WiMOD LoRaWAN EndNode Modem HCI Specification (Multicast)

Specification Version 0.1

Document ID: 4000/40140/0152

IMST GmbH
Carl-Friedrich-Gauß-Str. 2-4
47475 KAMP-LINTFORT
GERMANY

Document Information

File name	WiMOD_LoRaWAN_EndNode_Modem_Multicast_HCI_Spec.docx
Created	2017-11-08
Total pages	12

Revision History

Version	Note
0.1	Created, Initial Version Reference: WiMOD LoRaWAN EndNode Modem HCI Spec V1.20

Aim of this Document

This document describes the changes of the Host Controller Interface (HCI) protocol which is part of the WiMOD LoRaWAN EndNode Modem firmware which supports the Multicast feature available for class C. This firmware can be used in combination with the WiMOD LoRa radio module family.

Table of Contents

1. Introduction

1.1 Overview

This document is an extension to the WiMOD LoRaWAN EndNode Modem HCI document [1], covering the changes included in the WiMOD LoRaWAN EndNode Modem firmware supporting the Multicast feature for LoRaWAN class C.

2. Firmware Services Modification

This chapter describes the message format for the changes on the firmware services in detail. The services are ordered according to their corresponding endpoint.

2.1 LoRaWAN Services

This section describes the changes on the HCI messages with respect to [1]. The following additional services are available:

- Multicast Configuration
- Multicast Data Reception

2.1.1 Multicast Configuration

This service provides a method for configuration of the multicast parameters via HCI.

The multicast parameters must be known on both sides - the end-device and the LoRaWAN network.

The end-device will use the multicast configuration once it is successful activated (by ABP or OTAA) and the class C support is enabled. The end-device will use the sequence counter included in the first received multicast downlink to synchronize its internal downlink sequence counter.

Note: the multicast parameters are not stored in a non-volatile memory and therefore they do not persist after a reset of the device.

The radio stack allows the configuration of several parameters via HCI:

- Multicast Index
  used to identify the multicast parameters (up to three different multicast configurations are allowed).
- Multicast Device Address
  a 32-Bit device-address, used for multicast communication on the network.
- Multicast Network Session Key
  a 128-Bit network session key used for MIC calculation and verification associated to the multicast device address.
- Multicast Application Session Key
  a 128-Bit application session key used to encrypt and decrypt the payload field of application specific messages associated to the multicast device address.

2.1.1.1 Set Multicast Configuration

This service can be used to configure the multicast parameters.

Note: the selected multicast device address will be automatically enabled.

Command Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_SET_MCAST_CONFIG_REQ	Set Multicast Configuration Request
Length	37	37 octets
Payload[0]	Multicast Index	Multicast index (range from 0 to 2)
Payload[1..4]	32-Bit Device Address	32-Bit Integer (LSB first)
Payload[5..20]	128-Bit Network Session Key	Octet sequence (MSB first)
Payload[21..36]	128-Bit Application Session Key	Octet sequence (MSB first)

Response Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_SET_MCAST_CONFIG_RSP	Set Multicast Configuration Response
Length	1	1 octet
Payload[0]	Status Byte	see appendix

2.1.1.2 Get Multicast Configuration

This service can be used to get some information related to a single multicast configuration.

Command Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_GET_MCAST_CONFIG_REQ	Get Multicast Configuration Request
Length	1	1 octets
Payload[0]	Multicast Index	Multicast index (range from 0 to 2)

Response Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_GET_MCAST_CONFIG_RSP	Get Multicast Configuration Response
Length	7	7 octets
Payload[0]	Status Byte	see appendix
Payload[1]	Multicast Index	Selected multicast index
Payload[2]	Multicast Status	Current status of the selected index (0: inactive; 1: active)
Payload[3..6]	32-Bit Device Address	32-Bit Integer (LSB first)

2.1.1.3 Remove Multicast Configuration

This service can be used to remove a single multicast configuration.

Command Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_DEL_MCAST_CONFIG_REQ	Remove Multicast Configuration Request
Length	1	1 octets
Payload[0]	Multicast Index	Multicast index (range from 0 to 2)

Response Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_DEL_MCAST_CONFIG_RSP	Remove Multicast Configuration Response
Length	1	1 octets
Payload[0]	Status Byte	see appendix

2.1.2 Multicast Data Reception

After a successful LoRaWAN activation, a device in class C mode can start receiving multicast downlinks in the configured multicast device addresses.

Depending if the received data is valid or invalid one of the following HCI event messages will be sent to the Host:

- Multicast Data Indication
- Invalid Multicast Data Indication

2.1.2.1 Multicast Data Indication

This HCI message is sent to the host after reception of a valid multicast radio packet.

Event Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_RECV_MCAST_DATA_IND	Multicast Data Indication
Length	1+n (+5)	1+n (+5) octets
Payload[0]	Status and Format	Bit 0 : 0 = no attachment 1 = Rx Channel Info attached
Payload[1..4]	32-Bit Device Address	32-Bit Integer (LSB first)
Payload[5]	LoRaWAN Port	LoRaWAN Port number
Payload[6..n]	Application Payload	Application Layer Payload
Payload[n+1]	Channel Index	see [1]
Payload[n+2]	Data Rate Index	see [1]
Payload[n+3]	RSSI	RSSI value in dBm
Payload[n+4]	SNR	SNR value in dB
Payload[n+5]	Rx Slot	Rx Slot value

2.1.2.2 Invalid Multicast Data Indication

This HCI message is sent to the host after reception of an invalid multicast radio packet.

Event Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_RECV_MCAST_NO_DATA_IND	Invalid Multicast Data Indication
Length	6	6 octets
Payload[0]	Status and Format	Bit 0 : o attachment Bit 1 : wrong LoRaWAN frame received (error code attached)
Payload[1]	Error Code	Bit 0 : Wrong MType received (e.g. MType field must carry the value for Unconfirmed Data Down in a multicast downlink frame) Bit 1 : Wrong Device Address Bit 2 : Wrong MIC received Bit 3 : Unexpected FCnt received Bit 4 : MAC commands Error (e.g. MAC commands are not allowed in a multicast downlink frame) Bit 5 : Wrong downlink received Bit 6 : Multicast downlink error (e.g. the ACK and ADRACKReq bits must be zero in a multicast downlink frame)
Payload[2..5]	32-Bit Device Address	32-Bit Integer (LSB first)

3. Appendix

3.1 List of Constants

3.1.1 List of Endpoint Identifier

Name	Value
LORAWAN_ID	0x10

3.1.2 LoRaWAN Endpoint Identifier

3.1.2.1 LoRaWAN Endpoint Message Identifier

Name	Value
LORAWAN_MSG_SET_MCAST_CONFIG_REQ	0x41
LORAWAN_MSG_SET_MCAST_CONFIG_RSP	0x42
LORAWAN_MSG_SET_MCAST_CONFIG_REQ	0x43
LORAWAN_MSG_SET_MCAST_CONFIG_RSP	0x44
LORAWAN_MSG_DEL_MCAST_CONFIG_REQ	0x45
LORAWAN_MSG_DEL_MCAST_CONFIG_RSP	0x46
LORAWAN_MSG_RECV_MCAST_DATA_IND	0x48
LORAWAN_MSG_RECV_MCAST_NO_DATA_IND	0x4A

3.1.2.2 LoRaWAN Endpoint Status Byte

Name	Value	Description
LORAWAN_STATUS_OK	0x00	Operation successful
LORAWAN_STATUS_ERROR	0x01	Operation failed
LORAWAN_STATUS_CMD_NOT_SUPPORTED	0x02	Command is not supported
LORAWAN_STATUS_WRONG_PARAMETER	0x03	HCI message contains wrong parameter
LORAWAN_STATUS_WRONG_DEVICE_MODE	0x04	Stack is running in a wrong mode
LORAWAN_STATUS_DEVICE_NOT_ACTIVATED	0x05	Device is not activated
LORAWAN_STATUS_DEVICE_BUSY	0x06	Device is busy, command rejected
LORAWAN_STATUS_QUEUE_FULL	0x07	Message queue is full, command rejected
LORAWAN_STATUS_LENGTH_ERROR	0x08	HCI message length is invalid or radio payload size is too large
LORAWAN_STATUS_NO_FACTORY_SETTINGS	0x09	Factory Settings EEPROM block missing

LORAWAN_STATUS_CHANNEL_BLOCKED	0x0A	Channel blocked by Duty Cycle
LORAWAN_STATUS_CHANNEL_NOT AVAILABLE	0x0B	No channel available (e.g. no channel defined for the configured spreading factor)

3.2 List of Abbreviations

FW	Firmware
HCI	Host Controller Interface
LR	Long Range
LoRa	Long Range
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTC	Real Time Clock
SLIP	Serial Line Internet Protocol
SNR	Signal to Noise Ratio
UART	Universal Asynchronous Receiver/Transmitter
WiMOD	Wireless Module by IMST

3.3 List of References

[1] WiMOD_LoRaWAN_EndNode_Modem_HCI_Spec.pdf.

4. Regulatory Compliance Information

The use of radio frequencies is limited by national regulations. The radio module has been designed to comply with the European Union's R&TTE (Radio & Telecommunications Terminal Equipment) directive 1999/5/EC and can be used free of charge within the European Union. Nevertheless, restrictions in terms of maximum allowed RF power or duty cycle may apply.

The radio module has been designed to be embedded into other products (referred as "final products"). According to the R&TTE directive, the declaration of compliance with essential requirements of the R&TTE directive is within the responsibility of the manufacturer of the final product. A declaration of conformity for the radio module is available from IMST GmbH on request.

The applicable regulation requirements are subject to change. IMST GmbH does not take any responsibility for the correctness and accuracy of the aforementioned information. National laws and regulations, as well as their interpretation can vary with the country. In case of uncertainty, it is recommended to contact either IMST's accredited Test Center or to consult the local authorities of the relevant countries.

5. Important Notice

5.1 Disclaimer

IMST GmbH points out that all information in this document is given on an "as is" basis. No guarantee, neither explicit nor implicit is given for the correctness at the time of publication. IMST GmbH reserves all rights to make corrections, modifications, enhancements, and other changes to its products and services at any time and to discontinue any product or service without prior notice. It is recommended for customers to refer to the latest relevant information before placing orders and to verify that such information is current and complete. All products are sold and delivered subject to "General Terms and Conditions" of IMST GmbH, supplied at the time of order acknowledgment.

IMST GmbH assumes no liability for the use of its products and does not grant any licenses for its patent rights or for any other of its intellectual property rights or third-party rights. It is the customer's duty to bear responsibility for compliance of systems or units in which products from IMST GmbH are integrated with applicable legal regulations. Customers should provide adequate design and operating safeguards to minimize the risks associated with customer products and applications. The products are not approved for use in life supporting systems or other systems whose malfunction could result in personal injury to the user. Customers using the products within such applications do so at their own risk.

Any reproduction of information in datasheets of IMST GmbH is permissible only if reproduction is without alteration and is accompanied by all given associated warranties, conditions, limitations, and notices. Any resale of IMST GmbH products or services with statements different from or beyond the parameters stated by IMST GmbH for that product/solution or service is not allowed and voids all express and any implied warranties. The limitations on liability in favor of IMST GmbH shall also affect its employees, executive personnel and bodies in the same way. IMST GmbH is not responsible or liable for any such wrong statements.

5.2 Contact Information

IMST GmbH

Carl-Friedrich-Gauss-Str. 2-4
47475 Kamp-Lintfort
Germany

T +49 2842 981 0
F +49 2842 981 299
E wimod@imst.de
I www.wireless-solutions.de