Open Metering System Specification

Volume 1

General Part

Issue 2.0.1 / 2014-10

RELEASE

Document History

Version	Date	Comment	Editor
0.1	2008-02-12	Initial version for discussion in Open Metering Meeting 2008-02-26/26 in Laatzen	P. Gabriel, IMS <peter.gabriel@ims.fraunhofer.de >
0.2	2008-03-05	split into three documents; first changes after review	P. Gabriel
0.3	2008-03-06	Changes after mini review with Mr. Pahl and Mr. Guderjahn. Further integration of Laatzen review changes	P. Gabriel
0.4	2008-03-18	Changes after first review and review of version 0.3	P. Gabriel
0.5	2008-03-28	Changes after comments and correction of English texts	P. Gabriel
0.6	2008-04-02	Further correction	P. Gabriel
0.7	2008-05-08	Start editing 080508; div. Q on wording marked	H. Baden
0.8	2008-06-30	Changes of review by Mr. Pahl and Mr. Thor; Structure changed. List of members moved to an annex; New lists of tables and figures.	H. Baden
0.9	2008-07-12	Changes stated by Mr. Ziegler, Mr. Ossig Mr. Feuchtmeier and Mr. Pahl implemented. Fig.1 changed	H. Baden
0.9.1	2008-07-14	Review with Mr. Pahl	H. Baden
0.9.2	2008-07-14	Review with Mr. Feuchtmeier; Fig.2 Scen.3 changed; Last version before release of V.1.0 for external discussion.	H. Baden
1.0.0	2008-07-21	Minor correction proposals: Prof. Ziegler; Amendments by Mr. Feuchtmeier on 2.2, 3.3 and 3.4	H. Baden
1.0.1	2008-09-19 2009-01-12	Term 'Customer' changed to 'consumer' Chapter 'Security' extended	H. Baden
1.0.2	2009-01	3.3 M-Bus and 3.4 DLMS/COSEM completed; EN 13757-6 added to Appendix A; Review with several text corrections and amendments; App. C List of members completed	H. Baden / AG2
1.0.3	2009-02	Fig.1 changed: customer à consumer, PSTN à DSL, Metering Devices; 3.5.2 and 3.7.3 corrected; Fig.2 changed: customer à consumer; New Fig. 3, Encryption; List of members: EMS Patvag changed to Swiss Gas Metering AG / MEMS AG, CH	H. Baden / AG1-2 / on request of Mr. Sabattini
1.0.4	2009-03-02 to 2009-0318	Fig. 2 corrected; File name added to footer; changed Fig. 3 Encryption symmetric; New Fig. 4 Signature asymmetric; AMMBO added to App. B; Fig.1: Consumer Interface changed to ISO/IEC 14543; ISO/IEC 14543 added to App. A; PDF traced created, distributed to AG2; Fig.3 changed (KST, KSP); 3.7.3 and Fig.4 edited; Cleaned up for AG2 #20 and Plenum #8; Amendment on 3.5.3 Breaker;	H. Baden / on request of Mr. Lux, KNX / as of AG1 #20 / AG2 #20
1.0.4	2009-03-23	App. A: Reference Codes changed: DLM2008 à DLMS-UA MBUS2008 à MBUS-UG OBK2008 à OBIS-ConvTab SML2008 à SML-spec	H. Baden
1.0.4	2009-04-08	Version closed to be released as v.1.1.0	H. Baden
1.1.0	2009-04-26	Release	H. Baden

Version	Date	Comment	Editor
1.1.1	2009-05-07	New issue draft opened for editing; Reactivated: 3.4.2 Sophisticated Meter; Structure of '3 Definitions and Terms' enhanced and amendments added; Radiocrafts added to App. C; Review / changes at AG1 meeting; Definitions without numeration; Definition of repeater added; Fig.2 correction: connection of one meter to more than one MUC to be marked as alternatively but not at same time	H. Baden / as of AG2 #21 / as of AG1 #22
1.1.2	2009-06-12	New draft issue opened; Fig.2 Legend completed; lines shaped more clear; Abbreviation MUC definition completed; Issue distributed to AG1 and AG2 members for meeting review and release	H. Baden / as of AG2 #22 /
1.1.3	2009-07-04 to 2009-07-17	Editorial corrections; Reference ETSI2006 changed to ETSI-ERM; Definition 'Breaker' changed to 'Actuator' in accordance to Vol.2 / AG1; Reference REC7003 corrected to ERC7003; New references added: EN 60870-5-2 and NTPv4; Version closed for release as V.1.2.0; Final corrections (only formal)	H. Baden / as submitted by Mr. Evjen / in adaption to OMSS Vol.2 V.1.0.8
1.2.0	2009-07-17	Release for publication	H. Baden
1.2.1	2009-10-07	Checked for register value, no changes necessary	H. Baden
1.2.2	2009-12-18 to 2010-03-24	Definition of the OMS-MUC added to 3.2; 3.1 changed to table-structure; E-DIN 43863-5 added to App. A; App. C Member list updated	H. Baden as of AG-2, Action 21-09
1.3.0	2010-03-24	Editorial fix up and release	H. Baden
1.3.1	2010-03-29	Page 6 Line 12: KNX added	H. Baden as of Mr. Lux
1.3.2	2010-11-08 to 2010-11-10	Footer changed from Open Metering to OMS GROUP; OMS Logo added to front page and Headline; App. C Member list updated	H. Baden
1.3.3	2010-11-18	Abbreviations MUCC and OMSS added to App. B; Definition MUC rendered more precisely; editorial corrections	H. Baden as of Mr. Peters, Mr Sabbattini and Mr. Lorenzen
1.3.4	2010-12-01 to 2011-01-27	Changes on '3.5 Offline Tariffing' and '3.6 Security' to clarify the difference between basic and sophisticated meter; Headline / Logo edited Amendment to the definition MUCC; secondary communication added to 2.1	H. Baden as of OMS plenary #11 / H. Baden as of Mr. Pahl / H. Baden as of AG1#31
1.4.0	2011-01-31	Final editorial fix up and release	H. Baden
1.4.1	2011-05-17 to 2011-11-10	Amendments to App. B; According to the OMS Glossary; Definitions of Basic Meter and Sophisticated Meter enhanced, Table added	H. Baden
2.0.0	2013-11 to 2014-07	Editorial revision; deletion of 'MUC-Terminology' and pictures; reference to CEN/CLC/ETSI/TR 50572; decisions AG1 #50-12; feedback AG1 (Th. Blank, D. Matussek); actions #51-4, #51-5, #51-6, #51-7; action #52-5	A. Bolder
2.0.1	2014-10	Issue for release	A. Bolder

Table of contents

List of figures

List of tables

1 Introduction

The OMS-Group is a community of interest of associations, presently figawa[1]and KNX[2], with enterprises in the area of metering relevant to accounting. With the 'OMS metering system specification' the OMS-Group has developed an open, vendor independent standard for communications interfaces and basic requirements.

The Open Metering System (OMS) is the only system definition across Europe which integrates all media (electricity, gas, heat and water incl. submetering) into one system. It is developed by the industry in order to guarantee a future-proof communication standard and interoperability between all the meter products.

Working groups have been established consisting of members from different companies[3]. The Working group experts come from meter manufacturers, manufacturers for communication devices, energy suppliers, communication companies and scientific institutions. The Open Metering Working Groups specify communication interfaces for the gateway and different communication endpoints. The vendor associations, figawa and KNX together with the Board of the OMS Group and the General Assembly of the OMS members guide this process of specification creation.

This specification focuses on an automatic meter readout system. Part of this system is the functional separation between the metering devices and the communication device i.e. the gateway (GW).

Metering devices are sensors and actuators which are defined in Chapter 3 Definitions and terms. Metering devices and AMM Systems have to follow certain protocols which are described within this document for Open Metering conformity.

Communication with the gateway splits up into primary, secondary and tertiary communication:

- The primary communication handles multi-discipline metering devices for electricity, gas and thermal energy as well as water meter or HCA reading. Its goals are the definition of the transmission media, of the transmission techniques and of the protocols between the metering devices on one side and the gateway on the other side.
- The secondary communication focuses on an extension of the covered range (wired, PLC or wireless) using networking and (multi) hopping based on a routing protocol. This routing protocol requires an additional Network Layer which is not supported by the primary communication. A unified secondary communication is not defined yet. If necessary proprietary solutions for secondary communication may be used to transport data via a (meshed) network. In this case it has to be ensured that data send out by an OMS meter are provided as defined in the Open Metering System Specification.
  A simple manufacturer independent extension of the radio range, based on repeater technologies (without the additional Network Layer), is described in the part primary communication (OMSPC).

[1] Bundesvereinigung der Firmen im Gas- und Wasserfach e.V. – German association of the companies in the gas and water industry, Cologne, GERMANY

[2] KNX Association, Brussels, BELGIUM

[3] The current members of the OMS-Group are listed under http://oms-group.org/mitglieder/

- The tertiary communication is the interface between a gateway and the head-end systems for automated meter management (AMM). It specifies the data flow for defined pull and push procedures between the gateway and the AMMHES. The main topics in tertiary communication are data acquisition and data providing for presentation, event handling, configuration, control and clock synchronization.
  NOTE: Tertiary communication is no longer in the focus of OMS.

The OMS Group has published the following parts of the Open Metering System Specification:

- Volume 1 General Part [OMSGP] – this document
- Volume 2 Primary Communication [OMSPC]
- Volume 3 Tertiary Communication and MUC [OMSTC]
  This Volume is no longer applicable

Conformance with the OMS specifications can be obtained by having the devices tested against the Open Metering System Conformance Test (OMS-CT). The OMS-CT is also available on the Homepage of the OMS Group, see chapter 5 Document Reference.

2 General definitions and system description

This chapter presents a total system overview including all term definitions and references to used standards.

2.1 System overview

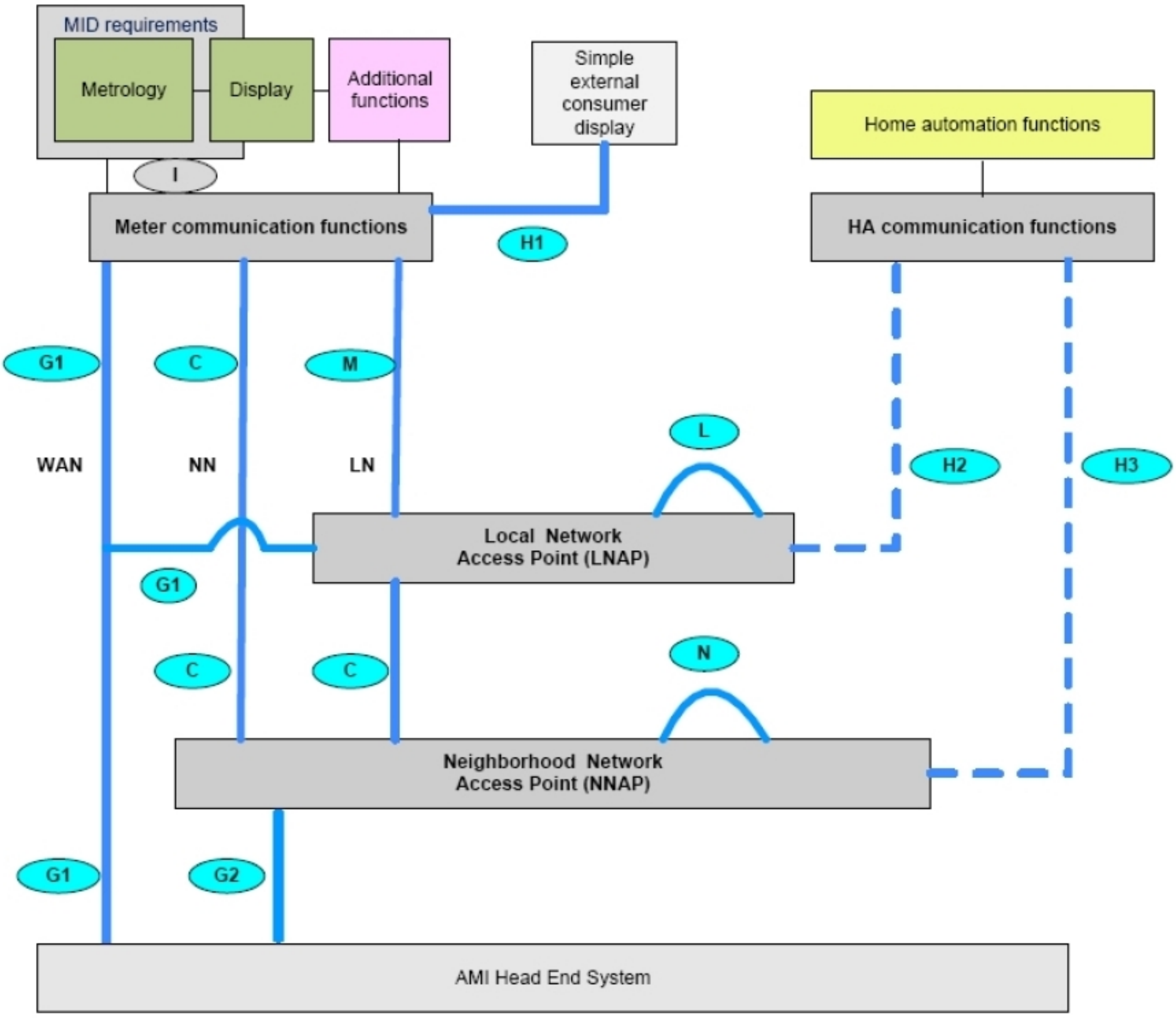

Figure 1 – Reference architecture diagram for smart metering communications[4]

Figure 1 gives an abstract overview of the functional entities and the interfaces, as defined by the mandate M/441 of The European Commission. The OMS specifications provide solutions which may be used at the following interfaces:

- Metering end device interface (M interface)
- Local connection to consumer display (H1 interface)
- LNAP Peer Interface (L interface)
- NNAP interface (C interface)

[4] Source: [TR 50572]

Table 1 shows the relationship between the interfaces according to mandate M/441 and the OMS Group.

Table 1 – Communication interfaces

OMS Interfaces	Interface in reference architecture
Primary communication	M, C, H1
Secondary communication	L, N, C
Tertiary communication	G1, G2

NOTE: The mandate M/441 does not see the two interfaces L and H1 within the scope of meter communication protocols but within the scope of home and building systems. Consequently CLC/TC 205 “Home and Building Electronic Systems (HBES)” has worked on the European Standard prEN 50491-11:2013 General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) – Part 11: Smart Metering – Application Specifications – Simple External Consumer Display. In this standard the existing communication protocols from e.g. EN 13757 are mapped to a data model allowing the implementation of simple in-home displays (read-only). Thus OMS specifications may be applicable to IHDs.

2.2 System topology

Figure 2 to Figure 4 show different scenarios of the system topologies. The AMM head-end system maintains a connection to several gateways. The gateways themselves keep the connection to several meters.

In practice **all shown scenario options may appear as a hybrid topology** if supported by the particular product.

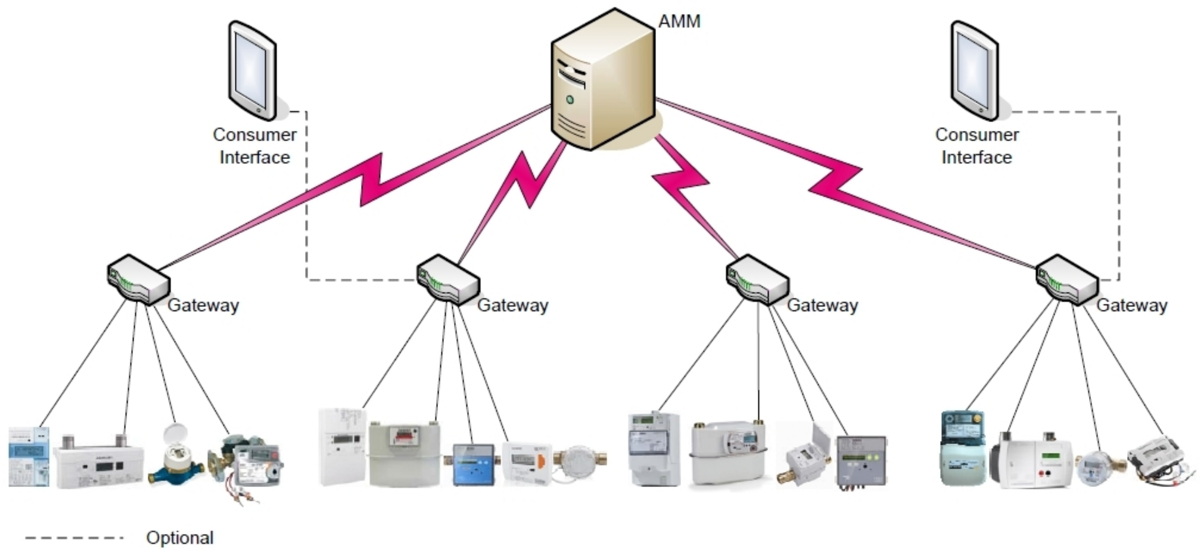

Figure 2 – System Topology Scenario 1

<u>Scenario 1</u> will be used if each apartment has its own gateway. Each metering device of an apartment is assigned to its one specific gateway.

Each consumer may have his own display unit (dedicated display, web browser application, PDA etc.) connected to his specific gateway, to receive energy consumption information and e.g. tariff data. Habitations or facilities are independent.

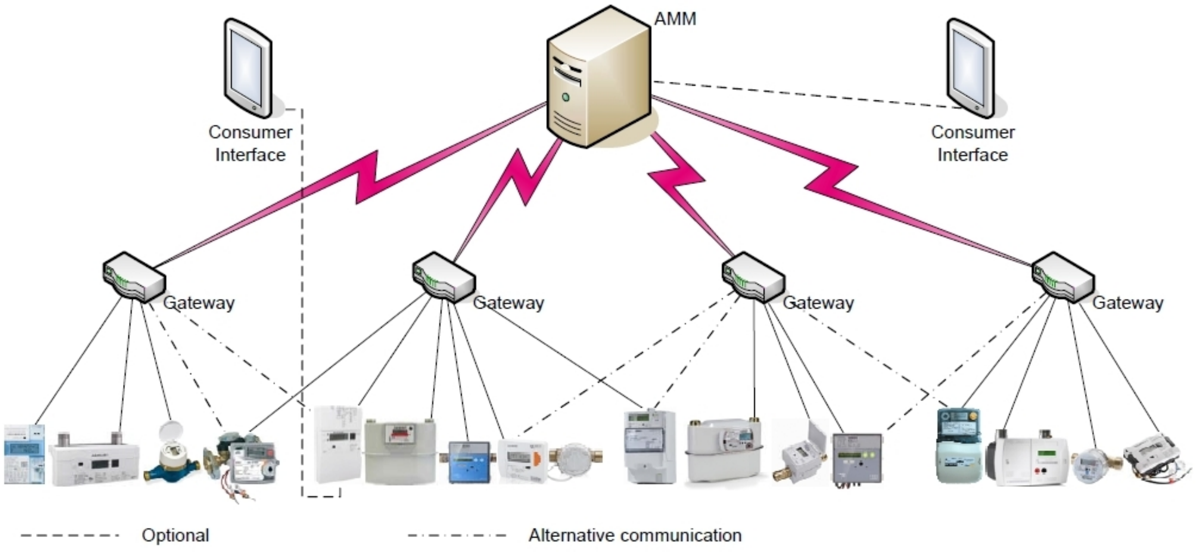

Figure 3 – System Topology Scenario 2

In Scenario 2 displays receive data from the AMM head-end, provided by an internet portal system, or they read meter data directly from the meter.

Meters may be shared among gateways to avoid out of range problems. Scenario 2 has the advantage, that redundant transmission from a meter via several gateways is possible. Scenario 2 has the disadvantage, that the different routing has to be tracked and that an occasional exchange of keys and/or certificates is more complex.

The Scenario 2 topology may also be used during the installation phase to set up installations for scenario 1.

NOTE: Legal restrictions may prohibit the use of Scenario 2.

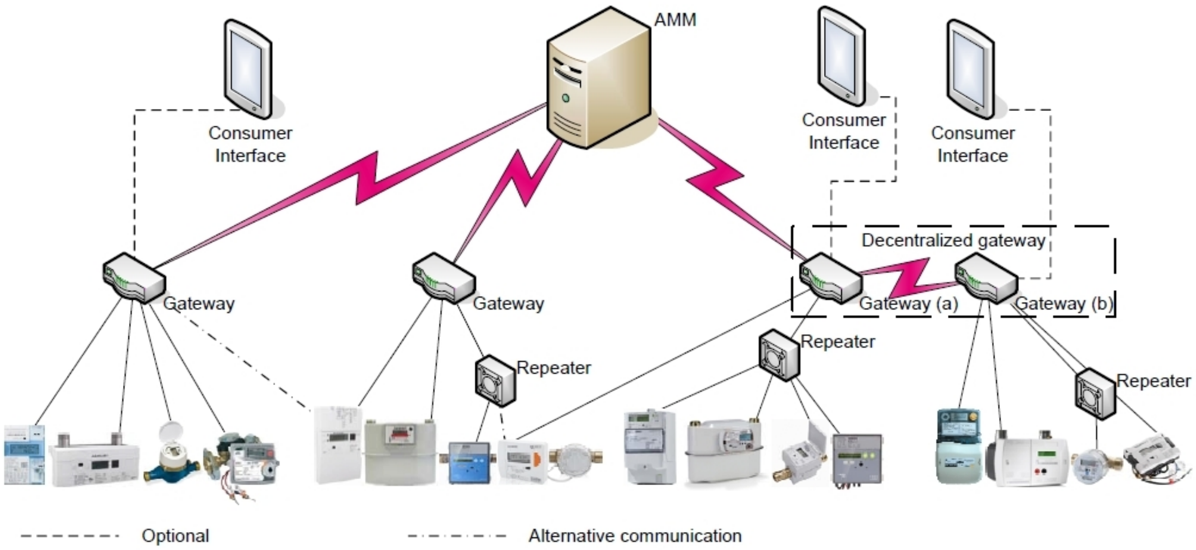

Figure 4 – System Topology Scenario 3

Scenario 3 shows the clustering[5] of some gateways and primary communication with additional repeaters.

5 This is not subject of the OMS specification but may be realized as a proprietary solution as long as defined requirements of this specification are fulfilled.

Here meters may also be shared among gateways to avoid out of range problems. Scenario 3 has the advantage, that redundant transmission from a meter via several gateways is possible. Scenario 3 has the disadvantage, that the different routing has to be tracked and that an occasional exchange of keys and/or certificates is more complex.

NOTE: Legal restrictions may prohibit the use of Scenario 3.

3 Definitions and terms

This chapter contains the major definitions and terms used in this specification.

More detailed definitions are given in a separate glossary document, see Annex A: Glossary of Terms.

3.1 Market roles

According to the European legislation for the internal energy markets a set of market roles were established to fulfil the requirements on legal and functional unbundling of consolidated companies.

Table 2 – Market roles

Term	Description
Meter Site Operator (MSO)	The MSO is generally the owner of the metering devices and responsible for the legal and operational functionality of the meter site
Metering Service Provider (MSP)	The MSP is an organizational entity that is authorized by the connected party (consumer) to read the meter and/or status data. He is the operator of an AMM head-end and distributor of meter data to authorized parties
Distribution System Operator (DSO)	The DSO is a company assigned to operate and manage one or more distribution networks, also known as grid operator
Supplier	Company that delivers (sells) energy (electricity, gas, thermal energy etc.) or water to consumers
Consumer (CSR)	The end user of energy and supplied media (i.e. electricity, gas, thermal energy, water), also known as customer

3.2 Functional units

A functional unit is an entity of hardware, software or both, capable of accomplishing a specified purpose separated by task or impact. At OMS the gateway is defined as a functional unit in order to leave open the position or physical outline. The gateway may be a unique device or a distributed system as well as an integrated functional unit within an electricity meter, for example.

3.2.1 Devices using primary communication

In this specification different device types are defined, which are commonly referred to as metering devices. These devices can communicate to or with a gateway via one of the primary communication interfaces. Such devices are sensors and actuators.

Sensors are metering devices which at least provide meter index data (current metering counter value).

Actuators are breakers, valves or load delimiters.

For authentication during communication different security profiles may be used. The security profiles supported by OMS and recommended for specific actions are listed in [OMSPC].

Unidirectional wireless M-Bus metering devices will always operate in push mode.

Pull mode may be possible with bidirectional data flow, if the metering device is supplied with external power or after communication has been established in push mode.

Wired M-Bus metering devices will always communicate in pull mode. Even alarm messages are pulled via frequent polling.

With other wired meter interfaces like RS232, RS485 or PLC, push and pull may be possible.

Table 3 – Meter functionalities and characteristics

Feature	**Basic Meter**	**Sophisticated Meter**
Wired meter …		
Transmits data in pull mode	**M**	**M**
Wireless meter …		
Transmits data in push mode	**M**	**M**
Transmits data in pull mode	**O**	**M**
Internal clock	**O**	**M**
Pairs value and timestamp	**O**	**M**
Attends to a time service	**N/A**	**M**
Detects current meter data in regular intervals	**M**	**M**
Parameters for periodic meter reading (e.g. load profile) are adjustable	**O**	**M**
Internal (billing relevant) tariffing	**N/A**	**O**
Internal (billing relevant) load profiling	**N/A**	**O**
Internal breaker or valve	**N/A**	**O**
M: Mandatory **O**: Optional **N/A**: Not applicable		

3.2.1.1 Basic meter

Basic meter are meters with minimal functionality. Current metering data is given by request or sent at regular intervals.

NOTE: Regular intervals are not precisely regular. A small deviation should be applied to minimize collisions on the rf interface.

Communication data flow can be unidirectional or bidirectional. Sent Metering data is identical with data displayed on an integrated display. The security profile requested for a basic meter is listed in [OMSPC].

3.2.1.2 Sophisticated meter

Sophisticated meters are basic metering devices with additional features such as data logging. The metering data given by these devices could include timestamps and metering profiles of the recorded consumption data.

Sophisticated metering devices have an internal clock to enable data logging of load profiles at regular metering periods (e.g. 60 min.) and other time related functions.

Communication data flow is always bidirectional. However, sophisticated meters sent their data initially in push mode. They deliver additional data after being requested in pull mode. The security profile requested for a sophisticated meter is listed in [OMSPC].

A feature to limit or cut-off the feed-in[6] might be used in sophisticated metering devices.

3.2.1.3 Actuator

Throughout this specification the term ‘actuator’ is used to describe appliances which can limit consumption or cut-off the supply of electricity or gas. Terms which are included in the term ‘actuator’ are breaker, limiter, shut-off-valve, gas valve or switch. Bidirectional communication is mandatory for these devices. The security profile requested for an actuator is listed in [OMSPC].

NOTE: The functional unit gateway as described by OMS does not contain the switching or delimiting functionality. Only data transfer of commands and status information is done by the OMS gateway.

NOTE: The widespread or mandatory installation of actuators may be subject to national regulation.

3.2.2 Repeater

To extend the range of wireless primary communication (e.g. on the wM-Bus) repeaters may be used.

On unidirectional metering devices a ’unidirectional’ repeater is defined which must not repeat any datagrams from a gateway assigned to a meter.

The bidirectional repeater is repeating datagrams in both directions from a metering device as well as from a gateway.

3.2.3 Gateway

The gateway is a meter data communication device which collects data from measuring instruments for electricity, gas and thermal energy as well as water consumption. Metering values will be transferred to the gateway and will be processed there to be transmitted to AMM head-end systems as well as to present energy usage information to the consumer.

As a special implementation the smart Meter Gateway (SMGW) is a GW which also processes meter data and may therefore be liable to metrological certification depending on national legislation.

3.2.4 AMM Head-End System

In this specification the endpoint where all gateways connect to is referred to as AMM head-end system (AMMHES). AMM stands for Automated Meter Management and refers to systems which collect data. AMM head-end systems can be found at Metering Service Providers (MSP) who may be identical with Meter Site Operators (MSO) or Distribution System Operators (DSO).

In literature the term ‘management’ is sometimes replaced by ‘infrastructure’, which results in Automated Metering Infrastructure (AMI).

AMM head-end systems themselves process the metering data so it may be transferred as billing and balancing information to ERP-Systems of resource providers or other suppliers.

[6] Compare: Actuator

3.3 Interfaces and Protocols

Hardware interfaces exist in many components such as various bus systems, other I/O devices etc. A hardware interface is described by the mechanical, electrical and logical signals at the interface and the protocol for sequencing them.

Communication systems use well-defined formats or protocols for exchanging messages. Each message sent has an exact meaning intended to provoke a particular response in or from the receiver. Thus, a protocol has to define the syntax, semantics and synchronization of communication. The specified behaviour should be independent of how it is to be implemented. Communication protocols have to be agreed upon by the parties involved. To reach agreement a protocol may be developed into a technical standard.

In the following sections the interfaces and protocols are described which are supported by the OMS and which are part of the OMS specifications.

3.3.1 M-Bus

M-Bus is defined as standard for primary communication particularly with regard to battery driven metering devices. Different physical media can be used.

In order to distinguish between different M-Bus transport mechanism and application protocols, the following terms are introduced:

- Wired M-Bus (M-Bus) is the term describing communication via a two-wire M-Bus line [EN 13757-2:2004].
- Wireless M-Bus (wM-Bus) is used for M-Bus radio transmission [EN 13757-4:2013].
- If the application protocol is referenced, this is done by the term M-Bus protocol [EN 13757-3:2013].
- The usage of M-Bus as a generic system is referenced to as M-Bus system.
- M-Bus communication via power line (M-Bus-PLC) is considered as a future option and is not in focus of this document.

With regard to the limited available energy of battery driven metering devices the shorter DIF/VIF coded data in a standard M-Bus-Application is transported more energy efficient than an OBIS based application protocol.

3.3.1.1 Wired M-Bus

Starting point for the design of the M-Bus are measuring instruments which provide their service in buildings and similar facilities. The underlying technical requirements are as follows:

- Limited amount of data – most of the meter values of a measuring instrument can be packed into datagrams with a maximum of 256 bytes.
- Relatively large reaction times – for many applications it is sufficient if the request from the master is answered by the measuring instrument within minutes.
- Variable data transfer speed – depending on environmental conditions, cable length of the M-Bus and number of the connected devices the data transfer rate can be adjusted.
- Cost-effective wiring – as standard two-wire cables (telephone cables) may be used.
- Noise immunity – a high voltage level on the line (> 12 V) reduces the influence by external interference.
- Short circuit and overvoltage protection – due to appropriate arrangements for the bus measuring devices are not adversely affected by a short circuit in the cable or by short-time overvoltage.

- Error detection – due to provisions in the datagram structure like parity and checksums most data transmission errors can be recognized.
- Power supply via the communication line – in addition to the transmission of information via the two-wire cable the measuring instruments or the communication device of the measuring instruments on the same line can be supplied with voltage.
- Simple organization of information transmission – with a master-slave principle and dispensation of elaborate organization rules for data transmission, the slave only requires low computing power.
- Large expansion and flexible topology of the communication infrastructure – up to 1.000 m length in a cable segment in a bus, tree or star structure, thus allowing large facilities with a very flexible wiring.
- Large number of measuring instruments in a system – up to 250 meters can be connected in one line segment; this can be expanded with repeaters to several thousand units.
- Simple installation guidelines – the reverse polarity protected connection of the measuring instruments avoids installation errors.
- Future orientation of the protocol definitions – the possibility to determine the content of the messages allow for expansion of potential meter readings.

The open approach of the M-Bus also includes weaknesses. E.g. the protocol layers are not fully specified. Prior to the use of new slaves compatibility with the master has to be ensured. Wired M-Bus installations are therefore not easy to extend and appropriate tests have to be carried out in advance when replacing individual components against other brands. Nevertheless large M-Bus installations in the utility and industry environment have been established over the years which are safe and cost effective. The OMS specifications aim at the weak spots of the M-Bus. By delimiting allowed variations and by specifying somewhat blurred descriptions an easy configurable interoperability is achieved. Mitigating or even solving these weaknesses was the main motivation for the foundation of OMS and is currently the scope of the working groups of OMS. The OMS volumes serve this purpose since the beginning of the OMS activities.

The extension of the M-Bus standard to wireless communication in the early 2000s has given a huge boost to the distribution of the M-Bus protocol.

3.3.1.2 Wireless M-Bus

The wireless M-Bus is the consequent enhancement of the successful wired M-Bus idea. It was first described in EN 13757-4 in the year 2003(?). This standard added an alternative definition for the Physical Layer and Link Layer to The M-Bus layer model (see Figure 7). The radio communication enables the possibility of plug-and-play installations of meters. Neither more wire installation nor configuration in the field is necessary anymore. Especially in the sub metering market the new radio technology has been very successful.

In the latest release of the standard there are several modes of radio communication described (see Chapter 4.1.4). This gives a high flexibility to cover the requirements of the known installation scenarios. It starts with mobile solutions optimized for Walk-By and Drive-By reading and proceeds with several kinds of fixed network solutions which are optimized for high density or wide area networks. The modes have sub-modes for unidirectional and bidirectional communication.

OMS decided to cover a subset of the modes in their specification. These are S1, S2, T1, T2[7] and since 2014 also C1 and C2, all operating in the frequency band 868 MHz to 870 MHz. The modes S1, T1 and C1 are defined for unidirectional communication from

[7] Refer to [EN 13757-4:2013] and [OMSPC]

meter to gateway. The modes S2, T2 and C2 provide a backwards channel for bidirectional communication.

- Mode S (Stationary mode) provides a data rate of 16.384 bit/s at a greater communication distance than Mode T. Modes S1 and S2 are compatible with the wireless KNX-system of ISO/IEC enabling combined systems for home automation and open metering.
- Mode T (Transmit frequently) provides a data rate of 66.667 bit/s. This is approximately four times higher than Mode S and for a given battery size allows more frequent transmissions without decreasing battery lifetime or increasing collision rate. This enables a faster user feedback regarding his consumption. Due to this higher transmission frequency, drive-by or walk-by meter readout is also feasible.
  The backwards channel of T2 uses the same frequency and data rate as S2 to allow economic receiver design.
- Mode C (data rate 50.000 resp. 100.000 bit/s) combines the advantages of Mode S and Mode T. It has a more compact data format and therefore allows transmission of more data within the same energy budget and with the same duty cycle. With Issue 4.0.2 of [OMSPC] Mode C is incorporated into the OMS specification.

The wireless M-Bus has several advantages in comparison to other short range radio devices.

- Minimal effort for implementation in embedded devices (compared to ZigBee, Z -Wave or Bluetooth).
- No meshed network, therefore a lean protocol implementation.
- Optimized for battery-operated meters, more than 12 years lifetime possible.
- As already mentioned above, various special modes allow precise and optimized selection of the physical transmission parameters through selection of the modes.
- Independent of the Application Layer (e.g. DLMS also possible).
- Adapter solutions are possible due to clean layer separation.
- Short datagrams (sub-millisecond range) provide good performance in crowded radio channels.
- Quote by Prof. Ziegler (inventor of the M-Bus) “We are the woodlice of radio technology” i.e. there are lots of small or short messages, some of which will always come through.
- Global uniqueness of the radio address.
- Fail-Safe by appropriate checksums and data encoding methods.
- As already mentioned, plug-and-play installation, easy expansion, no network administration costs – therefore a simple system.

In summary the cost per metering point is very low due to the points above.

3.3.2 DLMS/COSEM

DLMS/COSEM is an additional application protocol which will be applied in both primary and tertiary communication as an alternative software solution. This protocol transports the related OBIS code together with each data point.

OBIS coded COSEM data may also be carried via M-Bus.

3.3.3 SML

SML is an additional application protocol which may be applied in primary communication as an alternative software solution. This protocol transports the related OBIS code together with each data point.

OBIS coded SML data may also be carried via M-Bus.

With the new DLMS/COSEM framework[8] adopted as an IEC document the current [SML-spec] remains a national industry standard, with implementations in electricity meters according to the German EDL or SyM² specifications.

3.4 Security

Security items are recognized as absolutely essential in order to achieve legal and social acceptance within innovative residential metering systems.

There are three occurrences which need to be handled by security procedures:

- Loss of availability;
- Loss of confidentiality (to prevent unauthorized reading of data) – to be achieved by
    - Encryption of the data telegrams, especially on wireless and power line communication,
    - Change of telegram content even if no change of a meter index has occurred,
    - Sophisticated user and access rights management;
- Loss of integrity and authenticity – to be protected by signature of data records.

Security techniques are used in different contexts regarding authentication or secure transmission using different encryption techniques.

3.4.1 Encryption

To provide confidentiality of meter data and therefore the privacy of the consumer, these metering data should be encrypted. Encryption should be applied to primary communication, secondary communication as well as to tertiary communication.

Encryption is mandatory for wireless and PLC communication.

To provide confidentiality of transmitted data in primary communication, encryption methods are described in [OMSPC].

Figure 5 shows an example for symmetric encryption on primary communication and asymmetric encryption on tertiary communication. The private keys necessary for asymmetric encryption should be held in a security module in the specific device. Keys should be generated individually for every device..

[8] IEC 13/1548/CDV:2013 Electricity metering data exchange – The DLMS/COSEM suite – Part 1-0: Smart metering standardization framework

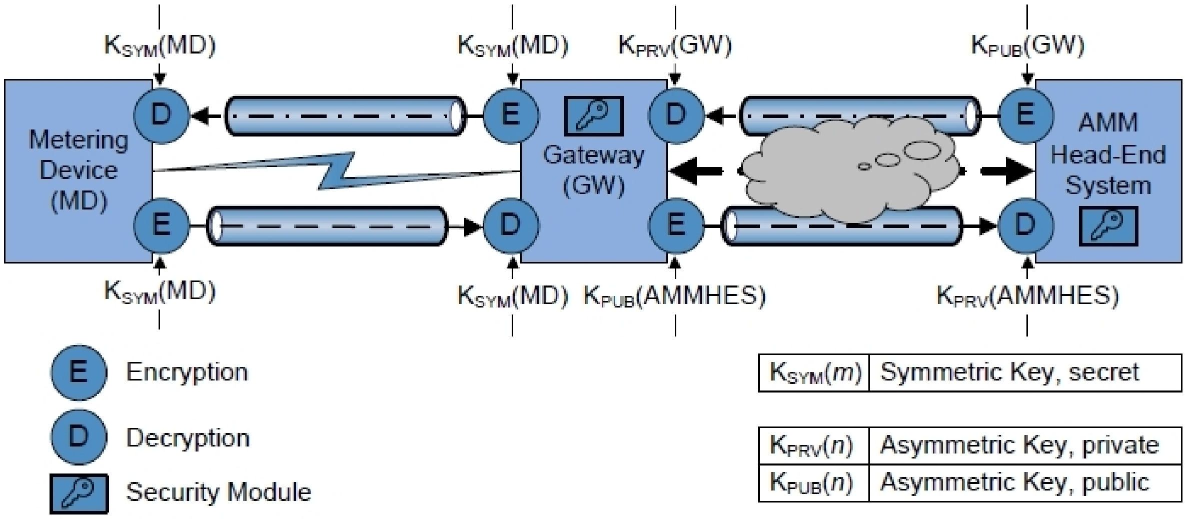

Figure 5 – Example for Encryption – Decryption

3.4.2 Authentication

Authentication should be considered in secondary and tertiary communication, where applicable. To provide authenticity and integrity of transmitted data in primary communication, authentication methods are described in [OMSPC].

Authentication can be provided by a MAC for symmetric solutions (devices using unidirectional primary communication) or by a signature for asymmetric solutions (sophisticated meter or tertiary communication – see chapter 3.4.3 Signature).

For the symmetric solution both communication partners must hold the same key. For transmitting a message over a public channel the sender is using the key to compute a MAC, which is attached to the message and can be verified by the recipient using his key.

The current OMS-Specification supports an authentication method for the primary communication to provide authenticity and integrity of transmitted data.

NOTE: Standardized IP-Transport protocols also support authentication methods for tertiary communication with adequate security strength.

3.4.3 Signature

To provide authenticity, integrity and non-repudiation of data, a digital signature has to be used. This cryptographic more secure technology (compared to a MAC) can be provided only for two-way means of communication for bidirectional devices in primary communication and for tertiary communication.

NOTE: The current version of the OMS-Specification does not support a digital signature.

There may be a meter signature used to sign metered data and a command signature to sign (and authorize) commands in the AMM head-end.

As stated above, a meter signature is not required at the current specification, which focuses on basic meters. As a future option the meter may sign the metered values to enable validation of the data source, if requested.

Also command signature is not required at the current state, but may be mandatory in the future for the following cases:

- Meter setting commands which influence the metering behaviour (e.g. tariff, due date);
- Delimiting or shut-off commands which affect the feed-in of the metered media.

Specifications of a signature may be subject to National legislation. The gateway may additionally sign pass-through data.

NOTE: In data messages the signature is an additional data point which has no effect on other data.

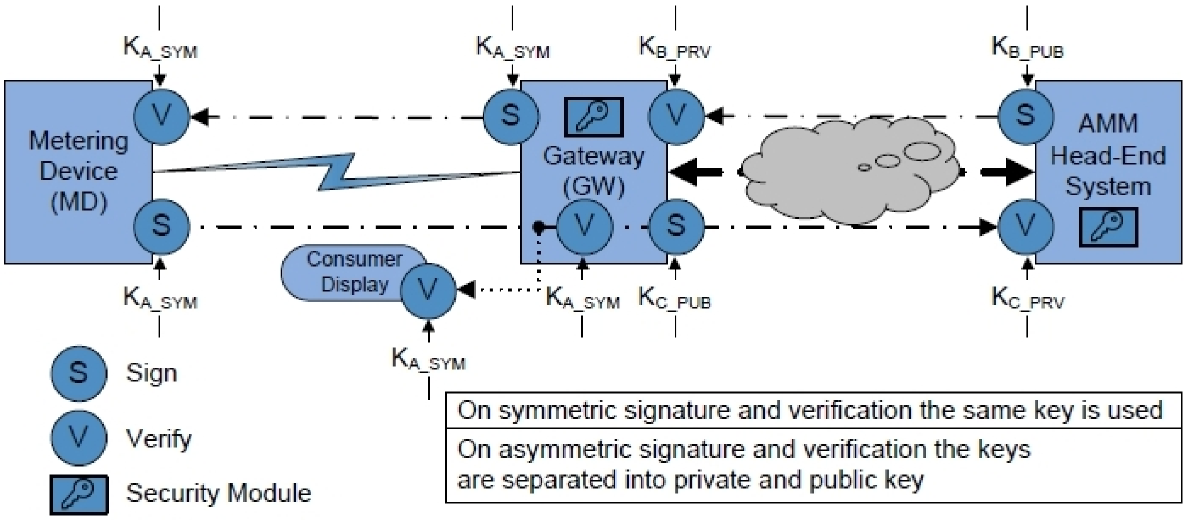

Figure 6 – Example for signature and verification

4 References to Standards

The intention of OMS has always been to use existing standards and not to create a new standard. Conformance to standards assures coexistence and interconnection but not necessarily interoperability or interchangeability. With M-Bus as the preferred primary communication the OMSS takes EN 13757 as its main reference and origin of its work.

The OMS specifications state more precisely where the existing EN 13757 leaves room for interpretations or allows alternative realizations.

Especially the parts -3 and -4 of the European Standard series serve as basis for the OMSS. The specifications made in earlier versions of the OMSS have made their way into the Standard.

4.1 EN 13757 Communication systems for meters and remote reading of meters

With the standardization of the M-Bus in the heat meter standard EN 1434 requests increased to use this communication standard for other measuring equipment, especially gas and water meters, where appropriate. This is made possible by the open structure of the M-Bus, which allows the definition of an almost arbitrary number of device types. At the suggestion of some national standardization organizations, particularly the French AFNOR, CEN BT[9] has approved the transfer of the communication part of the standard from CEN/TC 176 into its own Technical Committee. Although the initiators of the M-Bus standard were initially reluctant to this decision, it is now generally seen as a consensus way forward. The foundation and establishment of the Technical Committee CEN/TC 294[10] was a successful step to describe meter communication independent of the measured medium. Only because the world of standards is divided into an electrical and non-electrical part (DKE, CENELEC, IEC and DIN, CEN, ISO), the standard series EN 13757 covers – in its origin – not all media.

However, with the mandate M/441 Smart Metering[11] of the European Commission, the executive Smart Metering Co-ordination Group has achieved a mutual recognition of appropriate standards among the participating Technical Committees of CEN and CENELEC. I.e. electricity meters with a communication in accordance with EN 13757 are considered to be in compliance with CENELEC.

Thus, the standard series EN 13757 is the only communication standard for meters and related equipment, which places the user into a position to cover measuring instruments of all media economically with one communication system.

In the following sections the individual parts of the standard series EN 13757 Communication systems for meters and remote reading of meters are presented. The standard series is a modular kit. Various physical interface characteristics as well as various protocol applications are described. These may be combined with one another in each case, so that a very flexible protocol stack is created, see Figure 7. The M-Bus does not provide network functionality.

[9] BT: Bureau Technique

[10] CEN/TC 294: Communication systems for meters and remote reading of meters

[11] Doc. 83/2008 EN of 22 January 2009: Draft Standardisation mandate to CEN, CENELEC and ETSI in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability

Therefore, the layers 5 and 6 according to OSI are not filled[12]. Layer 3 is optional and is only needed when using the standard part 5 Wireless relaying.

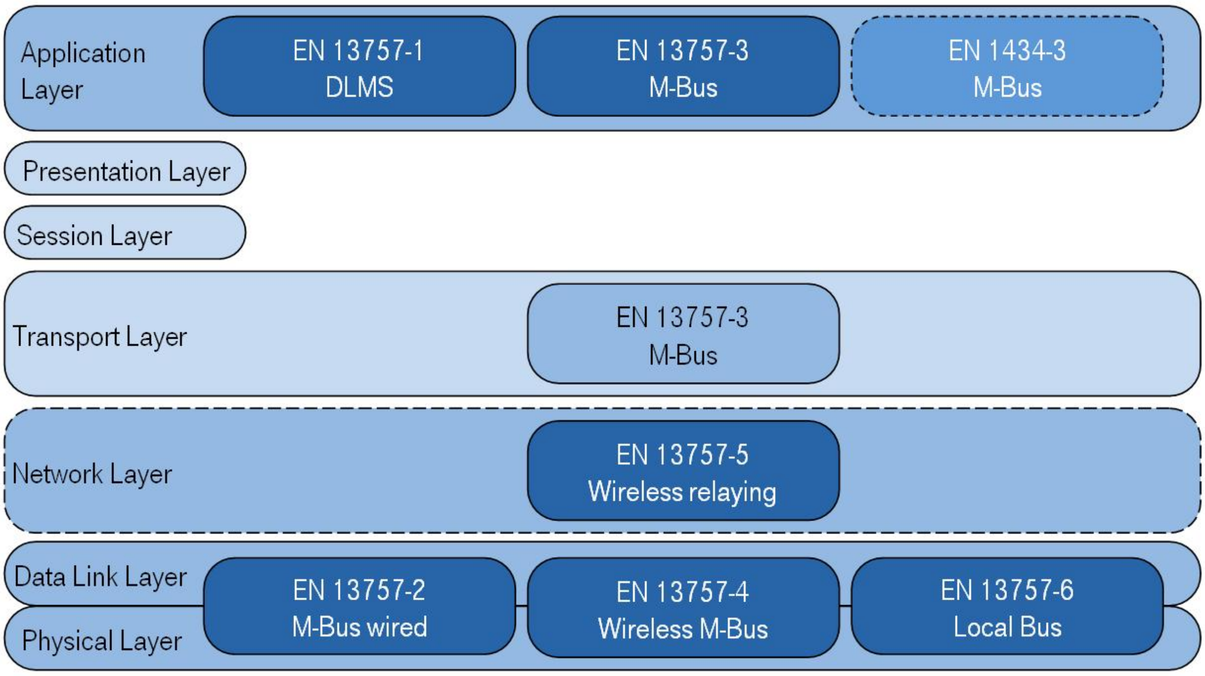

Figure 7 – Protocol stack EN 13757

4.1.1 EN 13757 Part 1: Data exchange

This part of the standard describes the general data exchange and communication for meters and remote reading of meters In particular; it specifies the COSEM Application Layer for meters with DLMS. EN 13757-1 is one of the basic documents to which the functional reference architecture from [TR 50572] of the mandate M/441 relates.

The currently valid version of EN 13757-1 was approved by CEN in November 2002.

From 2010 onwards there has been work done on a version that incorporates the interim renewals from the COSEM world governed by the DLMS User Association. This concerns e.g. extensive enhancements in the OBIS codes for gas. In addition new methods have been defined for secure data transmission.

Currently the draft European standard is submitted to CEN members for enquiry. A publication of EN 13757-1 is expected for August 2014.

4.1.2 EN 13757 Part 2: Physical and link layer

This part of the standard specifies the physical M-Bus via two-wire line. It is a compatible extension of the heat meter standard EN 1434-3:1997 and also covers the use of gas and water meters and heat cost allocators. In addition, the M-Bus master is also described. Reference is made to proven telecontrol protocols. The Physical Layer is partially based on EN 60870-5-1[13] and the Data Link Layer almost completely on EN 60870-5-2[14].

[12] The description of the Transport Layer in the new EN 13757-3:2013 is assigned to the Application Layer in the old version of the standard

[13] EN 60870-5-1:1993 Telecontrol equipment and systems - Part 5: Transmission protocols; section 1: Transmission frame formats (IEC 60870-5-1:1990)

[14] EN 60870-5-2:1993 Telecontrol equipment and systems - Part 5: Transmission protocols; section 2: Link transmission procedures (IEC 60870-5-2:1992)

The two-wire M-Bus may be combined with the different Application Layers as shown in Figure 7.

The currently valid version of EN 13757-2 was approved by CEN in September 2004.

The physical parameters of the two-wire M-bus are sufficiently specified. A revision of EN 13757-2 is currently not in the focus of CEN/TC 294.

4.1.3 EN 13757 Part 3: Dedicated application layer

This part of the standard specifies the M-bus Application Layer. It is a compatible extension of the M-bus Application Layer originally described in the M-bus heat meter standard EN 1434-3:1997. The Application Layer described in this standard can be combined with the Physical, Data Link and Network Layers shown in Figure 7.

This standard allows many degrees of freedom, which means:

- It supports coexistence and a general communication ability of hierarchical communication idevices;
- It does not guarantee any functional or communicational applied interchangeability of meters that follow this standard.

This interchangeability is achieved by the use of the OMS specifications.

The currently valid version of EN 13757-3 was approved by CEN in March 2013.

From 2009 onwards work there has been done on this new version of EN 13757-3, which adapts the M-bus to the requirements of a modern communication protocol. The essential changes are:

- Extension of existing data frames for different data protocols to support various radio transmissions (harmonization with EN 13757-4);
- A clearer assignment of layers – description of a Transport Layer;
- A new annex with a smart metering profile, which is based on the requirements of the mandate M/441;
- A new annex with a unique assignment of M-Bus data points to OBIS codes;
- Update of the allowed encryption methods to the best available techniques (AES 128);
- Extension of the data points for electricity meters;
- Inclusion of some annexes with explanations and examples.

4.1.4 **EN 13757 Part 4:** Wireless meter readout (Radio meter reading for operation in SRD bands)

This part of the standard specifies the requirements for the Physical Layer and the Link Layer for wireless applications for the remote reading of meters. In principle it is open for the application of different Application Layers. Mainly considered is radio equipment for short range devices (SRD) in the frequency band of 868 MHz to 870 MHz. There are different modes defined (Mode S, Mode T etc.) with different duty cycles (0,1 % and 1 %) that each have their preferred application.

- Walk-By
- Drive-By
- Stationary

With the possible alternatives of low data rate or high data rate the different use cases of high radio range or a high density of meters can be covered. One-way and two-way radio operation is defined. All parameters are optimised for use in battery-powered meters. The typical life span of usage without battery replacement is more than ten years. The carrier frequency in the Sub-Gigahertz range together with the extremely short transmission intervals guarantee a good penetration and low probability of collision in spite of the maximum transmission power in the European harmonised radio bands being limited to 25 mW.

This standard has been extremely successful, especially in Submetering. In Europe there are at least 80 million measuring instruments in use, based on this standard.

The currently valid version of EN 13757-4 was approved by CEN in June 2013.

From 2009 onwards work has been done on a significantly expanded version of EN 13757-4. This is evident with the new title of this part of the standard. In the past the wireless meter readout was limited to operation in the 868 MHz to 870 MHz SRD band only, now it is open to other SRD bands. New modes have been added (Mode C, Mode N and Mode F), some new frequencies (169 MHz and 434 MHz) as well as a new duty cycle (10 %). Thus future applications can be covered where the previous modes could not achieve optimum results. Also the used Link Layer for all modes was unified and its functionality extended.

4.1.5 EN 13757 Part 5: Wireless relaying

This part of the standard is an extension of EN 13757-4. It is not always possible to position the radio master so that all meters of a wireless network can be reached directly. EN 13757-5 describes the opportunity to expand a wireless network. Two different types of networks can be realized.

4.1.5.1 Router approach

All network nodes behave the same, are known to each other and are not hierarchical. The same protocol is used upstream and downstream. The way from the meter (data source) to the master (data sink) is specified before the first data transmission. Thus the network can not respond dynamically to changes, but the data overhead and the required computing power in each node is low. The individual nodes have knowledge about the final data sink. This is not compatible with the simple Link Layer approach of EN 13757-4. Therefore this part of the standard defines the Mode P.

4.1.5.2 Gateway approach

In this approach only the direct reachable network nodes are known to each other. This creates a hierarchical wireless network in which each node does not need any knowledge of the final data sink. The nodes can use the same Link Layer as the radio meters according to EN 13757-4. A gateway appears to a transmitting meter like a master and to a transmitting master like a meter. This relaying function is only specified for the Mode R2 in EN 13757-4, and not for the modes S and T.

The currently valid version of EN 13757-5 was approved by CEN in August 2008.

There has been work done on a revised version of EN 13757-5. This draft standard revises the existing network-enabled modes. As a significant change repeaters are introduced which enable the previously not supported data forwarding for all modes (including modes S and T) from EN 13757-4.

Currently the draft European standard is submitted to CEN members for Enquiry. A publication of EN 13757-5 is expected for August 2014.

4.1.6 EN 13757 Part 6: Local Bus

The insensitivity of the wired M-Bus to interference because of its high voltage level has advantages and disadvantages. The energy and material expenses for the operation of small installations is relatively high. Battery-powered masters are virtually impossible to achieve. For this reason, this part of the standard series defines a Physical Layer with low power levels and for a maximum of 6 meters connected to the bus.

The readout frequency is limited by the connected meters. A permanent power supply of the meters through the bus is not provided. Therefore the Local bus can be switched off completely if required. Both the M-Bus Application Layer of EN 13757-3 and the DLMS-based Application Layer of EN 13757-1 apply.

It is important to ensure that meters with an interface for the Local Bus are not operated on an M-Bus Master. The Local Bus is mainly used for water meters.

The currently valid version of EN 13757-6 was approved by CEN in October 2008. In 2014 the cyclical review of the standard status of EN 13757-6 is run by CEN and the affiliated National Standards Organizations. At least an editorial update of the standard is probable.

An interesting feature is that the physical quantities of the Local Bus are basically suitable for an Ex protection zone. If security features were to be applied it would be possible to have a secure wired communication protocol to gas meters and conversion devices in hazardous areas.

5 Document Reference

BSI TR03109	Technische Richtlinie BSI TR-03109 Smart Energy; Version 1.0, Datum 18.03.2013 https://www.bsi.bund.de/DE/Themen/SmartMeter/TechnRichtlinie/TR_node.html
BSI TR03109-3	Technische Richtlinie TR-03109-3 Kryptographische Vorgaben für die Infrastruktur von Messsystemen; Version 1.0, Datum 18.03.2013 https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Publikationen/TechnischeRichtlinien/TR03109/TR-03109-3_Kryptographische_Vorgaben.pdf?__blob=publicationFile
DLMS UA	DLMS User Association http://www.dlms.com Excerpt DLMS UA 1000-1 Ed. 11.0, COSEM interface classes and OBIS identification system; 2013-08-27 http://dlms.com/documents/Excerpt_BB11.pdf
ETSI-ERM	EN 300220-1 V.2.4.1 (2012-05) Electromagnetic compatibility and Radio spectrum Matters (ERM) - Short Range Devices (SRD) - Radio equipment to be used in the 25 MHz to 1000 MHz frequency range with power levels ranging up to 500 mW - Part 1: Technical characteristics and test methods
DIN 43863-5:2012	Identification number for measuring devices applying for all manufacturers
EN 1359:1998 + A1:2006	Gas meters - Diaphragm meters
EN 12405-1:2005 + A2:2010	Gas meters - Conversion devices - Part 1: Volume conversion
EN 13757-1:2002	Communication systems for meters and remote reading of meters - Part 1: Data exchange
FprEN 13757 -1:2013	Communication system for and remote reading of meters - Part 1: Data exchange
EN 13757-2:2004	Communication systems for and remote reading of meters - Part 2: Physical and link layer
EN 13757-3:2013	Communication systems for and remote reading of meters - Part 3: Dedicated application layer
EN 13757-4:2013	Communication systems for meters and remote reading of meters - Part 4: Wireless Meter Readout (Radio meter reading for operation in SRD bands)
EN 13757-5:2008	Communication systems for meters and remote reading of meters - Part 5: Wireless relaying
prEN 13757-5:2014	Communication systems for meters and remote reading of meters - Part 5: Wireless relaying
EN 13757-6:2008	Communication systems for meters and remote reading of meters - Part 6: Local Bus
prEN 13757 -6 rev:2014	Communication systems for meters and remote reading of meters - Part 6: Local Bus

EN 60870-5-2:1993	Telecontrol equipment and systems - Part 5: Transmission protocols - Section 2: Link transmission procedures (IEC 60870-5-2:1992)
EN 62056-6-1:2013	Electricity metering data exchange - The DLMS/COSEM suite - Part 6-1: Object Identification System (OBIS) (IEC 62056-6-1:2013)
ERC 70-03	ERC Recommendation 70-03 Relating to the use of Short Range Devices (SRD); Tromsø 1997, Subsequent amendments, 9 October 2013 http://www.erodocdb.dk/docs/doc98/official/pdf/rec7003e.pdf
FIPS 197	Federal Information Processing Standards Publication 197; Announcing the ADVANCED ENCRYPTION STANDARD (AES), Nov 2001 http://www.csrc.nist.gov/publications/fips/fips197/fips-197.pdf
OMS	Open Metering System http://oms-group.org/download4all/
OMSGP	Open Metering System Specification Vol. 1 – General Part http://oms-group.org/download4all/#c288
OMSPC	Open Metering System Specification Vol. 2 – Primary Communication http://oms-group.org/download4all/#c288
OMSTC	Open Metering System Specification Vol. 3 – Tertiary Communication http://oms-group.org/download4all/#c288
PTB A50.7:2002	PTB-A 50.7 Anforderungen an elektronische und softwaregesteuerte Messgeräte und Zusatzeinrichtungen für Elektrizität, Gas, Wasser und Wärme; April 2002 Anhang PTB-A 50.7-2 Software-Anforderungen an Messgeräte und Zusatzeinrichtungen gemäß PTB-A 50.7 Geräteklasse 2: Gerät mit Datenübertragung über Kommunikationsnetzwerke; April 2002 http://www.ptb.de/de/org/2/23/234/download_info-center/ptb-a50_7-2.pdf
RFC4492	Network Working Group Request for Comments: 4492 Elliptic Curve Cryptography (ECC) Cipher Suites for Transport Layer Security (TLS); May 2006 http://www.ietf.org/rfc/rfc4492.txt
RFC4493	Network Working Group Request for Comments: 4493 The AES-CMAC Algorithm; June 2006 http://www.ietf.org/rfc/rfc4493.txt
RFC5246	Network Working Group Request for Comments: 5246 The Transport Layer Security (TLS) Protocol Version 1.2; August 2008 http://tools.ietf.org/rfc/rfc5246.txt
RFC5289	Network Working Group Request for Comments: 5289 TLS Elliptic Curve Cipher Suites with SHA-256/384 and AES Galois Counter Mode (GCM); August 2008 https://ietf.org/doc/rfc5289/
RFC5905	Internet Engineering Task Force (IETF) Request for Comments: 5905 Network Time Protocol (Version 4): Protocol and Algorithms Specification; June 2010 http://tools.ietf.org/rfc/rfc5905.txt
RFC6066	Internet Engineering Task Force (IETF) Request for Comments: 6066 Transport Layer Security (TLS) Extensions: Extension Definitions; January 2011 https://ietf.org/doc/rfc6066/

RFC7027	Internet Engineering Task Force (IETF) Request for Comments: 7027 Elliptic Curve Cryptography (ECC) Brainpool Curves for Transport Layer Security (TLS); October 2013 http://www.rfc-editor.org/rfc/rfc7027.txt
SML-spec	Smart Message Language Version 1.03 (published) http://www.emsycon.de/downloads/SML_081112_103.pdf intended to be standardized by DKE/AK 461.0.14; published Version 1.04 available under https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Publikationen/TechnischeRichtlinien/TR03109/TR-03109-1_Anlage_Feinspezifikation_Drahtgebundene_LMN-Schnittstelle_Teilb.pdf?__blob=publicationFile
TR 50572	Technical Report CEN/CLC/ETSI/TR 50572 Functional reference architecture for communications in smart metering systems, December 2011 ftp://ftp.cen.eu/cen/Sectors/List/Measurement/Smartmeters/CENCLCETSI_TR50572.pdf

Annex A: Glossary of Terms

The Glossary of Terms is a separate document.

The actual version (RELEASE A 2014-10 or later) may be downloaded from the OMS Homepage (http://oms-group.org/download4all/#c288).