INTRODUCING (GAS) SMART METERS IN EUROPE: THE CHALLENGE OF STANDARDS

Authors:
Daniel Hec, MARCOGAZ
David Johnson, Eurogas
Catherine Vigneron, CEN/CENELEC
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The introduction of intelligent (or smart) metering systems is promoted by the European Union through recent legislation that should lead to a wide rollout in Europe of electricity and gas meters with additional functionalities.

In the Third Energy package, Directives 2009/72/EC for electricity and 2009/73/EC for gas refer to the implementation of "intelligent metering systems that shall assist the active participation of consumers in the [electricity/gas] supply market." The main drivers for such initiatives are greater energy efficiency awareness by end users and the potential for energy savings. Smart metering also constitutes the basis for the development of smart electricity (and potentially smart gas) grids.

STANDARDISATION MANDATE

In 2009, the European Commission issued the Mandate M/441 for the standardization of smart metering functionalities and communication for use in electricity, gas, heat and water applications. The Mandate requires standardisation to ensure interoperability of technologies and applications within a harmonized European market. The European standardisation activity is mandated to the three European Standards Organisations (ESOs), CEN (European Committee for Standardisation), CENELEC (European Committee for Electrotechnical Standardization), and ETSI (European Telecommunications Standards Institute).

A standardisation procedure in Europe and a set of standards relevant to smart metering already exist; these are available and maintained by the relevant technical bodies. There are already around 110 applicable technical standards available today which cover parts of a smart metering application. However, there are gaps and overlaps that need to be addressed.

To respond to the Commission Mandate M/441, the Smart Metering Coordination Group (SM-CG) was established in 2009. This group has a broad representation and is composed of representatives of the relevant CEN, CENELEC and ETSI Technical Committees, CEN and CENELEC members, CEN associate members and technical committee liaison organizations, industry stakeholders and CENELEC cooperating partners (including consumer organizations).

The Commission envisages potential benefits arising from smart meters not only in terms of energy efficiency and energy savings, but also from more accurate billing and improved consumer switching, lower bills due to better customer response, new services for customers (including vulnerable customers), improved tariff innovation (time-of-use tariffs), reduced costs and increased convenience for prepayment customers, less environmental pollution and facilitation of microgeneration. The background to the Mandate and these expected benefits is the recognition of rapid technological developments in metering, by which customers can be provided with improved information to help them manage their energy use and reduce carbon emissions.

The result of the mandated work should be to facilitate the smooth introduction of more advanced metering systems offering additional functionalities. In parallel, a subsequent mandate (M/490) seeks to facilitate the introduction of smart electricity grids.

SCOPE OF STANDARDISATION WORK

Standardisation work overseen by the SM-CG focuses on meeting the needs of the residential and small and medium enterprise (SME) sectors. As required by M/441, smart metering standards should permit a range of approaches – from fully integrated instruments to modular and multi-part solutions.

The first phase of Mandate M/441 requests the ESOs to identify the main possible functional communications implementations relevant for smart metering systems and the standards relevant to meeting the requirements of M/441, in particular to assist the active participation of consumers. The second phase requests the ESOs to ensure there are European (or international) standards suitable for the functionalities and communications interfaces identified.

As no single standard could cover all aspects and the full application range of smart metering systems, it was decided that the most comprehensible approach of presenting standards related to M/441 phase 1 would be a Technical Report containing possible architectural

setups and the relevant standards related to it. The document was finalized at the end of 2011 and is now freely available as TR 50572.

FUNCTIONAL REFERENCE ARCHITECTURE

Smart metering systems comprise all functions, entities and interfaces from the utility smart metering applications to smart metering end devices and / or home automation devices used in a smart metering context.

The scope of M/441 with respect to communications is limited to the communication infrastructure between the smart metering head end system and the metering end devices, including all functional entities in between.

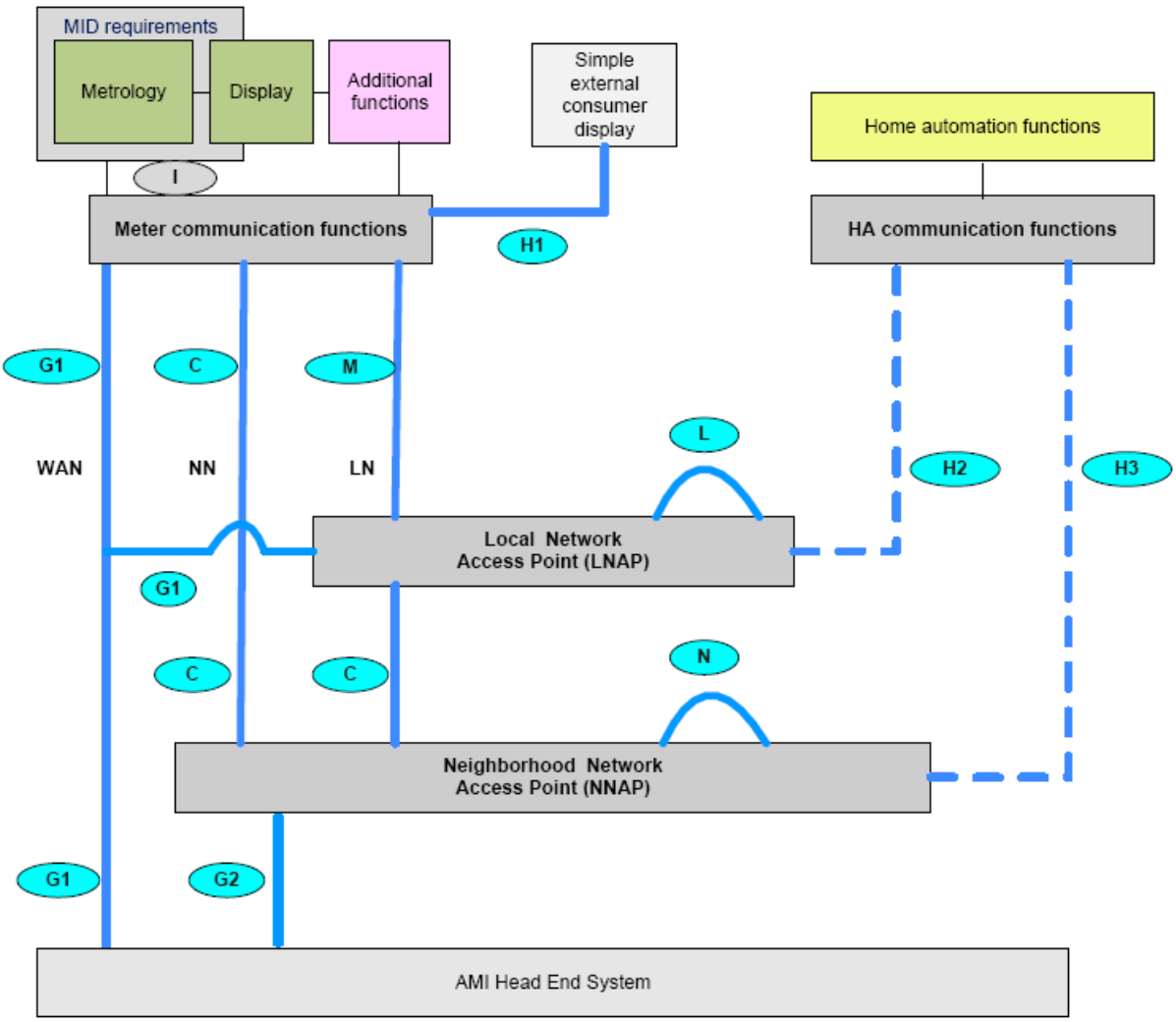

Figure 1 — Reference architecture diagram for smart metering communications

Figure 1 gives a simplified overview of functional entities and interfaces in a smart metering communications network; the boxes correspond to functions that in physical terms can be implemented in a number of different ways.

Technical Report 50572 is concerned solely with the communications interfaces; the internal functions and interconnections of the metering end device are outside the scope of the first phase of M/441. The dotted lines H2 and H3 provide interfaces to support the provision of energy efficiency and demand side management services.

A smart metering system always comprises (a) head end system(s) and metering end devices, together with the communication network between them, which may include:

- Wide Area Network (WAN) connecting the head end systems to the local systems or networks
- Neighbourhood Network (NN) covering a number of premises (optional)
- Local Network (LN) within the same premises (optional).

A NN, when present is accessible through a Neighbourhood Network Access Point. Similarly, a LN, when present, is accessible through a Local Network Access Point.

Metering end devices may have interfaces to communicate on the LN, the NN or the WAN. These are the M, C and G interfaces respectively and at least one of these should be present. Note: the “I” interface describes the internal link between the metering functions and the communication functions within the metering end device and is outside the scope of M/441; no European standards for such an interface are envisaged.

A metering end device may have an interface (H1) for a local connection to a simple external consumer display. Home automation end devices (including more advanced displays) may have connections to one or more network access points (H2 and H3).

Access to end devices on the LN is provided by the local network access point (LNAP). An LNAP has one or more M and H2 interfaces to communicate with the end devices on the LN and one or more C or G interfaces to communicate on the NN and the WAN.

Similarly, access to end devices and to LNAPs on the NN is provided by the neighbourhood network access point (NNAP). A NNAP has a C interface to communicate with entities on the NN and a G interface to communicate through the WAN with the metering head end system(s). It may also have an H3 interface to home automation systems. Because the

network access points (LNAP, NNAP) have to interconnect different networks and may need to translate protocols, they contain a gateway function.

The different kinds of metering end devices and display and home automation devices may share a LN or they may have their own LN. Entities on a given hierarchical level may communicate with each other via an entity at the next higher level. Note: an entity at a higher level is generally closer to the head end system.

Additionally, entities at the same level may communicate with other entities at the same hierarchical level. Note: this permits network configurations with branched, chained or meshed interconnection, by means of the L and N interfaces.

In a practical smart metering system, the reference architecture permits a mix of scenarios to be present.

For example:

- Some metering end devices may be accessible through the WAN using the G interface
- Some metering end devices may be accessible through the WAN + NN via the C interface
- Some metering end devices may be accessible through the WAN + NN + LN via the M interface
- Advanced displays and home automation devices may be accessible through the WAN + NN + LN via the H2 or H3 interface.}}

There are also variations in practice concerning the standards which may be used for the different interfaces. For example, while the C interface is used to connect the NNAP and the metering end device or LNAP, in practice standards envisaged for the M interface may be used.

Modular and multi-part installations may require additional interfaces between the constituent parts – these are considered to be outside the scope of M/441.

ADDITIONAL FUNCTIONALITIES

For the purposes of identifying where new standards might be required or existing standards have to be adapted, it was deemed appropriate to determine functionalities starting at a high level. Thus, a top down approach was adopted. High level functionalities have been broken

down further into specific use cases in order to confirm that functional requirements for standards are properly defined.

In order to ensure suitable communications standards to support the development of smart metering systems, standardization is taking account of the following six broad areas of additional functionality:

- **Functionality 1**: Remote reading of metrological register(s) and provision to designated market organizations
- **Functionality 2**: Two-way communication between the metering system and designated market organization(s)
- **Functionality 3**: To support advanced tariffing and payment systems
- **Functionality 4**: To allow remote disablement and enablement of supply and flow/power limitation
- **Functionality 5**: To provide secure communication enabling the smart meter to export metrological data for display and potential analysis to the end consumer or a third party designated by the end consumer
- **Functionality 6**: To provide information via web portal/gateway to an in-home/building display or auxiliary equipment.

The functionalities are services, which can be provided via a smart metering system, without excluding the possibility of certain services being provided by means other than via this system.

The list of functionalities should not be seen as a minimum or a maximum list of smart metering functionalities to be implemented in Europe, since not all functionalities will necessarily feature in all applications or in all member states and functions outside this list may also be defined.

USE CASES

To clarify standardization requirements and to ensure interoperability and consistency in the smart meter dataflows anticipated, it is helpful to consider the additional functionalities in greater detail, through use cases. Use cases can be defined at different levels, depending on their purpose. The Technical Report shows how the use cases adopted by the SM-CG relate

to each of the above functionalities in order to describe how different actors interact with a smart metering system. The SM-CG is currently carrying out further work on use cases.

The use cases are intended to define functional and technical requirements, which then help determine the nature of the bidirectional upstream and downstream communications. , The Task Force "Use Cases" of the SM-CG works with the relevant CEN/CENELEC/ETSI Technical Committees to finalize the Use Cases for Smart Metering based on the six additional functionalities mentioned above. This work is planned to be finished in Q1 2012.

The Smart Metering Use Cases are not developed from scratch but input is taken from various European sources. The final set can be used not only as input for standardisation bodies to develop or adapt their standards, but also by Member States to define their local requirements for Smart Meters. After the development by the SM-CG, the set of Use Cases will be maintained by one of the international standardisation bodies, probably being IEC TC8.

SMART METERING IN THE CONTEXT OF SMART GRIDS

Particularly in relation to electricity metering, there is the important additional objective of facilitating smart grid applications, notably through the incorporation of distributed generation and demand side management. The M/441 mandate envisages smart metering as a key enabler for smart grids, providing for two-way information flows between the meter and the designated market organization(s).

Smart metering applications may overlap with applications of smart grid systems and building/home automation systems. The communications infrastructures supporting these applications may be separate or may be usefully shared.

CONCLUSION

The results achieved are significant. The first phase of Mandate M/441 was finalized at the end of 2011 and the CEN CENELEC ETSI Technical Report 50572 is the concrete result of a considerable work by the experts of the relevant CEN, CENELEC and ETSI technical bodies and the stakeholders actively participating in SM-CG debates. The document represents a broad consensus.

In order to fulfil the second phase of Mandate M/441, experts are currently working at Technical Committee level, drafting and/or revising standards containing harmonized

solutions for additional functionalities and related Use Cases within an interoperable framework using, when needed, the reference functional architecture for communication protocols defined above.

It is the intention that a full set of standards corresponding to the functional and technical requirements for smart meter implementation in Europe will be ready by the end of 2012.