0x35	1	1	NACK
Book meeting in future response	0xB6	1	1	ACK
	0x36	1	1	NACK
Finish Meeting	0xB7	1	1	ACK
	0x37	1	1	NACK

3.1.3.4 Booking application get room status response

A single UL get room status request may result in multiple DL responses and acknowledgements. Each message block is formatted as shown in Figure 3-13. A big-endian format (MSB first) is always followed.

The message ID field is the response for the message UL request (as described in Table 2-2).

Message ID bit 7(A/N) of the message ID determines whether message is ack or nacked. For room status response, this bit determines whether room is occupied (bit value 1) or available (bit value 0).

Byte 0 (B_0), bit 7 (EPD_E) describes if EPD screen needs to be turned off. This is required for turning off the screen during off hours to save battery.

- ON (bit value of 1)
- OFF (bit value or 0)

Byte 0 (B_0), bit 6 (TS_E) describes if touch screen needs to be turned off. This is required for turning off the screen during off hours to save battery or locking the screen.

- ON (bit value of 1)

- OFF (bit value or 0)

NOTE: For battery powered units, when EPD_E and TS_E bits are OFF, the unit will go to deep sleep mode for 14 hour predefined timer. When same bit are turned on unit comes out of deep sleep. In order to come out of deep sleep user may tap the EPD screen to wake up but would go back to sleep for predefined timer of 30 seconds. The application may send room status response with EPD_E and TS_E bits turned ON before the 14 hour timer expiry to wake up from deep sleep, at this point the unit will be out of deep sleep mode and ready for regular operation. To summarize, the unit will stay in deep sleep mode for 14 hours. If user taps the screen in middle of this 14 hour period, unit will wake up for 30s and go back to deep sleep. The application can wake up the unit before the 14 hour period by sending EPD_E and TS_E bits ON in room status response.

Byte 0 (B_0), bit 5 (Nx/C) describes what this DL frame contains

- Next booking information (bit value 1)

  Next booking information (Nx):

  - Next booking time (Byte B_0, B_1) HH:MM AM/PM
  - Booked by string size maximum of 30 bytes.
  - Booked by string - N bytes of string

- Current booking information (bit value 0).

  Current booking information (C):

  - Current booking Till time (Byte B_0, B_1): HH:MM AM/PM
  - Booked by string size maximum of 30 bytes.
  - Booked by string - N bytes of string

Byte B_0, bit 4 determines the time is PM (bit value of 1) or AM (bit value 0)

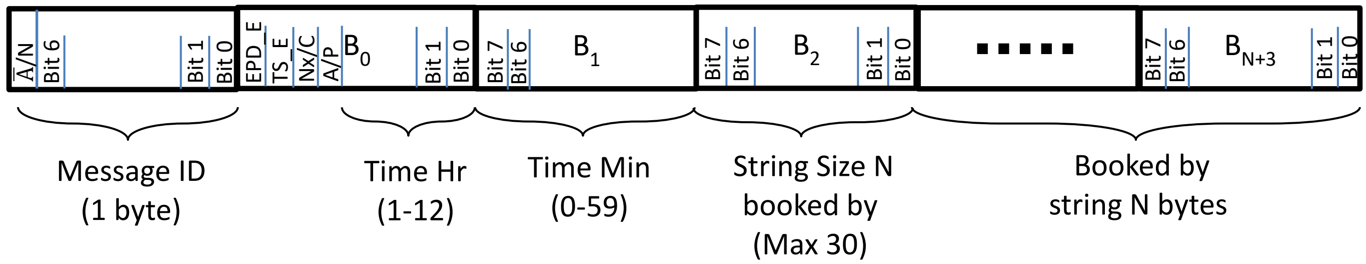

Figure 3-4: The format of a DL booking application get room status message block.

The uplink booking application get room requests require response split into 2 DL frames.

First DL frame containing information of current meeting (till time, booked by) and following DL frame containing information about next meeting (next meeting book time, next meeting booked by).

The following table describes the booking application get room status downlink response message.

Table 3-9: DL Frame Booking Application get room status response.

Information Type	Message ID Field Value	Maximum DL Frame size (Bytes)	Number of DL messages per UL message request	Information
Room status response	0xB3	34	2	Occupied
	0x33	34	1	Available

Get room status response is sent on ***LoRaWAN port 102.***

3.1.3.5 Booking application get room information response/acknowledgement

This message response/acknowledgement is different from regular DL booking application acknowledgments described in earlier section.

The following the DL frame format for get room information response message.

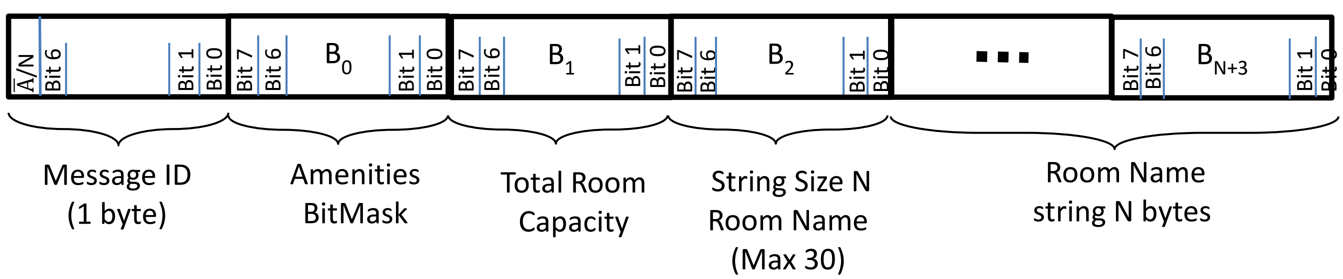

Figure 3-5: The format of a DL booking application get room information acknowledgment message block.

Message ID bit 7(A/N) of the message ID determines whether message is ack or nacked.

Byte 0 (B_0) for this response message contains the Amenities presence bit mask

- Bit 0 – TV
- Bit 1 – Projector
- Bit 2 – Web Camera

- Bit 3 – White Board

Byte 1 (B_1) is size of the Room name string N bytes.

Subsequent bytes is room name string of N bytes.

The following table describes the booking application get room information downlink acknowledgment.

Table 3-10: DL Frame Booking Application get room information acknowledgement.

Information Type	Message ID Field Value	Maximum DL Frame size (Bytes)	Number of DL messages per UL message request	Information
Room information response	0xB8	34	1	ACK
	0x38	1	1	NACK

Get room information acknowledgement/response is sent on ***LoRaWAN port 103.***

3.1.3.6 Booking application get amenities status response

This message response/acknowledgement is different from regular DL booking application acknowledgments described in earlier section.

The following the DL frame format for get room information response message.

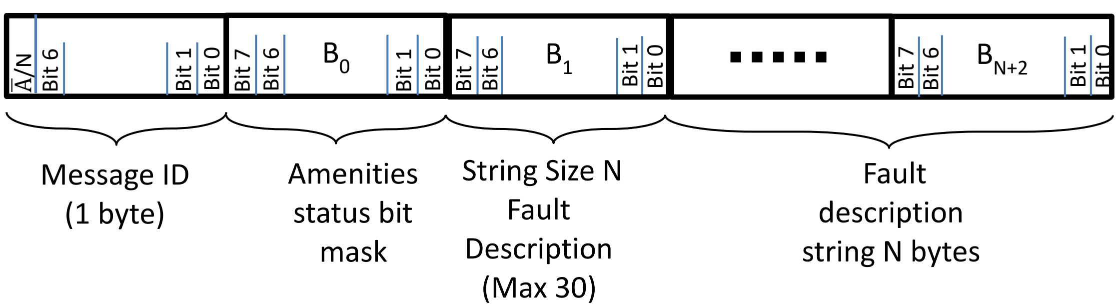

Figure 3-6: The format of a DL booking application get amenities acknowledgment message block.

Message ID bit 7(A/N) of the message ID determines whether message is ack or nacked.

Byte 0 (B_0) for this response message contains the Amenities status bit mask

- Bit 0 – TV
- Bit 1 – Projector

- Bit 2 – Web Camera
- Bit 3 – White Board

Bit value of 1 means the amenity is at fault.

Byte 1 (B_1) is size of the fault description string N bytes.

Subsequent bytes is fault description string of N bytes.

The following table describes the booking application get amenities status downlink acknowledgment. Get amenities status acknowledgement/response is sent on ***LoRaWAN port 104.***

Table 3-11: DL Frame Booking Application get amenities status acknowledgement.

Information Type	Message ID Field Value	Maximum DL Frame size (Bytes)	Number of DL messages per UL message request	Information
Get Amenities status response	0xB9	33	1	ACK
	0x39	1	1	NACK

3.1.4 MRDT Sensor Command and Control

Configuration changes are not retained after a power cycle unless they are saved in the flash memory. Figure 3-1 shows the structure of the Command and Control registers. In this table, B_i refers to data byte indexed *i* as defined in Figure 3-1.

Table 3-12: Sensor Command & Control Register

Address	Access	Name	# Bytes	Description
0x70	W	Flash Memory Write Command	2	B_0, bit 5: Write App Config B_0, bit 6: Write LoRa Config B_1, bit 0: Restart Sensor In all cases: 0 = De-asserted, 1 = Asserted Other bits are ignored.
0x71	R	FW Version	7	B_0: App version major B_1: App version minor B_2: App version revision B_3: LoRaMAC version major B_4: LoRaMAC version minor B_5: LoRaMAC version revision B_6: LoRaMAC region number
0x72	W	Reset Config Registers to	1	0x0A: Reset App Config 0xB0: Reset LoRa Config

	Factory Defaults[2]	0xBA: Reset both App and LoRa Configs Any other value is ignored.

Note: The Flash Memory Write Command is always executed after the full DL configuration message has been decoded. The reset command should always be sent as an "unconfirmed" DL message. Failure to do so may cause the NS to continually reboot the Sensor.

3.1.4.1 LoRaMAC Region

The LoRaMAC region is indicated by B_6 in the FW Version register (Reg 0x71). Current LoRaMAC regions and corresponding region numbers are listed in Table 3-12

Table 3-13: LoRaMAC Regions and Region Numbers

LoRaMAC Region	Region Number
EU868	0
NA915	1
AS923	2
AU915	3
IN865	4
CN470	5
KR920	6
RU864	7

3.1.4.2 Command Examples

In the following examples, the Command Field is boldfaced:

- Write application configuration to flash memory
  - DL payload: { 0x **F0** 20 00 }
- Write application and LoRa configurations to flash memory
  - DL payload: { 0x **F0** 60 00 }
- Reboot Device
  - DL payload: { 0x **F0** 00 01 }
- Read FW versions, and reset application configuration to factory defaults
  - DL payload: { 0x **71 F2** 0A }

3.1.5 Preventing Sensor Bricking

Care has been taken to avoid stranding (hard or soft bricking) the Sensor during reconfiguration. Hard bricking refers to the condition that the Sensor does not transmit any

[2] Resetting to factory defaults takes effect on the next power cycle.

more as all periodic and event-based reporting (see subsequent sections) have been disabled and the configuration has been saved to the Flash memory. Soft bricking refers to the condition where the Sensor has been configured such that all event-based reporting is disabled and any periodic reporting is either disabled or has a period of larger than a week. Therefore, transmissions from a soft-bricked Sensor cannot be smaller than a week apart.

To avoid these situations, for any reconfiguration command sent to the Sensor, the following algorithm is automatically executed:

After the reconfiguration is applied, if all event-based reporting is disabled, then periodic reporting is checked (see Section 3.1.3.1 for periodic reporting). If all periodic reporting is disabled or the minimum non-zero period is greater than a week, then to avoid bricking the Sensor, the core tick is set to 86400 (i.e. one day), and the battery voltage tick is set to 1 (one).

References

[1] LoRa Alliance, "LoRaWAN Specification," ver. 1.0.3, Jul 2018.

[2] LoRa Alliance, "LoRaWAN Regional Parameters," ver. 1.1, rev. B, Jan 2018.

[3] State Machine, "Meeting Room Tablet State Machine," ver 0.4, April 17, 2020