WiMOD LoRaWAN EndNode Modem Firmware

Feature Specification Version 1.11

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Document Information

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Revision History

Version	Note
0.1	Created, Initial Version
0.2	Draft Version Created For Review
0.3	Preliminary Version
1.0	First Release
1.1	Chapter 1 updated for Test Application Chapter 2 and 3 added
1.2	Chapter 4 added
1.3	Chapter 2.9 updated
1.4	Chapter 2.3 and Chapter 2.9 updated
1.5	Chapter 2.3 and Chapter 2.9 updated
1.6	Chapter 1.1 and 2.5 updated for multi band support
1.7	Chapter 2.9 updated for current consumption diagram
1.8	Chapter 1 updated for LoRaWAN Specification V1.0.1 Chapter 2.10 added for activation parameters
1.9	Chapter 2.1 updated for recommendation
1.10	Chapter 2.9 updated for current consumption information
1.11	Chapter 2.5 updated

Aim of this Document

This document outlines the WiMOD LoRaWAN EndNode Modem firmware features. This firmware is designed for the WiMOD radio module family (e.g. iM880A-L, iM880B-L, iU880A, iM881A).

Table of Contents

1. Overview

The WiMOD LoRaWAN EndNode Modem firmware provides the following features:

- Compliants to LoRaWAN Specification V1.0.1
- Supports Class A and Class C (only unicast messages supported)
- Over The Air Activation (OTAA) and Activation By Personalization (ABP)
- Multitasking Operating System WiMOD-OS with Automatic Power Saving (APS)
- Host Controller Interface (HCI) for access to radio functions & parameters (see[1])
- EndNode Test Application required for the certification process
- Multi Band support

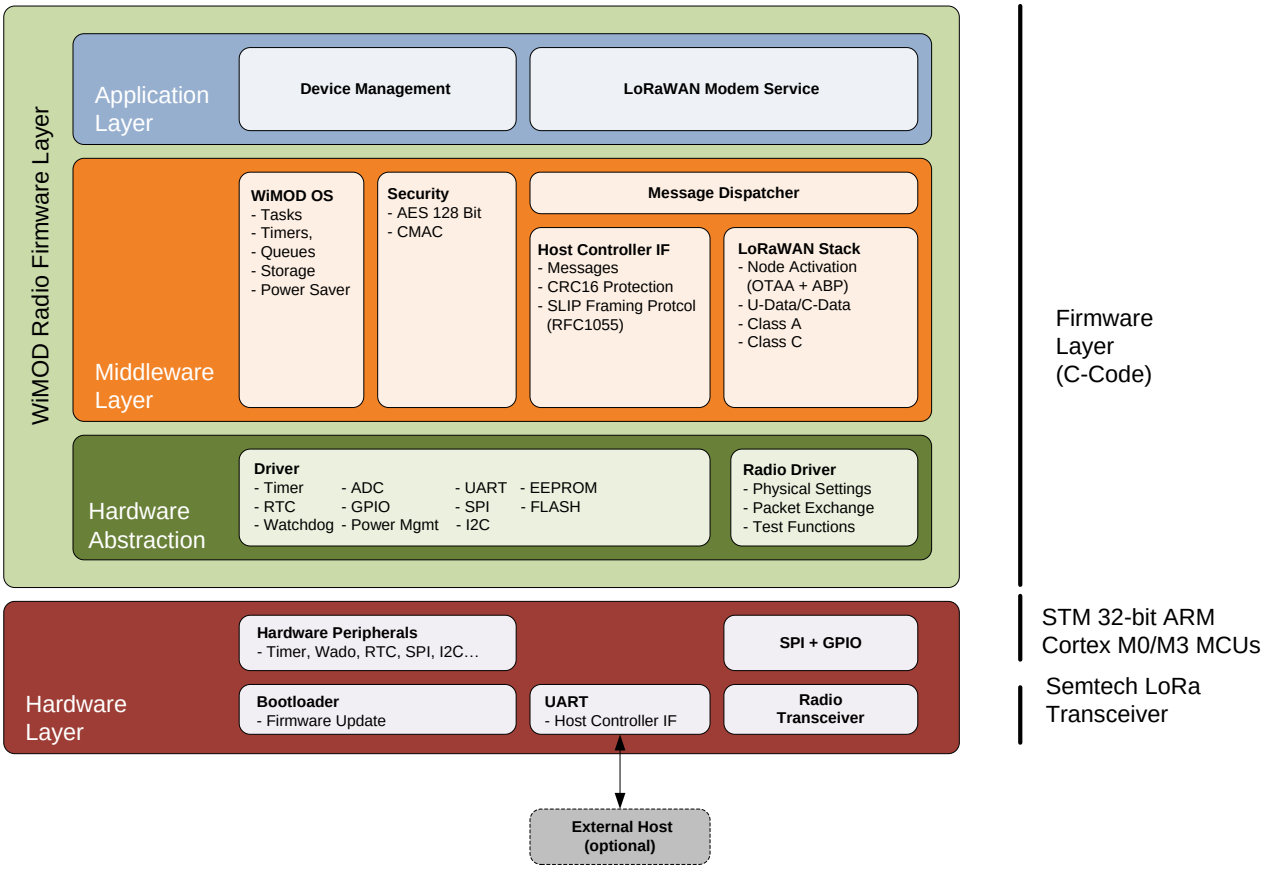

Fig. 1-1: WiMOD LoRaWAN EnNode Modem Firmware Architecture

2. Functional description

This chapter explains several points to clarify the functionality of the WiMOD LoRaWAN EndNode Modem firmware.

2.1 Payload

The maximum length of the LoRaWAN message is limited to 128 bytes. This allows a maximum length of 115 bytes (if no MAC commands are piggybacked in the header) or 100 bytes (if the maximum allowed MAC commands are piggybacked in the header) for the application payload. In case the application data exceeds these limits the corresponding error code will be returned (see [1]).

Note that in case the FSK modulation is being used, the maximum length of the message is limited to 63 bytes. This permits a maximum length of 50 bytes (if no MAC commands are piggybacked in the header) or 35 bytes (if the maximum allowed MAC commands are piggybacked in the header) for the application payload.

It is recommended that the maximum length of the payload should not exceed 51 bytes to ensure that during the data rate back-off procedure (e.g. confirmed frame retransmission) the maximum payload size defined in the LoRaWAN specification is satisfied.

2.2 Acknowledgement Procedure

The end-device will transmit an acknowledgement using an empty data message immediately after the reception of a data message requiring a confirmation. A new transmission is not allowed before it either has received a downlink message or the second receive window is expired (see 3.1).

2.3 Retransmission Procedure

The end-device uses the retransmission procedure recommended in the LoRaWAN specification. In the absence of the acknowledgement the end-device will try to retransmit the same data again, with a maximum number of retries. The frame will be retransmitted on a new frequency channel. Each data rate will be used twice and will be lowered after that till DR0 is achieved (see 3.2).

The number of retransmissions to be sent can be changed in the end-device configuration (see [1]). The maximum value allowed is 254.

2.4 MAC Commands

The end-device will send the answer to the MAC commands piggybacked within the next uplink. If this is not possible because they exceed the length of 15 bytes, they will be sent immediately using the port 0 (see 3.3).

2.5 Join Procedure

The end-device uses the frequencies defined by the corresponding radio band (see [1] for radio band configuration) to broadcast the JoinReq message. Note that these transmissions follow the duty-cycle requirements, even if this is deactivated.

The join procedure is similar to the retransmission one, where the join request will be retransmitted on a new frequency channel if no join accept message is received. The first transmission happens with DR5. Each data rate will be used twice and will be lowered after that (see 3.4).

After a successful activation of the end-device, it will send an empty LoRaWAN frame. This also applies to the activation by personalization. For this, the already stored radio stack configuration (e.g. data rate, tx power) will be used. Note that in case a data rate, which remains invalid in the default channel configuration, is selected, the next lower available data rate will be used (e.g. SF7BW125 instead of FSK or SF7BW250, in EU686 MHz band).

2.6 Frame Pending Bit

The frame pending bit functionality is implemented according to the LoRaWAN specification. An empty frame will be sent immediately after the reception of a data message with the frame pending bit set to 1. A new transmission is not allowed before the reception of a data message with a frame pending bit set to 0 (see 3.5).

2.7 Unconfirmed Data Retransmission

If the end-device is configured to retransmit the unconfirmed data frames and an unconfirmed data frame is sent, a new transmission is not allowed before it either has received a downlink message or the second receive window of the last retransmission is expired.

The data frame will be retransmitted on a new frequency but using the same data rate (see 3.6).

2.8 Duty Cycle

A new transmission is not allowed if all channels are blocked by duty cycle. The application should try to send the data again (see 3.7).

2.9 Automatic Power Saving

In case the Automatic Power Saving is enabled, the end-device will enter low power mode whenever possible and the current consumption will be reduced to a typical low power current in the range of 1.4µA to 1.8µA depending on the given hardware module, where the RTC remains running (for more information refer to the corresponding hardware datasheet, e.g. see [2]).

Note that if class C support is enabled the current consumption will increase to a typical value of 11.2mA due to the continuously listening mode.

The end-device does not enter low power mode direct after a transmission and this is not enabled before it either has received a downlink message or the second receive window is expired (no Rx indication).

The following picture shows an example of a voltage graph measured at a 27 Ω resistor on a iM880B-L module, including the current consumption of each state.

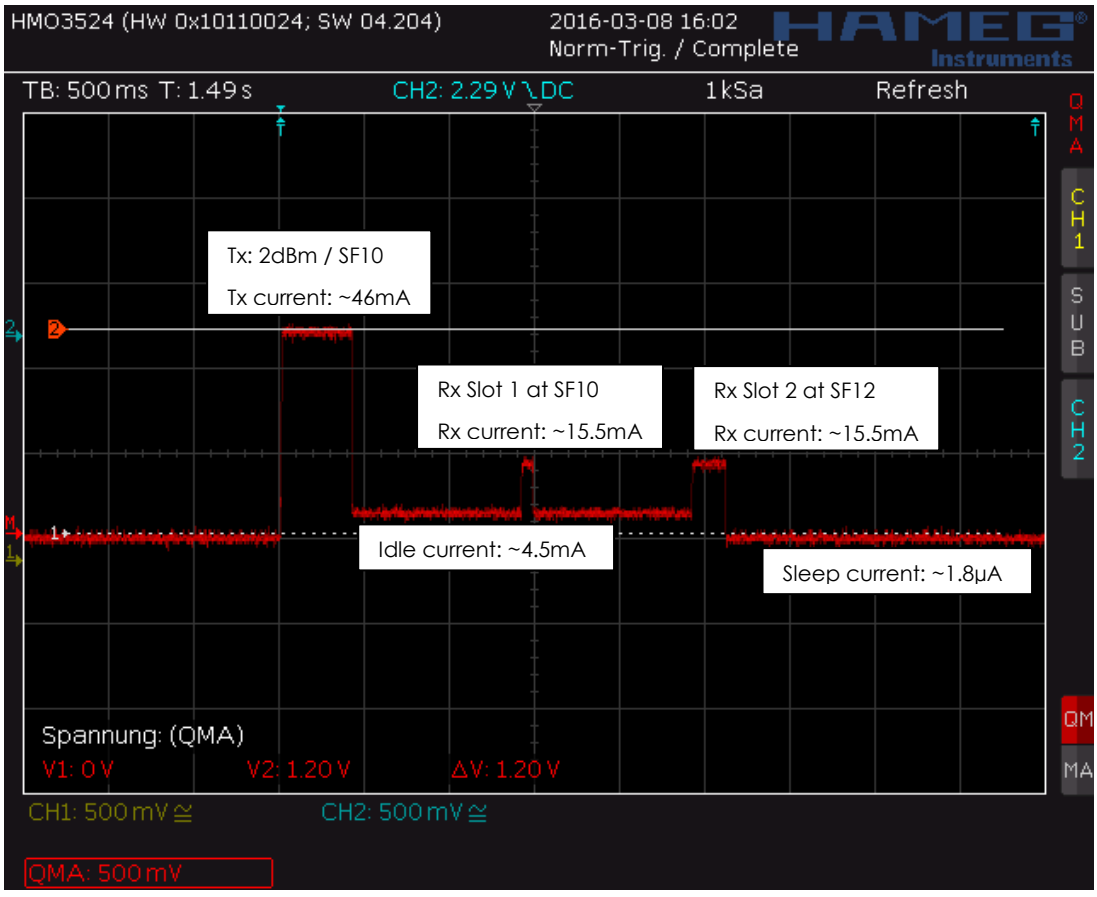

Fig. 2-1: Current Consumption Diagram - iM880B-L

2.10 Activation Parameters

The parameters required for Over The Air Activation and Activation By Personalization are configurable via HCI interface. These parameters are not readable and they are stored in encrypted form in a non-volatile memory to resist a power cycle.

3. Sequence Charts

3.1 Acknowledgement Procedure

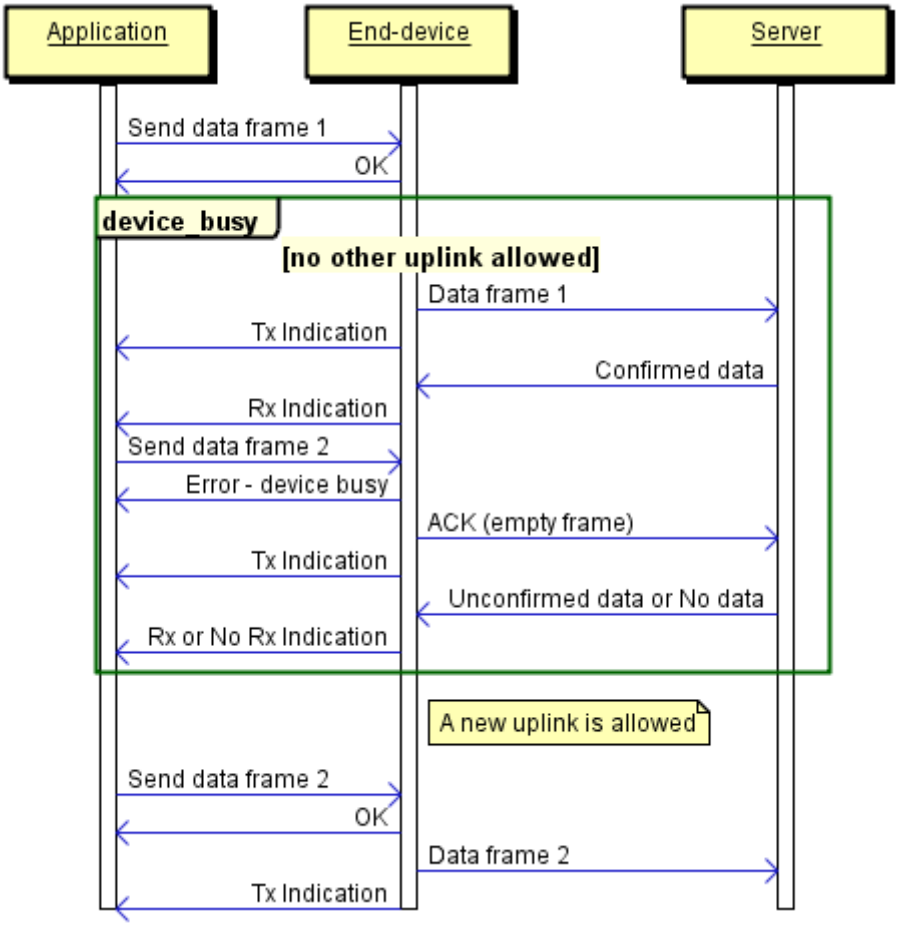

Fig. 3-1: Sequence chart - Acknowledgement procedure

3.2 Retransmission Procedure

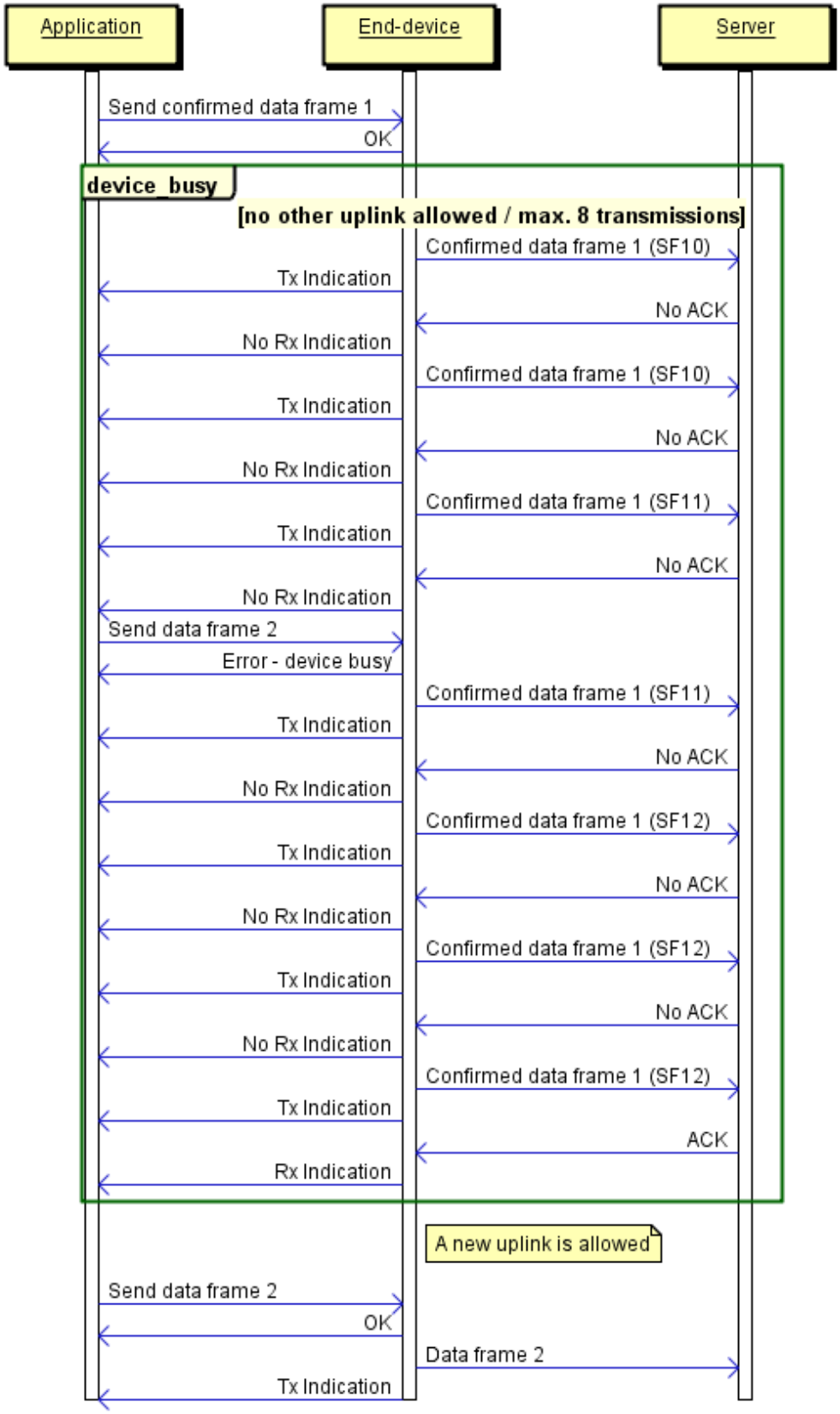

Fig. 3-2: Sequence chart - Retransmission procedure

3.3 MAC Commands

3.3.1 MAC Commands – Piggybacked in Header

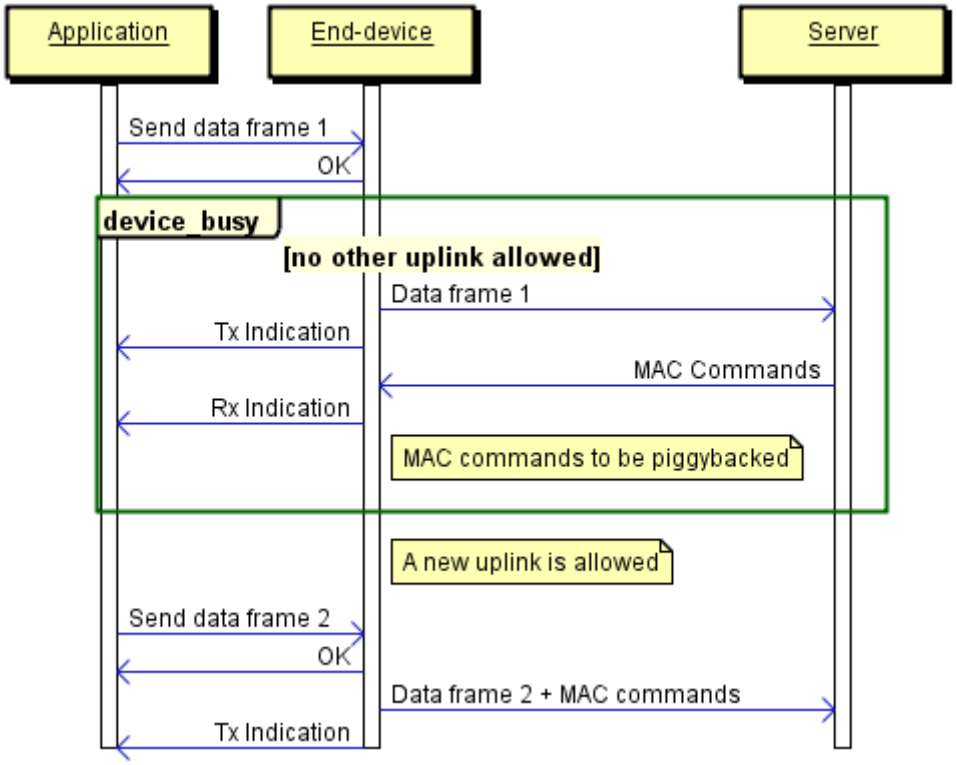

Fig. 3-3: Sequence chart - MAC Commands (piggybacked in header)

3.3.2 MAC Commands – Port 0

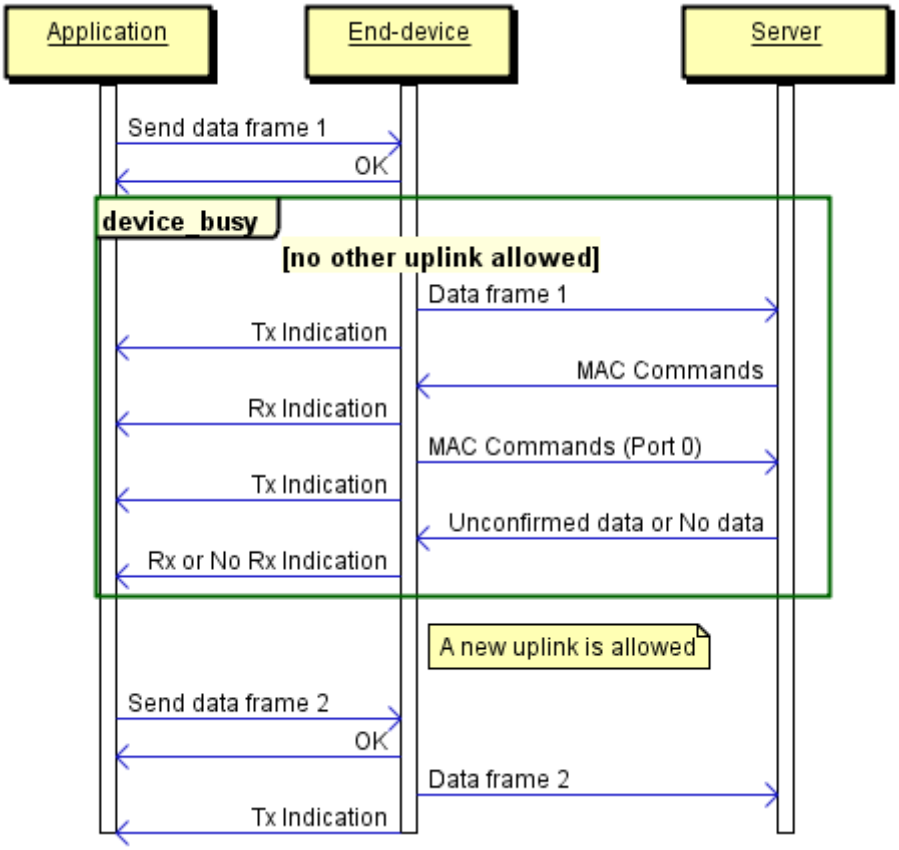

Fig. 3-4: Sequence chart - MAC Commands (using port 0)

3.4 Join Procedure

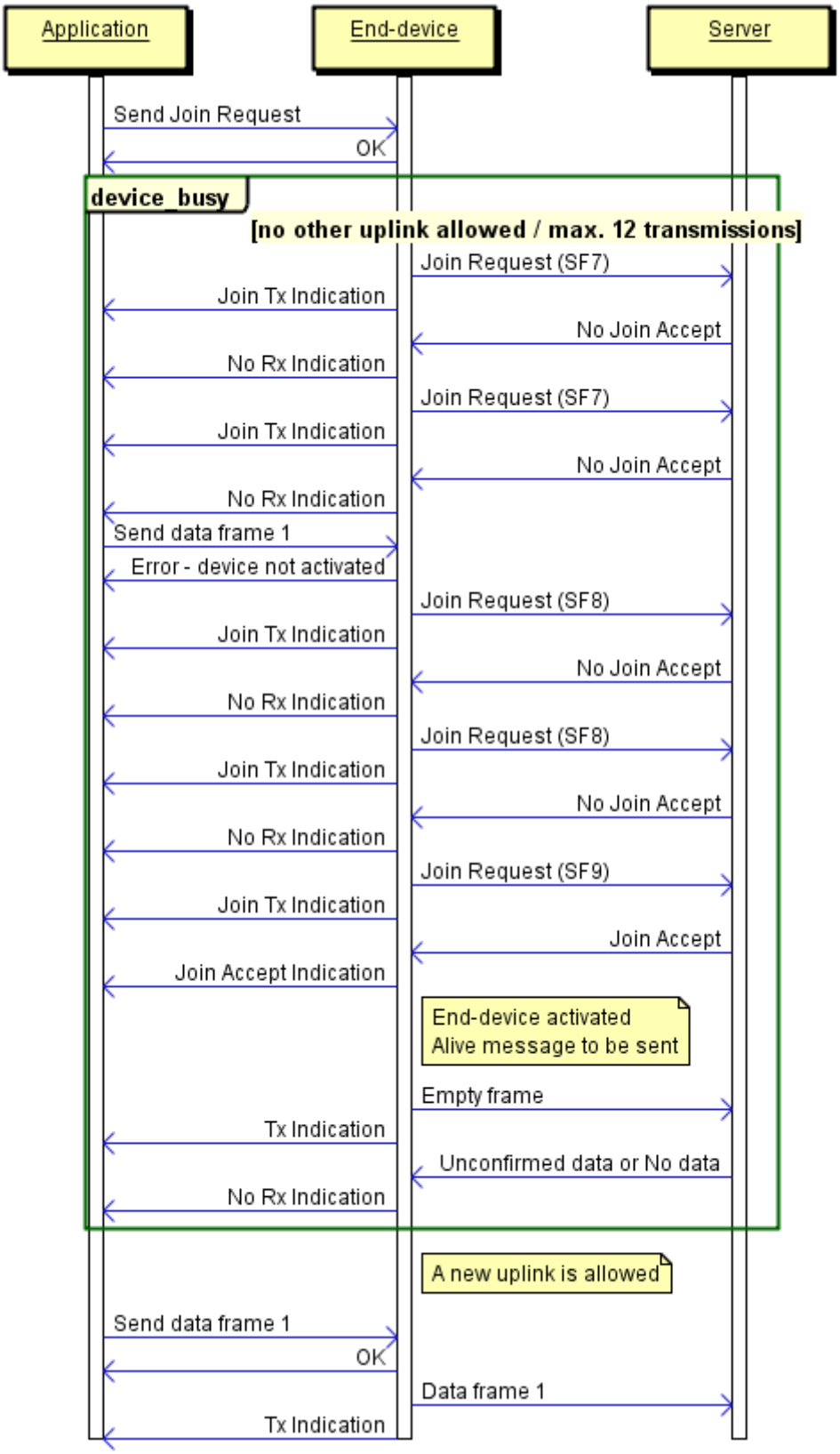

Fig. 3-5: Sequence chart - Join procedure

3.5 Frame Pending Bit

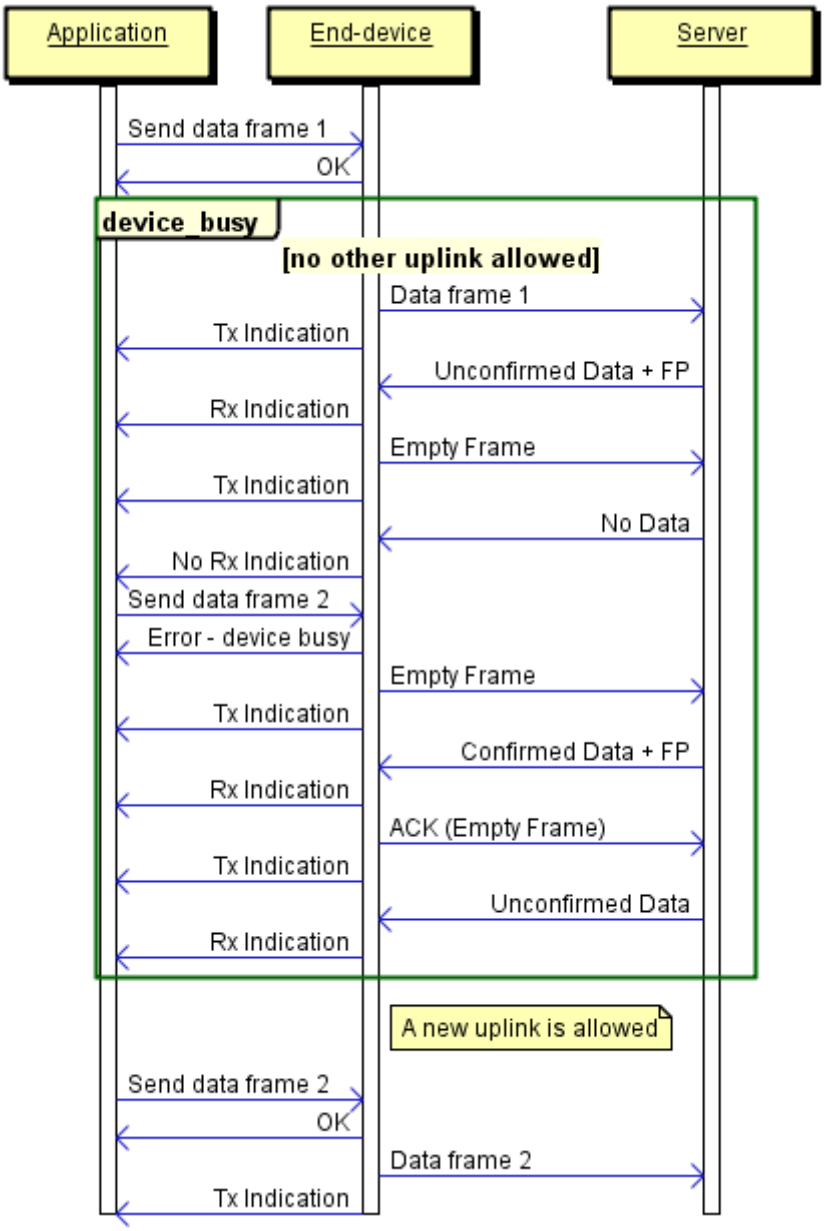

Fig. 3-6: Sequence chart - Frame pending bit

3.6 Unconfirmed Data Retransmission

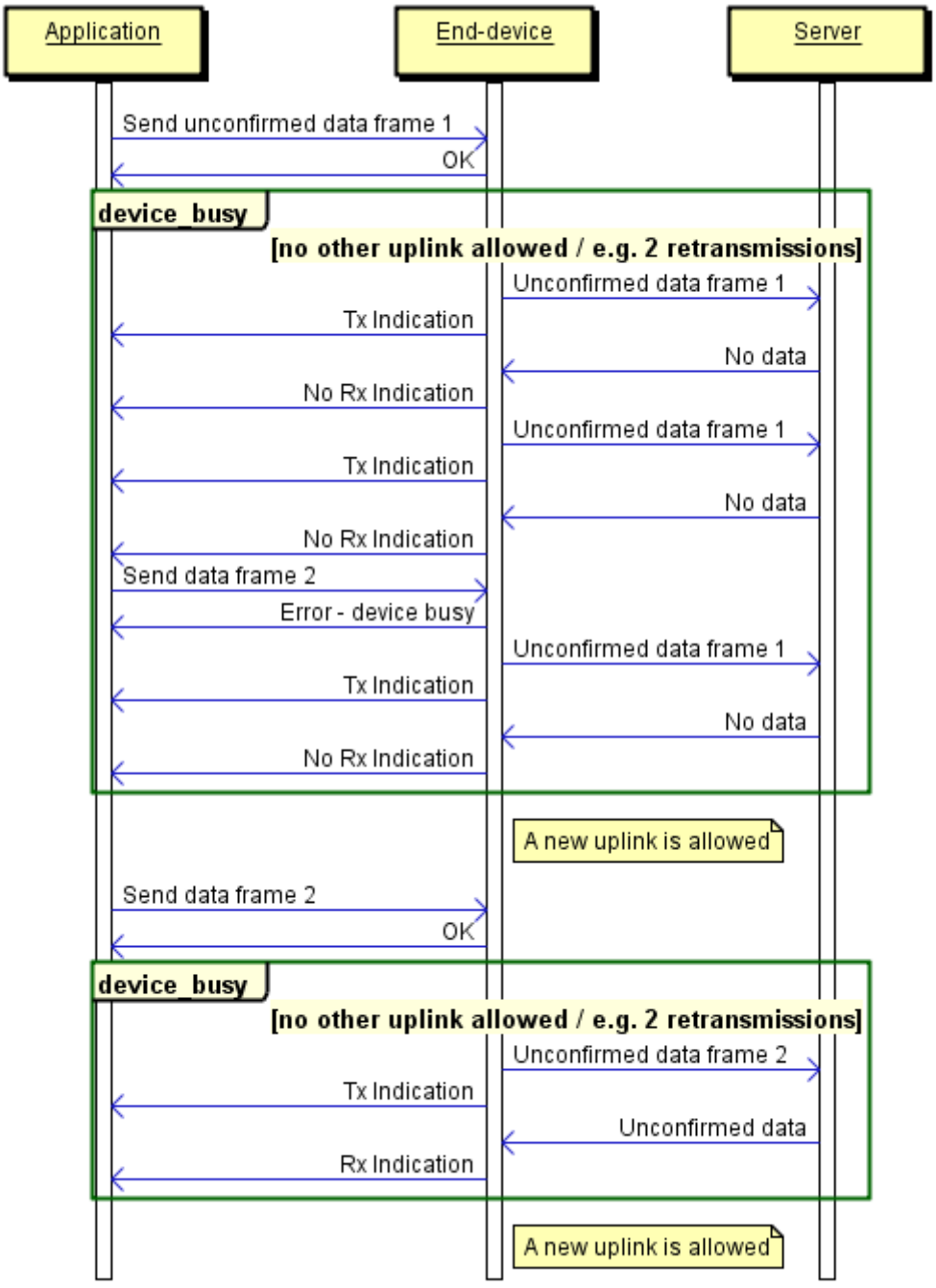

Fig. 3-7: Sequence chart - Unconfirmed data retransmission

3.7 Duty Cycle

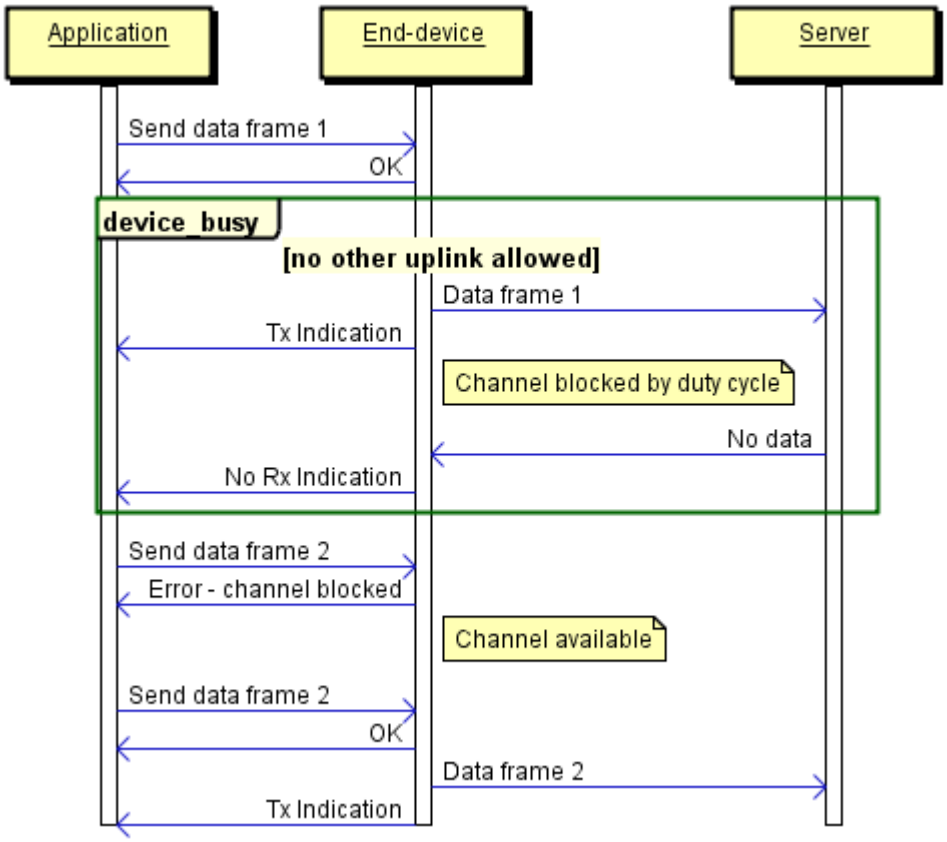

Fig. 3-8: Sequence chart - Duty Cycle

4. Known Limitations

This chapter lists the current known limitations related to the WiMOD LoRaWAN EndNode Modem firmware:

- No multicast messages implemented (Class C)
- FSK mode not supported during continuously listening (Class C)

5. Appendix

5.1 List of Abbreviations

FW	Firmware
HCI	Host Controller Interface
HW	Hardware
LR	Long Range
LoRa	Long Range
LPM	Low Power Mode
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTC	Real Time Clock
SW	Software
UART	Universal Asynchronous Receiver/Transmitter
WiMOD	Wireless Module by IMST

5.2 List of References

[1] WiMOD_LoRaWAN_EndNode_Modem_HCI_Spec.pdf

[2] iM880B_Datasheet.pdf

5.3 List of Figures

6. 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.

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