SMIP Interfaces & High Level Architecture

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Version	Date	Author	Changes
0.1	4.11.10	Simon Harrison, ERA	Initial draft
0.2	4.11.10	Simon Harrison, ERA	Updated following team review
1	7.12.10	Simon Harrison, ERA	Update following comment and baseline for distribution

This Paper

At the SMDG on 21.10.10, the ERA were asked to support the establishment of a group containing both SMDG and DCG members. It is envisaged that this group will consider end to end issues, and the first area of concern was clarity on the interfaces and high level architecture.

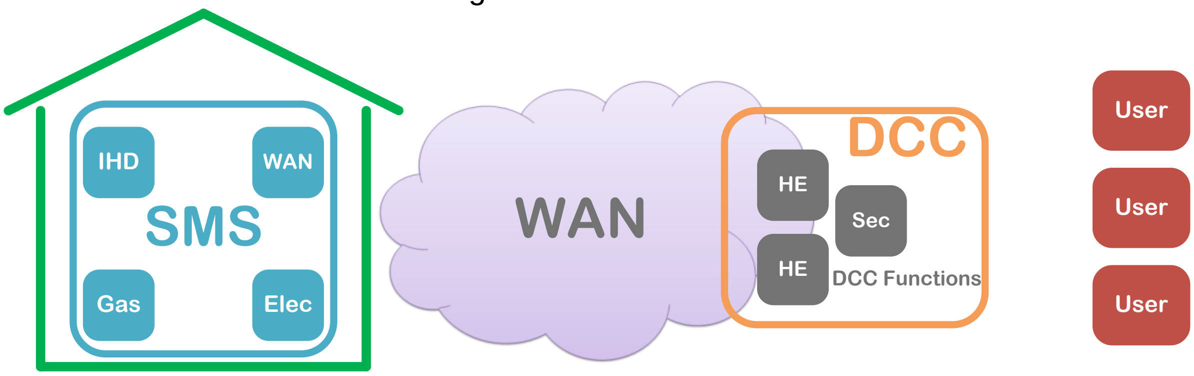
The paper has been structured to introduce concepts such as interoperability, layered stacks, interfaces etc. sequentially to assist with developing understanding to appreciate the final illustrations of architecture and interfaces.

In order to keep this paper as straightforward as possible, it does not specifically address the additional requirements or implications of supporting end to end security within the infrastructure. Generally the available or proposed solutions for interoperability and interfaces include security measures.

This paper presents the opinions of the ERA SRSM project team only and does not represent the preferences of the ERA members collectively or individually

High Level Architecture

Based upon the Ofgem Prospectus and briefing materials, at the very highest level, the architecture for smart metering is as follows



Within a home there will be a Smart Metering System (SMS), typically comprising of Electricity and Gas meters, an In Home Display (IHD) and at least one WAN modem. Of course, not every home has a gas supply, and some solution approaches could result in the WAN function being physically delivered within the same box as the electricity metrology.

The Wide Area Network (WAN) cloud is how the SMS connects to the Data Communications Company (DCC). This is shown above as having a number of internal, and transparent to the SMS and Users, functions such as Head Ends (HE) and Security (Sec).

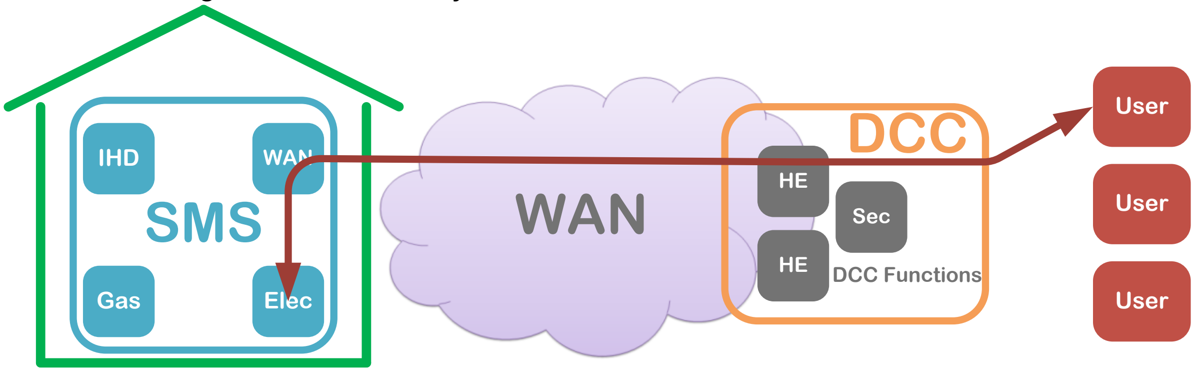
At the far right are the Users of the infrastructure, the energy Suppliers and Network Operators, along with any suitably authorised third parties.

The fundamental interoperability requirement is, subject to authorisation, ***for any User to interact with any SMS component and vice versa, regardless of the manufacturers or providers of individual systems and components***.

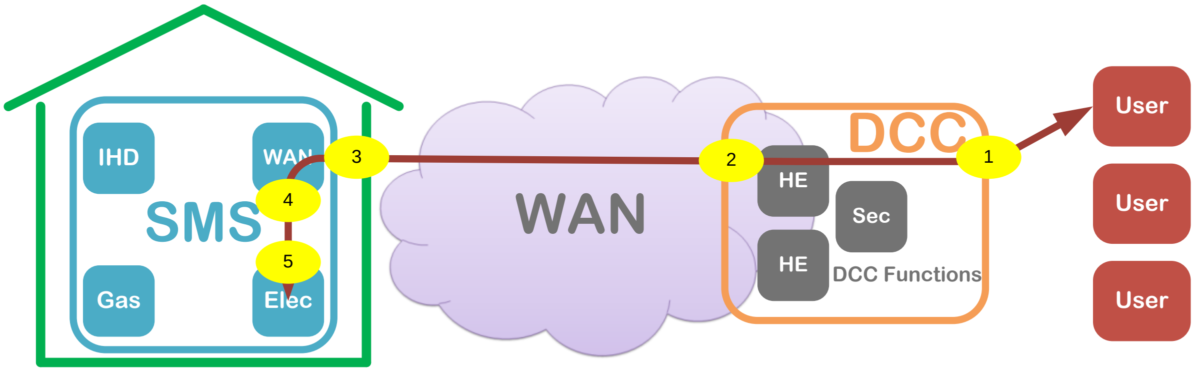
In order to support innovation and differentiation of products and services, it is not necessary to prescribe every element of a homogenised end to end architecture, but to deliver an interoperable infrastructure, certain key interfaces need to be defined.

Basic Interfaces

As an example of a high level end-to-end use case, the illustration below shows a user interacting with an electricity meter:



In order for this interaction to be successful, the exchange would need to pass through a number of interfaces between various systems and components in the infrastructure.



Describing the highlighted interfaces in more detail:

1. Interface between DCC and Users
2. Interface between Head End System and WAN
3. Interface between WAN module and WAN
4. Interface between WAN module and HAN
5. Interface between Electricity Meter and HAN

It should be noted that logically, and physically, some of these interfaces are the same – e.g. 2 & 3 – but have been illustrated separately for clarity.

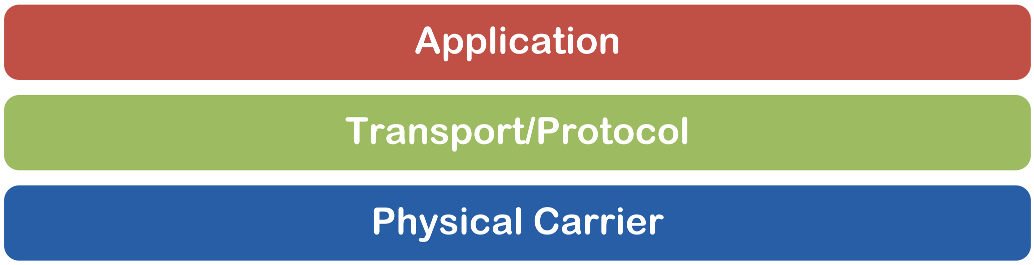
It is important to note that some of these interfaces, or elements of them, can be achieved by common solutions – e.g. 4 & 5 could be the same HAN solution.

It is also important to note that some of these interfaces are entirely within the scope of DCC activities – i.e. 2 & possibly 3, and therefore may not need to be fully interoperable or defined in detail by the Programme – connection can be achieved by alternative means.

Layers of Interoperability

A concept often discussed with regards to interoperability is a layered approach. This is usually based on the OSI (Open System Interconnection) 7 layer model[1] and often quite impenetrable to non-engineers.

To attempt to simplify things to a more basic level to assist with better understanding, this paper will use three basic layers covering the 7 layer model to explain interoperability:

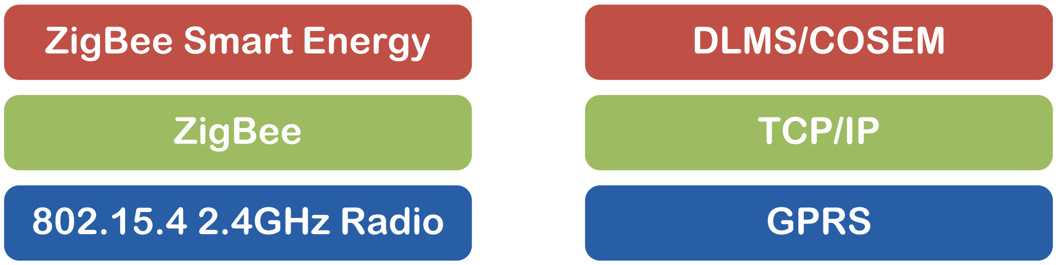


The **Physical Carrier** is the actual connection between two points, such as a phone line, power cable, radio signal etc. The **Transport/Protocol** includes the so-called 'lower layers' of the OSI model and generally sets the rules for and manages the connection over the physical carrier. Finally, the **Application** is the upper layer and is the service or activity that takes place once a connection is made.

Both the Transport and Application layers will include more granular elements within them – for example the application layer could define activities independently of data formats. Also, depending on the combinations of elements, some features could be handled in one or more of these layers – e.g. addressing.

To put this into examples of specific metering contexts:

[1] http://en.wikipedia.org/wiki/OSI_model



It is important to be aware of intra-layer support. At the moment the ZigBee Smart Energy application layer will only be supported by ZigBee transport layers and 802.15.4 radios (although this is being developed). Without modification, the upper ZigBee layers will not work, for example, on a GPRS physical carrier.

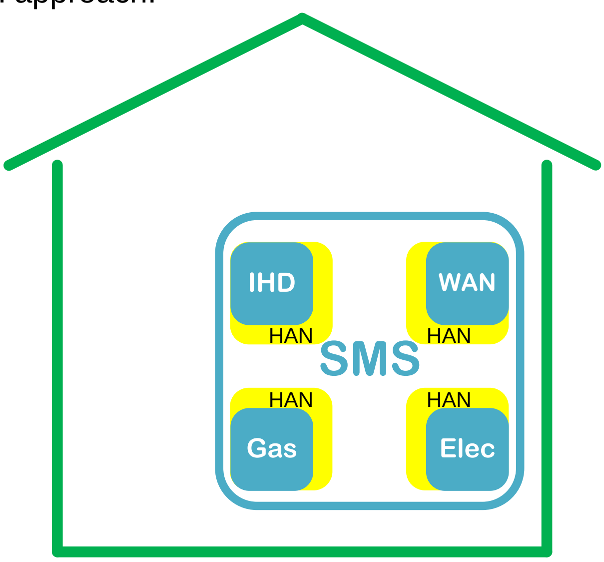
As a comparison, and as a more established standard, DLMS/COSEM as an application can be supported by a number of transport layers for a range of physical carriers – Optical Port, Ethernet, ISDN, GPRS, PSTN, GSM and Power Line Carrier.

It is important to note that even for these two key examples, all of the named solutions within each of the layers are published standards – this is the key to interoperability. Where even a single element of the 'stack' is proprietary – or even a part of a layer is non-standard, there is no guarantee that other parts of the stack will work as designed, and if the 'stack' of layers do not work correctly, devices attempting to communicate using them will not work correctly.

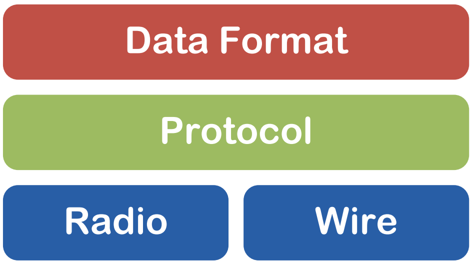
It is anticipated that the focus of the programme will be on the Application Layer – the lower layers are already interoperable and in use in a range of combinations in a number of data communication contexts.

HAN Architecture

There are clear requirements for components of the Smart Metering System (SMS) within homes to interact with each other, and this has been defined as generally being achieved by the HAN. There will be variances in specific implementations (i.e. WAN module in electricity meter, or how Gas meters operate to preserve battery life), but as a general approach:

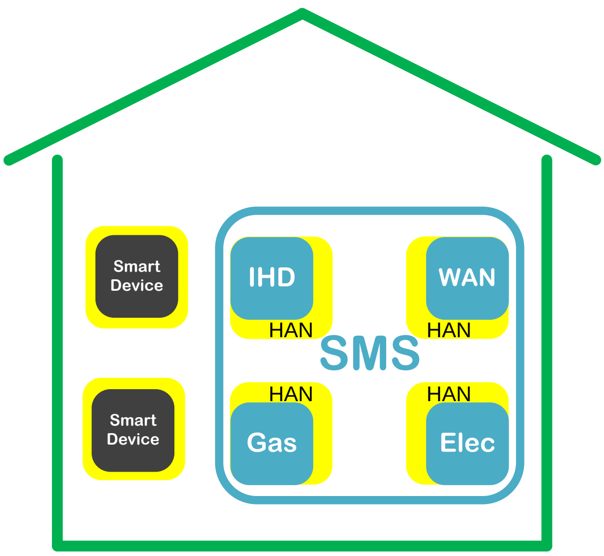


All SMS components will use a common, defined HAN interface to interact with each other. This HAN interface will actually comprise an interoperable 'stack' – discussions within SMDG sub groups have highlighted the requirements that will result in the following:



It is anticipated that it will not be possible to economically deliver coverage for 100% of GB properties using radio based HAN technologies and that support for wired physical carriers, alongside low power radios will be necessary. This is particularly relevant for multiple occupancy premises and those where the metering components are particularly remote from the living space where the IHD would be used. Wired and wireless physical carriers are already supported by the M-Bus standard, and this is due to be delivered by the ZigBee Alliance.

Finally, subject to clarification within the programme, there are requirements to integrate SMS and non-SMS components, possibly using the HAN interface (but also possibly making use of technology bridges and additional equipment). This will meet the requirement to support innovation in consumer goods, future smart grid applications, microgeneration etc.

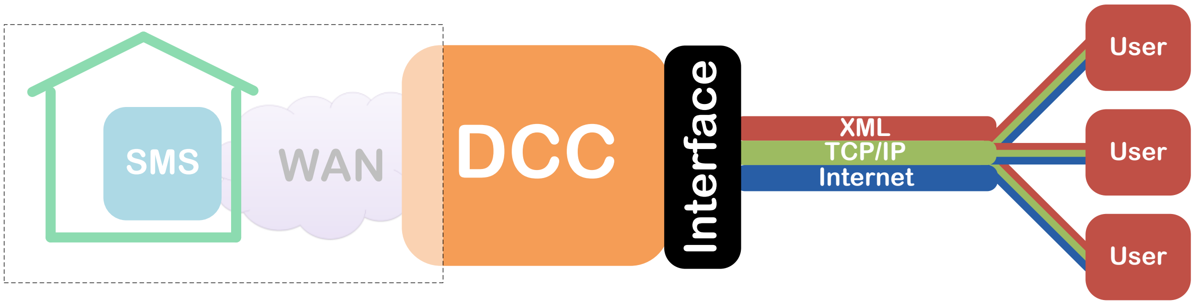


'Smart Devices' (or Extra Network Devices), if they comply with the interoperability definitions used by the SMS HAN, will be capable of interacting with the SMS, and potentially access the WAN, subject to suitable agreement, authorisation and configuration.

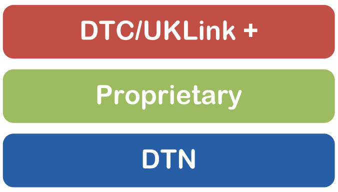
Beyond the scope of this introductory paper, but certainly within the scope of the Programme is understanding the challenge of establishing a 'Network Controller' for the HAN architecture – the local device which sets and administers the rules. A similar subject to be addressed is the concept of a HAN-enabled engineer device to support installation and maintenance tasks.

Interface to DCC

Whilst the scope and service requirements for the DCC remain subject to consultation and development, it will not be possible to accurately show how this interface will operate – the illustration below is based on assumptions, themselves based on existing paradigms and discussions within the Programme.



It shows that individual users will connect with the DCC using defined interoperable stacks – an internet based stack is shown here, but this could equally be one based on existing industry layers developed to interact with the DCC.



The users only interact with the DCC interface – connection through to SMS components in the home is delivered transparently to them. 'Session' based interactions, where end to end exchanges might occur in seconds (for some technologies or services, others may take longer), are similarly transparent.

The key element of the 'stack' for the DCC interface to users is the application layer – there are a range of options here, from developing the existing catalogue based industry flows, to switching to adopt a semantic (self descriptive) language such as XML to remove the need for a catalogue. This interface could be achieved through the use of web services, the dominant solution for interactive, internet based exchanges.

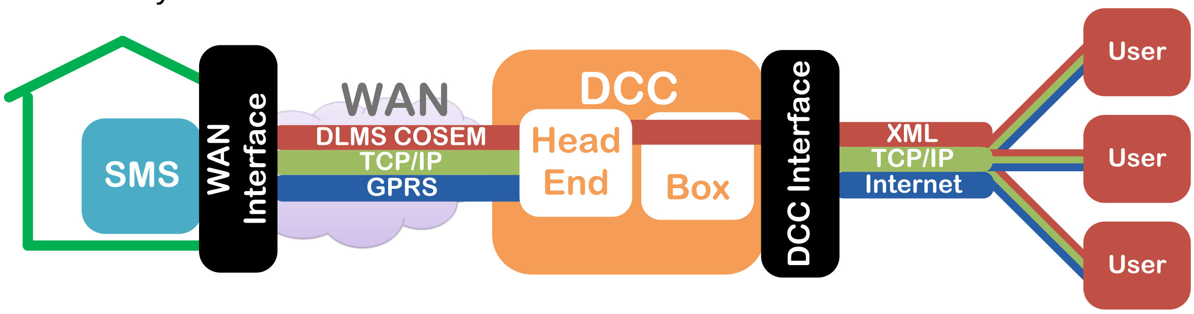
DCC Function

Alongside providing security and any associated services, a key function of the DCC would be to connect Users to remote SMS's in premises using the WAN.

WANs connect modems in premises to Head End management systems, there may be a number of Head End systems, either for geographies or different physical carriers, but only one is shown in these illustrations for simplicity.

The DCC needs to be able to convert the User request from the data type used at the DCC interface into a format that the SMS can understand. In the example below, the SMS and WAN support a DLMS/COSEM application layer, and hence a function of the DCC – shown as a ‘Box’ here – is to take XML based requests and translate them into DLMS/COSEM, and vice versa for the return flow of data.

All of the layers shown here are illustrations



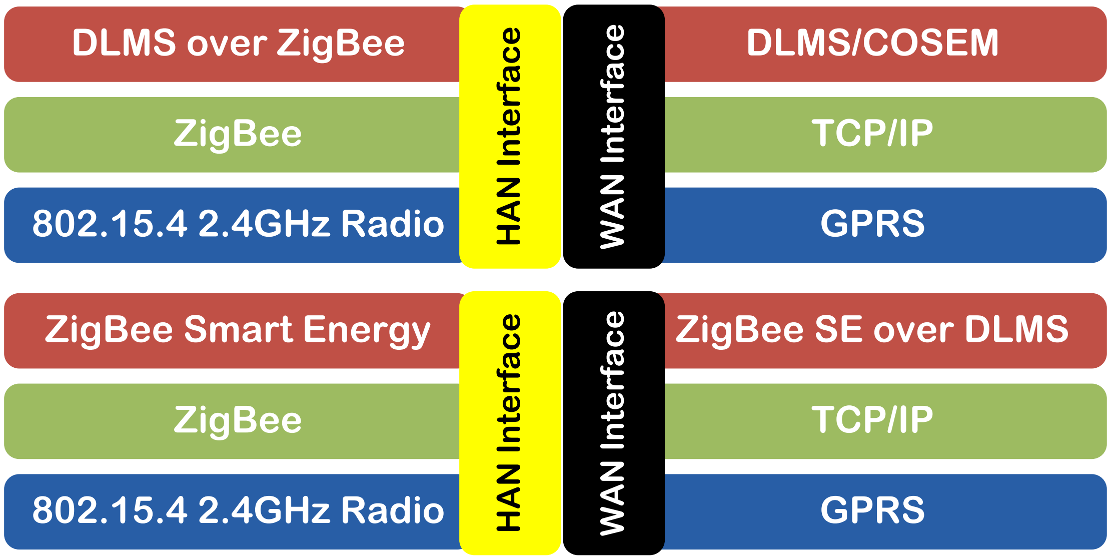
As previously discussed, this is an internal function of the DCC and should be completely transparent to users and SMS components.

WAN to HAN to WAN

At the boundary of the SMS is the WAN module. It connects to the WAN and DCC using the WAN interface. It also connects to other SMS components using the HAN interface. Where any layer of the ‘stack’ is different, the WAN module needs to complete a similar task to the DCC ‘Box’ and perform the necessary translations to facilitate the end to end activity.

For the lower layers, this connection is technical, sometimes physical and readily achieved. For the application layer, there are options being developed which could see the data format ‘tunnel’ – i.e. the application layer supports other data formats, as shown below.

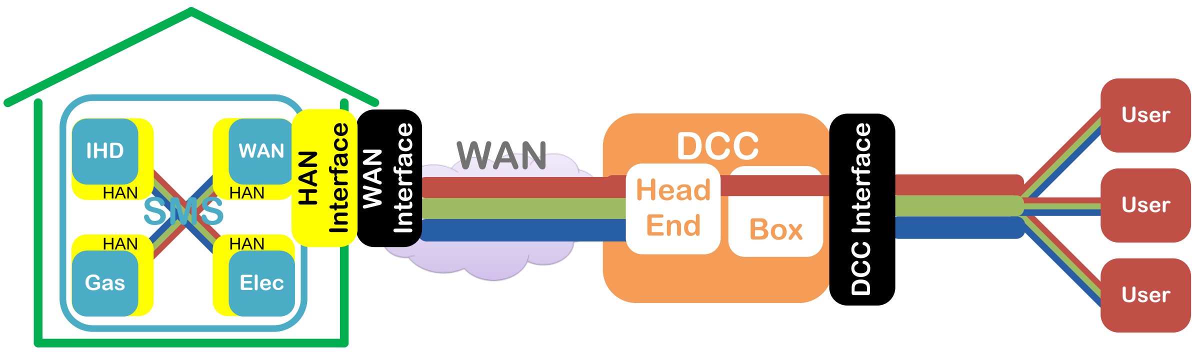
ENERGY
RETAIL
Association



Both of these approaches, and others, are under development – removing the need for data translation in application layers or SMS components.

Overall Interoperable Interface Based Architecture

Pulling these concepts together, one can anticipate an overall smart metering architecture, including three key interoperable interfaces.



In order for these interfaces to be interoperable, the Programme will need to define which standards will apply, as illustrated below.

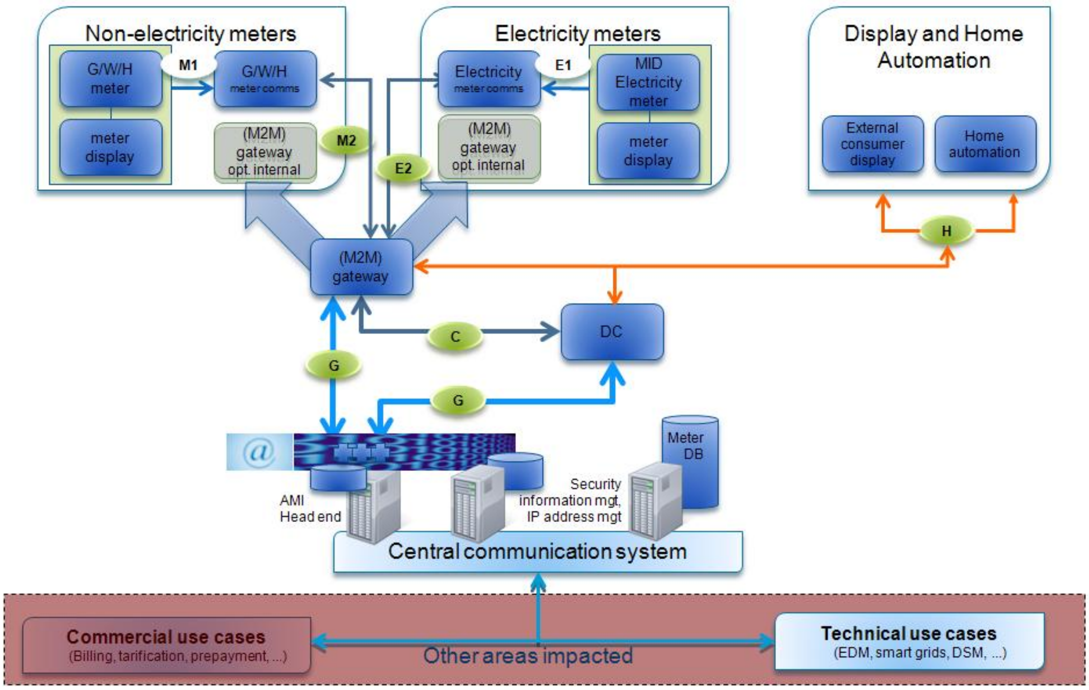
WAN Interface		
Physical Carrier(s)	Transport(s)	Application
GPRS, PSTN, PLC etc.	Any supported	DLMS COSEM
HAN Interface		
Physical Carrier(s)	Transport(s)	Application
802.15.4 RF Homeplug 1.0	ZigBee Homeplug	ZigBee Smart Energy 1.x
DCC Interface		
Physical Carrier(s)	Transport(s)	Application
DCC defined	As supported	GB Smart Meter XML Schema

The final product would need to use full and formal normative references to these standards to remove any ambiguity.

Also critical to the over discussion of interfaces will be the determination of who 'owns' these interfaces.

Comparison to M441 Interface Architecture

The figure below is the version of the European Standards Interface Architecture from v0.3 of the Technical Report being prepared for the Commission.



The European approach needs to accommodate existing and planned implementations with a variety of technologies and market structures and is inherently more complicated than the one illustrated in this paper for GB.

Their draft report contains lists of many dozens of available and compatible standards for many of the interfaces in their architecture.