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Communication systems for meters

Part 8: Adaptation layer

National foreword

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Contents	Page
European foreword.....	4
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 Abbreviations and symbols	7
4.1 Abbreviations	7
4.2 Symbols.....	9
5 Network architecture	9
5.1 Overview	9
5.2 General description of network entities.....	10
5.2.1 Head End System	10
5.2.2 Core network	10
5.2.3 Gateway	11
5.2.4 End device.....	11
6 General layer structure.....	12
6.1 Overview	12
6.2 Encapsulation schemes.....	13
6.2.1 M-Bus over non-IP based communication technologies.....	13
6.2.2 M-Bus over IP based communication technologies	14
7 Adaptation layer description.....	15
7.1 Adaptation layer structure	15
7.2 Adaptation layer services.....	15
7.2.1 MBAL Control field (MBAL-CL)	15
7.2.2 Other MBAL fields	19
Annex A (informative) Overview of LPWAN technologies.....	20
A.1 LPWAN features for metering communication	20
A.2 Segregation matrix	20
Annex B (informative) MBAL implementation examples	21
B.1 MBAL for alarm data pulling scenario.....	21
B.2 MBAL for user data push and pull.....	21
B.3 Confirmed User Data transmission.....	22
Annex C (informative) Adaptation mechanism for Cat. NB (NB-IoT) and Cat. M1 (LTE-M).....	23
C.1 Cat. M1 and Cat. NB brief description.....	23
C.2 Cat. M1 and Cat. NB characteristics.....	23
C.3 Cat. M1 and Cat. NB network architecture	23
C.4 M-Bus over CIoT.....	26
Annex D (informative) Adaptation mechanism for LoRaWAN.....	47

D.1 LoRaWAN brief description 47

D.2 LoRaWAN network architecture 47

D.3 LoRaWAN security services description 49

D.4 LoRaWAN main features 50

D.5 LoRaWAN frame structure overview 50

D.6 M-Bus over LoRaWAN 51

Annex E (informative) Adaptation mechanism for TS-UNB..... 57

E.1 TS-UNB/MIOTY brief description 57

E.2 MIOTY network architecture..... 57

E.3 MIOTY principles 58

E.4 MIOTY frame structure overview 59

E.5 M-Bus over MIOTY..... 60

Annex F (informative) Adaptation mechanism for Wize 64

F.1 Wize brief description 64

F.2 Wize services..... 64

F.3 Wize network architecture 65

F.4 M-Bus over Wize 70

Bibliography 72

European foreword

This document (EN 13757-8:2023) has been prepared by Technical Committee CEN/TC 294 “Communication systems for meters”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2024, and conflicting national standards shall be withdrawn at the latest by March 2024.

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Introduction

This document belongs to the EN 13757 series, which covers communication systems for meters. EN 13757-1 contains generic descriptions and a communication protocol. EN 13757-2 contains a physical and a Link Layer for twisted pair-based Meter-Bus (M-Bus). EN 13757-3 contains detailed description of the application protocols especially the M-Bus Protocol. EN 13757-4 describes wireless communication (often called wireless M-Bus or wM-Bus). EN 13757-5 describes the wireless network used for repeating, relaying and routing for the different modes of EN 13757-4. EN 13757-7 describes transport mechanism and security methods for data. The Technical Report CEN/TR 17167 contains informative annexes for EN 13757-2, EN 13757-3 and EN 13757-7.

The M-Bus protocol upper layers (Transport and Application) can be used with various lower layers (Network, Data Link and Physical) as described in EN 13757-1. Systems based on the M-Bus protocol stack are well established in the metering market in Europe. In parallel, other wireless communication networks known as LPWAN (Low Power Wide Area Networks) have been widely deployed and target metering applications as well. The OSI reference model enables the transport of M-Bus upper layers on top of LPWANs lower layers. To ensure a seamless transition of the legacy systems based on Wireless M-Bus to LPWAN, an M-Bus Adaptation Layer (MBAL), is needed to provide the necessary services and information to the upper layers via an adequate interface, to minimize the impact on their existing implementations.

1 Scope

This document describes the functionalities and specifies the requirements of an adaptation layer to be applied when transporting M-Bus upper layers using a wireless communication protocol other than wireless M-Bus. These alternative radio technologies developed outside CEN/TC 294 can be based on Internet Protocol or not and operate either in licensed or unlicensed frequency bands.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13757-1:2021, *Communication systems for meters — Part 1: Data exchange*

EN 13757-3, *Communication systems for meters — Part 3: Application protocols*

EN 13757-4:2019, *Communication systems for meters — Part 4: Wireless M-Bus communication*

EN 13757-5, *Communication systems for meters — Part 5: Wireless M-Bus relaying*

EN 13757-7:2018, *Communication systems for meters — Part 7: Transport and security services*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 core network

set of logical and physical entities providing the communication services between the HES and the end devices

3.2 downlink

transmission in the direction from a gateway or a Head End System to the end device

3.3 end device

communication end node

EXAMPLE A radio adapter, a meter or similar device.

3.4 frame

unit of transmission at the Data Link Layer

3.5**gateway**

intermediate node in a data communication network, connected to two or more logical networks, where the protocols or modes used on the logical networks are different

3.6**Head End System**

system responsible for the management, reading and data collection of end devices applications

3.7**Low Power Wide Area Network**

wireless technologies with characteristics such as large coverage areas, low bandwidth, possibly very small packet and application-layer data sizes, and long battery life operation

3.8**L(n)**

refers to layer level (n) in the OSI model

3.9**uplink**

transmission in the direction from an end device to the gateway or Head End System

4 Abbreviations and symbols**4.1 Abbreviations**

AES	Advanced Encryption System
AFL	Authentication and Fragmentation Layer
APL	M-Bus Application Protocol Layer
AS	Application Server
Cat NB	Narrow band LTE category 1 and 2
Cat M1	LTE category for Machine Type Communication
CBOR	Concise Binary Object Representation
CI	Control Information (field)
CIoT	Cellular IoT
CN	Core Network
CoAP	Constrained Application Protocol
COSE	CBOR Object Signing and Encryption
CSGN	CIoT Serving Gateway Node
DLL	Data Link Layer
DoNAS	Data over NAS
ECM	EPS Connectivity Management
ED	End Device

eDRX	extended Discontinuous Reception
ELL	Extended Link Layer
eNB	Evolved Node B
EPC	Evolved Packet Core
EPS	Evolved packet System
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
FUOTA	Firmware Update Over The Air
GPRS	General Packet Radio Service
GTP-U	GPRS Tunnelling Protocol – User Plane
GW	Gateway
HARQ	Hybrid Automatic Repeat Request
HES	Head End System
HTTP	Hyper Text Transfer Protocol
IoT	Internet of Things
IP	Internet Protocol
LLC	Logical Link Control
L_n	Layer n according to OSI reference model definitions
LPWAN	Low Power Wide Area Network
LPWAN ID	LPWAN Unique Identifier
LTE	Long Term Evolution
MAC	Medium Access Control
MBAL	M-Bus Adaptation Layer
MCL	Maximum Coupling Loss
MME	Mobility Management Entity
MNO	Mobile Network Operator
NAS	Non-Access Stratum
NIDD	Non-IP Data Delivery
NWL	Network Layer
PCI	Protocol Control Information
PDCCP	Packet Data Convergence Protocol
PDN	Packet Data Network
PDU	Protocol Data Unit

PGW	PDN Gateway
PHY	Physical Layer
PSM	Power Saving Mode
PTW	Paging Transmission Window
RAN	Radio Access Network
REST	Representational State Transfer
RF	Radio Frequency
RFU	Reserved for Future Use
RLC	Radio Link Control
RRC	Radio Resources Control
S1AP	S1 Application Protocol
SCTP	Stream Control Transmission Protocol
SDU	Service Data Unit
SGW	Serving Gateway
TAU	Tracking Area Update
TCP	Transmission Control Protocol
TPL	Transport Layer
UDP	User Datagram Protocol
UE	User Equipment

4.2 Symbols

Hexadecimal numbers are designated by a following “h”.

Binary numbers are designated by a following “b”.

Decimal numbers have no suffix.

5 Network architecture

5.1 Overview

The typical LPWAN network architecture is illustrated in Figure 1 showing the physical devices (as squares) and software instances (as circles).

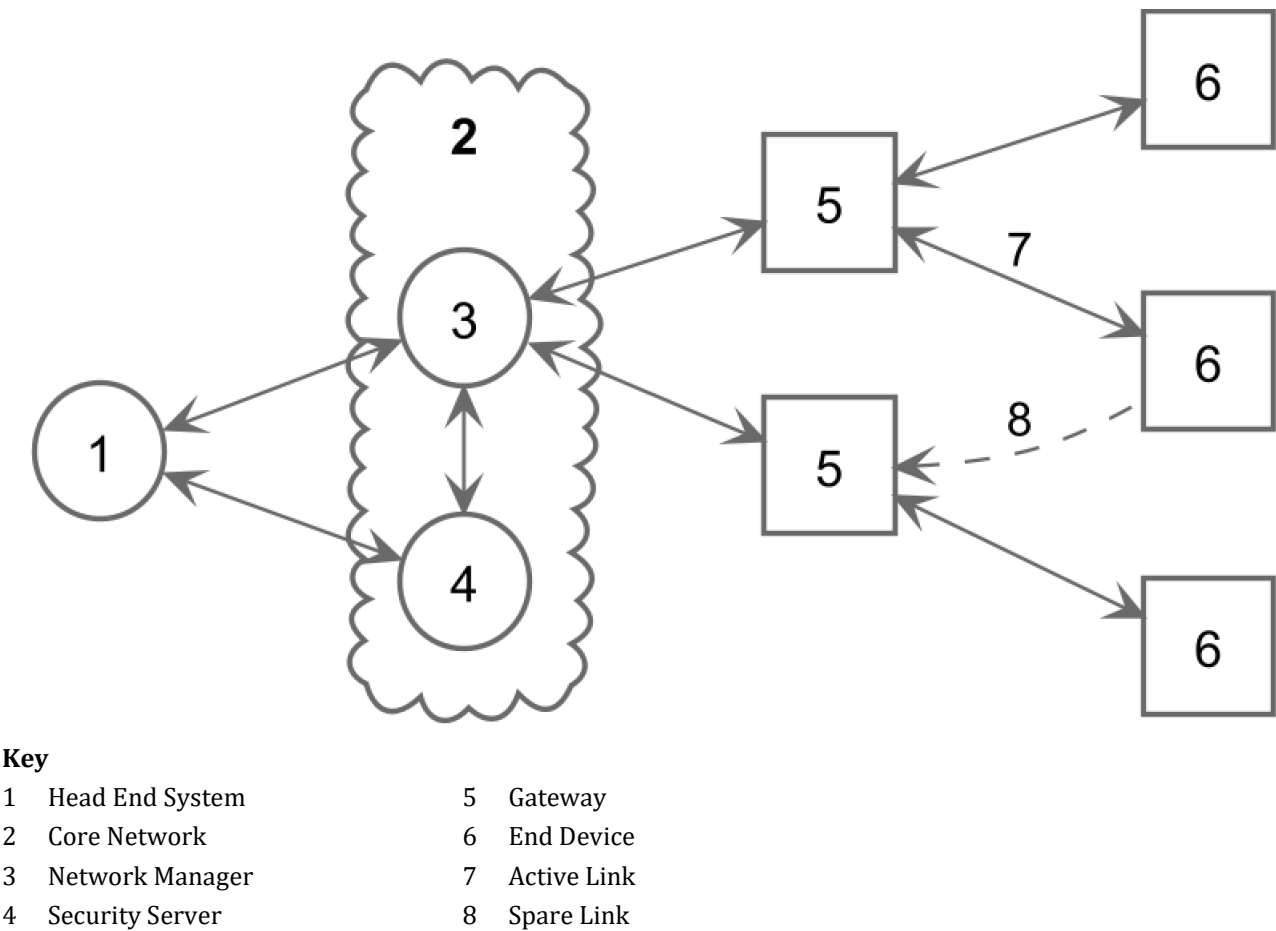


Figure 1 — LPWAN network architecture overview

An overview of LPWAN technologies is given in Annex A.

5.2 General description of network entities

5.2.1 Head End System

The HES is deployed and managed by the metering service or application provider. HES, and its related components are responsible for handling TPL/AFL/APL layers. It can be built of several components each of which is dealing with a given set or subset of functionalities or services, typically fragmentation.

The HES is connected to the Core Network via dedicated interfaces and protocols and uses its services to exchange data messages with the end devices. It may also be connected to the security server to manage the communication security requirements.

5.2.2 Core network

5.2.2.1 Network manager

The Network Manager is responsible for managing communication links and infrastructure using Network, DLL, and MAC services according to the protocol specifications. It allocates the necessary resources to establish a communication between the HES and the end device. These services enable the configuration and setting of different communication parameters to optimize network and end devices resources usage and enforce wireless communication rules.

The network manager may communicate with the end devices through the gateways. Both elements can be under the control of the network manager. In order to secure the communication link, the network manager can be connected to the security server to retrieve the adequate security material.

5.2.2.2 Security server

The security server is responsible for managing the security services. It holds the necessary cryptographic keys and credentials of the end devices. It distributes those to the network server and the HES, via dedicated and secure interfaces, to achieve the required level of data confidentiality, integrity and authentication. These security materials are conveyed and stored in the security server in a way compliant with standard security policies.

5.2.3 Gateway

The gateway is a network element responsible for the transfer of RF frames between the network manager and the end device. Any frame transmitted to the end device via the gateway is called downlink frame. Reciprocally, any frame transmitted by the end device to network manager via the gateway is called uplink frame. One uplink frame can be received on several gateways while a downlink is transmitted by a single gateway (refer to element 7 and 8 in Figure 1).

A gateway is potentially capable of operating on different frequency bands and/or channels and transmitting or receiving multiple frames at the same time.

5.2.4 End device

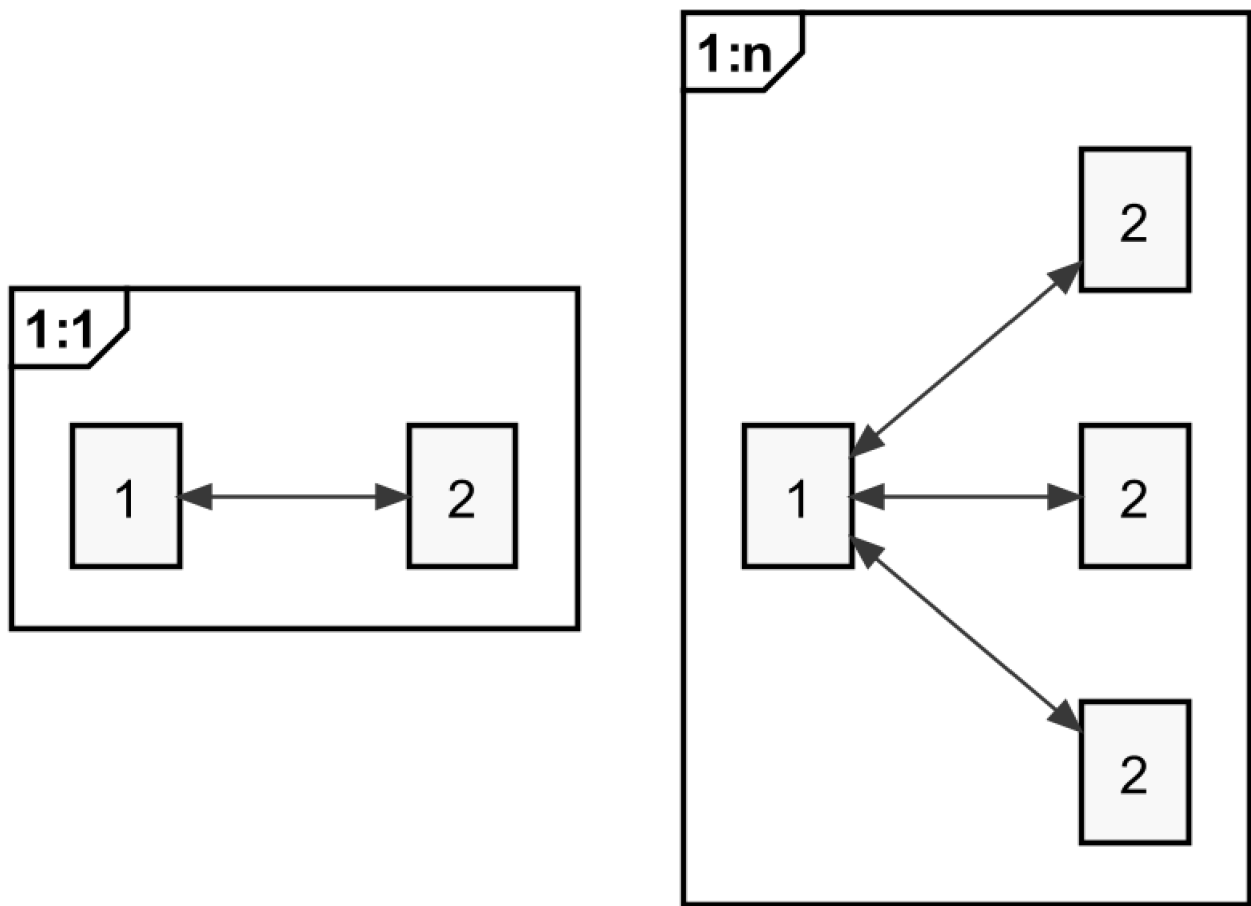
The end device is responsible for managing all layers. It communicates with the gateway on the LPWAN layers and with the HES on the upper layers (APL/TPL/AFL). An end device is potentially capable of running several applications using one or multiple LPWAN. The necessary security material is either stored in the end device's memory or conveyed from the security server.

Each end device has a unique identifier called LPWAN ID which is equivalent to the MAC address. The upper layers use the application address, contained in the TPL, to identify the end device when communicating with the HES.

Attention should be paid to the cases where multiple meters or sensors are served by a single end device acting as a radio adapter. In that case, the long header format of the TPL shall be used in each application message in both directions (ED <-> HES) while the end device uses its LPWAN ID at the lower layers.

To announce the relationship between the LPWAN ID and the application address, the latter shall be transmitted at least during the initialisation phase.

If there is a 1:1 relation between the LPWAN ID and the application address, then the transmission of the application address may be skipped in any later message transfers. Otherwise, the application address needs to be provided at any time. Both cases are illustrated in Figure 2.



Key

- 1 LPWAN module of the end device with a unique LPWAN identifier
- 2 End device application like a meter with a unique application address

Figure 2— End device LPWAN identifier and application address relations

6 General layer structure

6.1 Overview

This specification describes a mechanism, called M-Bus Adaptation Layer (MBAL), to be used to transport M-Bus datagrams over different wireless communication protocols, known as LPWAN, using the layered approach that has been defined in EN 13757-1:2021, 4.2 and the layer model structure specified in EN 13757-7:2018, 5.1. In the following parts, the upper layers will refer to APL, AFL and TPL that operate end-to-end while the lower layers refer to Network, Data Link and Physical layers as specified in the OSI basic reference model [1].

The MBAL is inserted between the M-Bus upper layers and the LPWAN lower layers as depicted in Table 1. Its goal is to keep the M-Bus data exchange principles effective while using wireless technologies defined outside of the EN 13757 series to minimize the impact to this transition and to ensure interoperability at the upper layers level. In this context of “M-Bus over LPWAN”, the MBAL provides the necessary services to the upper layers as described in Clause 7 of this document.

Table 1 — General layer structure

OSI Model	M-Bus Layers (acc. to EN 13757-7)	Layers for M-Bus over LPWAN
Application Presentation	APL (EN 13757-3)	APL according to EN 13757-3
Session Transport	TPL (EN 13757-7)	TPL according to EN 13757-7
	AFL (EN 13757-7)	AFL according to EN 13757-7
Adaptation Layer ^a	-	MBAL according to EN 13757-8
Network	NWL (EN 13757-5)	LPWAN related specifications
Data Link	ELL (EN 13757-4)	
	DLL (EN 13757-4)	
Physical	PHY (EN 13757-4)	
^a Adaptation layer is an extension of the original OSI model for the purposes of M-Bus over LPWAN.		

6.2 Encapsulation schemes

6.2.1 M-Bus over non-IP based communication technologies

For the sake of end device power efficiency and spectrum occupancy optimizations, some LPWAN technologies feature a collapsed communication protocol stack where only L1, L2 and potentially L3 for relaying, are needed and specified.

In that scenario, the M-Bus upper layers PDU is concatenated with the MBAL fields and transmitted to the LPWAN layers. The latter encapsulates this M-Bus payload as an SDU, adds the appropriate PCI and sends it to the GW which will use an IP backhaul connection to forward the M-Bus payload to the HES through the CN. The HES receives the M-Bus payload including the MBAL fields and will process it according to M-Bus layers specifications.

Symmetrically, in the downlink scenario, the HES upper layers message is appended to the MBAL fields and transmitted as an M-Bus payload to the CN using the adequate interface and application protocol. The CN will route the payload to the serving GW to be conveyed using the LPWAN link when the ED provides an access slot. ED's LPWAN layers will de-encapsulate the M-Bus payload and present it to the upper layers which will take care of processing MBAL and M-Bus upper layers fields. Both scenarios are described in Table 2.

Table 2 — M-Bus over non-IP LPWAN encapsulation

ED	Core Network		HES
APL/TPL/AFL			APL/TPL/AFL
MBAL			MBAL
		TCP/UDP	TCP/UDP
LPWAN	LPWAN	IP	IP
		L2	L2
		L1	L1

The adaptation mechanism is given in respectively Annex D (LoRaWAN), Annex E (TS-UNB) or Annex F (Wize).

6.2.2 M-Bus over IP based communication technologies

When the LPWAN being used is based on IP, M-Bus payload, including APL/TPL/AFL and MBAL, will be encapsulated in the IP packet which will be encapsulated itself in the LPWAN frame. In that scenario, the ED will act as a standard IP node using IPv4/IPv6 address and implements standard IP transport protocols (like TCP or UDP) procedures to send its payload to the CN. The latter retrieves the IP packet and sends it using a dedicated interface to the HES which will de-encapsulate the message and retrieve the initial M-Bus payload. All the intermediate IP nodes are transparent to the M-Bus upper layers and MBAL which acts on an end-to-end basis between the HES and the ED as described in Table 3.

It should be noted that this encapsulation mechanism may be extended to introduce an intermediate application protocol layer, considered as an optional “transfer layer” below the MBAL. In that case, the M-Bus payload is placed in the transfer protocol message which is encapsulated in a TCP/UDP datagram.

Table 3 — M-Bus over IP-based LPWAN encapsulation

ED	Core Network		HES
APL/TPL/AFL			APL/TPL/AFL
MBAL			MBAL
Transfer layer ^a			Transfer layer
TCP/UDP	TCP/UDP	TCP/UDP	TCP/UDP
IP	IP	IP	IP
IP based LPWAN (Cat. M1 & Cat. NB)	IP based LPWAN (Cat. M1 & Cat. NB)	L2	L2
		L1	L1

^a The usage of the transfer protocol is optional.

The adaptation mechanism for Cat. M1 (LTE-M) and Cat. NB (NB-IoT) is given in Annex C.

7 Adaptation layer description

7.1 Adaptation layer structure

For the M-Bus Adaption layer the CI-fields according to Table 4 are reserved.

Table 4 — CI-fields of MBAL

CI-field	Designation	Remarks
CC _h to CE _h	RFU	Reserved for Future Use
CF _h	MBAL	MBAL Structure acc. to Table 5

The adaptation layer applies a structure according to Table 5.

Table 5 — Structure of M-Bus Adaption layer with CI-field CF_h

Size (bytes)	Field Name	Description
1	CI	Indicates an M-Bus-adaptation layer ^a
1	MBAL-CL	MBAL Control field
^a The presence of the CI-field is optional and depends on the applied LPWAN technology.		

The LPWAN implementation description provides information on whether a CI field is present. If the CI-field is not used, the MBAL Control field will be the only byte of the MBAL. For a given LPWAN technology, the presence of the CI field is described in the related annex.

NOTE The MBAL Control field (version 1) will not use the value of CF_h. If the first byte has a value of CF_h the presence of the CI-field as first byte can be assumed.

7.2 Adaptation layer services

7.2.1 MBAL Control field (MBAL-CL)

7.2.1.1 Structure of MBAL Control field

The MBAL Control field provides several subfields which differs between uplink and downlink communication. The MBAL Control field for the uplink is defined in Table 6 and for the downlink in Table 7.

Table 6 — MBAL Control field in uplink

MS Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LS Bit 0
Version	Version	Access	Access	Function code	Function code	Function code	Function code
V	V	A	A	F	F	F	F

Table 7 — MBAL Control field in downlink

MS Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LS Bit 0
Version	Version	Latency	Latency	Function code	Function code	Function code	Function code
V	V	L	L	F	F	F	F

The applicable versions are defined in the MBAL-CL subfield version (refer to 7.2.1.2). The content of the other subfields is described in the following subclauses.

7.2.1.2 Subfield Version

The MBAL Version subfield is used to identify the version of the applied MBAL structure. So far only one version is supported according to Table 8.

Table 8 — MBAL-CL Version subfield

MBAL-Control bit 7 bit 6	Version
0 0	Version 1 (initial version of MBAL)
0 1	RFU
1 0	RFU
1 1	RFU

7.2.1.3 Subfield Access (uplink)

The MBAL-CL Access subfield is only available in the uplink communication. It describes the current accessibility of an end device. This information can be used to estimate the availability of an access window of the end device in the case a command is intended to be sent by the HES. The accessibility is defined in Table 9 and based on the accessibility of a wireless M-Bus end device as defined in EN 13757-4:2019, Table 37. When using M-Bus security modes 0 or 5, Bits A and B (Access and Bidirectional) located in the Configuration field of the TPL (refer to Table 23 of EN 13757-7:2018) should be ignored.

Table 9 — MBAL-CL Access subfield

MBAL-Control bit 5 bit 4 (uplink)	Accessibility
0 0	No access or temporary no access
0 1	Short or limited access window after transmission
1 0	Unlimited or continuous access
1 1	Unused or unavailable

NOTE In case of an MBAL Access subfield 00b, it is useful to postpone the downlink transmission to avoid a timeout.

7.2.1.4 Subfield Latency (downlink)

The MBAL-CL Latency subfield is only available in the downlink communication. It describes the proposed latency for the end device response. This information is used by the TPL layer to control the response timing of the end device. The latency subfield is defined in Table 10.

Table 10 — MBAL-CL Latency subfield

MBAL-Control bit 5 bit 4 (downlink)	Latency
0 0	RFU
0 1	Response or TPL ACK can be sent with delay
1 0	Response or TPL ACK is expected as soon as possible
1 1	Unused or invalid

7.2.1.5 Subfield Function code

The MBAL-CL Function code subfield is used in uplink and downlink communication to separate and distinguish different types of a message.

The function code describes the type and function of a message.

The separation of the message types is essential to avoid confusion between different data streams.

NOTE 1 For example, using the message type helps by not taking an unsolicited SND-NR message from the end device as a response to a pending request in downlink.

NOTE 2 The function codes of the MBAL are based on the wireless M-Bus function codes as described in EN 13757-4:2019, 12.5.4 although they are not identical. Since the communication possibilities in the LPWAN exceed those of the wireless M-Bus, further function codes have been added in Table 11 and Table 12.

Table 11 defines the values of the MBAL-CL subfield Function code used for the uplink and Table 12 for the downlink.

Table 11 — MBAL-CL Function code subfield (uplink)

Function code	MBAL-Control bit 3 to bit 0 (uplink)	Symbolic name	Function	Confirmed by
0 _h	0 0 0 0	TPL-ACK	The end device acknowledges the reception of the message	-
1 _h	0 0 0 1	TPL-NACK ^a	Negative acknowledgement from the end device in case an unknown or unsupported function code was received	-
2 _h	0 0 1 0	SND-UD	Send unsolicited application data and expect an acknowledgement from HES ^b (refer to Annex B)	TPL-ACK
3 _h	0 0 1 1	-	RFU	-
4 _h	0 1 0 0	SND-NR	Send unsolicited application data and expecting no response from HES ^b	-
5 _h	0 1 0 1	ACC-DMD2 ^c	This message requests an access to the end device (Compact communication sequence; refer to Annex B)	REQ-UD1
6 _h	0 1 1 0	SND-IR	Send manual initiated installation data with request to be registered by the HES ^b	CNF-IR
7 _h	0 1 1 1	ACC-NR	Send solicited/periodical message without application data to provide the opportunity of access to the end device	-
8 _h	1 0 0 0	RSP-UD	Response of application data after a request from the HES	-
9 _h	1 0 0 1	-	RFU	-
A _h	1 0 1 0	ACC-DMD ^c	This message requests an access to the end device	TPL-ACK
B _h to E _h	1 0 1 1 to 1 1 1 0	-	RFU	-
F _h	1 1 1 1	-	Function code is not used	-

^a The TPL-NACK is responded to any type of message in the case no valid function code is detected.

^b The statements about an expected response refer to the final recipient (HES) and make no statement about whether or not the intermediary network acknowledges the reception of a message to the sender.

^c According to EN 13757-4:2019, E.6 the ACC-DMD will be responded with a TPL-ACK. The request of alarm data happens later. To shorten the communication steps in the LPWAN, the additional ACC-DMD2 is introduced, which expects a REQ-UD1 as an immediate response.

Table 12 — MBAL-CL Function code subfield (downlink)

Function code	MBAL- Control bit 3 to bit 0 (downlink)	Symbolic name	Function	Confirmed by
0 _h	0 0 0 0	TPL-ACK	The recipient acknowledges the reception of the message	-
1 _h	0 0 0 1	TPL-NACK ^a	Negative acknowledgement from the recipient in case an unknown or unsupported function code was received	-
2 _h	0 0 1 0	SND-UD	Send data and expect an acknowledge from recipients ^b	TPL-ACK
3 _h	0 0 1 1	SND-UD2	Send data and expect a response from recipients ^b	RSP-UD
4 _h	0 1 0 0	SND-NR	Send data and expect no response from recipients ^b	-
5 _h	0 1 0 1	SND-UD3	Send data to multiple receivers at the same time and expect no response from recipients ^b	-
6 _h	0 1 1 0	CNF-IR	Confirms the registration by the recipient	-
7 _h	0 1 1 1	SND-NKE	Terminates the communication session	-
8 _h to 9 _h	1 0 0 0 to 1 0 0 1	-	RFU	-
A _h	1 0 1 0	REQ-UD1	Alarm request, (Request User Data Class 1) from the end device	RSP-UD or TPL-ACK ^c
B _h	1 0 1 1	REQ-UD2	Data request (Request User Data Class 2) from the end device	RSP-UD
C _h to E _h	1 0 1 0 to 1 1 1 0	-	RFU	-
F _h	1 1 1 1	-	Function code is not used	-
^a The TPL-NACK is responded to any type of message in the case no valid function code is detected. ^b The statements about an expected response refer to the upper layers of end device and make no statement about whether or not the lower layers acknowledge the reception of a message to the sender. ^c In case there are no alarm data the end device responds with an TPL-ACK.				

The mandatory or optional support of message types of Table 11 and Table 12 shall be according to the rules defined in Table 34 and Table 35 of EN 13757-4:2019. The support of message types not defined in EN 13757-4:2019 is optional.

7.2.2 Other MBAL fields

With version 1 (refer to 7.2.1.2) no further MBAL fields are supported.

Annex A (informative)

Overview of LPWAN technologies

A.1 LPWAN features for metering communication

To be used with the defined MBAL mechanism, the LPWAN protocol should fulfil the following conditions:

- 1) Available in CEN member countries;
- 2) Technical specifications publicly accessible;
- 3) Compatible with the use cases within the scope of CEN/TC 294 Communication systems for meters.

On the technical level, the LPWAN technology are characterized by the following properties:

- a) Low power consumption: to enable +10 years lifetime;
- b) Low-cost modem: to keep affordable price for radio units;
- c) Long range: to cope with deep indoor conditions;
- d) Robust link: to be resistant to interferences;
- e) High capacity: to support thousands of end devices within cities;
- f) Support bi-directional communication;
- g) Built on a star topology.

A.2 Segregation matrix

Some known and deployed LPWAN technologies are compared according to technical criteria in Table A.1.

Table A.1 — LPWAN technologies comparison matrix

LPWAN Technology	Cat. M1	Cat. NB	LoRaWAN	MIOTY	Sigfox	Wi-Sun	WIZE
IP based	1	0/1 ^a	0	0	0	1	0
Licensed Spectrum	1	1	0	0	0	0	0
Confirmed Message	1 ^c	0/1 ^b	0/1 ^d	0/1 ^d	0	1 ^d	0/1
Star topology	1	1	1	1	1	0	1
NOTE A value 0 means “False” or “not supported” while 1 value means “True” or “Supported”. 0/1 means that both options are possible.							
^a Cat. NB supports a non-IP based model called NIDD. ^b Cat. NB: Confirmation and repetitions are handled on the RLC layer (HARQ) but not possible on the transport layer when using UDP. ^c Cat. M1: Confirmation and repetitions are handled on the RLC layer (HARQ) in addition to the transport layer when using TCP. ^d Confirmation and repetitions are handled on the MAC layer.							

Annex B
(informative)

MBAL implementation examples

B.1 MBAL for alarm data pulling scenario

Message types introduced by the function code of the MBAL have been extended to introduce some new functionalities compared to those provided by EN 13757-4:2019. Figure B.1 describes the usage of MBAL to access alarm data using the newly defined ACC-DMD2 message type. The communication is established at the upper layers level between the ED Upper Layers (ED_UL) and the HES Upper Layers (HES_UL).

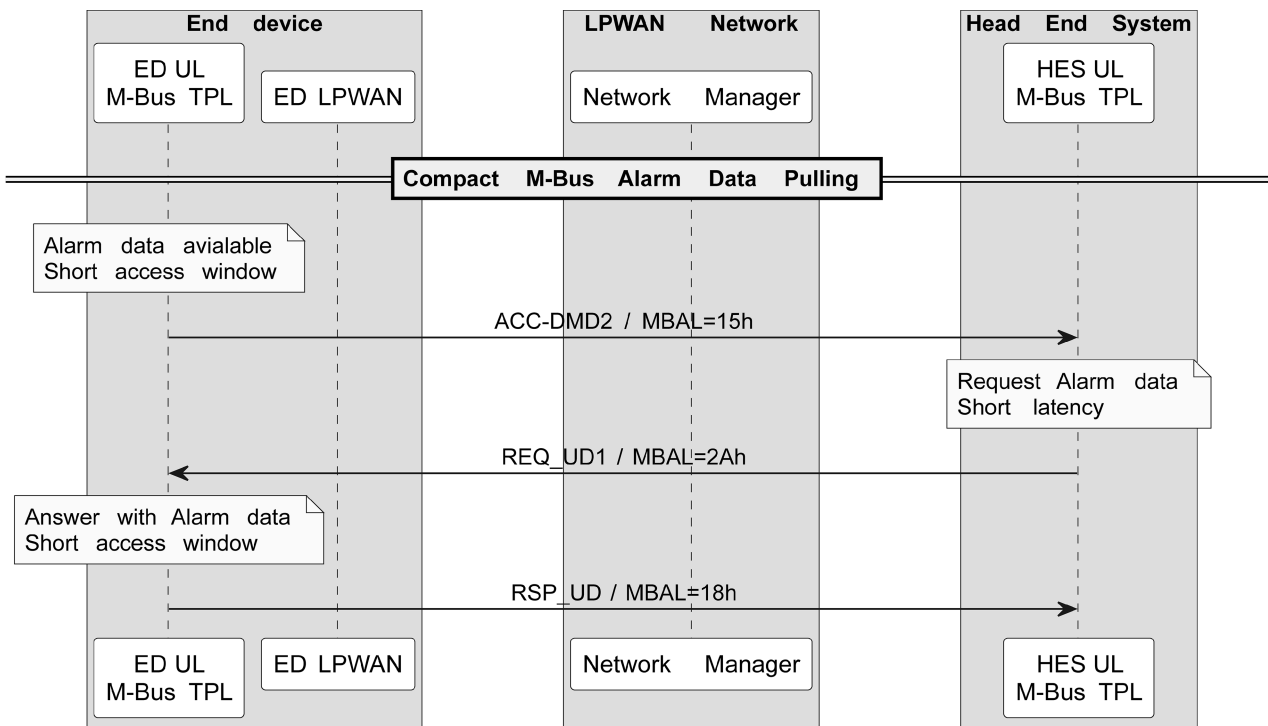


Figure B.1 — M-Bus alarm data pulling using MBAL

B.2 MBAL for user data push and pull

MBAL allows efficient data exchange between the ED and HES. In the scenario depicted in Figure B.2, the ED transmits its application data using the SND-NR and provide a short access window. The HES takes advantage of this opportunity to ask for additional user data by the means of REQ-UD2 message. When the latter request is received, the ED answer back as soon as possible, given duty cycle and battery constraints, by sending the application data using RSP-UD message.