Review of IEC/EN Standards for Data Exchange between Smart Meters and Devices

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Abstract. With energy monitoring and control playing an increasingly important role in home energy management, Smart Meters are the key technology for the smart house deployment. Smart Meters collect data from devices to databases for analysis and billing purposes, do data logging, power quality and real time monitoring, offering the knowledge of energy consumption in order to control the flow of energy inside a house. However, the lack of common standard architectures for telecommunications to ensure interoperability between equipment and systems from different manufacturers makes a common Smart Meter adaptation more difficult. Working toward a common standard this paper presents the IEC/EN standards for data exchange between Smart Meters and devices.

Keywords: Smart Meters, standards, data exchange, communication.

1 Introduction

In the ideal world a consumer would purchase a new Smart Meter and when it is plugged into the home for the first time it would automatically identify itself and register with the home network. There are currently a number of barriers to this vision, most significantly the lack of a global standard for meter networking.

Without a single standard, meter manufacturers would be required to offer a number of different solutions incurring additional development expense. The other barrier is that security concerns mean that only trusted appliances can share information with the Smart Meter.

Automatic Meter Reading (AMR) is a technology which automatically collects data from metering devices like water, gas, heat, electricity and transfers these data to a central database for analysis and billing purposes. Many AMR devices can also do data logging. The logged data can be used for water or energy use profiling, time of use billing, demand forecasting, demand side management (DSM), rate of flow recording, leak detection, flow monitoring, etc. [2]

Smart Meter goes a step further than simple AMR. They offer additional functionality including a real-time or near real-time indications and power quality monitoring. Standards for Smart Metering include requirements and test methods to cover data models and protocols for Meter data exchange.

N. Hatziargyriou et al. (Eds.): E-Energy 2010, LNICST 54, pp. 95–103, 2011.

2 IEC/EN Standards for Data Exchange between Smart Meters and Devices

A schematic diagram of a Smart Meter is shown in Figure 3.1 [1]. The Smart Meter Infrastructure as an Advanced Metering Infrastructure (AMI) can be divided into three segments [2]:

- The local network segment
- The access network segment
- The back-haul network segment

The local network connects Smart Meters belonging to the same entity (home, building, facility) as well as end-user applications (Home Area Network (HAN)) to a node acting as a local data collector and gateway between access and local network.

The access network comprises the networks between house gateway and a hub/data concentrator or the data management center in case there is no data concentrator.

The backhaul network is the final segment between hub/data concentrator and the data & management center for utility services and customer-related services.

In case that there is no hub/data concentrator, the data are sent directly to data & management center.

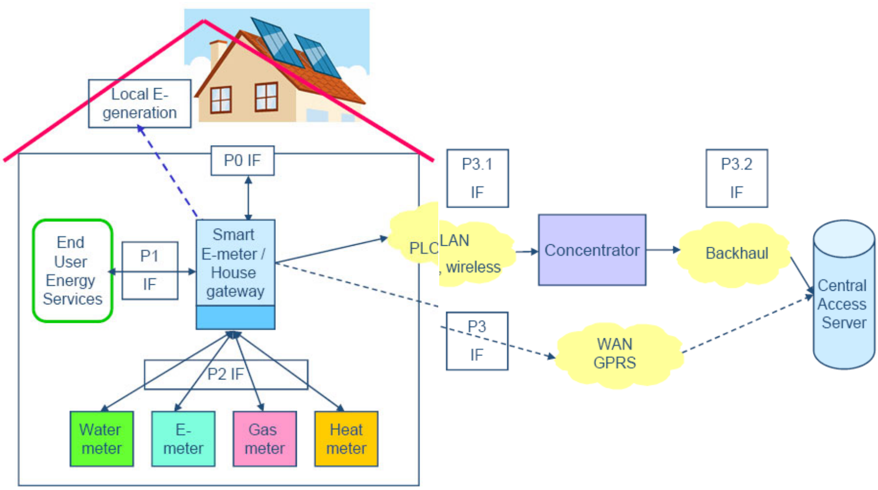

Fig. 1. Schematic diagram of a Smart Meter Infrastructure [1]

2.1 Interfaces

There are five interfaces (Ports) that designate the connection of the Smart Meter with other devices, plus an interface between the Concentrator and the Central Access Server.

Port 0. Communication with external devices (e.g. hand-held terminal) during installation and on-site maintenance of the metering installation.

Port 1. Communication between the metering installation and ISP module or auxiliary equipment.

Port 2. Communication between the metering system and one or more metering instruments and/or grid company equipments.

Port 3. Communication between the metering installation and the Central Access Server (CAS).

Port 3.1. Communication between the metering installation and the Data Concentrator (DC).

Port 3.2. Communication between the Data Concentrator (DC) and the Central Access Server (CAS)

2.1.1 Port 0: Local Port

Table 1. Local port standards [1]

Standard	Description
IEC 62056-21	Electricity metering - Data exchange for meter reading, tariff and load control - Part 21: Direct local data exchange
EN 13757-6	Communication Systems for meters and remote reading of meters. The physical layer for local bus

IEC 62056-21 "Flag"

IEC 62056-21 is also known as the "Flag protocol". This protocol was the first standard protocol for meter data exchange and is globally used. Today, its main use is for local data exchange. The current loop is a local bus supporting up to eight meters. PSTN and GSM are supported with appropriate modems [2]. It specifies three local physical interfaces [3], an *Optical interface, an Electrical current loop interface and* an *Electrical V.24/V.28 interface.*

Table 2. Applications

Applications	
Local AMR	Supported, by using a hand held or a permanently connected device
Remote AMR	Supported via PSTN or GSM modems. Several devices can be connected on a current loop.
AMI	Supported when used in Mode E with DLMS/COSEM and remote two-way communication.
Home Automation	Not supported

EN 13757-6

This standard specifies the physical layer parameters of a local meter readout system ("Local Bus") for the communication with and the readout of a single meter or a small cluster of maximum 5 meters via a single battery powered readout device ("master") which can be connected for the communication directly to a meter (i.e. local readout) or via a fixed wiring or a small bus (total cable length max. 50 m, i.e. local remote readout). The Local Bus is an alternative to the M-Bus. The bus has to be switched on before data exchange. [4]

2.2 Port 1: Home Area Network

The Home Area Network (HAN) is contained within a user's premises and interconnects home IT and entertainment devices and their peripherals as well as home security systems, and "smart" appliances such as lighting, heating, cooling, etc.

A number of technologies might be used for this interface. According to the Open meter Deliverable, the only way to succeed in this interface is to specify an interoperable technology, using standard profiles, while the technology must be already available in consumer gadgets such as mobile phones, PDAs or laptops.

Taking everything into account the candidate technologies are, Wi-Fi, ZigBee, Bluetooth, IEEE802.11, IEEE802.15.4 and 6lowPAN. The potential protocols are, IEC 62056-21 Mode D (DLMS/COSEM on local port), *IEC 62056-21 Mode A, B or C should be considered, in order to have two way communication between the HAN and the Smart Meter,* SML, ZigBee SEP and KNX.

The communications between the HAN and the Smart Meter must be secure so that customers' data are not sent to other customers. In practice this will mean that once the customer buying a HAN, would have to agree the identity of the HAN with the utility and then the utility should program the Smart Meter.

One way of approaching this, is to have a 'USB port' on the Smart Meter. The customer plugs their transmitter into this port and the customers' transmitter then talks to the Customers HAN using whatever communication protocols is available. At this stage only the 'USB Style Port' would have to be standardized.

2.3 Port 2: In-House Wired/Wireless

2.3.1 In-House, Wired

Table 3. In- house wired standards [1]

Standard	Description
IEC 62056-31	Electricity metering - Data exchange for meter reading, tariff and load control - Part 31: Use of local area networks on twisted pair with carrier signaling
EN 13757-2	Communication Systems for meters and remote reading of meters. Physical and link layer

IEC 62056-31 "Euridis"

Euridis is a pragmatic and reliable solution for remote meter reading. Nowadays, Euridis is the only standardized interface for the remote reading of electricity meters with a twisted-pair cable, using carrier signaling. [2]. The baud rate is 1200 Baud, 3 minutes to read 100 meters and up to 500 meters local bus.

Table 4. Applications [1]

Applications	
Local AMR	Supported, by using a hand held or a permanently connected device, via a magnetic plug. Gateways to other protocols are possible
Remote AMR	Euridis is a pragmatic and reliable solution for remote meter reading
AMI	Not supported
Home Automation	Not supported

2.3.2 In-House, Wireless

Table 5. In-house wireless standards [1]

Standard	Description
EN 13757-4	Communication Systems for meters and remote reading of meters. Wireless meter readout
EN 13757-5	Communication Systems for meters and remote reading of meters. Wireless relaying

EN 13757-4

The physical and the data link layers for wireless data exchange are specified in EN 13757-4. Three modes of operation are available:

"Stationary mode", *mode S*, intended for unidirectional or bi-directional communications between stationary or mobile devices.

"Frequent transmit mode", *mode T*. In this mode, the meter transmits a very short frame (typically 2 ms to 5 ms) every few seconds thus allowing walk-by and/or drive by readout.

"Frequent receive mode", *mode R2*. In this mode, the meter listens every few seconds for the reception of a wakeup message from a mobile transceiver. After receiving such a wakeup, the device will prepare for a few seconds of communication dialog with the initiating transceiver. In this mode a "multi-channel receive mode" allows simultaneous readout of several meters, each one operating on a different frequency channel.

The available baud rate for the T mode is 67/16 kBaud, for the S mode is 16/16 kBaud and for the R mode is 2.4 / 2.4 kBaud.

An M-Bus device may support one, several or all modes. The M-Bus wireless protocol is optimised for power consumption and low cost, [2].

EN 13757-5

This standard specifies relaying for wireless networks, to extend the action radius of the radio signal. The following modes are specified:

The specified modes are, Mode P using routers, Mode R2 protocol using gateways and Mode Q protocol supporting precision timing. This mode allows using DLMS/COSEM [2].

2.4 Port 3.1: PLC/Wireless LAN

2.4.1 PLC LAN

Table 6. PLC LAN standards [1]

Standard	Description
IEC 62056-53 *S-FSK specified by DLMS UA, to be added*	Electricity metering - Data exchange for meter reading, tariff and load control - Part 53: COSEM application layer

Communication with electricity metering equipment using the COSEM interface object model is based on the client/server paradigm where metering equipment plays the server role. In this environment, communication takes place always between a client and a server. These services are provided via exchanging messages between the client and the server. In general, the client and the server APs are located in separate devices; exchanging messages is done with the help of the communication protocol.

Table 7. Applications [2]

Applications	
Local AMR	Supported via an optical port, current loop interface or RS-232. The physical interfaces are specified in IEC 62056-21. Most meters on the market support both Mode C using ASCII data transfer and Mode E using DLMS/COSEM
Remote AMR	DLMS/COSEM is widely used for AMR with two-way remote data exchange over various media.
AMI	The functions modelled with the COSEM data model support all AMI functionality. Combined with bi-directional data exchange, DLMS/COSEM supports AMI.
Home Automation	Not supported However, DLMS/COSEM devices may serve as a gateway towards HA systems. The principles of the COSEM model also make it suitable to model HA functionality.

2.4.2 Wireless LAN

Although PLC seems to be the dominant technology, Wireless LAN technologies could be used in cases where PLC is not an option. The WLAN communication technologies are specified by the European Telecommunications Standards Institute.

2.5 Port 3.2: Backhaul Network

Table 8. Backhaul network standards [1]

Standard	Description
IEC 62056-21	Electricity metering - Data exchange for meter reading, tariff and load control - Part 21: Direct local data exchange
EN 13757-6	Communication Systems for meters and remote reading of meters. The physical layer for local bus
ETSI	Relevant European Telecommunications Standards Institute standards

This interface is for communication between the Data Concentrator (DC) and the Central Access Server (CAS). The used standards are the same as Port's 0 (Local Port).

2.6 Port 3: PTSN/GSM or Internet/GPRS WAN

2.6.1 PTSN/GSM WAN

Table 9. PTSN/GSM standards [1]

Standard	Description
IEC 62056-42	Electricity metering - Data exchange for meter reading, tariff and load control. Physical layer services and procedures for connection-oriented asynchronous data exchange
IEC 62056-46	Electricity metering - Data exchange for meter reading, tariff and load control - Part 46: Data link layer using HDLC protocol

IEC 62056-42

This standard specifies the physical layer services and protocols within the COSEM three-layer connection oriented profile for asynchronous data communication. (PSTN) To allow using a wide variety of media, the following assumptions are made: The communication is point – to – point or point to multipoint, both half-duplex and full-duplex connections are possible, asynchronous transmission with 1 start bit, 8 data bits, no parity and 1 stop bit, [9].

IEC 62056-46

This part of IEC 62056 specifies the data link layer for connection-oriented, HDLC-based, asynchronous communication profile, including a number of enhancements compared to the original HDLC, for example in the areas of addressing, error protection and segmentation. The communication environments might be point-to-point and point-to-multipoint configurations, dedicated and switched data transmission facilities, half-duplex and full-duplex connections, asynchronous start/stop transmission, with 1 start bit, 8 data bits, no parity, 1 stop bit. Furthermore multicasting and broadcasting are possible using UI frames. In the present environment, this is allowed only for the clients – servers are not allowed to send frames with broadcast or multicast address in the Destination Address field, [10].

2.6.2 Internet/GPRS WAN

Table 10. Internet/GPRS standards [1]

Standard	Description
IEC 62056-47	Electricity metering - Data exchange for meter reading, tariff and load control - Part 47: COSEM transport layers for IPv4 networks

This part of IEC 62056 specifies the transport layers for COSEM communication profiles for use on IPv4 networks. These communication profiles contain a connection-less and a connection-oriented transport layer, providing OSI-style services to the service user COSEM application layer. The connection-less transport layer is based on the Internet standard User Datagram Protocol (UDP). The connection-oriented transport layer is based on the Internet standard Transmission Control Protocol (TCP).[11]

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6. EN 13757-2: Communication Systems for meters and remote reading of meters. Physical and link layer
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8. EN 13757-5: Communication Systems for meters and remote reading of meters. Wireless relaying
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11. IEC 62056-47: Electricity metering - Data exchange for meter reading, tariff and load control - Part 47 COSEM transport layers for IPv4 networks