REVIEW AND ASSESSMENT OF INTERNATIONAL COMMUNICATION STANDARDS

Précis

This paper provides advice on the state of communication standards that have been, or are about to be, deployed to support smart meter rollouts in a number of international jurisdictions.

In examining communication standards, this paper takes the view that the underlying issue relates to interoperability of the end-to-end process. This starts at the back office systems used by Accredited Parties[1] and ends at customer premises (including the meter and Home Area Network). The deployed communications form only one component of the entire end-to-end process. It is emphasised that to support interoperability it is necessary to analyse all the components used in the end-to-end process.

The introduction discusses the development of modern applications, which separate the application from the communications being used. The term 'protocol' will be used to describe how applications share information. The review of international smart meter rollouts reveals a number of meter protocols which can be successfully transmitted over a range of different communication technologies.

Texas, the UK and New Zealand jurisdictions were selected because of the similarity of their energy markets to the Australian NEM, specifically the separation of energy retail from energy distribution. These rollouts also include functionality similar to that proposed in the Australian Smart Metering Infrastructure Functionality Specification, for example load control and support for customer interactions via a Home Area Network.

The selection of the Spanish jurisdiction as it represents a vertically integrated electricity utility choosing to install interchangeable meters. Their efforts to specify a single communications technology capable of reaching all their meters allows them to select from a range of meters all of which are certified to be interchangeable.

The review shows that several smart meter protocols have matured significantly in the past few years. The analysis concludes that international standards could be used to define a smart meter protocol providing interoperability for any smart meters deployed in Australia.

For the purpose of clarification, this advice does not cover the topic of access to meters. Access to the meter is a separate topic unrelated to a discussion of end-to-end interoperability.

[1] In this review the Accredited Party is considered to be any party authorised to interact with the customer's meter or devices on the HAN. This includes parties given consent by the customer to access their meter or HAN

Contents

Introduction

Asking a question about communications standards is paramount to asking a question about interoperability. Interoperability between different devices allows users to choose the options that work best for them. To explain this statement, and by way of an introduction, the following explanation is provided.

As a case study let's consider early personal computers (PCs) where owners were forced to choose between a genuine IBM PC, copies of the IBM PC or an Apple Macintosh. The problem was that there was very little interoperability between these computers. Applications running on the genuine IBM PC could prove unreliable on PC copies and would not run at all on the Apple Mac. Having made a selection PC owners quickly found they were "locked in" to a particular technology with future choices limited by that initial decision.

The development of standards supporting interoperability provided users with the freedom to choose. For example today we can confidently purchase a new printer, plug it into the USB port and start using it with all the applications loaded on the PC. In an office environment interoperability provides even greater flexibility with users able to select from a number of (different) printers from all Applications installed on the PC:

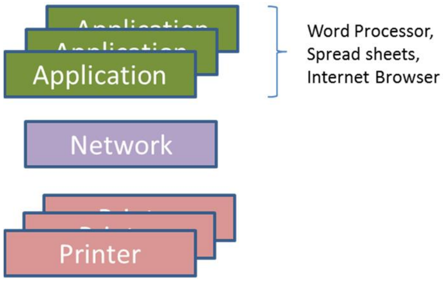


Figure 1: Multiple PC Applications can select from multiple printers connected to one network

Such interoperability was not achieved "overnight". The standards allowing us to select from a range of network connected printers from any application running on the PC took years to develop. The standards required numerous associations to collaborate on the development of these multiple standards. Then of the many competing standards that emerge from innovation, the industry over time generally settles on the preferred solution, for example VHS v Betamax or Blu-ray v HD DVD.

Interoperability Spectrum

Interoperability is not an all or nothing concept with most systems offering some level of interoperability. When reviewing international jurisdictions we propose a simple assessment framework as shown in Figure 2:

Figure 2: Proposed Interoperability Spectrum

Considering smart meters the reference points on the assessment framework are defined in the following way:

- Not Interoperable
  - No ability to interact with the meter (e.g. Unpublished proprietary protocol).
- Protocol Translation
  - Able to interact with the meter by converting protocols, however there may be some loss of functionality. For example Itron MV90 is only able to read meter data - it cannot alter meter settings.
- Common Protocol
  - All meters use a common protocol so interactions occur without loss of functionality (may offer different functionality).
- Interchangeable
  - One meter can be swapped with another with no system impacts. No need to change back office applications

The reference points on the assessment framework refer to the term "protocol". Here we use the term "protocol" to describe how Applications unambiguously exchange information (this will be discussed in greater detail below).

It is also important to understand that the interoperability offered by a system may differ depending on who is looking at the system. To explain how the perspective may change the assessed level of interoperability we use a modern smart phone.

- A smart phone user can use the internet browser application to view almost all websites regardless of whether the phone is using the iOS (Apple) operating system or the Android (Google) operating system. From the perspective of the user the different solutions are "Interchangeable".
- Viewed from the perspective of an Application developer they must use different software tools to work on each phone, one for Apple and another for Google. From the perspective of an Application developer the two phones are "Not Interoperable".

During the review of international jurisdictions we have chosen to viewed interoperability from three perspectives:

- an Accredited Party remotely accessing the meter,
- an Accredited Party locally accessing the meter (e.g. via the optical port)
- a general comparison of all deployed meters against each other.

For this assessment we have assumed that the Accredited Party can access the meter (both remotely and locally). This is a separate topic which is beyond the scope of a discussion of end-to-end interoperability.

Separating the Application from the communications

At the start of the introduction we considered the ability of a PC user to access a number of different printers installed on a corporate network. This is made possible by separating the PC Application from the method of communicating with the printer. The Open Systems Interconnect Model ("the OSI Model") provides a theoretical model of how to achieve interoperability between different systems. An alternative model (sometimes considered to be a practical implementation of the OSI

Model) is the Internet Layers Model. While Figure 3 shows all the layers, the important point is that 'layering' allows the Application to be developed independently of the communications (for example the printer works whether it is directly connected via USB or via the corporate Ethernet cable)

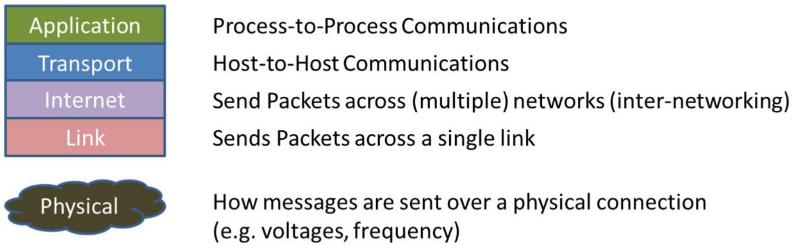


Figure 3: Internet Layer Model

To demonstrate the usefulness of this model we extend the printer example by adding corporate file storage. The PC is connected only to one corporate network, but different applications running on the PC are able to access the printer and file storage. This is depicted in Figure 4:

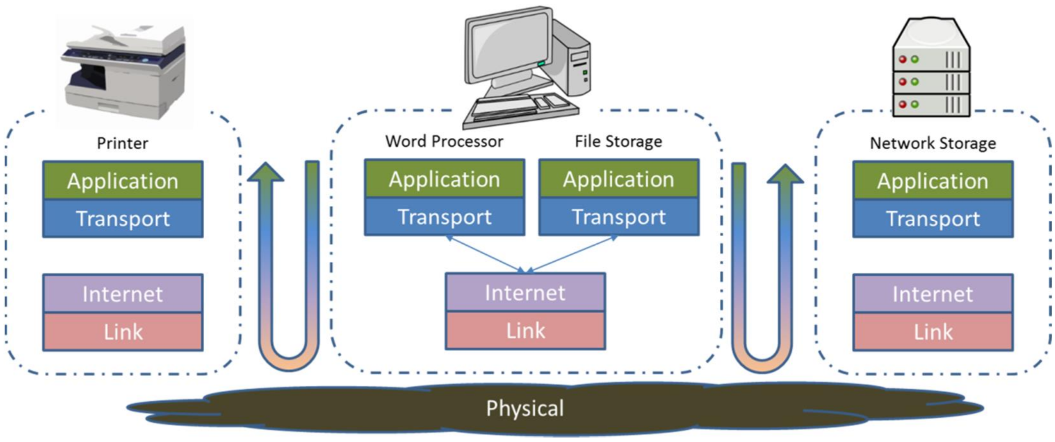


Figure 4: Example of Interoperability using the Internet Layers Model

In the centre of the figure we have the user PC running two applications: a Word Processor and File Storage. On the left of the figure we see the network printer with an arrow indicating that the Word Processor is able to send documents to the printer. On the left of the figure we show the Network storage with an arrow indicating that an application on the PC can store (and retrieve) files to the Network Storage. At the bottom of the figure we show the single physical layer (the corporate Ethernet network).

This is made possible by carefully defining the interface between each layer. The application developer only uses the defined interface to the Transport Layer. The layers between the Application Layer and the Physical Layer allow the Application to work over a range of different communications technologies (provided that the new communications technologies support the Internet Layer Model). The following sections consider the development of smart meter interoperability.

Automatic Meter Reading (AMR)

Early smart meter applications were only required to replace manual meter reading. This was achieved by adding communications to existing meters. The main interoperability concern was to ensure the meter data which was read remotely could be integrated into the existing Meter Data Management System (along with manually read meter data).

Early adopters of smart meters were forced to choose between numerous proprietary (non-interoperable) solutions. While these solutions satisfied initial utility requirements they locked the utility into a particular technology and eventually restricted future enhancements.

As the complexity of smart metering applications increased it became clear that standards were needed. These standards enabled utilities to select solutions meeting their current requirements, whilst providing confidence that functionality could be added in the future. Significantly as the standards matured they adopted the Internet Layers model. This means that smart meter applications can be developed in isolation of the communications, thereby allowing utilities to deploy a range of communications solutions.

A Standard Protocol

For applications to exchange information they must be able to unambiguously communicate with each other. Here we will use the term “protocol” to describe how this occurs. Readers are encouraged to think of a protocol as the language used to describe the information they wish to share. Note that the definition of a protocol must be very precise. Consider using the statement “Put it in the trunk”. In Australia this will result in an item being placed in a large suitcase, while in America an item will be put into the back of a car. Conversely using the statement “Put it in the boot” in Australia will result in an item being placed in the back of a car, but in America will result in an attempt to place the item into a large shoe.

Having agreed on a language precisely describing the shared information the parties must now agree on how they will communicate. Between humans common examples include a phone call, email, etc. For smart meters common examples include cellular modems, RF Mesh, power-line carrier, etc. In either case it is desirable that the language continues to be unambiguously exchanged regardless of the selected communications technology. This concept was introduced in the Internet Layers Model (shown in Figure 3). As noted this requires the selected communications to provide a suitable interface, for example a telephone has a keypad to allow users to enter the number.

End-to-end interoperability requires agreement on the language used to describe items (the protocol) and the interfaces that various communications options must provide. Figure 5 depicts a range of different electricity meters and a range of different communications systems. Provided that all the meters use the same language and that the communications provide suitable interface(s) the user can use the same application to unambiguously exchange information with all the meters. The Internet Layer Model is shown at the bottom of the figure.

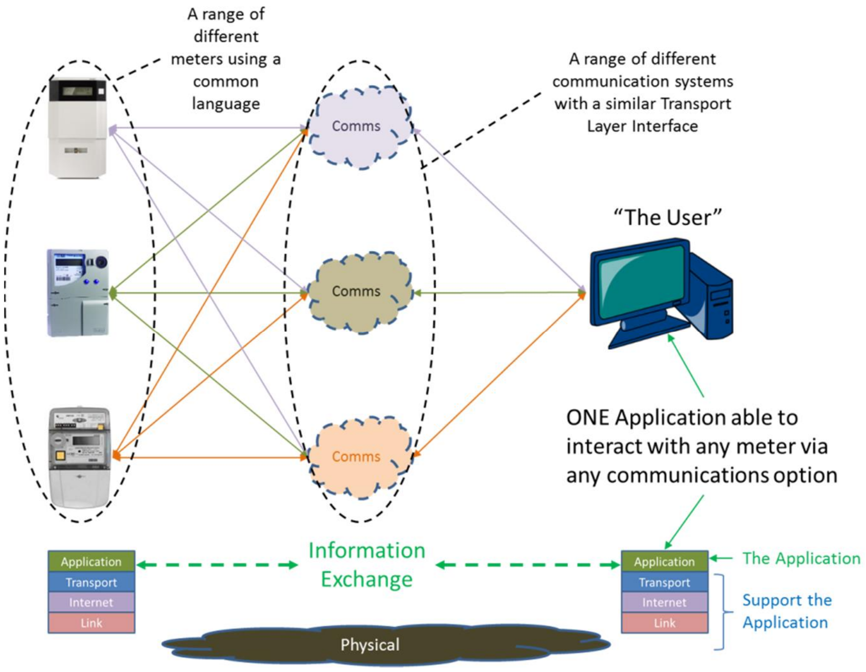


Figure 5: Depicting how the Internet Layers Model supports meter interoperability

The people who develop modern smart meter protocols have recognised that they need to describe the language and how the language will be transmitted over a range of communications options. These communications options are usually described in standards developed by other people, for example the ZigBee Association does not attempt to define the details of the physical layer their protocol requires, they instead refer to a standard developed by the IEEE. It is noted that a single " protocol" may be defined in numerous international standards not all of which are maintained by the people developing the meter protocol.

The "Head End Systems"

Figure 5 shows "ONE Application" able to interact with a range of meters using several different communications technologies. In the figure the Application is depicted as a single PC, but in large smart meter rollouts there will be multiple operators (and many of these operators will actually be fully automated). The Application should be viewed as an integral part of the suite of software programs run by utilities. This suite of programs is often referred to as the "back office".

To separately identify the smart meter Application(s) from other software applications running in the utility back office we will use the term "Head End Systems" to describe them. Note that in this context it is assumed that the same Head End System will be capable of interacting with all functions offered by the smart meter, including all operations involving devices on the Home Area Network.

The following sections review a number of international smart meter rollouts assessing the maturity of the standards and the level of interoperability that the various solutions have achieved.

Review and assessment of international jurisdictions

Four international jurisdictions have been chosen for this comparison. These are:

- Texas, USA;
- United Kingdom;
- New Zealand;
- Spain;

The characteristics (common and unique) of the protocols commonly used internationally are explained for each jurisdiction to set the context for an explanation of the protocols used in that jurisdiction.

Texas, USA

Summary of the rollout

Meter rollout principle:	Distributor lead rollout of smart meters (with cost recovery via a surcharge)
Size of rollout:	Approximately 7 million premises
Status of rollout:	Complete (currently enhancing Accredited Party access to customer HAN)

Standards used in the rollout

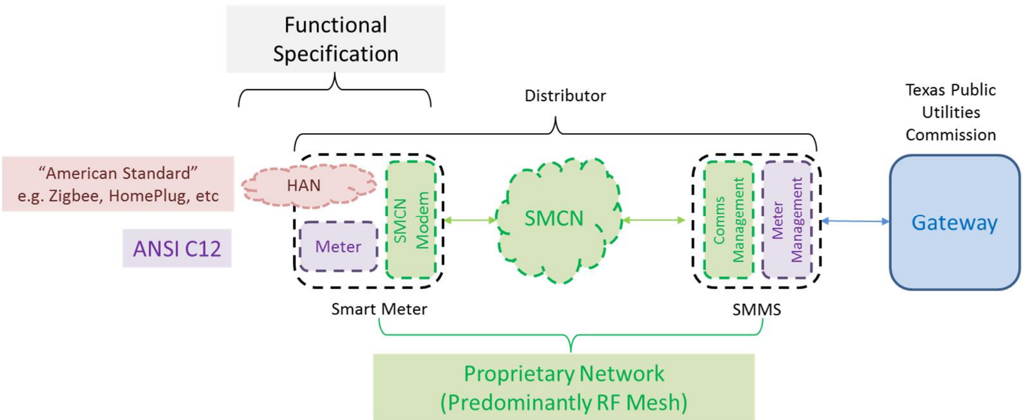


Figure 6: Context for the Texas Smart Meter Rollout

Meter Protocol:	ANSI C12 (American national metering standard)
HAN Protocol:	Required to use an American national standard e.g. ZigBee, HomePlug or equivalent. Appears most have selected ZigBee
Communications Technology:	Most distributors have selected RF Mesh
Certification of devices:	No requirement to certify meters. A list of approved HAN devices is available (indicating testing is undertaken)

GOOD BUSINESS PRACTICE

Functional Specification:	High level specification is included in the substantive rules

Assessment of the rollout

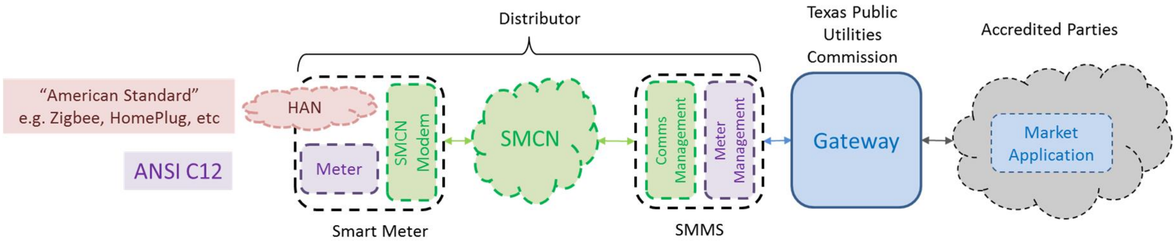


Figure 7: End-to-End depiction of Texas smart meter rollout

<u>Meter Interoperability</u>	
Remote access by Accredited Parties	Protocol Translation Access to all meters via the Texas PUC web-portal
Local access by Accredited Parties	Common Protocol All meters in the rollout use a standard meter protocol
Comparing all meters	Common Protocol All meters in the rollout use a standard meter protocol
<u>HAN Interoperability</u>	
Remote access by Accredited Parties	Protocol Translation Access to the HAN is provided via the Texas PUC web-portal
Comparing all HAN devices	Not Interoperable The HAN standard was not specified, as such interoperability between devices is not guaranteed. Most rollouts appear to have settled on ZigBee

American national metering protocol (ANSI C12)

The American metering market defined a standard protocol for interacting with electricity meters in the 1990's. The standard is defined in a number of separate documents including physical dimensions of meter sockets (C12.7), a standard optical port (C12.18) and "data tables" (C12.19). The definition of "data tables" in C12.19 was initially aimed at ensuring hand held devices could unambiguously read the meter data from meters.

The series of standards has been enhanced with the addition of standards covering remote communications to the meters including C12.21 which describes telephone communications and more recently C12.22 describing how C12.19 data tables can be transmitted over a range of different communications links including TCP/IP and UDP links.

The American National Standard ANSI C12.22-2008 Protocol Specification for Interfacing to Data Communications Networks also describes a physical interface between an electricity meter and a communications module. It is noted that in the USA the communications modem is not field replaceable, instead the modem is integrated inside the electricity meter during production (generally by the meter manufacturer). The standard interface uses an RJ-11 connector and specified the pin allocations, voltage levels, etc. This interface simplifies the connection of different communication technologies into electricity meters.

American HAN Standard

The rules covering the Texas rollout state that the meter is "Required to use an American national standard e.g. ZigBee, HomePlug or equivalent" to support the HAN.

The ZigBee family of application protocols provides several options for the management of household electricity use. The family includes[2]:

Figure 8: A selection of ZigBee Application Protocols relating to electricity use

While the application layers share the same physical layer (IEEE 802.15.4) they provide different application layers (which are not interoperable). It is therefore insufficient to specify "ZigBee" and expect this to support device interoperability. To achieve interoperability it is also necessary to specify the application layer (and as we will discuss later it may also be necessary to specify some options in the physical layer).

There is evidence that ZigBee SEP has been selected as the defacto HAN standard by the majority of Texas distributors. A list of ZigBee approved devices is available on the PUC website providing customers sufficient information to confidently purchase devices tested to interoperate with installed smart meters. It was not clear who maintains the list of devices or who undertakes the interoperability testing.

It is assumed that most of the Texas distribution utilities have specified ZigBee SEP 1.x since SEP 2 was unavailable at the commencement of the Texas rollouts. Incompatibility between the SEP 1.x and SEP 2 application layers probably ensures they will not upgrade to ZigBee SEP 2.

The other American national (HAN) standard mentioned in the rules is HomePlug. HomePlug describes an advanced method of communicating over powerlines. The HomePlug.org website states "With HomePlug technology, the electrical wires in your home can now distribute broadband Internet, HD video, digital music & smart energy applications".

The HomePlug standards are defined in IEEE 1901.2010, however this standard includes several different physical layers: the original high speed AV2 (Audio-Video) specification and a lower speed Green PHY specification. Green PHY was specifically designed to use less energy and to support

[2] More information (and the other ZigBee protocols) can be found at their website www.zigbee.org.

lower cost devices. In the context of Smart Metering HomePlug is assumed to be referring to Green PHY.

It is also important to note that the HomePlug standard “only” provides the physical layer, it does not provide a HAN Application Layer. Rather than develop their own HAN Application the HomePlug association worked closely with the ZigBee alliance to ensure that the ZigBee SEP 2 HAN application layer can utilise HomePlug physical layers. This should be taken as further evidence of the significance of the Internet Layering Model and the advantages offered by separating the Application from communications technologies providing a suitable Transport Layer interface.

Summary

The Texas smart meter rollout supports interoperability (from the perspective of the Accredited Party) via a web-portal. The format of commands sent to the web-portal allows Accredited Parties to interact with a range of different meters in a consistent manner. Individual distribution businesses provide the communications network.

United Kingdom

Summary of the rollout

Meter rollout principle: Retailer lead mandated rollout of smart meters

Size of rollout: About 30 million premises.

Status of rollout: Described as the "Foundation Stage". This is basically the rollout of meters meeting an early functionality specification

Standards used in the rollout

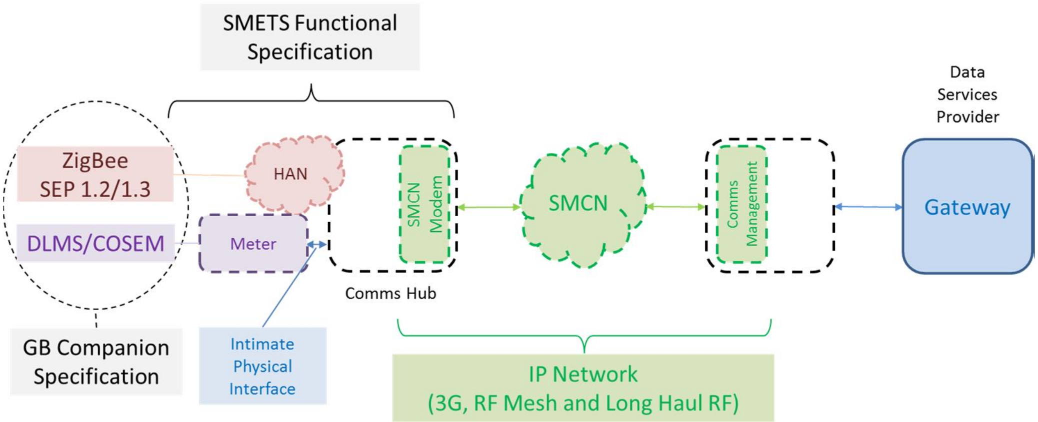


Figure 9: Context of the UK Smart Meter Rollout

Meter Protocol:	DLMS/COSEM (with Companion Specification)
HAN Protocol:	ZigBee SEP 1.x
Communications Protocol:	Internet Protocol (IP)
Communications Technology:	Commercial Cellular, RF Mesh, Long Range Radio
Certification of devices:	Devices must be tested to allow registration on the network
Functional Specification:	Detailed technical specifications developed for all major components (meters, comms hub, IHD, etc)

Assessment of the rollout

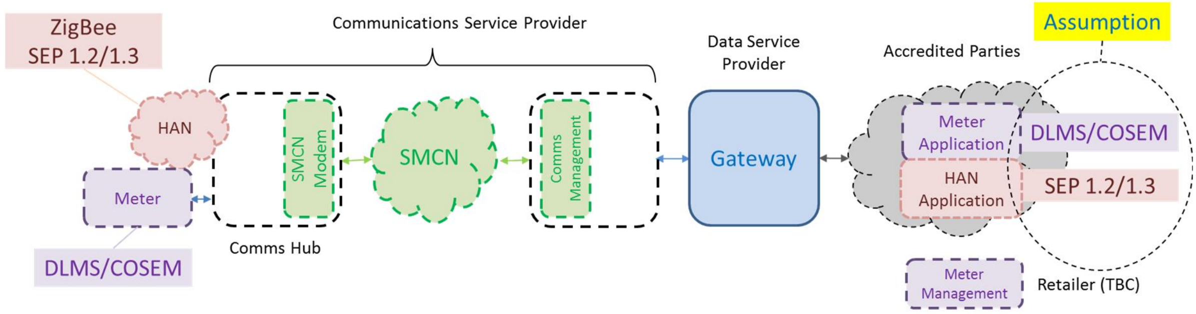


Figure 10: Adding the Head End Systems to the UK smart meter rollout

<u>Meter Interoperability</u>	
Remote access by Accredited Parties	Interchangeable Single gateway supports access to all meters. Detailed functional specifications ensure all meters will appear identical
Local access by Accredited Parties	Interchangeable The rollout uses a standard meter protocol (DLMS/COSEM) and Companion Specification
Comparing all meters	Interchangeable Detailed functional specification including a “Intimate Port” allows different communications options to installed in the field
<u>HAN Interoperability</u>	
Remote access by Accredited Parties	Interchangeable Single gateway supports access to all HANs (in Comms Hub). Detailed functional specifications ensure all Comms Hubs have identical functionality
Comparing all HAN devices	Common Protocol HAN is established by the Comms Hub and three different communication service providers have been selected. Certification of ZigBee SEP 1.x devices will ensure interoperability

Note: As a member of the European Union the UK is obliged to use international standards throughout the rollout (refer to EU Mandate M/441 discussed below under Observations from international rollouts)

While it has not been possible to determine the exact protocol used by Head End Systems it is assumed[3] they will be based on the standard protocols DLMS/COSEM and ZigBee SEP 1.x. This is noted in Figure 10.

[3] This assumption is based on an inability to find any technical documentation describing a different protocol between the Data Services Provider and Accredited Parties

Unique Features

The UK rollout places its focus on the provision of communications to the HAN. The Communications Hub provides remote communications and establishes the HAN. Communications with the meters is via the HAN. In contrast most other smart meter rollouts establish communications directly with the meter, and communications to devices on the HAN is via the meter. To highlight the difference compare the connection to the meter on the left hand side of Figure 9 against that in Figure 6.

DLMS/COSEM protocol

The DLMS User Association maintains the DLMS protocol. There are now over 270 members from over 50 countries. The protocol is comprehensive and includes certification testing of devices for compliance.

DLMS/COSEM is an entire suite of protocols that together define a common protocol and methods for communicating with a range of meters in an unambiguous manner. The standards define many more features than are required to meet the UK smart meter rollout. To ensure interoperability a working group has carefully defined the base set of features (objects) which must be supported by all smart meters. This base set of features is described in the “GB Companion Specification”. The Companion Specification defines the base objects that must be included in any meter. The Companion Specification is discussed below in the following section: Selecting “A Standard” may not support interoperability.

To aid understanding the following provides an example of two base objects. In this case two register values:

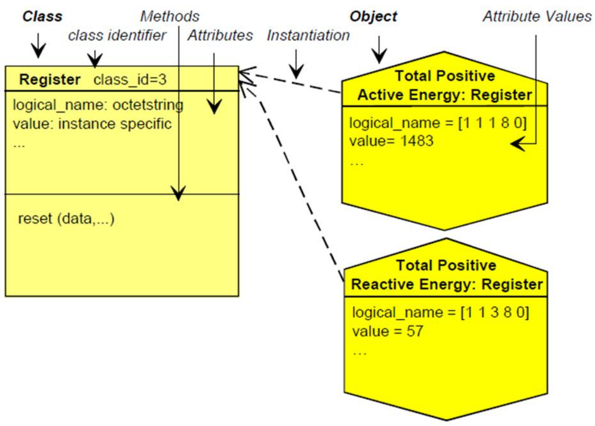


Figure 11: Example of two base objects available in COSEM Interface Classes

The left hand box in Figure 11 describes the class (in this case “Register”) and methods which can be used on the class (e.g. ”Reset”). On the right are two examples of possible Registers, Total Positive Active Energy and Total Positive Reactive Energy.

A UK smart meter working group is coordinating with the DLMS User Association to ensure changes to the DLMS standard are incorporated in time to meet the planned meter rollout. These changes will also ensure adequate testing and certification of all products.

ZigBee Smart Energy Profile 1.x

Like the selected meter protocol, the ZigBee protocol defines more functionality than is required in the UK smart meter rollout. The UK is therefore working with the ZigBee alliance to have changes incorporated into the ZigBee SEP profile. This will ensure that HAN device certification will support a minimum set of required functionality.

The physical layer used by ZigBee is described in IEEE 802.15.4. To date most ZigBee devices have used the 2.4GHz class licenced (often incorrectly referred to as unlicenced) spectrum since this band is available in most countries. This is the same frequency used by many WiFi devices and also Bluetooth devices. The IEEE association ensures that the various standards are able to co-exist despite using the same spectrum.

The problem with the 2.4 GHz frequency is its penetration capability. In the UK there is concern that 2.4GHz may not provide adequate in-home coverage (especially to the remotely located gas meter).

The ZigBee standard also allows operation in other class licenced bands, for example in Australia (and the USA) the 900MHz Instrumentation, Scientific and Medical band will support greater coverage. The 900MHz band is not available in the UK, instead there is a narrow band available at 868MHz. The UK is trying to encourage the development of ZigBee products in the 868MHz band, however this may cause interoperability issues since they are currently not considering dual band operation (2.4GHz and 868MHz) for the Communications Hub.

Despite the EU mandate M/441, it is noted that the UK have chosen ZigBee SEP 1.x which contains a “proprietary” (but well described) Media Access Layer. The UK rollout was considering ZigBee SEP 2 as specified in the Australian SMI FS. The main difference between SEP 1.x and 2 is support for IP addressing as described in several Internet Engineering Task Force (IETF) standards. The use of IETF standards allows the SEP 2 application to use ANY IP communications network. Despite greater adherence to international standards the UK elected to retain SEP 1.x after doubts were raised about the battery lifetime of HAN devices offering SEP 2[4].

The UK smart metering program is currently working with the ZigBee Alliance to finalise a new release of the Smart Energy Profile. It is believed that the major rollout will use SEP 1.3. As observed in Texas, ZigBee SEP 2 devices cannot interoperate with ZigBee SEP 1.x devices so it is assumed that the UK will not migrate to SEP 2.

Summary

The UK smart meter rollout has ensured that all components of their rollout utilise internationally specified standards and protocols. Despite high levels of interoperability Accredited Parties still access the infrastructure via a single gateway operated by the Data Services Provider (DSP). The DSP uses one of three different Communications Service Providers to communicate with the meters.

[4] Unsubstantiated information indicates that the main reason for choosing ZigBee SEP 1.x was the need to retain support for legacy SEP 1.x devices currently being deployed by British Gas. This point, if correct, is important when considering the implication for the current Victorian AMI program.

New Zealand

Summary of the rollout

Meter rollout principle:	Retailer lead rollout (Government is "supportive" but there is no mandate)
Size of rollout:	Around 1.5 million meters
Status of rollout:	Mostly complete

Standards used in the rollout

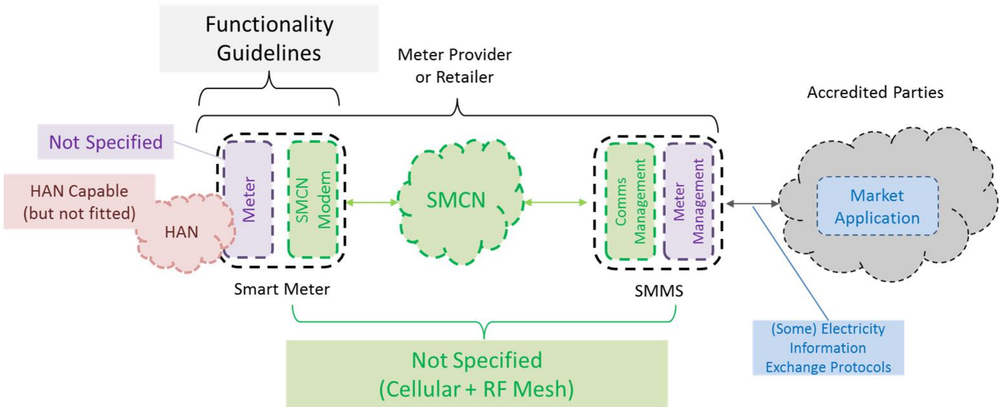


Figure 12: Context of the New Zealand Smart Meter Rollout

Meter Protocol:	Not specified – any manufacturer's meter may be used
HAN Protocol:	Not specified – any HAN technology may be used
Communications Technology:	Not specified (most appear to be using commercial cellular but RF Mesh is also mentioned)
Certification of devices:	Not required ("nothing to test against")
Functional Specification:	Government has provided functionality Guidelines

Assessment of the rollout

Meter Interoperability	
Remote access by Accredited Parties	Protocol Translation Electricity Information Exchange Protocol does provide some guidance (a market protocol not a standard)
Local access by Accredited Parties	Not Interoperable No common protocol for meters in the field
Comparing all meters	Not Interoperable Limited adherence to the recommended functional specification has resulted in a range of different meters being deployed

HAN Interoperability	
Remote access by Accredited Parties	Not Interoperable No common standard and limited adherence to the recommended functional specification indicates very few premises actually support HAN functionality
Comparing all HAN devices	Not Interoperable No common standard

Unique Features

Unlike the first two international examples there is no common gateway. Accredited Parties must negotiate access to meters with various meter operators. It is also noted that a large percentage of meters in New Zealand are owned by dedicated meter providers (old figures suggest almost 50% of the meter population). Meter providers lease access to retailers for an annual fee. One advantage is that on customer churn the customer meter is rarely replaced.

While there is no smart metering functional specification the Electricity Commission has released a list of recommended functionality. These are contained in Guidelines on Advanced Metering Infrastructure Version 2.0 released 28 Jan 2009. It is emphasised that this document is only intended to provide some guidelines.

Summary

The New Zealand smart meter rollout uses the guiding principle that the Accredited Party should negotiate an appropriate interface to the smart meters with the smart meter platform operator. The guiding principle leaves this protocol up to the Accredited Party and the smart meter platform operator. As a consequence of these guidelines the smart meter platform operator may be required to implement several different interfaces and protocols.

A review of the New Zealand smart meter rollout has been undertaken by the New Zealand Parliamentary Commissioner for the Environment (PCE). The PCE report suggests that the rollout of smart meters in NZ has not been as successful as initially hoped specifically some smart meters do not support the functionality required to benefit customers or network operators.

Both topics are discussed in greater detail below in the section Observations from international rollouts.

Spain

Summary of the rollout

In Spain, the vertically integrated utility Iberdrola has undertaken a rollout of smart meters to meet regulatory requirements. This jurisdiction has been included here due to their decision to rollout interchangeable meters and the communication technology they developed (despite there being limited market pressure to do so).

Meter rollout principle:	Mandatory rollout imposed on vertically integrated utility
Size of rollout:	Approximately 10 million meters
Status of rollout:	Globally over 2 million meters estimated that 1 million are in Spain

Standards used in the rollout

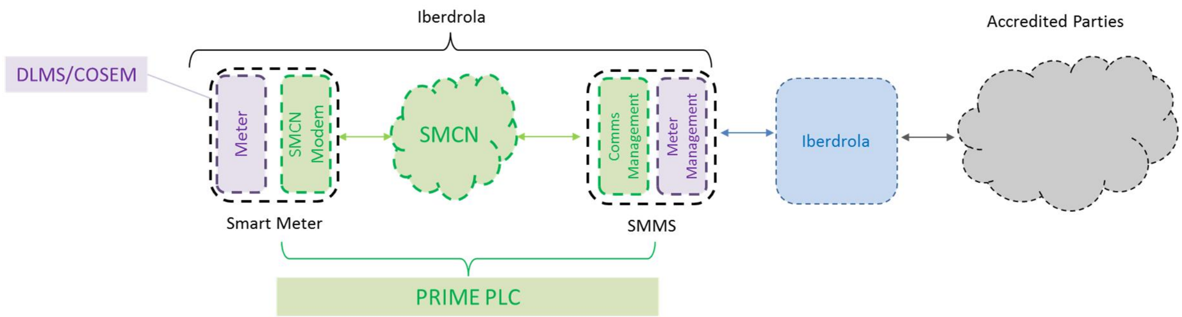


Figure 13: Context of the Spanish rollout by Iberdrola

Meter Protocol:	DLMS/COSEM (with Companion Specification)
HAN Protocol:	The PRIME PLC standard can be used to support HAN functionality
Communications Protocol:	Internet Protocol
Communications Technology:	PRIME (a “3rd Generation” Distribution Line Carrier)[5]
Certification of devices:	DLMS certification required. PRIME certification also required
Functional Specification:	“Comprehensive functional metering specification is being defined”

Assessment of the rollout

Meter Interoperability	
Remote access by Accredited Parties	Interchangeable As the founding member of the PRIME Alliance they have helped develop and then deployed a system complying with international standards

[5] PRIME (PoweRline Intelligent Metering Evolution) is the name given to this technology, just as WIFI or Blue-Tooth is given to different forms of wireless technology.

Local access by Accredited Parties	Interchangeable Detailed functional specification ensures meters from different manufacturers are interchangeable (Common communications technology used to communicate with all meters)
Comparing all meters	Interchangeable Detailed functional specification ensures meters from different manufacturers are interchangeable (Common communications technology used to communicate with all meters)
HAN Interoperability	
Remote access by Accredited Parties	Not Assessed
Comparing all HAN devices	Not Assessed

Summary

Traditionally a vertically integrated utility is not required to select a solution offering interoperability. The utility is free to choose the extent to which deployed devices are interoperable. The Spanish market has responded to the European Mandate M/441 by developing a standards based open solution. The solution includes the deployment of meters that are interchangeable. Amongst other things, it allows Iberdrola to select meters from a range of meter vendors confident that they are certified to work identically.

Maturity of the standards

The above analysis reveals that smart meter protocols are now reaching a high level of maturity. These are:

- DLMS/COSEM
- ANSI C12
- ZigBee SEP

The protocols allow complex smart metering systems to be deployed each capable of utilising a range of communications options.

It must be noted that the development of standards always lags the leading edge of what is technically feasible. The UK has expended considerable effort to accelerate enhancements to the DLMS/COSEM and ZigBee SEP standards. By 2014 both these standards will be capable of supporting functionality outlined in the Australian SMI FS.

While deployments of the ANSI C12 standard have successfully incorporated HAN functionality it is less clear that this has been achieved without relying on 'Factory Extensions' to the protocol. Factory extensions are an area of uncertainty when considering interoperability. More research would be required to determine the level of interoperability for this functionality.

Convergence of the standards

All the standards discussed have moved to separate the Application from the communications technology (using the Internet Layering). The ZigBee SEP 2, DLMS/COSEM and ANSI C12 protocols can all be transmitted over communications technology using Internet Protocol (IP). This suggests that any discussion of "standard protocols" should separate the selection of the Application Layer protocol from the Physical Layer protocol.

For the UK rollout extensive work has been undertaken ensuring that DLMS/COSEM and ZigBee SEP 1.x can be transmitted over the same communications network. Given that ANSI C12 can also be transmitted over an IP based communications network it suggests it is theoretically possible to install meters using ANSI C12 on the same communications network as meters using DLMS/COSEM. While this may be technically possible, it is not particularly practical. The party communicating with the meter would need to support two Head End Systems (one for each protocol).

Suitability for adoption in Australia

DLMS/COSEM

DLMS is a mature standard supported by a wide range of international meter vendors. Significantly for Australia many of these meters are similar to those typically used in Australia.

From the DLMS User Association website (www.dlms.com)

> DLMS
> Device Language Message Specification - a generalised concept for abstract modelling of communication entities
>
> COSEM
> COmpanion Specification for Energy Metering - sets the rules, based on existing standards, for data exchange[6] with energy meters

A review of meter protocols was undertaken while considering Interoperability for Meters/Devices at Application Layer (Function 18) by the Australian National Smart Metering Program. This review concluded that DLMS/COSEM was the leading contender if Australia was to specify a meter protocol.

The DLMS/COSEM protocol has been developed for deregulated energy markets which may require (controlled) multi-party access to the meter. In a deregulated market the DLMS/COSEM protocol allows control over which parts of the meter an Accredited Party has access. Specifically Accredited Party access can be restricted to sub-sets of the total data held in the meter. (this topic is relevant when considering the topic of meter access).

The DLMS/COSEM protocol has advanced support for message authentication and message encryption. There are numerous security features described in various DLMS standards making this one area which must be addressed using the Companion Specification. This may require the participation of an Australian representative in the DLMS User Association – a point for further discussion.

From the very start the DLMS User Association has taken the approach that all devices must be verified for compliance with the standard. Devices can be tested in an independent test lab or vendors can self-test using a test tool provided by the DLMS User Association. Certification of devices requires test documentation to be provided to the DLMS User Association who approve the testing and issue a certificate of compliance.

A number of software vendors offer the DLMS/COSEM protocol suitable for inclusion in smart meters. These vendors also offer software suitable for inclusion in Head End Systems. These software packages can significantly reduce the time to develop compliant solutions and are offered at reasonable cost. Training in the protocol is offered by several organisations.

Several Australian metering manufactures are already members of the DLMS User Association and offer meters certified as DLMS compliant.

[6] For clarification in this context ‘data exchange’ is not restricted to meter data. It includes all data that may be exchanged with the meter including meter settings, configuration data, etc.

American National Standards Institute (ANSI) Metering Protocol C12

The ANSI series of standards is very mature. When discussing protocols for use in Australia the series contains two important parts:

- C12.19 Utility Industry End Device Data Tables (-2006)
- C12.22 Protocol Specification for Interfacing to Data Communication Networks (-2008)

The majority of meters using the ANSI C12 standard are unsuitable for use in Australia. Firstly the USA uses a standard meter socket (as described in ANSI C12.7 Requirements for Watthour Meter Sockets) while the majority of Australian meter installations are "bottom connected" using screw terminals[7]. Secondly most domestic appliances in America use 110Volt 60Hz (single phase three wire) while Australian appliances use 230V 50Hz (single phase two wire).

While ANSI meters may not be applicable to Australia, the protocol is in use in Australia. The Victorian AMI rollout chose remote communications systems developed in the USA (based on transmitting C12.19). It has been reported that meter vendors wishing to integrate the chosen communications solutions into their meters were required to support ANSI C12.19 data tables. From experience, this exercise would take approximately 1 week to convert a translation layer from a proprietary meter protocol to an American developed (C12.19 based) communications module and produce a working prototype.

Note that the last update to C12.19 was in 2006. Smart metering functionality has matured significantly in the intervening years, almost guaranteeing that the C12.19 data tables will not document a number of smart meter functions. It is known that the previous version of C12.19 did not describe how to control the Supply Contactor or Load Contactor. To address this "Factory extensions" can be used to allow vendors to offer functionality not described in the standard tables. Unfortunately in most cases factory extensions become vendor specific and are therefore not interoperable. Specifically while two meters may offer the same advanced functionality (e.g. remote switching of the Supply Contactor) they will require different Applications to utilise the functionality.

ZigBee

The ZigBee standard is mature and continues to address current and future needs through continued development. It is highlighted that ZigBee SEP 1.0 was selected as the HAN protocol for the Victorian AMI rollout. Recently customer portals have been released allowing Victorian electricity customers to enable HAN devices in their home (including a number of In Home Displays).

As an early version of the ZigBee Smart Energy Application SEP 1.0 supports less functionality. One function missing from SEP 1.0 is the ability to remotely upgrade the ZigBee application running on deployed devices (which was added to all versions from SEP 1.1 onwards).

During 2013 an upgraded version of ZigBee SEP was approved allowing the application to utilise any communications network supporting IP. While the Australian SMI FS specifies the same 2.4GHz physical layer as Victorian AMI it specified the ZigBee SEP 2 Application layer. As noted earlier SEP 2 devices are not interoperate with SEP 1.x devices.

---

[7] Plug in sockets were used in Australia by some distributors. It is noted that the Australian socket is not compatible with the American socket.

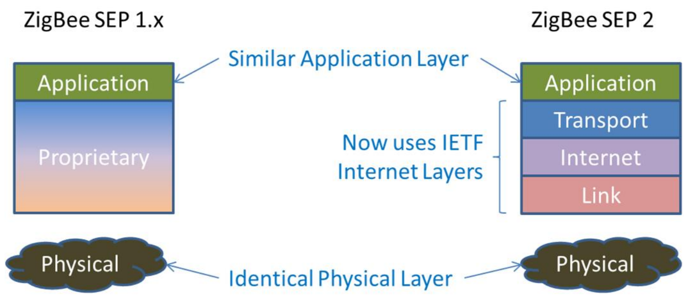


Figure 14: Comparison of ZigBee SEP 1.x and SEP 2

There is a good support for ZigBee in Australia with several companies listed as members of the ZigBee Alliance (including meter manufacturers and device manufacturers). Several of these companies have already successfully developed ZigBee certified products.

Certification testing requires the device to be sent to one of a number of approved test houses. Once the device passes the tests the ZigBee Alliance will issue a test certificate.

Further evidence of international acceptance of ZigBee for establishing home area networks is shown by the ECHONET[8] consortium's recent decision to support ZigBee. ECHONET is developing an application layer protocol for smart appliances and home automation. The partnership ensures that ECHONET can use the ZigBee IP transport layers. (Note ZigBee IP transport is used in SEP 2 providing further support for Australia's adoption of this version of the protocol)

Several silicon chip vendors offer integrated chipsets suitable for use in ZigBee equipped devices (including meters, in home displays, load control switches, etc). These chipsets provide the radio interface and complete computer capable of running the chosen ZigBee application. Many of these vendors can provide a complete implementation of the desired ZigBee protocol stack.

Security has also been designed into the ZigBee standard. Device[9] manufacturers are required to place a security certificate into each ZigBee device. Before a ZigBee device can connect to the utility meter the security certificate is checked for validity.

Internet Protocol (www.IETF.org)

The mission of the Internet Engineering Task Force (IETF) is "*to make the Internet work better*". The standards are so well accepted that almost all modern communications system support Internet Protocol (IP). Indeed adoption of IP has been so extensive that the world is running out of IP addresses forcing an upgrade from IPv4 to IPv6.

Commercial cellular networks offering data services have used IP addressing for over a decade. IP transport was first offered on GPRS networks (so called 2.5G), but is now universally supported on 3G and 4G networks. It is also important to note that many "proprietary" communications solutions incorporate various IETF standards, including IP transport (this is particularly true of RF Mesh networks which rely on message routing).

[8] ECHONET is a home networking technology intended to integrate many devices and systems to reduced electricity use and manage electricity demand. See www.echonet.gr.jp.

[9] In this context a ZigBee device should be considered to be all smart appliances, including in-home displays, electric-vehicle charging controllers, pool pumps, etc.

There are several thousand Request for Comment (RFC) documents describing all aspects of operation of the Internet. It is emphasised that not all these RFC documents are relevant in the context of a communications system supporting smart meters. A particular communications system can select features and functionality described in the RFC documents. For example the PRIME standard refers to RFC documentation describing a method of compressing header information (reducing protocol overheads and improving data throughput).

Given the vast number of RFCs it is necessary to ensure that any communications solution provides the correct interface to the Application. Referring to the Internet Layer Model (shown in Figure 3) the Application Layer must be able to interface with the Transport Layer. For example both DLMS and ANSI C12.22 can utilise communications links using either the Transport Control Protocol (TCP) or User Datagram Protocol (UDP), but the Transport Layer must support at least one of these Transport Layer protocols[10].

Summary of Interoperability standards

Starting with the HAN the review of international smart meter rollouts indicates that ZigBee SEP has gained acceptance as an international standard. The selection of SEP 1.x or SEP 2 is less clear given recent efforts by UK working groups to enhance the 1.x standard.

A review of meter protocols undertaken during the NSMP found that DLMS/COSEM provided the best fit to Australian requirements. A review of current international smart meter rollouts suggests this assessment has not changed. The need to develop (and maintain) a companion specification is discussed below.

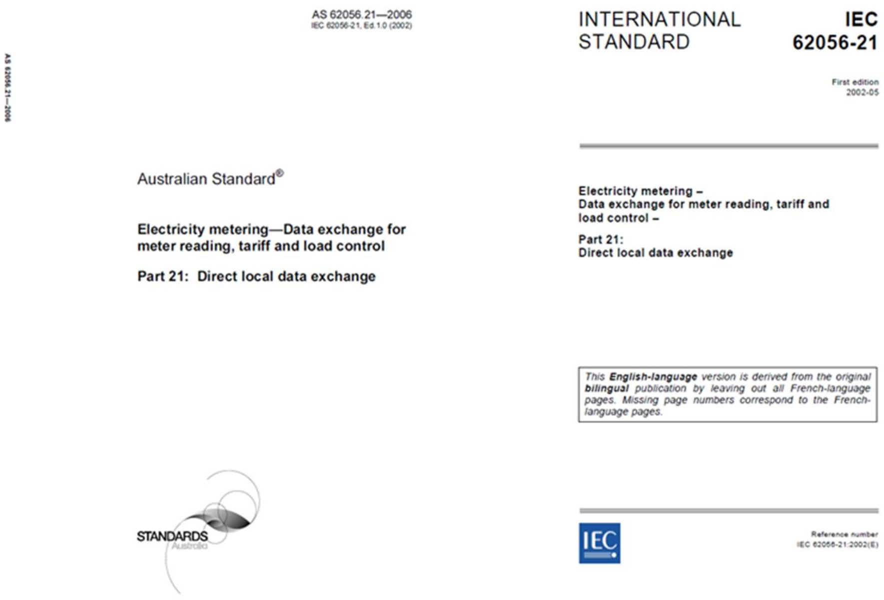
The selection of a single communications technology for all Australian meters cannot be recommended. As discussed the UK has dropped its earlier restriction to only utilise commercial cellular communications and has selected a range of solutions.

The selection of a communications protocol is straight forward. All of the modern smart meter rollouts have specified Internet Protocol (specifically TCP/IP and/or UDP/IP). DLMS, ANSI and ZigBee can all be transmitted over any communications network supporting these IP protocols.

Adopting the standards for use in Australia

There is an existing close relationship between the IEC[11] and Standards Australia. Indeed many Australian Standards are (heavily) based on existing European standards. For example meter accuracy tests specified in Australian metering standards are largely rebadged versions of the equivalent IEC standards. Relatively recently Standards Australia elected to align the numbering of the Australian Standard with that used in the IEC, for example the following figure shows the title page of AS 62056-21 alongside the IEC standard upon which it is based (IEC 62056-21):

[10] Recall from the Internet Layer Model that the Transport Layer provides Host-to-Host communications. Both TCP and UDP allow an Application to send information to an Application on another Host, but the reliability of the communications is very different. There are advantages and disadvantages to each.
[11] IEC means International Electro-technical Commission



AS 62056.21—2006
IEC 62056-21, Ed.1.0 (2002)

Australian Standard®

Electricity metering—Data exchange for meter reading, tariff and load control

Part 21: Direct local data exchange

STANDARDS Australia

INTERNATIONAL STANDARD

IEC 62056-21

First edition 2002-05

Electricity metering –
Data exchange for meter reading, tariff and load control –

Part 21:
Direct local data exchange

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

IEC

Reference number
IEC 62056-21:2002(E)

Figure 15: The title page of AS 62056-21 and IEC 62056-21

Australian metering equipment can be tested to ANY standard. Meter testing is not restricted to tests specified in Australian Standards. This leads to the assumption that should Australia wish to use a standard meter protocol documented in international standards they can directly reference the applicable overseas standard. This would ensure that protocol standards are always up-to-date without the complexity of maintaining a specific Australian version.

To give a specific example the following is a list of some of the standards which are referenced by the DLMS/COSEM protocol:

- IEC 62056-21 Direct local data exchange
- IEC 62056-42 Physical Layer Services and Procedures for Connection-Oriented Asynchronous Data Exchange
- IEC 62056-46 Data link layer using HDLC protocol
- IEC 62056-47 COSEM transport layers for IPv4 networks
- IEC 62056-53 COSEM application layer
- IEC 62056-61 OBIS Object identification system
- IEC 62056-62 Interface objects

Maintaining Australian Specific versions of so many standards would be a major undertaking hence the recommendation to directly reference the international version and use the Companion Specification to clarify any options.

Custodian of "the standard"

Existing interoperability requirements in Australia

The NEM already ensures a reasonable level of interoperability between various Accredited Parties. Many of these protocols (and systems) are coordinated by the Australian Energy Market Operator (AEMO). For example the provision of the Business-to-Business (B2B) gateway including the specification and maintenance of supported commands. Another example is the definition of NEM12/13 data formats needed to support the exchange of metering information.

The NEM has also documented requirements for remotely read meters. Chapter 7 of the National Electricity Rules documents requirements for metering types 1 to 4 which are fitted with remote communications.

The AEMC's Power of Choice suggests that future smart meters should (as a minimum) support the functionality documented in the Smart Metering Infrastructure Functionality Specification (SMI FS). Several functions were related to interoperability:

- Home Area Network using an Open Standard
    - Application Layer: ZigBee SEP 2
    - Transport Layer: IETF IPv6
    - Physical Layer: IEEE 802.15.4 operating at 2.4GHz
- Interoperability for Meters/Devices at Application Layer
    - Only specified as a placeholder
- Hardware Component Interoperability
    - Only specified as a placeholder

The SMI FS was developed by working groups formed under the National Smart Metering Stakeholder Steering Committee (NSSC). The NSSC and its working groups have been disbanded so this resource is not option.

In Australia, "Pattern Approval" is predominantly associated with ensuring the accuracy of measurements and electrical safety of the meter. The accuracy of measurements is required since most meters are used to bill customers. Safety ensures that the meter does not represent a risk to the householder. Pattern Approval involves the National Measurement Institute.

Selecting "A Standard" may not support interoperability

Quoting from the Open Meter[12] program:

> "To cover the largest possible range of applications, international standards specify a wide range of possibilities and options. They can be seen as a set of standard building blocks, of which tailor-made applications can be built."

Put another way, it is possible to use the standard "building blocks" to construct a wide range of systems, not all of which will support the same functionality. Further guidance is required to ensure

[12] Open Meter (Open and Public Extended Network METERing) was created with the objective of ensuring interoperability through the development of a standard technology and architecture for remote multi-meter management. The project was completed in 2011 but appears to have continued as the PRIME Alliance

that all the solutions support the same functionality. In the DLMS Association this guidance is provided using a Companion Specification. A Companion Specification is used to facilitate interoperability by ensuring that all solutions use common options described in relevant international standards.

A Companion Specification identifies the required list of basic meter objects. This includes the definition of interface classes, access rights and data types. The specification also defines specific data security including authentication methods and encryption. The companion specification may also be required to addresses protocol specific features, for example specifying values for options where the base standard(s) offer more than one choice.

The UK smart meter program is currently developing their Companion Specification. Quoting from Smart Metering Implementation Programme: Government Response to the Consultation on the second version of the Smart Metering Equipment Technical Specification Part 2 dated 1st July 2013. Under the title of “Assurance of Smart Metering Equipment Interoperability”

> 43 The GB Companion Specification will set out those elements of the base ZigBee SEP and DLMS communication protocol specifications applicable to the GB market and successful testing against these specifications will enable equipment to receive protocol certification.

While the selection of a standard protocol is relatively straight forward, developing a suitable Companion Specification is more involved. In many cases the Companion Specification requires detailed (intimate) knowledge of the protocol. As such the Open Meter Project suggests:

> “It is essential that this Companion Specification should be developed by a joint effort of manufacturers and utilities and other stakeholders”

Certification testing

Both the DLMS User Association and ZigBee Alliance have developed methods to certify that products correctly implement their protocols. The UK and Spanish rollouts will rely on this testing (including the Companion Specification) to ensure their goal of device interoperability is actually achieved.

While only mentioned briefly above the UK will only allow devices which have been appropriately certified to be enrolled to the Data Communications Company (DCC). Showing the whole quote from “Assurance of Smart Metering Equipment Interoperability”

> 43 The GB Companion Specification will set out those elements of the base ZigBee SEP and DLMS communication protocol specifications applicable to the GB market and successful testing against these specifications will enable equipment to receive protocol certification. The equipment will also be security certified under the [Commercial Product Assurance] CPA – Foundation Level regime. On achievement of both certificates, the equipment will be placed on a ‘certified products list’ to be introduced and maintained by the [Smart Energy Code] SEC Panel. SMETS 2 equipment that is not on the certified product list will not be eligible for automatic enrolment into the DCC.

Discussions around the selection of a standard protocol should consider the level of device certification that is desired.

Conclusion

End-to-end interoperability only starts with the selection of a protocol.

- The meter and HAN protocols will support many language options which should be defined
- Geographic considerations suggest deployments of smart meter in Australia will use different communications technologies. A selection should be made of (at least) one standard interface to be offered by all likely communications technologies. (The specified interface should be described in the selected meter and HAN protocols)
- A decision should be made on the minimum level of security (This may also involve a consideration of Accredited Party access)
- The discussions should consider the level of protocol certification and if there is a need additional interoperability testing

Using the terminology from the DLMS User Association these steps are all included in the preparation of a “Companion Specification”. As already noted this should involve “a joint effort of manufacturers, utilities and other stakeholders”.

The development of the protocol should be facilitated by a neutral party with an understanding of smart metering and an understanding of the Australian Energy Market. Here we consider three possible custodians

Association	Pros	Cons
Standards Australia		Companion Specification is not a “standard” Cost to develop the “standard” Limited knowledge of smart metering
Australian Energy Market Operator (AEMO)	Good knowledge of metering and the NEM	May not be a suitable party (discussed below)
National Measurement Institute (NMI)	Knowledge of metering and certification testing Used to working in highly technical areas	

The table notes that AEMO may not be a suitable party. Whilst this comment relates to meter access, it is relevant here due to their underlying interest in the interoperability debate. AEMO currently provides the B2B gateway to participants in the NEM enabling parties to exchange messages. The potential problem is that relatively little design effort is required to transform the B2B Gateway from a “manual interface” to automated interfaces. With automated interfaces the B2B Gateway would provide some of the functionality discussed in the Texas PUC web-portal. Were AEMO B2B gateway selected as a means of providing Open Access they would move from being a neutral party to being a stakeholder. Whilst at first glance the choice of AEMO may appear to be a natural choice, in our view choosing them to manage the development of the protocols should be carefully considered from a policy perspective.

The conclusion is that the task of coordinating the Companion Specification should be facilitated by the NMI. This view has not been explored with the NMI at this time.

Observations from international rollouts

The following section lists some general points of interest that were noted during the assessment of each jurisdiction.

Texas, USA

The Texas electricity market supports retail contestability. Very similar to the current situation in Australia the meter is installed by the distribution business, but the customer is able to select different energy retailers.

The Texas Public Utilities Commission (PUC) has developed the functional specification (included in the rules) and coordinates various working groups. They have also developed the web-portal providing Accredited Parties with access to deployed meters.

The rules provide a relatively high level functional description of smart metering requirements. These requirements are outlined in the Texas Substantive Rules for Advanced Metering. Distribution businesses choosing to install meters complying with the rules are able to request cost recovery (however they must first submit rollout costs for approval)

The Texas rules clarify that customers have a right to their metering data. For example customers who register on the web-portal are able to grant third party access to their meter data (this access automatically expires after 12 months). Customers are also able to use the web-portal to assign control of individual HAN devices to different Accredited Parties.

The Texas PUC has not mandated the rollout of smart meters, instead they have provided a means for electric utilities to recover costs incurred for deploying advanced metering systems consistent with the substantive rules. These rules (Chapter 25 Substantive Rules Applicable to Electric Service Providers, Subchapter F Metering Section 25.130 (g) AMS features) define required smart meter functionality at a relatively high level. No evidence was found of more detailed functional specifications.

While a distributor lead rollout of smart meters, the rules allow retailers (REP) to request an alternative meter. Referring to Section 25.130 (g)(2)(A):

> A REP may require the electric utility to provide non-standard advanced meters, additional metering technology, or advanced meter features not specifically offered in the electric utility's tariff, that are technically feasible, generally available in the market, and compatible with the electric utility's AMS;

The last clause "compatible with the electric utility's AMS" is understandable but without high levels of smart meter interoperability it could also provide a means of refusing to install a new meter.

From unsubstantiated information it is understood that retailer access to the customer HAN would not be guaranteed. Several retailers immediately started to offer remote control of home thermostats using the customer's internet connection. Concerns over the loss of controlled load lead to an agreement to ensure Accredited Party access with the development of a centralised web-portal.

It is also worthwhile noting that some Texas retailers still offer load control products using the customer's internet connection (rather than the smart meter) to provide load control services (these are mainly programmable communicating thermostats).

UK

There has been significant Government involvement to coordinate the UK's smart metering implementation programme. This includes establishing close to twenty different working groups who have developed numerous (very) detailed specifications.

The resulting Smart Metering Equipment Technical Specifications (SMETS) is very detailed with the most recent versions separately describing the smart electricity meter, smart gas meter and the communications hub. It is noted that these specifications provide much more detail that the Australian SMI FS.

In August of 2013 the UK Government awarded contracts totalling over £2billion for the provision of the data and communications services for the next 10 years. These contracts ensure the provision of the Data Communications Company (DCC), Data Services Provider (DSP) and Communications Service Provider (CSP). There was also a contract awarded for the provision of security advice.

The rollout is centred on the provision of communications to customer premises. Each premise is fitted with a Communications Hub which establishes the HAN. The electricity (and gas) meters are then read via the HAN (using the 'secure tunnel' technique). This is contrasted to most smart meter rollouts where remote communications is connected directly to the meter (it is acknowledged that the UK is going to develop an "intimate interface" to enable the Communications Hub to be installed on (and powered by) the electricity meter (although it is currently unknown if this interface will also allow direct communications between the two devices).

While other smart meter rollouts have a HAN it is not used to read the meter. For example the communications card installed in Victoria's Advanced Meters establishes the HAN but the meter is read directly via the communications card, not via the HAN.

When the UK smart meter rollout was first proposed it was suggested it would utilise existing cellular data services with roaming SIMs (to avoid cellular provider lock-in). It may be beneficial to determine the major reasons for allowing the Communications Service Provider to offer a range of different (non-interoperable) communications technologies. This would require further research.

The development of interoperable smart meters is an objective of European Commission. Their Mandate M/441 "Standardisation mandate to CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization) and ESTA (Energy Services and Technology Association) in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability" states:

> The general objective of this mandate is to create European standards that will enable interoperability of utility meters (water, gas electricity, heat) which can then improve the means by which customers' awareness of actual consumption can be raised in order to allow timely adaption to their demands (commonly referred to as 'smart metering')

The commencement of the UK rollout has already been delayed by over a year. This delay has allowed them to ensure that compliance testing included in the two selected protocols ensures a high level of interoperability.

New Zealand

There are a number of features of the New Zealand smart meter rollout which are worthy of note.

Specific advanced meter infrastructure system requirements are included in the Government guidelines. The first point is (highlight added by author):

> 8. The various parties wishing to use an Advanced Metering Infrastructure (AMI) system should be provided access through a common services access interface. The details of how this occurs can be left up to the service user wanting access and the AMI platform operator. It is possible different service users may require different interchange protocols, and these could be offered by the platform operator. The guiding principle should be that no mechanism should be used to frustrate the process of accessing platform features or services, and that the net outcome will be that all service users will experience materially equal treatment.

Similarly under Data Access the guidelines state:

> 35. Access to all services (including the data available from a service) should be provided by the platform operator via the services access interface. This is system specific, and the platform operator will provide any protocol conversion required.

Review of the rollout by the NZ Parliamentary Commissioner

The New Zealand Parliamentary Commissioner for the Environment (PCE) in her June 2013 Update Report "Smart electricity meters: How households and the environment can benefit" suggested that meters being installed:

> "by electricity retailers were not as smart as they should be and thus not provide benefits for householders or the environment".

The PCE report also states:

> The smart meters report stressed that both households and the environment benefit from reducing electricity consumption especially at peak times. Lines companies are also beneficiaries of reducing peak power because it avoids or delays the need for expensive upgrades in line capacity. But in the same way in which the retail companies rolling out the smart meters have failed to put in the functionality that would benefit householders and the environment, they have also not put in the functionality that would benefit lines companies.
>
> This is clearly illustrated in Waikato where the lines company WEL Networks are currently installing 'smart boxes' in 45,000 homes and businesses in order to gain the ability to manage the network better. The smart boxes include the capacity for consumers to better control their electricity use in the future. In effect, thousands of Waikato households will soon have two digital electricity meters – one installed by the retailer, Genesis Energy, and another installed by the lines company WEL Networks.

The report also highlights that the lack of mandated functional specification lead to ambiguous use of terminology:

> A source of confusion that persisted throughout the Commerce Committee hearings was the use of the terms 'HAN-functional' and 'HAN-capable'. A HAN is a home area network. The Commissioner said that smart meters should be HAN-functional. The Electricity Authority said that the meters were HAN-capable, leaving the impression that these were the same. A HAN-capable meter must be retrofitted with an additional device to become HAN-functional, requiring a visit from an electrician to the house.

Spain

The Iberdrola meter rollout was selected because while it is a vertically integrated utility they are founding members of the PRIME Alliance (which appears to be a continuation of the Open Meter project). Their goal is to support certified meter interchangeability among different meter devices, data concentrators and even management software.

The open standard they have developed is referred to as PRIME (PoweRline Intelligent Metering Evolution). The physical layer specified in PRIME uses modern distribution line communications (with greater reliability and around 50 times the data throughput when compared to earlier DLC systems, e.g.as used in Italy by ENEL for their 29 million meter rollout). Quoting from the Iberdrola website:

> This is why IBERDROLA coordinated the PRIME project, with the objective of developing an AMI infrastructure for automatic meter management that is public, open and standard. Working on this project are some of the most important industrial leaders in the areas of metering, telecommunications and silicon manufacturing, such as Advanced Digital Design, CURRENT Group, Landis+Gyr, STMicroelectronics, Usyscom and ZIV. A large number of European utilities have already joined to the project.
>
> All these companies have joined efforts to launch a new public, open and non-proprietary telecommunications architecture that will support the new AMM functionality and enable the building of the electricity networks of the future, or SmartGrids.

Sitting above the Physical Layer is the Internet Layer which uses the IETF Internet Protocol standards. To provide greater data throughput they have specified the use of compressed headers, but fundamentally PRIME should be considered to provide an IP link layer.

The application layer of PRIME relies on DLMS/COSEM. To ensure interoperability they have defined a Companion Specification setting out specific objects (this was also discussed in the UK rollout).

One of the advantages of standardising on a single communications solution is that the communications modem can be integrated into the meter. This avoids additional hardware costs needed to support different communications options.

It is worthwhile highlighting potential costs of developing a new standard. The following figure is taken from a presentation given by Alfredo Sanz discussing the Evolution of PLC standards to the American Smart Grid. He is suggesting that it has taken 5 years JUST to develop a new Physical Layer (recall that PRIME uses DLMS/COSEM as the Application Layer)

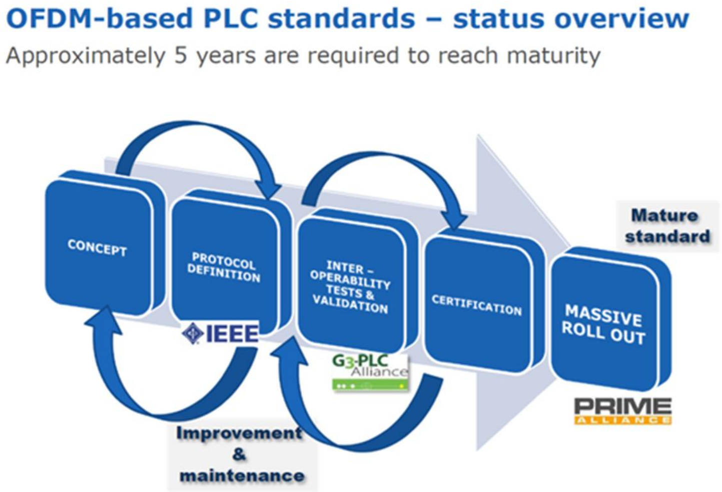


Figure 16: Timeline to develop a new communications standard (from Alfredo Sanz)

The PRIME standard is gaining global acceptance. The PRIME Alliance website "estimates" that globally there are over 2 million meters already deployed. Quoting from the Iberdrola website:

> IBERDROLA is at the point of completing its first smart grid projects in the United States of America, where it has installed more than 550,000 smart meters in Maine, and in Scotland, where 30,000 customers also enjoy the benefits of this technology in Glasgow.

Germany

After the Netherlands smart meter rollout ran into issues, when 'stop smart meter' advocates raised privacy concerns, the German government has decided to consider how to ensure only approved parties have access to smart meter data. Germany is considering two different models for the collection of meter data[13].

- In the first model each accredited party is given access to the meter to collect the meter data relevant to them. This may result in several parties (retailer and distributor at least) downloading the same (or very similar) data which would increase the amount of data sent from the meter to the various Head End Systems.
- In the second model a single meter data provider downloads all the data from the meter and then provides controlled access to the data from a centralised location. Access to this information would need to be tightly controlled to satisfy privacy concerns.

Germany has not yet settled on which model will be deployed.

Another item that was mentioned was using the meter to support Time of Use (ToU) electricity tariffs whilst addressing customer concerns about third party access to interval data. It has been suggested that customers can choose to have their meters programmed with the applicable ToU rates with their meter accumulating energy use into several separate ToU registers. At the end of the month the retailer only receives accumulated energy totals (and not the interval data).

[13] Note that this discussion is limited to access to meter billing data and but may be relevant to other data collected by smart meters.

Remaining Questions

Role of the Gateway

There are two basic options for the role of the Gateway. The first option is that the Gateway facilitates direct (real time) access between the Accredited Party (e.g. if a command is rejected the Accredited Party is responsible for taking corrective action). The alternative is that the Accredited Party sends the command to the Gateway, and the Gateway undertakes all the interactions with the meter on behalf of the Accredited Party (e.g. if the command is rejected the Gateway takes appropriate corrective action).

A similar situation occurs when considering access to metering data. A meter data provider reads and stores all data from the meter and then makes this available to Accredited Parties. The alternative is to provide each Accredited Party direct access to their data from the meter (being considered in Germany to address privacy concerns). While both options support Open Access to the meter data it is only the second option which supports Open Access to the meter.

Some of the UK information indicates that the Data Services Provider stores meter data and makes available for Accredited Parties while other information implies Accredited Parties have direct access to the meter.

Site Configuration Information ('standing data')

It is suggested that there are advantages for providing Accredited Parties access to basic information about a customer premise (without having to communicate with the premise). For example what type of meter is installed, the certified version of the protocol that it supports (with remote firmware upgrades this may change overtime), the number and type of HAN devices currently configured at the site. Some of this information could be stored in the standing data for a particular connection point.

The review of international jurisdictions was able to determine this information is important, but not who stores the information or who has access to it.

Clarification of where Interoperability is required

The functionality described in the SMI FS was based on a cost benefit assessment performed for the Ministerial Council on Energy (MCE) which found societal benefits were greatest when meters were deployed under a distributor lead mandate. The working assumption during the development of the SMI FS was that all the functionality described in the SMI FS was delivered by the distributor. The SMI FS does not consider the format of commands sent to and from the SMMS.

IP Address Resolution

The review shows that modern meter protocols support the use of any communications technologies that supports Internet Protocol (TCP or UDP). What has not been explained in any of the rollouts is the method by which Accredited Parties might obtain the IP address of the meter which is a first step in enabling direct communications with the meter.

On the internet Domain Name Servers (DNS), websites (e.g. www.aemc.gov.au) can be converted into their unique IP address (e.g. 118.127.74.4). Ensuring each device is assigned a unique IP address, and that Accredited Parties are able to obtain the assigned address, is a relatively complex topic.

Enduring Interoperability

None of the international rollouts have provided guidance on how they will manage interoperability for functionality beyond basic requirements. This problem was discussed when considering interoperability for functionality not described in ANSI C12.19 data tables. The PoC suggests that customers can choose meters with functionality beyond the minimum (this was also supported in rules covering the Texas smart meter rollout). It is suspected that the UK will have considered this possibility but no documentation could be found.

These questions are unresolved and will require further study to fully understand.