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Machine-to-Machine communications (M2M); Applicability of M2M architecture to Smart Grid Networks; Impact of Smart Grids on M2M platform

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Machine-to-Machine communications (M2M).

1 Scope

The present document highlights the applicability of M2M architecture to smart grid networks. The present document develops the most relevant Smart grids use cases, used to derive high level requirements. In addition it provides a standard gap analysis (applicability of M2M APIs for Smart Grid applications, mechanisms to manage energy for end users, etc), and derives a set of recommendation for the work of ETSI M2M.

Finally it shows dependencies and relationships with other works within ETSI TCs and other standards organisations (including the ones covering the energy Layer: NIST, CEN/Cenelec and IEC in particular).

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] CEN/CENELEC/ETSI SMCG: "Functional reference architecture for smart metering systems" (Final draft Technical Report CEN/CLC/ETSI/FprTR 50572 July 2011).

[i.2] http://www.3gpp.org/.

[i.3] http://www.sensus.com/ and http://sensus.co.uk/documents/10303/259817/UK-licensing-brochure.pdf.

[i.4] http://portal.etsi.org/portal/server.pt/community/TISPAN/339.

[i.5] IEC 62055-31: "Electricity metering - Payment systems - Part 31: Particular requirements - Static payment meters for active energy (classes 1 and 2)".

[i.6] http://www.zigbee.org/.

[i.7] "Companion Specification for Energy Metering" IEC 62056-21, IEC 62056-42, IEC 62056-46, IEC 62056-47, IEC 62056-53, IEC 62056-61, IEC 62056-62.

[i.8] IEEE P802.11: "Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

NOTE: Available at http://standards.ieee.org/develop/project/802.11.html.

[i.9] IEEE 802.16/Conformance04-2006: "IEEE Standard for Conformance to IEEE 802.16 - Part 4: Protocol Implementation Conformance Statement (PICS) Proforma for Frequencies below 11 GHz".

NOTE: Available at http://standards.ieee.org/develop/project/802.16.html.

[i.10] "ZigBee® Smart Energy Overview".

NOTE: Available at http://www.zigbee.org/Standards/ZigBeeSmartEnergy/Overview.aspx

[i.11] "ZigBee® Smart Energy, version 2.0".

NOTE: http://www.zigbee.org/Standards/ZigBeeSmartEnergy/Version20Documents.aspx.

[i.12] Final report of the CEN/CENELEC/ETSI Joint Working Group on Standards for Smart Grids, 04 May 2011.

[i.13] NIST Special Publication 1108: "NIST Framework and Roadmap for Smart Grid Interoperability Standards", Release 1.0.

[i.14] ANSI C12.19: "American National Standard for Utility Industry End Device Data Tables".

NOTE: http://www.nema.org/Standards/Pages/American-National-Standard-for-Utility-Industry-End-Device-Data-Tables.aspx.

[i.15] http://portal.etsi.org/portal/server.pt/community/OSG/355.

[i.16] IEEE 1377/C12.19-1997: "IEEE Standard for Utility Industry End Device Data Tables".

NOTE: Available at http://standards.ieee.org/develop/project/1377.html.

[i.17] M/490 EN: "Smart Grid Mandate".

[i.18] Barney L. Capehart: "Distributed Energy Resources (DER)".

NOTE: http://www.wbdg.org/resources/der.php.

[i.19] EU Commission Task Force for Smart Grids: "Expert Group 3: Roles and Responsibilities of Actors involved in the Smart Grids Deployment".

NOTE: Available at http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group3.pdf.

[i.20] M/441: "Smart Metering Mandate".

[i.21] ETSI TS 102 241: "Smart Cards; UICC Application Programming Interface (UICC API) for Java Card (TM)".

[i.22] ETSI TS 102 225: "Smart Cards; Secured packet structure for UICC based applications".

[i.23] ETSI TS 102 226:"Smart Cards; Remote APDU structure for UICC based applications".

[i.24] ETSI TS 102 690 (V1.1.1): "Machine- to- Machine communications (M2M); Functional architecture".

[i.25] IEC 62351: "Power systems management and associated information exchange - Data and communications security".

[i.26] IEEE Standards corner: "Focus on the IEC TC 57 standards".

NOTE: Available at http://www.ieee.org/portal/cms_docs_pes/pes/subpages/publications-folder/TC_57_Column.pdf.

[i.27] Directive 2004/22/EC of the European Parliament and of the Council of 31 March 2004 on measuring instruments.

NOTE: Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:135:0001:0080:EN:PDF.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

concentrator: This is used as a network and protocol converter between the two transport technologies.

NOTE: Obviously, it contains some others features that will be mentioned in the architecture document. The concentrator may have a multi utility role, in order to be able to handle meters managed by different kind of energy utilities.

energy gateway: The energy gateway establishes the link between the communication network of an energy consumer (industrial facility, home environment, apartments building etc.) and the communication network used by other actors in the energy market (Energy retailer, DSO, third party involved in Demand/Response schemes, etc).

home "equipment(s)": generic wording that includes, in one or several boxes, Modem for xDSL, GPRS or any other Wide Area network, Residential/Home GatewayHome Service Gateway or/and Multi-Utility concentrator, the list is non-exhaustive

NOTE: Numerous domestic appliances could also be connected to the HAN. A PC or/and a displaying device is connected to the HAN.

local network: any less-than-1 km-range technology, wired or wireless (some examples could be ZigBee®, M-Bus, Wireless M-Bus, PLC, etc.)

NOTE: Star or meshed network is possible.

operators: potential users for a specific use case from any of these different roles: (utility provider / distributor, SM provider, Network Operator, etc.)

Smart Metering (SM) Information System: generic name that gathers several roles: service provider, energy supplier, energy distributor, network operator

NOTE: The exact content of this Smart Metering Information System and their physical implementation is out of scope of the Use Cases document.

use case: system descriptions from the user point of view

NOTE: They treat the system as a black box, and the interactions with the system, including system responses, are perceived as from outside the system. Use cases typically avoid technical jargon, preferring instead the language of the end user or domain expert.

The present document on hand lists and defines **system use cases**, which are normally described at the system functionality level (for example, create voucher) and specify the function or the service system provides for the user. A system use case will describe *what* the actor achieves interacting with the system. For this reason it is recommended that a system use case specification begin with a verb (e.g., *create* voucher, *select* payments, *exclude* payment, *cancel* voucher). Generally, the actor could be a human user or another system interacting with the system being defined.

A brief use case consists of a few sentences summarizing the use case.

Use cases should not be confused with the features/requirements of the system under consideration. A use case may be related to one or more features/requirements, a feature/requirement may be related to one or more use cases.

Wide Area Network (WAN): long range technology that enables exchanging data between parts of the Smart Metering Information System and the Concentrator

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ADA	Advanced Distribution Automation
AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
AP	Application Protocol
APDU	Application Protocol Data Unit
API	Application Protocol Interface
BEMS	Building Energy Management Systems
BHEM	Building Home Energy Management
BPL	Broadband Power Line
BS	British Standards
CIM	Common Information Model
CNG	Customer Network Gateway
CSP	Curtailment Service Providers
DER	Distributed Energy Resource
DR	Demand Response
DS	Distribution Systems
DSL	Digital Subscriber Line
DSO	Distribution System Operator
EN	European Standards
EV	Electric Vehicle
EVCE	Electric Vehicle Charging
GPRS	General Packet Radio Service
GSEC	Gateway Security Function in M2M Architecture
GSM	Global System for Mobile Communications
GSO	Generation System Operator
GW	GateWay
GW/DR	Gateway/Demand R
HAN	Home Area Network
HEM	Home Energy Management
HES	Home Energy Systems
HTTPS	Hypertext Transfer Protocol
HV	High Voltage
HVAC	Heating, Ventilation, Air Conditioning
ICT	Information and Communication Technology
IHD	In Home Display
IP	Internet Protocol
ISP	Internet Service Provider
IT	Internet Technology
JWG	Joint Working Group
KNX®	Konnex (World's Only Open Standards for Home and Building Control)
KW	Kilo Watts
LAN	Local Access Network
LN	Local Network
LNAP	Local Network Access Point
LRR	Long Range Radio
LV	Low Voltage
M2M	Machine-to-Machine (communications)
MB	Mega Bit
MV	Medium Voltage
MW	Medium Watts
NAN	Neighbourhood Area Networks
NAT	Network Address Translator
NGN	Next Generation Network
NN	Neighbourhood Networks
NNAP	Neighbourhood Network Access Point
NRAR	Network Reachability Addressing and Respository
NSCL	Network Service Capability Layer

NSEC	Network Security Function in M2M Architecture
OSGP	Open Smart Grid Protocol
PC	Personal Computer
PEV	Plug-In Electric Vehicle
PEV-SP	Plug-In Electric Vehicle – Service Provider
PEV-SW	Plug-In Electric Vehicle -Software
PLC	Power Line Communication
PMU	Phase Measurement Unit
PV	Photo Voltaic
REQ	REQUIREMENT
RF	Radio Frequency
SCADA	Supervisory Control and Data Acquisition
SCP	Substation Computing Platform
SG	Smart Grid
SG-CG	Smart Grid Co-Ordination Group
SGTF	Smart Grid Task Force
SLA	Service Level Agreement
SM	Smart Metering
SMCG	Smart Metering Co-ordination Group
SM-CG	Smart Metering Co-ordination Group
SP	Service Provider
SRD	Short Range Devices
TC	Technical Committee
TFR	Transient Fault Recorder
TR	Technical Report
TSO	Transmission System Operator
UDP-IP	User Datagram Protocol_Internet Protocol
UICC	Universal Integrated Circuit Card
UML	Universal Machine language
WAM	Wide Area Measurement
WAMS	Wide Area Measurement System
WAN	Wide Area Network
WI-FI	Wireless Fidelity (Industry name for wireless LAN (WLAN))
XML	Extensible Markup Language

4 Introduction and Background

Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it - generators, consumers and those that do both - in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.

The European commission issued a standardization mandate M/490 [i.17] to European Standardisation Organisations (ESOs) to support European Smart Grid deployment. The scope of "Smart Grid" for the purpose of this mandate is as defined in the Task Force for the implementation of Smart Grids into the European internal market.

The 6 high level services, the Smart Grids Task Force defined, are:

- enabling the network to integrate users with new requirements;
- enhancing efficiency in day-to-day grid operation;
- ensuring network security, system control and quality of supply;
- enabling better planning of future network investment;
- improving market functioning and customer service;
- enabling and encouraging stronger and more direct involvement of consumers in their energy usage; and
- management.

Smart grid networks have to rely on a telecommunication infrastructure that provides the level of coverage and accessibility, quality, security, privacy and reliability needed to allow the migration of power grids to smart grid networks. A power grid qualifies to become a smart grid if it provides the following functionalities [i.12]:

- Self-healing from power disturbance events
- Enabling active participation by consumers in demand response
- Operating resiliently against physical and cyber attack
- Accommodating all generation and storage options
- Enabling new products, services, and markets
- Optimizing assets and operating efficiently

It is commonly agreed that smart grid networks will rely on a wide scale monitoring and sensor infrastructure in addition to the ongoing deployments of smart metering infrastructures. ETSI M2M architecture may be considered, in particular to determine if extensions are needed to match the smart grids requirements.

The present document supports the needs expressed in the European Commission Task Force on Smart grids [i.12].

4.1 Description of Smart Grids architecture concept

The ETSI Board Of Directors (BoD) architecture for Smart Grids is conceptually divided into 3 main layers [i.12]:

1) the Energy Layer which handles the energy (production/generation, distribution, transmission and consumption), i.e. sensors, electricity generation, storage and interconnection, transmission and distribution power systems;

2) the Control & Connectivity Layer which ensures the energy control and connectivity including management functions such as substation automation, condition, monitoring/diagnosis, supervision and protection, time synchronisation, metering, OAM-style functions (sanity check of sensors), traffic engineering, protection and restoration, virtualisation, routing, access technologies (for geographical coverage purposes);

3) the Service Layer which is composed by all services related to Smart grid usage, billing, e-commerce, data models, subscription management and activation, applications, and business processes.

The focus of ETSI M2M for Smart Grid will be on the control and connectivity and service layer since the objective is to assess the impact on M2M functional architecture [i.24]. Figure 4.1.1 illustrates the conceptual architecture of Smart Grid.

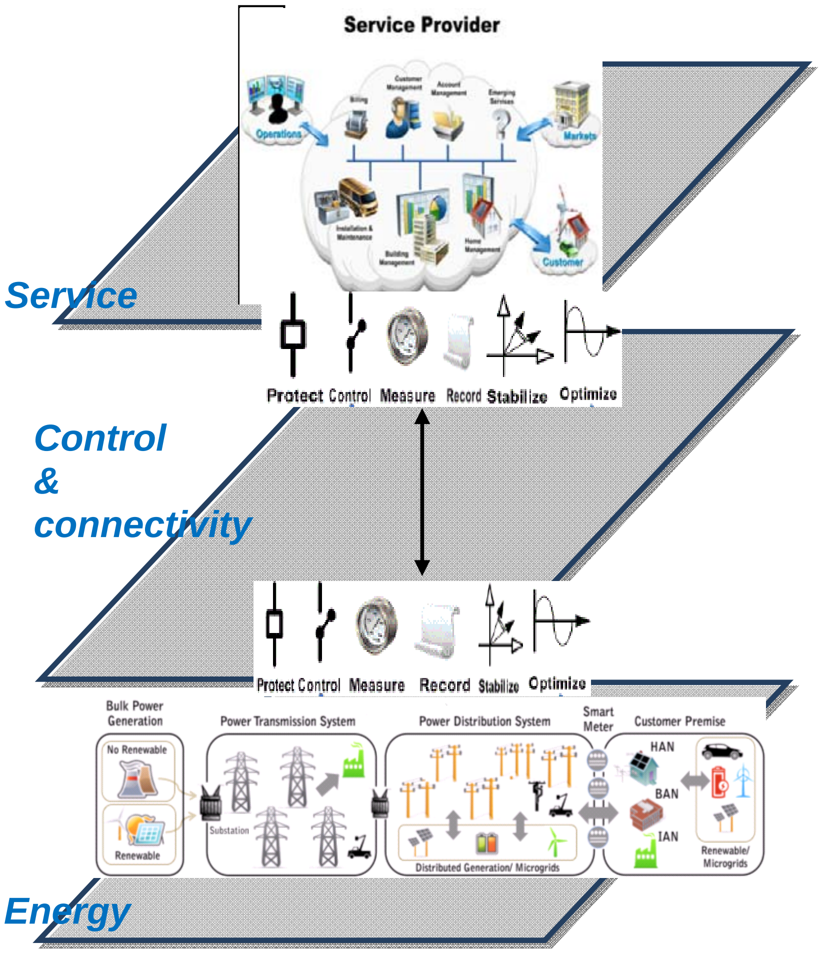


Figure 4.1.1: ETSI BoD architecture for Smart Grids

4.2 Key Technical Elements of Smart Grid

4.2.1 Distributed Energy Resources (DER)

Distributed Energy Resources see [i.19].

The areas related to the integration of Distributed Energy Resources (DER) and storage as well as electric vehicles charging infrastructures within the smart grid has received limited consideration so far, though efficient integration of such resources is fundamental to deliver the expected benefits of smart grid infrastructures in terms of CO2 emission reductions. Intermittent generation from renewable source combines advantageously with Vehicle-to-grid technology to exploit the transient storage capacity of electric vehicles batteries connected to a charging facility. In this context locally plugged Electric Vehicles can be integrated in the grid as a DER, even while they are seen as a load at other times. This requires transmission of proper tariff incentive to the customers and easy-to-use interfaces for configuration of customer's choices upon plug-in.

The term "Prosumer" has been used in reference to the resulting need to measure and bill customers based on the (positive or negative) difference between the energy generated from their facilities (wind power generators, solar panels, or local, e.g. electric vehicle, storage drawn from local charging station at time of peak) and the energy consumed locally: A positive difference corresponds to energy that can be redistributed to the network from the consumption point, while a negative difference represents an actual energy consumption from the network as in the traditional model. Such "prosumer nodes" may be aggregated by specific market actors to be seen as Virtual Power Generation facilities. The consumption of on-site generated electricity (e.g. by tenants) needs to be subject to efficient and reliable commercial process, though not necessarily managed via existing market communication processes. These measures might increase trust and participation of the end consumer.

On the power side, DER integration requires the support of bi-directional energy flows in the Distribution domain, which is a change of paradigm from traditional energy grids and introduces new risks with potential hazardous physical impact on expansive power elements (transformers etc.). Safe connection of local (low or medium voltage) generators to the network requires proper control of the generated power (active and reactive), to ensure good synchronisation in terms of phase, frequency and voltage. Therefore, the security of the ICT control infrastructure for managing DER is not less sensitive than for other parts of the distribution domain, while it is potentially more exposed to attacks due to proximity to network access points on the customer side (communication gateway with access to metering units for consumed and generated power) and risk of frauds impacting the payment and settlement system for DER generation.

In principle, the measurement of DER-generated energy transferred to the network will be subject to similar risks (tampering for fraud) as identified for other metering equipments (see Recommendation EG2.M.1 from SGTF EG2 EG2 REQ regarding conformity with the measuring instrument directive [i.27]). This assumes that the measurement takes place after the DER-generated energy (e.g. continuous current) has been converted and synchronized to fit the local grid energy waveform. Such measurements typically take place at the point of entry to the grid. The owner of the DER resources connected to the entry point, however, cannot always be identified unambiguously, and in the future, flexibility will require accommodation of displaceable resources such as electric vehicles allowing the energy network to draw energy from their battery during hours of high demand. Such scenarios will require the capability to uniquely identify the locally plugged resource to handle the billing properly. Therefore secure identification and authentication capabilities such as those offered by TC M2M will be required for DER integration.

4.2.2 Demand Response (DR)

Demand Response sees [i.18] Automated demand response: DR can apply to any process that can dynamically modify its consumption (or Production) level

Major contributions from smart grids to CO2 emission reductions are expected by improved Demand Response management, which covers:

- Better smoothing Demand over time, thanks to e.g. introduction of dynamic tariffs, managed services and customers incentives to shift their demand away from peak time to periods of lower demands. This assumes active customer involvement in the energy market, including releasing some control over power-hungry equipments to third-parties to lower the bill. High levels of trust from the consumers are critical for demand response actors.

- Better balancing demand and response at all levels in the network, by dynamically optimizing the power flows within the grid to accommodate local conditions of supply and demand while minimizing transmission losses.

Better prediction and control over demand behaviour and resulting reductions in spurious generation will have beneficial impacts on costs and CO2 emissions.

4.2.3 Electric Vehicle (EV)

EV definition [i.19].

Efficient integration of Electric Vehicles in the smart grid requires ways to ensure that charging will mainly occur during times of low energy demand and will not affect peak demand, otherwise no benefits in terms of CO2 reduction can be expected from this technology. The further possibility to use the storage capacity of electric vehicles batteries as temporary storage to draw upon during peak demand, subject to proper incentives and user consent, provides a way to fully leverage on EV technologies. Finally in charging mode, EV are geographically moving loads that need to be managed through proper demand response mechanisms, while when the user accepts the use of his battery as a temporary storage while parked, they behave as DER resources. Efficient vehicle-to-grid communication technology while moving as well as while parked is a fundamental requirement for efficient EV integration.

4.2.4 Building/Home Energy Management (BHEM)

BHEM is the management of energy in the home and building (residential and commercial) of its demand and supply, and energy optimization through centralised units. The BHEM is connected to the power grid so that demand and supply can be adjusted in regional and community units for optimized energy use. The use of M2M in BHEM enables visualisation of power consumption on different possible displays (either local or remote), monitoring and control of individual appliances including alarm notifications in case of abnormal consumption, renewable energy resource and electric vehicle, forecasting static operation according to plan/ optimisation logic, and efficient operation of various resources (demand control devices, supply control devices, etc.). Control include activities such as switching off appliances in response to a pricing request or as a result of a sensed event in order to reduce the environmental impact, or to balance load by shifting load in time to alleviate the peak demand on the power grid. BHEM also includes automated discovery functionality to identify individual appliances and apply the appropriate action.

4.2.5 Smart Metering

Smart Metering Co-ordination Group (SM-CG) developed a functional reference architecture for the smart metering following the acceptance of the Mandate M/441 [i.20] for smart meter.

The work undertaken in response to M/441 [i.20] considers the high-level smart metering functionalities which are additional to the traditional metrological requirements applying to electricity and other meters. The major focus of the mandated work under M/441 [i.20] is the provision of improved information and services to consumers and enabling consumers to better manage their consumption.

Particularly in relation to electricity metering, there is the important additional objective of facilitating smart grid applications, notably through the incorporation of distributed generation. SM are outside the scope of the mandated work of SG. However the M/441 [i.20] mandate envisages smart metering as a key enabler for smart grids, providing for two-way information flows between the meter and the designated market organisation(s).

Smart metering systems may exist in the context of larger smart grid infrastructures and may co-exist with home automation systems. This is illustrated in Figure 4.2.1.

Applications of smart grid systems and home automation systems may overlap with smart metering applications. The communications infrastructures supporting these applications may be separate or may be usefully shared [i.20].

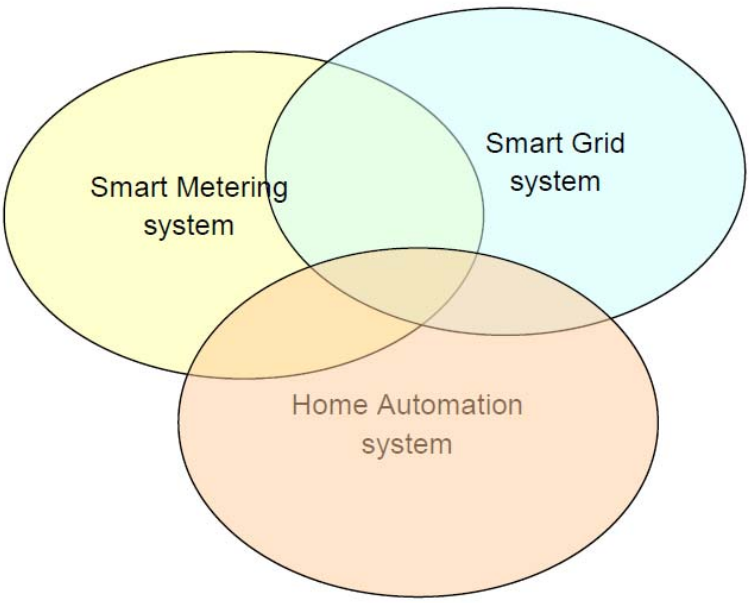


Figure 4.2.1: Smart metering in the context of smart grid and home automation

Automated Metering Infrastructure (AMI) is the only area of smart grids that has already been well explored. They should provide the necessary information for the efficient management of the energy transmission and distribution network, enable proper billing of the consumers, and provide further information required for demand response mechanisms such as sending events when a customer purposely switches off equipment in response to a system's signal. Identification and authentication of the consumer needs to be ensured, and this is where the security bootstrapping mechanisms specified by TC M2M are of special interest. Beyond this, AMI need to be designed as to minimize the exposure of personal information owned by the consumer, such as raw energy consumption measurements. The best approach to this problem is to enable the actors requiring information from the AMI system to download standardized applications executed locally within a customer's environment, accessing the raw data via a standardized API to compute the resulting information needed by this actor. The raw data are never communicated outside of a customer's environment without his consent, and the processing applications only send the information required by their provider (resulting from local processing of the raw data) directly to their provider over a secure communication channel established with the provider. This is depicted in figure 4.2.2.

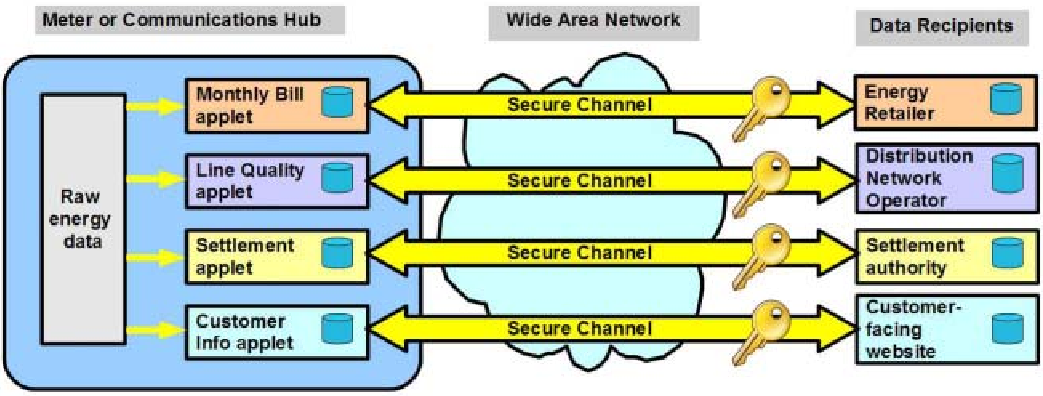


Figure 4.2.2: Smart metering in the context of smart grid and home automation

In this example:

- The monthly bill applet simply calculates the monthly consumption from the raw data and rate information, and sends the resulting bill amount to the customer. Thus the energy retailer gets the information he needs, but no more.
- Information of interest to the energy distribution network, such as voltage levels, is sent to the distribution network on occurrence of specific events or upon request. Again the DSO receives all the information he needs to smooth network operation, but no more.
- The settlement applet generates time of use profile information that is sent to a settlement authority, which can use this to improve the settlement process. Here again the raw data are not transmitted as they are not needed.
- The customer information applet could process and display consumption analysis locally or offer a comparison service interactively via a website, if the customer accepts to share her data this way. The customer who installs such an applet on his system expresses his informed consent.

ETSI TC M2M specifications enable the reuse of ETSI SCP TS 102 241 [i.21], TS 102 225 [i.22] and TS 102 226 [i.23] specifications, which provide the above capabilities.

4.2.6 Advanced Distribution Automation (ADA)

Beyond the presence of an Automated Metering Infrastructure, the smart grid mainly consists of control systems optimizing the operation of the energy transmission and distribution network. Improper operation of such control systems may result in physical damages with safety hazards (e.g. fire or explosion of transformers) and/or cause huge financial or social losses to affected economic actors (e.g. hospitals cut off from the grid during critical times). Therefore ADA can only rely on telecommunication systems that ensure the integrity and authenticity of the exchanged information, as well as secure access control and authentication mechanisms. This is the most security-sensitive part of the smart grid, and this is why today, the communication security specifications for SCADA systems expressed in IEC 62351 [i.25] are considered as the pillar for smart grid communication security.

4.2.7 Communications

The role - and impact - of ICT in smart grids is a key element in the way smart grid architecture will be defined [i.13], (v1.12 JWG). In particular, a variety of communication technologies may potentially shape a very different role for the communication networks.

The functional architecture (IEC/TC57 [i.26] model) considers communication through specific subsystems such as the communications infrastructure subsystem (encompassing public and private networks) or the internet.

However, it is important to note that: there may be several communication networks involved: Home Area Networks (HAN), Enterprise LAN, Neighbourhood Area Networks (NAN), Powerline Communication Networks, Wireline Access Networks, Wireless Access Networks, Core Network. The SMCG may also use Neighbourhood Networks (NN) and Local Network (LN). There may be a variety of underlying communication technologies: powerline, cellular wireless, adhoc/mesh wireless sensor networks, etc. There are many possible connectivity scenarios between functional subsystems, generally involving only a subset of the communication networks. Various communication technologies can be used at the different layers of the communication stack. The choice will depend on the specific requirements and business models.

A more specific Communication Architecture can help understanding the impact of the communication standards on the organization of the subsystems. The definition of a generic model may help the coherent definition of specific sub-models. That is why JWG recommended to develop a Communication Architecture to take into account the large variety of network and connectivity scenarios involving communications interfaces.

4.3 Smart Grid Standardisation

4.3.1 European conceptual model

This clause covers European view [i.12].The European Smart Grids Task Force Expert Group 3 (EG3) identified a list of actors and associated Roles and Responsibilities:

- Markets. They play a role in the extension of the business capabilities within smart grids by enabling a diverse set of intermediations. EG3 identifies several roles for these actors, like Power Exchange, Trader, etc.
- Service providers. In this role, a variety of actors offer technology, products and services to other actors in the model. Examples of service providers identified by EG3 are Ancillary Services Providers, Metering Operators, ICT Service Providers, Electric Power Grid Equipment Vendors, etc.
- Home/building customers. This refers to residential consumers as well as private or business buildings. Like all customers they can be involved in contract based demand response.
- Industrial customers. In addition to the previous customers, this refers to large consumers of electricity in an industrial and manufacturing industry, in particular consumers of electricity providing transport systems.
- DER. Distributed Energy Resource systems provide an alternative to or an extension or enhancement of the traditional electric power systems using small-scale power generation technologies.
- Transmission/distribution. From a standardization standpoint, transmission and distribution require the same set of activities and do not need to be differentiated.
- (Bulk) generation. Refers to generation of electricity, active contribution to voltage and reactive
- Power control, required to provide the relevant data (information on outages, forecast, actual production) to the energy marketplace.
- Grid operations. Refers to the undertakings of operating, building, maintaining and planning the
- Electric power transmission and distribution networks.

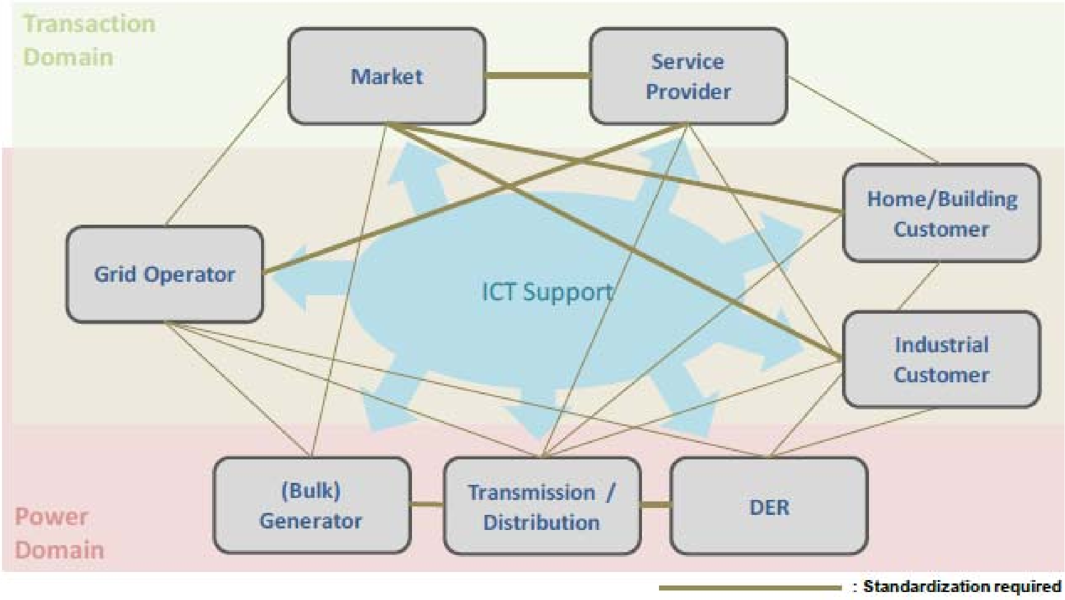


Figure 4.3.1: European conceptual model

Two major domains in which actors are playing:

- Transaction domain. In this domain, the vast majority of the interaction between actors takes.
- Place using ICT-based software, applications and solutions.
- Power domain. In this domain, most of the interaction concerns control and optimization of the
- Power flows.

4.3.2 NIST conceptual model

This clause covers NIST view [i.13].

The **Customer domain** is where the electricity is consumed by the end users. The end user could also generate, store, and manage the use of energy. Traditionally, three customer types are discussed, each with its own domain: residential, commercial, and industrial.

The Markets are where grid assets are bought and sold. Actors in the Markets domain exchange price and balance supply and demand within the power system.

The Service Providers are the organizations providing services to electrical customers and utilities.

The Operations are Actors involved in the smooth operation of the power system.

Bulk generation are the generators of electricity in bulk quantities (may also store energy for later distribution).

Transmission is the carriers of bulk electricity over long distances (may also store and generate electricity).

Distribution: the distributors of electricity to and from customers (may also store and generate electricity).

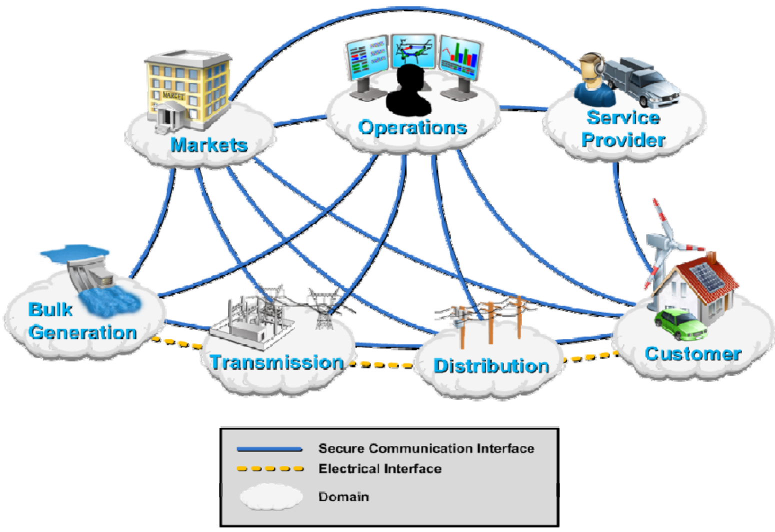


Figure 4.3.2: NIST concept model

4.3.3 ETSI Conceptual Model

There are three architecture layers proposed for Smart Grid within ETSI, these are as follows:

- **Service layer,** this consists of the following:
  - Market: operators and participants in grid/electricity markets
  - Service Provider: providing services to electrical customers
- **Control and connectivity layer,** this consists of the following:
  - ICT support
  - Communication
  - DR
- **Energy layer,** this consists of the following:
  - Bulk generation
  - DER
  - Transmission (High voltage)
  - Distribution (Medium / low voltage)

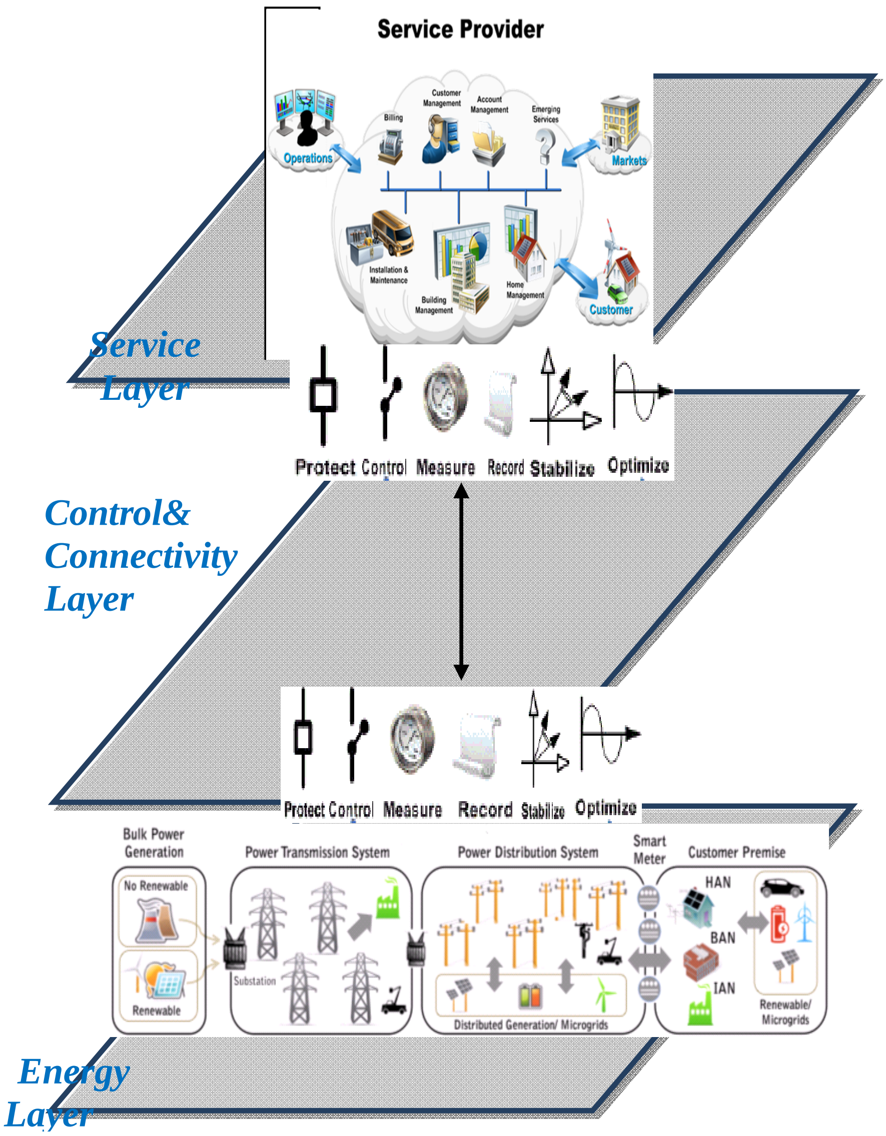


Figure 4.3.3: ETSI Smart Grid Layer

4.4 Smart Grid Roles and Responsibilities

Figure 4.4.1 depicts the logical structure of Smart Grid, the associated voltage levels of the energy layer and the corresponding roles and responsibilities.

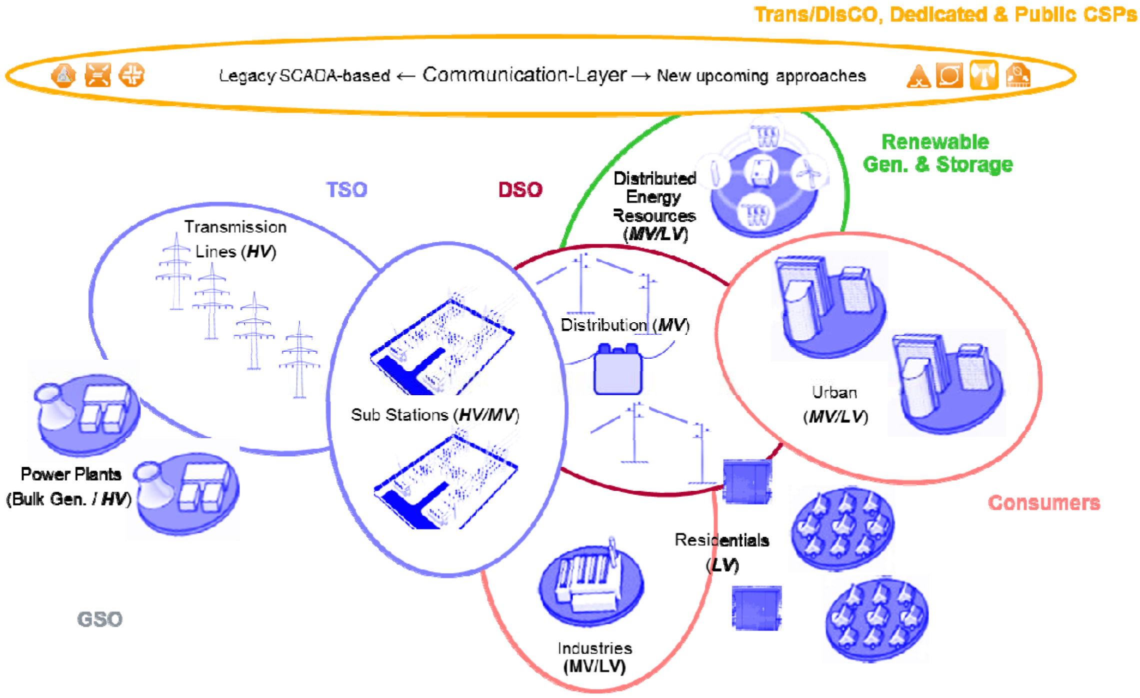


Figure 4.4.1: Smart Grid structure and roles: Logical structure and associated voltage levels of Energy Layer

Operators

Energy Operators

Generation System Operators (GSO):
Generation system operator (GSO) is responsible for the generation of bulk electricity, contributing to voltage and reactive power control and providing relevant data to the energy marketplace.

Transmission System Operators (TSO):
Transmission System Operator (TSO) is responsible for operation, maintenance and development of the transmission network in its own control area and at interconnections with other control areas, long-term power system ability to meet the demand, and grid connection of the transmission grid users, including the DSOs.

Distribution System Operators (DSO):
Distribution System Operator (DSO) is responsible for operation, maintenance and development of its own distribution grid and where applicable at the connections with other grids, ensuring the long-term ability to meet the distribution demand, regional grid access and grid stability, integration of renewables at the distribution level and regional load balancing (if that is not done by the balance responsible party).

Telecommunication Operators

Teleco or Access Network Operator (Telco): Provider of Access Network

M2M Operator: Operates Machine to Machine Networks

Service Providers

Providers of services in the following areas:

- Energy
- Telecommunication
- Machine-to-Machine (M2M)
- Internet Service Providers (ISP)

Some services include but not limited to the following:

- Electric power grid equipment vendors
- Ancillary services providers
- Metering operator
- ICT SP
- Grid communication net providers: TSO, DSO or independent actor; But responsibility is still on TSO and DSO
- Home Appliances vendors
- Building energy management systems (BEMS) provider
- Electric transportation/Vehicle solution providers

Prosumer

Prosumers are customer/consumer/ End users who, besides consuming electricity, can generate electricity and be involved in contract based demand response. Depending on their characteristics, Prosumers are classified as follows:

- Industrial customer: A large consumer of electricity in an industrial / manufacturing industry.
- Transportation customer: A consumer of electricity providing transport systems.
- Buildings: A consumer of electricity which is a private or business building.
- Home/residential customer: A residential consumer of electricity (including also agriculture users).

Figure 4.4.2 illustrates the evolution of the Smart grid structure in terms of business opportunities and corresponding roles.

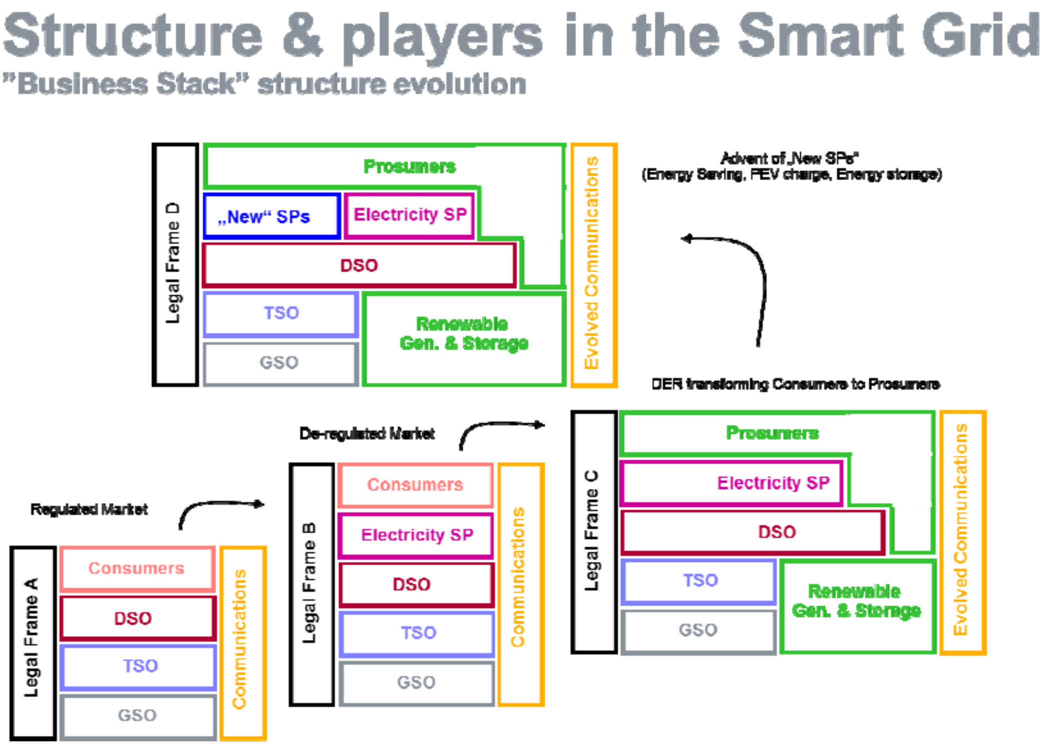


Figure 4.4.2: Smart Grid business

4.5 SG Communication Requirement values in Relation to M2M services

Table 4.5.1 lists typical functions of Smart Grids performed by means of communication systems.

Table 4.5.1

Function	Typical response time	Data amount	Number / Magnitude of communication nodes	Feasibility assessment to TC M2M work
Protection of nodes in SG	1 ms to 10 ms	Bytes	1 to 10	Use case for M2M communication / service platform to be assessed further
Control of nodes in SG	100 ms	Bytes	10 to 100	Use case looks feasible for M2M communication / service platform, has to be assessed further
Monitoring of nodes in SG	1 s	kBytes	1 000	Use case for M2M communication / service platform
Metering / Billing	1 h to 1 d	Mbytes	Millions	Use case for M2M communication / service platform
Reporting	1 d to 1 year	GBytes	Millions	Use case for M2M communication / service platform

5 Smart Grid Use Cases

This clause describes the smart grid use cases in more details. The use cases may be classified according to the ETSI conceptual model as follows:

Energy Layer:

- Advanced Distribution Automation WAMS (Wide Area Measurement System)
- DER control (Distributed Energy Resources)
- DR control (Demand Response) for large scale application
- DS supervision (Distribution System)
- DER, DR/Microgrid control
- Electric Vehicle (EV) charging and power feed
- PV generation (Photo-Voltaic)
- Next Generation traffic systems (M2M automotive use cases TR)

Control and Connectivity Layer:

- User Case for Service Providers Management

Service Layer:

- Home-DR applications (Demand Response) for consumer appliances
- Home Energy Management (HEM)
- Smart Grid/Metering Customer Domain Use Case Deployment Scenarios

5.1 Smart Grid Energy Layer Use Case

5.1.1 Advanced Distribution Automation WAMS (Wide Area Measurement System)

5.1.1.1 Scope and Objectives of Use Case

Scope and Objectives of Function
This use case covers the introduction of a Phase Measurement Units ("PMUs, aka Synchrophasors") that can provide Proper state information about the initial network health over a whole country or even beyond. Due to their exact measurement time marking, high resolution phase information can be made available to TSO/DSO control centres to initiate automatic counter measures within seconds, to protect a whole wide-area network from black-out events. As can be seen from recent nation-wide failure events, black-out causes are propagating within minutes and sometimes only seconds through entire national and even international transport & distribution networks to cause volatile regional energy generation, becoming increasingly important when introducing power plants relying on sun or wind energy in large scale.

5.1.1.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
PMUs usually generate bulk statistical information transmitted hourly or daily, they are capable of continuously monitoring the wide-area network status on-line. In this use case there will be continuous information streaming data available to control centres from hundreds of PMUs at once which requires a stable communication network with sufficient capacity and quality.
Complete description
PMUs are positioned across the High-Voltage transmission and distribution network (HV-Grid, operated by Transmission and Distribution System operators - TSO/DSOs), typically in Sub Stations, where network node connections are made and the distribution of load flow is of importance. In Sub Stations typically broadband data connections via optical fibres are available; there may be other locations (e.g. handover or remote sites) where external communications means are required in which case a public or private broadband communication network which is typically capable of transporting IP traffic. In this use case PMUs are connected via this communication network to show the applicability of HV network supervision especially via Mobile Broadband networks, thus not requiring any additional TSO/DSO-internal network extensions. Of course, when utilising a public 3G or later 4G communication infrastructure, sufficient power back-up resources should be available to the network, but this is of course true for dedicated networks as well. Considering transmission delays of < 1 s in the depicted red communication network, especially electricity network phase information may be transported in near real time to the control centre. By correlation of wide-area phase, current and voltage information in TSO-control centres, immediate decisions may be enforced to shut down regional networks to protect nation-wide or even international networks from being overloaded, thus avoiding black-out-spreading as initialised e.g. by a controlled shutdown of a HV-line in northern Germany (2006), in combination with unexpected transmission capacity bottlenecks, harming wide areas of Europe for hours. On the other hand DSOs may supervise their regional distribution networks in their control centres to work around critical situations caused locally, by local intervention, with the aim to avoid catastrophic influences on the electricity transmission network. Regarding data transmission network implementation, an always-on connection scenario for PMUs is reasonable. Individual data traffic from a PMU is rather low, compared to other mobile broadband usage (e.g. private file download, even internet surfing), but it is continuous. As described in a CIGRE® paper continuous PMU operation covering 12 channels each 50 Hz cycle, will generate < 50 Kb/s net frame data rate. Considering continuous UDP-IP transmission, the air data rate will stay below < 100 Kb/s and typically below < 1 Mb/s for a Sub Station location. Considering intended burst transmission, e.g. transmission of bulk daily or hourly data, e.g. from a transient fault recorder (TFR), data volume may reach into the 3-digit MB range causing a high-bandwidth-burst of transmitted data. Data from other measurements devices may have to be collected by the WAM.

5.1.1.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Consumer	Person		Users of electricity
Telco Operator	Operator		Providing measurement information to TSO/DSO control centers
TSO/DSO	Energy Operator		Initiate automatic counter measures to protect a whole wide area network from black-out event.

5.1.1.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

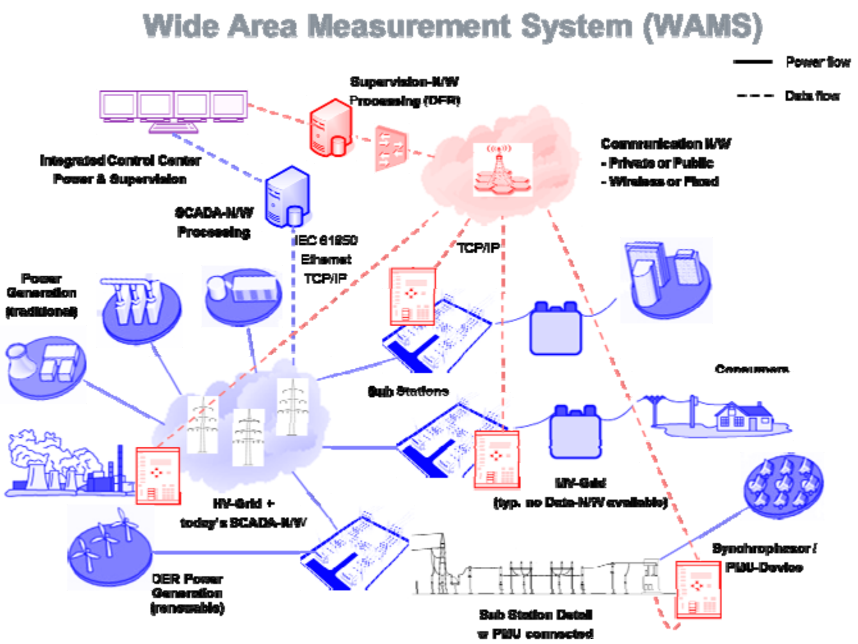


Figure 5.1.1: Drawing or Diagram of Use Case

5.1.2 DER control (Distributed Energy Resources)

5.1.2.1 Scope and Objectives of Use Case

Scope and Objectives of Function
When dealing with many Distributed Energy Resources in an Energy-N/W, most of the resources will be connected to the MV-Distribution-N/W due to their distributed nature, as well as their power-class in the lower MW range (E.g. Wind-Turbines, large PV-Arrays, etc.). Since Comm's-N/W capabilities are rather limited in today's MV-Distribution-N/Ws, an efficient and flexible Comm's-N/W overlay implementation is crucial for local DER-rollout. With the help of regional energy management, generation may be controlled according to demand and better Distribution-N/W protection becomes possible on a regional, instead of a local basis.

5.1.2.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
Use of Telecommunication infrastructure to carry data resources between Distributed Energy systems
Complete description
DERs, communicating with a regional MV control centre via wireless networks, seem to be the most viable solution, when dealing with Distributed Energy Resources, from the aspects of comm's availability and data throughput. Comm's CAPEX and OPEX-wise, a clear cut between the different players (i.e. the Distribution-N/W and the DER-operator) concerning the write-off of comm's infrastructure installation burden, also justifies the case for utilising a public wireless CSP offering. SCADA-based control offers very efficient message exchange between devices and their control centre. In the case of a public-CSP comm's solution, the security of the comm's solution needs to be ensured. An envisaged number of DER devices in such a network reach from a few to several dozen (e.g. Wind-Turbine farms) contributing with an average of some Kb/s in continuous operation, requires comm's acknowledgement in the several-second range.

5.1.2.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Consumer	Person		Users of electricity
Telco Operator	Operator		Providing measurement information to TSO/DSO control centres
TSO/DSO	Energy Operator		Initiate automatic counter measures to protect a whole wide area network from black-out event

5.1.2.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

5.1.2.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

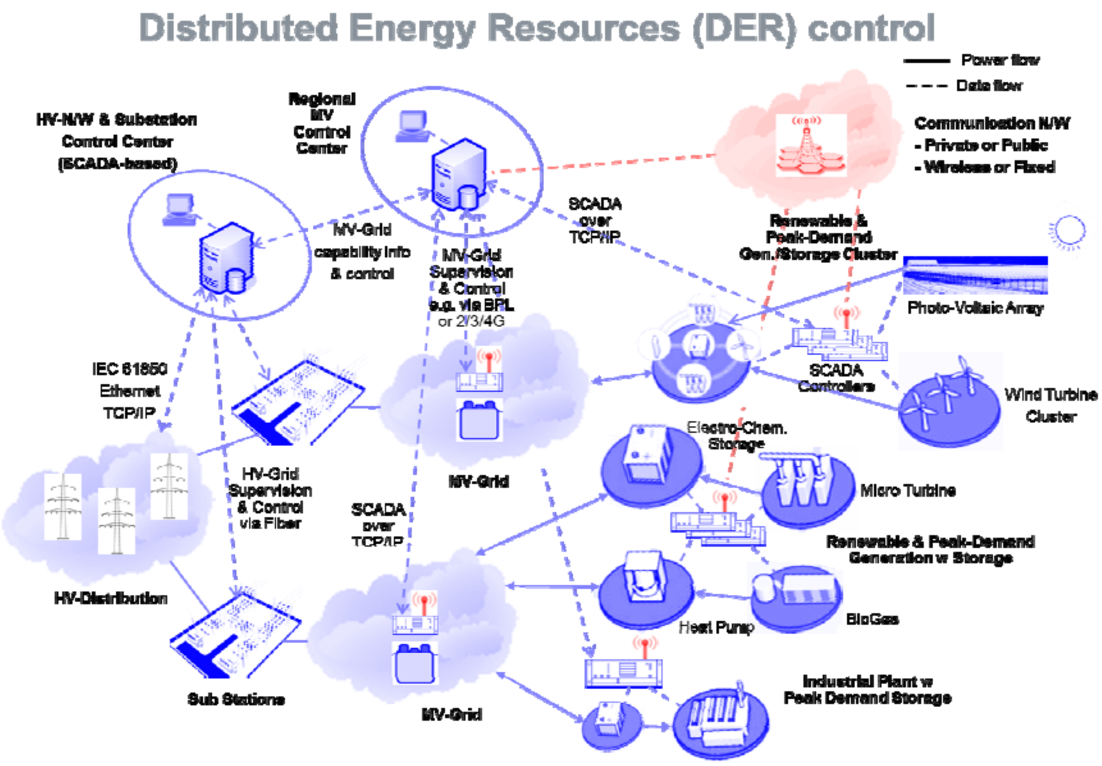


Figure 5.1.2

5.1.3 DR control (Demand Response) for large scale application

5.1.3.1 Scope and Objectives of Use Case

Scope and Objectives of Function
Similar to the Distributed Energy Resources scenario/use case, the Demand Response scenario/use case for large scale applications is very much located in the MV-Distribution-N/W due to its distributed nature, as well as its power-class in the medium KW range (e.g. aggregated Home/Campus-DR, Street Lighting, Recreational Parks, etc.). Please note that DR applications in this use case are dedicated to "fixed-gear" home appliances (like HVAC, Pool & Sauna appliances), which are enabled for bulk control directly from the utility, rather than from a separate service provider, as described in the Home-DR applications section for consumer appliances . The basic goal in this DR use case is to stabilise the network, by equalising peak energy demand over short times (quarter hours range) and to protect the Distribution-N/W against black-out situations or support the recovery process following a black-out.

5.1.3.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
It is about a DR application in the MV-Distribution N/W with focus on "fixed gear" home appliances which are enabled for bulk control from utility rather than separate service provider. It also emphasises on the requirement of front end SCADA controller and communication N/W to control large amount of households.
Complete description
Discussion for the Comm's N/W in the DER Use Case applies to this DR control use case, including expected data traffic throughput and latency expectations. Please note also the various load measuring points in the MV-Distribution-N/W, which are supporting the load measurement accuracy derived in the Sub Stations. The information is aggregated in the Regional MV Control Centre, processed and will yield control commands for the attached SCADA controllers for DR purposes. One important difference though is the distribution of demand response signalling in the Home area. SCADA controller (shown in figure 5.1.3), dedicated to the residential area, needs a communication and protocol front-end to control a large amount (dozens) of households, probably connected to the same MV-to-LV transformer for infrastructure reasons. Privacy concerns are of less interest in this application, due to the primarily unidirectional way of "broadcast" communication. This is described in more detail in the DA for Transformer Stations (MV to LV) section for DER, DR/Microgrid control Use-Cases

5.1.3.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Electric Network SP	Service Provider		Also responsible for bulk control of "fixed gear" home appliances
Telco Operator	Operator		To provide the communication N/W services to home appliances. Reliable Communication N/W: • between front end SCADA controller and regional MV control centre • between SCADA front end and residential area

5.1.3.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

5.1.3.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

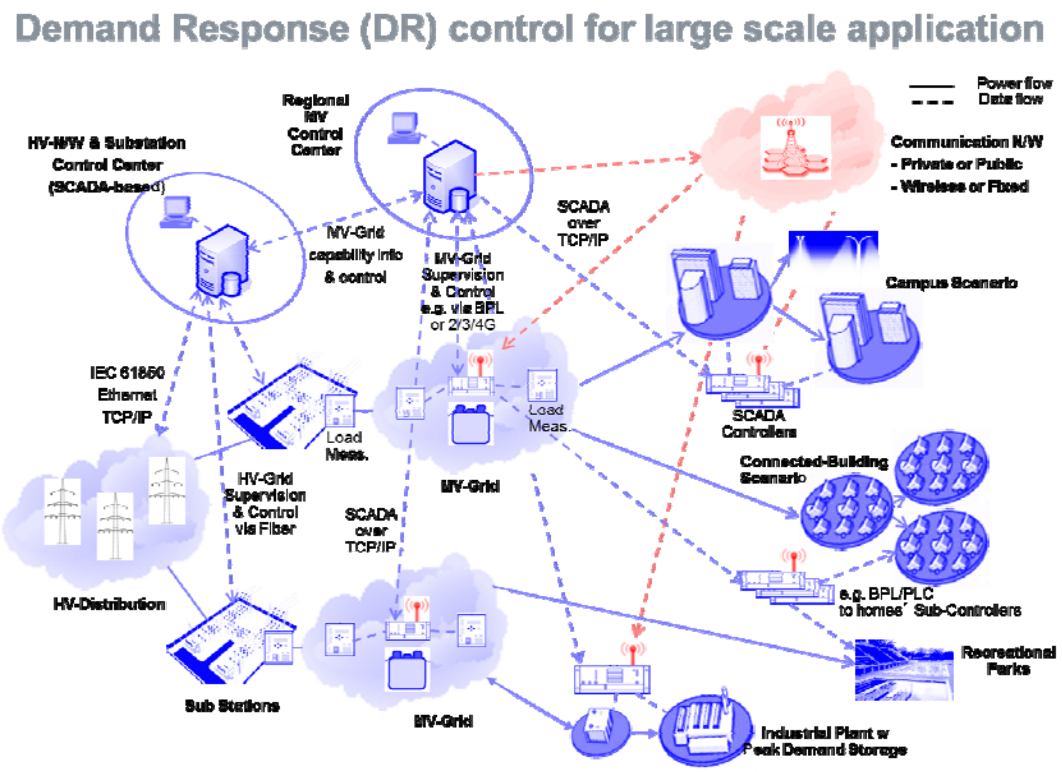


Figure 5.1.3

5.1.4 DS supervision (Distribution System)

5.1.4.1 Scope and Objectives of Use Case

Scope and Objectives of Function
The aim of Distribution System Supervision is primarily to notify faults in Distribution-N/W faster than end users would do and to analyse the fault situation in more detail from remote. In combination with better focused field force activity, this leads to an increase of Distribution-N/W availability. Different to the sensing and measuring in the DR control, which is related to certain infrastructure points in the Distribution-N/W, the DS Supervision relates more to a distributed task, supervising passive infrastructure, like lines, cables and branching points alongside, plus the information gathered from specific premises and using communication network to transport the information.

5.1.4.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
Use of Telecommunication infrastructure to carry data resources between Distributed Energy systems
Complete description
The Distribution System Supervision yields qualitative information about the N/W-status along the lines, i.e. where electricity is still available and whether Voltage Dips occurred (e.g. caused by automatic Recloser actions). The installations for DR and DER-control will support the situational analysis with their measurement capabilities, but the Distribution System Supervision allows for fast status checking in between.

5.1.4.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Consumer	Person		Users of electricity
Telco Operator	Operator		Providing measurement information to TSO/DSO control centres
TSO/DSO	Energy Operator		Initiate automatic counter measures to protect a whole wide area network from black-out event

5.1.4.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

5.1.4.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

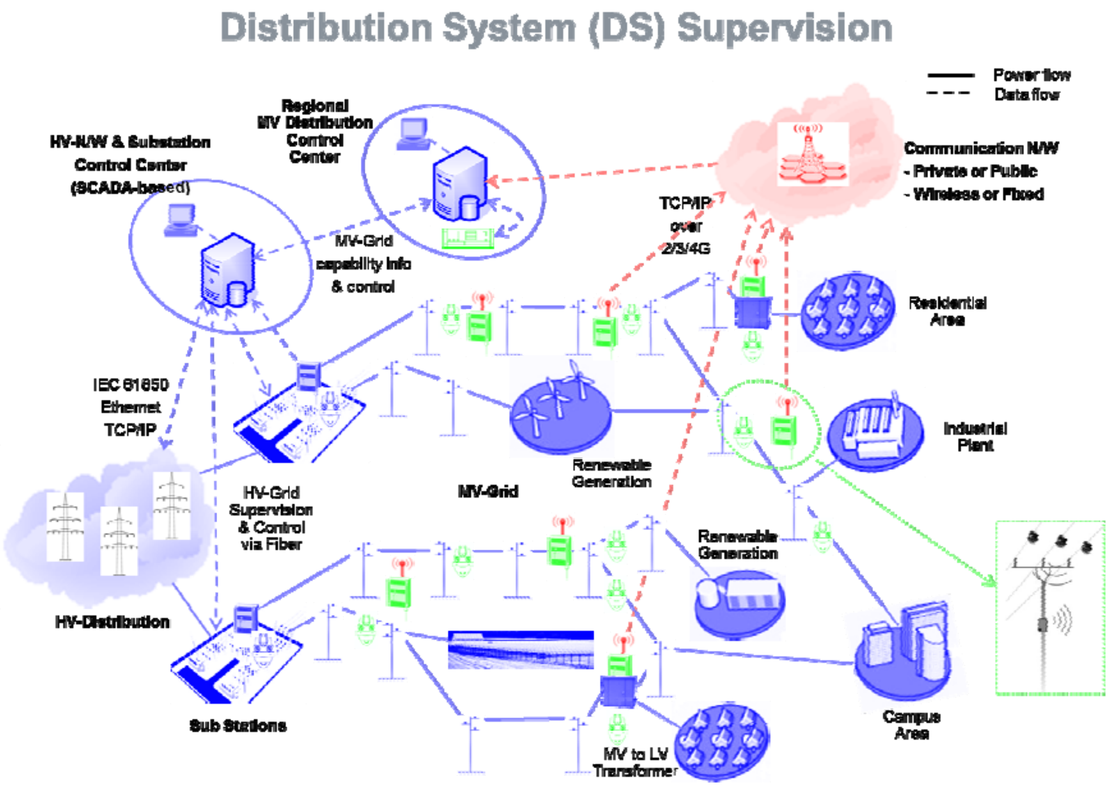


Figure 5.1.4

5.1.5 DER, DR/Microgrid control

5.1.5.1 Scope and Objectives of Use Case

Scope and Objectives of Function
DER, DR/Microgrid control is focused around the handover point at the MV-to-LV transformer sites, where the LV-distribution and generation takes place. This task is about stabilising the network, by • Equalising peak energy demand over short times (hours range) • Protecting the LV-Distribution-N/W against overload or excessive voltage situations (caused by strong local sun or wind-based generation) • Actively compensate Reactance with enabled devices (e.g. PV-Inverters) as well as to • Supporting the recovery process following a black-out Please note that DR applications in this use case are dedicated to "fixed-gear" home appliances (like HVAC, Pool & Sauna appliances), which are enabled for bulk control directly from the Local Electricity N/W-SP Control Centre, rather than from a separate service provider.

5.1.5.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
This is about a DER/ DR application with a focus on: 1) fixed gear appliances that are under the control of electricity N/W provider, 2) local/LV distributed DER, and 3) LV communication infrastructure.
Complete description
1) There are 3 applicable ways to accomplish the comm's task with individual homes ("fixed gear" appliances), demand or generation (e.g. street lighting, PV generation) sites as shown in the examples below. One is physically connected via the MV-to-LV transformer site, utilising BPL/PLC towards the LV-Grid. *(Please note that the MV-to-LV transformer separates the MV and LV BPL/PLC N/Ws not only physically but also logically for their different comm's purposes)* Another aspect concerning the public BPL/PLC installation are interferences which might be generated by home-based BPL equipment, therefore only a limited QoS can be expected: **2)** Second is a proprietary Meshed-Radio-N/W solution like ZigBee® or Z-Wave® which allows hop-to-hop-meshing to extend and stabilise the comm's-N/W. The root station would be co-located with the transformer station. Since such radios predominantly operate in unlicensed frequency bands, there exists as well only a limited QoS expectation. **3)** Third depicts a wireless solution, based on public or private CSP offering, which operates in licensed frequency bands and will offer a suitable QoS, when properly set-up (2G/3G/4G) /Long Range Radio[LRR]). Such a solution may be used also as a feeder, in combination with the previously described local comm's solutions, installed in the transformer station. Suitable bandwidth and latency is available via 3G and 4G networks. An independent feeder for the transformer station also ensures MicroGrid operation from a communication perspective, when the MV-feeder is down. All attached distributed generating contributors are then still within control of the Local Electricity N/W-SP Control Centre, thus enabling an "Island" or "MicroGrid" mode of operation, when generating enough local power and DR-enabled devices acting accordingly. The "last mile" comm's link, connecting the residential homes, will terminate in fixed installed devices in the homes (e.g. G/Ws located in fuse-boxes). Either in a direct way, in a dedicated device (e.g. relay circuit control or in an advanced HVAC-controller) or in an indirect way, via installed smart meters' relay control outputs, using the same comm's infrastructure. In any case, the installed home or DER-G/W needs to be compatible with the Local Electricity N/W-SP's basic installations, not only in terms of communication stack (Authentication, Authorisation) but also in terms of Object-Data Modelling. Since the Object-Data modelling definition and standardisation is still ongoing, a solution, defined & operated by the Local Electricity N/W-SP, is rather mandatory today. Therefore it is likely that this SP will provide the necessary control and comm's equipment to the DR/DER partners. In the U.S., the Smart Grid Interoperability Panel (SGIP) is currently setting up a Priority Action Plan (PAP17) to define the necessary elements to support this definition phase. In Europe, similar work is taking place in the SGCG.

5.1.5.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description A Selection List	Further information specific to this Use Case
Electric Network SP	Service Provider		Also responsible for bulk control of "fixed gear" home appliances
Telco Operator	Operator		To provide the communication N/W services to home appliances and local DER. Communication N/W may be one the following options: • BPL/PLC N/Ws • Proprietary meshed-Radio N/W such as e.g. ZigBee® or Z-Waves® • Wireless solution in licensed bands such as 2G/3G/4G/ Long Range Radio (LRR)

5.1.5.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

5.1.5.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

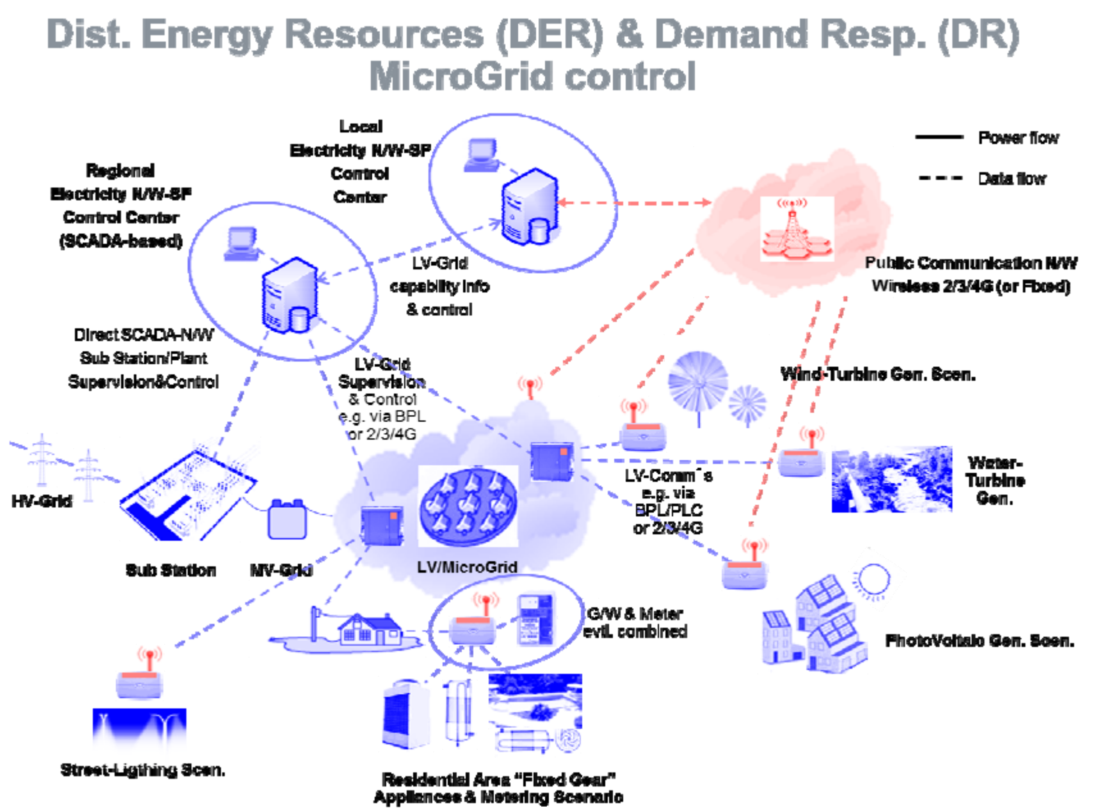


Figure 5.1.5

5.1.6 Electric Vehicle (EV) charging and power feed

5.1.6.1 Scope and Objectives of Use Case

Scope and Objectives of Function
The aim of the Plug-In Electric Vehicle (PEV) Charging and Power feed use case to the show the interaction between the different players that can be involved in the charging of Electric Vehicle in the home The scenario includes an option to engage an Electricity-SP (El.-SP) next to the delivering Electricity-N/W-SP (El.-N/W-SP), whilst obtaining an Electric Vehicle Charging (EVCE) solution from a dedicated Electric Vehicle Charging SP (EVC-SP), who takes care of special functions like the DR enablement (cost effective PEV Charging and Power Feed) and functions in conjunction with PEV service and maintenance (providing a data connection for PEV health purposes, e.g. managing Power Feed cycles, PEV-SW upgrading & remote fault analysis, etc.) by the PEV-SP (the PEV-SP should not be identical to the PEV manufacturer, options like independent Fleet Management SPs are possible). In parallel, a Power Feed (back) option from the PEV's battery into the Electricity-N/W may reduce the cost of ownership for the complete PEV eco-system.

5.1.6.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
Interaction between different Service Providers involved in the charging of electric vehicle
Complete description
The El.-N/W-SP is responsible for the residential homes (smart) metering. Depending on local laws, the metering for the EVCE may be independent and might be a physical part of the EVCE. This yields also the advantage that the branching from the residential homes primary power supply can be utilised in front of the homes fuse box, even from the outside, if the electricity is delivered above ground via poles. Depending on the PEV's brand, a parallel wired data connection may be included in the EVCE charging plug to enable the PEV's controller to access its agreed service and maintenance provider (PEV-SP). In case of no wired connection (high data rate, e.g. Ethernet), a short reach link, e.g. via ZigBee® or even Bluetooth® may be established (medium data rate ~2 Mb/s). This connection will then be routed via the EVCE's mobile broadband link to the PEV-SP's control centre in parallel to the charging and power feed control data, which is routed to the EVC-SP's control centre.

5.1.6.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Electric Network SP	Service Provider		Is responsible for the residential homes (smart) metering. Depending on local laws, the metering for the EVCE may be independent and might be a physical part of the EVCE. This yields also the advantage that the branching from the residential homes primary power supply can be utilised in front of the homes fuse box, even from the outside, if the electricity is delivered above ground via poles.
Telco Operator	Operator		Will provide the public wireless data service (2G/3G/4G). Assuming no broadband data connection in the garage, where the EVCE may be located. Depending on the PEV's brand, a parallel wired data connection may be included in the EVCE charging plug to enable the PEV's controller to access its agreed service and maintenance provider (PEV-SP). In case of no wired connection (high data rate, e.g. Ethernet), a short reach link, e.g. via ZigBee® or even Bluetooth® may be established (medium data rate ~2Mb/s). This connection will then be routed via the EVCE's mobile broadband link to the PEV-SP's control centre in parallel to the charging and power feed control data, which is routed to the EVC-SP's control centre.
Electric Vehicle Charging SP	SP		Takes care of special functions like the DR enablement (cost effective PEV Charging and Power Feed) and functions in conjunction with PEV service and maintenance (providing a data connection for PEV health purposes, e.g. managing Power Feed cycles, PEV-SW upgrading & remote fault analysis, etc.
Electricity-SP (El.-SP)			
Electric Vehicle Service Provider (PEV-SP)	Service Provider		PEV-SP (the PEV-SP should not be identical to the PEV manufacturer; options like independent Fleet Management SPs are possible).

5.1.6.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

5.1.6.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

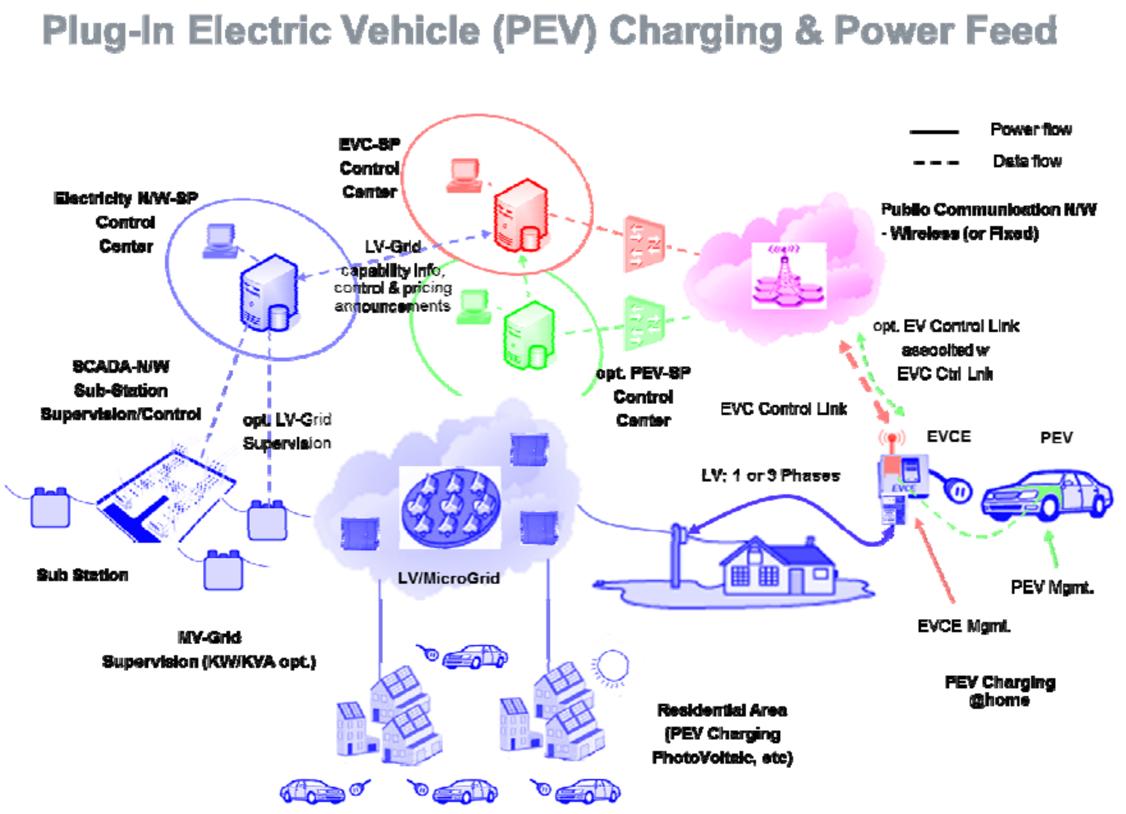


Figure 5.1.6

5.1.7 PV Generation (Photo Voltaic)

5.1.7.1 Scope and Objectives of Use Case

Scope and Objectives of Function
The PV Generation & Control use case is architecture-wise very similar to the DER, DR/Microgrid control scenario (it can be seen as a subset of it), but due to the specific character, it has a different utilisation focus. In this advanced use case the following may be possible: • PV-based electricity generation • Limited Reactance control in the local distribution layer • Power control to stabilise the LV-Grid • Enable MicroGrid operation

5.1.7.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
The use case is focusing on the photo-voltaic generation, highlighting the difference between electricity consumption and metering, time-of- day tariff of PV generation, and differentiating home/distribution communication infrastructures and the roles and responsibility of electricity service providers where possible.
Complete description
The Use case consist of a Smart Meter which is dedicated for electricity generation measurement purposes and may therefore differ from regular Smart Meters for consumption measurement. The advantage of this use case is the capability to support weighted electricity generation refunding, based on time-of-day tariffing (e.g. intended off-optimum-axis PV-panel placement to equalise the regional generation characteristic over the course of the day). There is a Home-LAN which is primarily dedicated to configure, monitor and maintain the PV-installations. There is no control foreseen from the Local Electricity N/W-SP via this link. A PV-Inverter-control may be enforced via the dedicated Smart Meter for generation purposes. This architecture may be extended to other DERs' control schemes (Wind, Water, BioGas, etc.) to enable an independent local LV-MicroGrid operation, reinforced by other MicroGrid areas through connection via the MV-Distribution-N/W and controlled by a Local Electricity N/W-SP. Controlling such architecture requires reliable comm's link with reasonable throughput and latency (per device in the N/W). Due to the lesser price pressure on these applications, wireless 3G or later 4G I/Fs are arguable, especially when utilising BPL or Meshed-Radio based central control from the LV-Grid. In this case all local control traffic will be aggregated at the LV-transformer sites and transmitted via this central site. A 3G/4G connection to the LV-Grid also yields the advantage of independent MicroGrid operation w/o MV-Distribution-N/W connection (on which the BPL is transmitted). In order to reduce the control traffic and make the local LV-Grid even more resilient, some power control could be "sourced-out" from the Local Electricity N/W-SP's control centre to a partial independent local control instance, to allow limited autarkic operation. Such a "Pre-Aggregation-Controller" could be co-located on the LV-transformer premises.

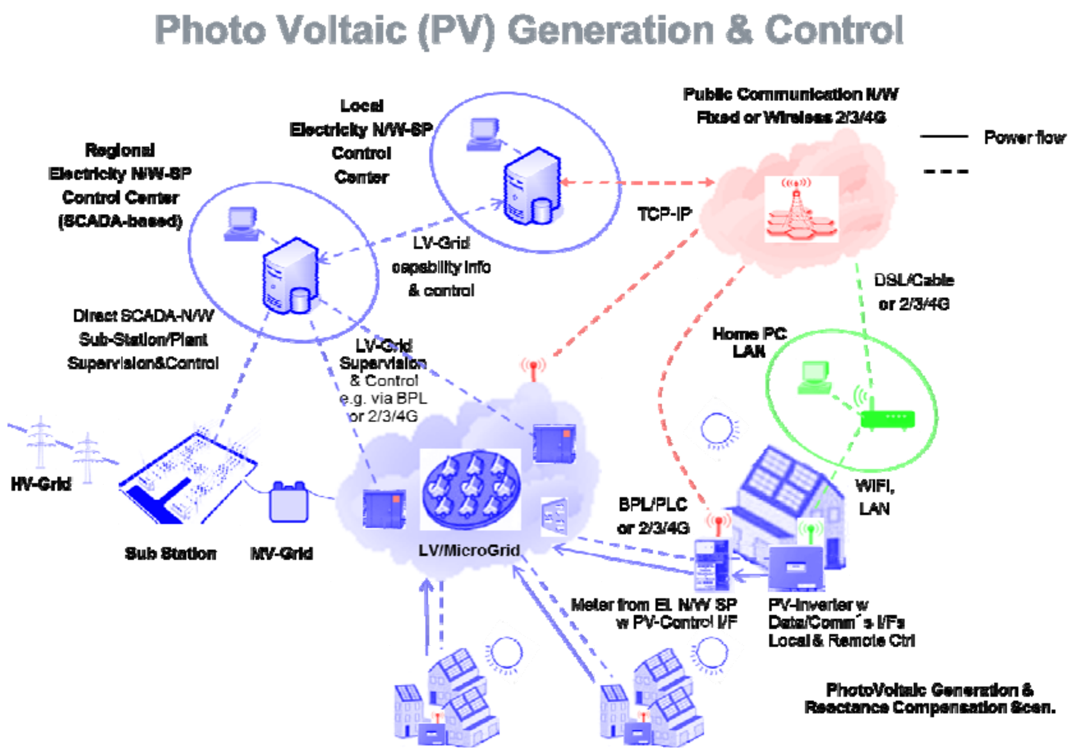
5.1.7.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Electric Network SP	Service Provider (SP)		No control foreseen from the local Electricity N/W SP on home-LAN which is dedicated to configure, monitor and maintain the PV-installations. SP may control PV inverter via a dedicated link to the dedicated smart meter for generation.
Aggregator SP	Service Provider		Provide resilient LV-grid control due to aggregation of control traffic and allow limited LV autartic operation.
Telco Operator	Operator		May provide the public wireless data service (2G/3G/4G) yielding the advantage of independent Microgrid operation w/o MV Distribution N/W connection. Provides BPL or meshed-Radio based central control from the LV-Grid so that all local control traffic will be aggregated at the LV transformer and transmitted via this central site.
Electricity-SP (El.-SP)	Service Provider		Receives LV-Grid capability, control and pricing information from the Local El.-N/W-SP.

5.1.7.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy	No data privacy in the generation case	

5.1.7.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML
 Figure 5.1.7

5.2 Control and Connectivity Layer Use Cases

5.2.1 Use Case for Service Providers Management

5.2.1.1 Scope and Objectives of Use Case

Scope and Objectives of Function
This clause describes Smart Grids uses cases that demonstrate the need for B to B (business to business) communication. More specifically, the need for communication between multiple service platforms and between smart meters / gateways that may be owned by different parties.

5.2.1.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
The Smart Grid Service Plane can include multiple energy service platforms; i.e. building management, energy services, billing services, customer management, account management, repair management, etc. Data and control are required to flow between service platforms and smart meters / gateways and between the service platforms. The subparts of the corresponding infrastructure in this use case may all be owned by different parties.
Complete description
Energy Service platforms may be owned and operated by different parties. Energy-related management of the customer, account, and repair may be owned by the utility provider and operated by a third party (i.e. energy services provider). The building management and energy services platforms may be owned by an energy services provider, while the smart meter / gateway may be owned by the building owner. The building management service platform is used by the building owner to control appliances and monitor energy history usage. Additionally, the platform can recommend behaviour modifications to improve efficiency. The account management platform is used to monitor the building energy consumption and it can be used to enable or disable services. The repair / fault management platform manages responses to transmission system and power system faults. It may initiate the shutdown of several power generators and dispatch a repair crew in response to a group of transmission lines being knocked down. Although the service platforms may be operated by different parties, a certain level of coordination will be required between all of the energy services platforms. For example, the Fault Management platform may notify the Building Management Service of a planned shutdown event.

5.2.1.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
End Users	Person/Business		• **Consolidated Control and Reporting:** The building owner is able to utilize an energy service platform to view consolidated energy usage information (across multiple utility providers) and control all smart grid appliances in a building.
Service Providers	Business		• Ability for utility owned service platforms to securely share individuals' energy consumption information with service platforms that are owned by third parties: Building and Energy management services to obtain usage information from the utility. • Ability for service platforms that are owned by third parties to provide information and commands to the control plane: Building and Energy management services should be able to control subscribers' appliances.
Telco operator	Communication		• **Multiple Energy Gateways:** A building owner may have multiple utility providers (e.g. separate gas and electric providers). This may result in an architecture that requires multiple energy gateways and communication between the gateways. • **Privately Owned Energy Gateway:** A building owner may have multiple utility providers (e.g. separate gas and electric providers). This may result in an architecture where the building owner owns the energy gateway and multiple utility providers make use of it. • **Multiple Connections to the Service Plane:** Multiple Service Platforms may communicate with the Energy Gateway via the control and connectivity plane.

5.2.1.4 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

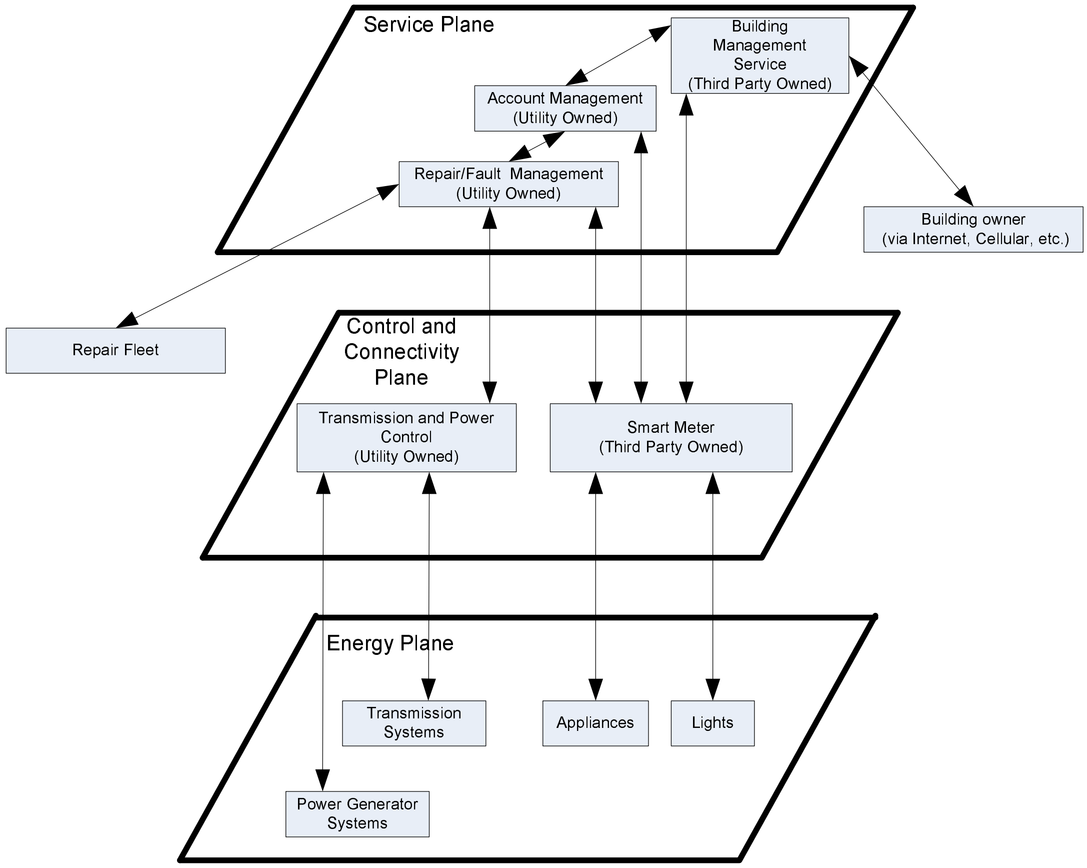


Figure 5.2.1: B to B Use Case - Communication Across Planes and Service Platforms

5.3 Service Layer Use Cases

5.3.1 Home-DR applications (Demand Response) for consumer appliances

5.3.1.1 Scope and Objectives of Use Case

Scope and Objectives of Function
In this use case, Home-DR applications are defined through White and Red Ware equipment, which the user sets up, i.e. these devices are connected to a regular outlet, located wherever suitable in the home and are suitable for Home-DR application. In addition, operation of such devices should flexible enough to fulfil consumer's requirements. Examples are deep freezers, which are capable of delaying cooling intervals until a suitable time of day, when the electricity-N/W SP is able to offer a relatively low price for electricity. In case of the freezer, cooling may be activated at noon, when the sun shines most (high generation from PV) or when there is strong wind energy available, otherwise at default times of day, off the recurring peak demand hours. Further examples are washing machines, tumble dryers and dish washers, where the customer may agree on a proposed scheduled runtime or movable heating/cooling devices to simply reduce high priced time of day operation.

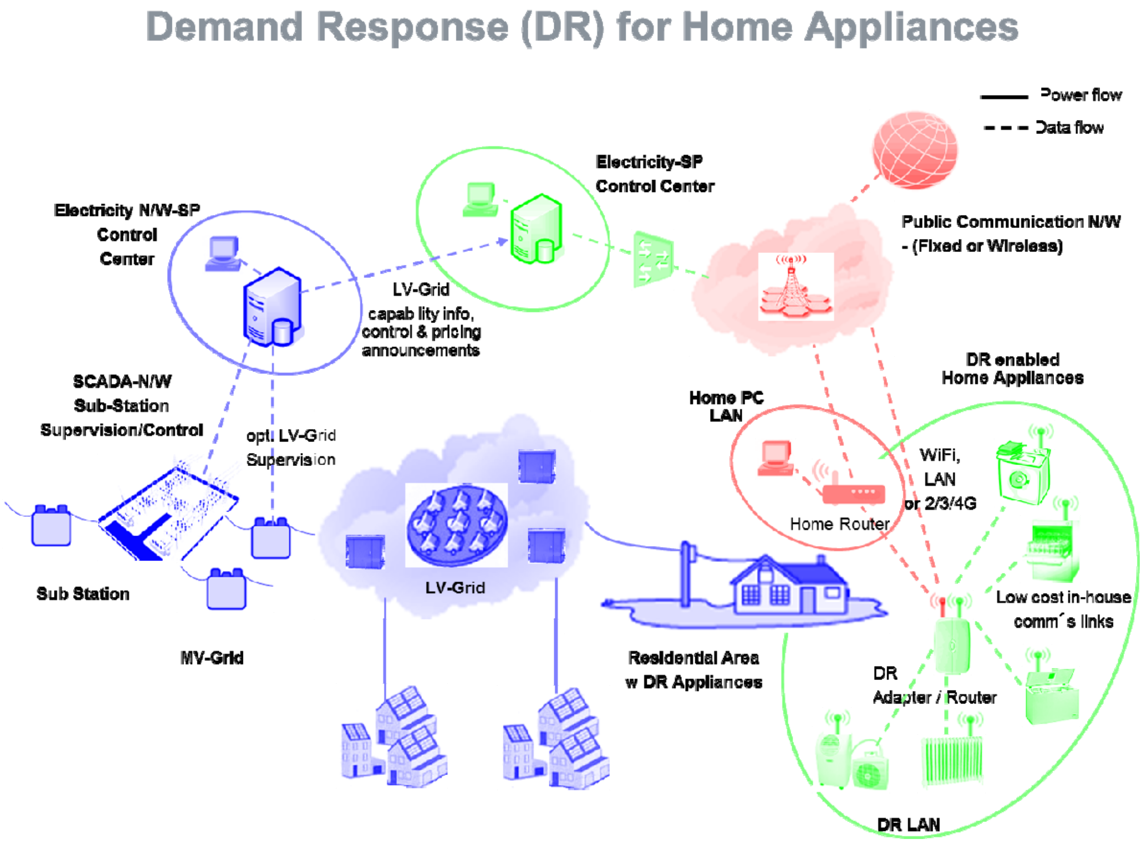
5.3.1.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
This use cases is about home DR application involving home appliances defined through White and Red Ware equipment under the combined control of the user and Electricity service provider. It also involves different service providers to independently provide electricity supply and DR services. It involves different communication protocols with different security requirements between El.SP and its supplied GW/DR router, and between DR router and home appliances. It allows different tariff accounting and home appliance behaviour depending on pricing and time of the day and peak demand.
Complete description
This proposal is forward looking, since the LV-Distribution-N/W needs to be prepared for flexible tariff accounting. Therefore it is required that the Local Electricity N/W-SP installs a Smart Meter infrastructure in its LV-Grid. This use case does not cover the Smart Metering, but assumes that it has been installed and used in the use case. Another advantage of this proposal is to fulfil the legal requirement to be able to choose a suitable local Electricity-SP. It is anticipated that the Electricity-SP is interested to offer Home-DR services to differentiate itself from the competition. The El.-SP Control Centre receives LV-Grid capability, control and pricing information from the Local El.-N/W-SP. This information is harmonised by the Local El.-N/W-SP with the Smart Meter tariff, accounted in the consumers' residential home via the Communication-N/W (and evtl. including the consumer' s Home-N/W, when operating via Fixed Network) the El.-SP announces its pricing information to a G/W it has supplied, designated as DR-Adapter/Router. This DR-Adapter/Router is proposed as a new device class in the residential home, at best logically comparable with a set-top box (for e-Energy management purposes, instead for multimedia). The DR Adapter/Router receives and stores the control and pricing information. On demand, the subsequently connected devices ask for currently available options, when the consumer communicates with ("programs") them or as in case of the freezer, upon internal demand planning by the device's controller. This requires a simple low profile object model for each device to be connected and controlled, which may be supplied by the White or Red Ware manufacturer and adapted to the DR-Adaptor/Router by the El.-SP, on a forward-looking basis and downloaded to it on a regular update basis. End-to-End comm's protocol security and privacy between the El.-SP and the DR Adapter/Router (including the comm's N/W path) may meet at least high consumer requirements (if not national law requirements as in the Smart Meter comm's case), which is comparable to home-banking application standards, due to the financial analogy. This advises strong data encryption and privacy, which should be administered and guaranteed by the El.-SP or an approved regional or national .authority. Comm's protocols between the DR-Adapter/Router and the White & Red Ware are predominantly of the low cost type, like wired ones or wireless ones ZigBee®, Z-Wave®, KNX® etc. Data security and encryption requirements are moderate, since a practical local security (symmetrical password, e.g. like Bluetooth®) should be regarded as sufficient, implying the consent of the consumer and the limited possible access to the DR-Adapter/Router control-software part via this I/F. Important to note is the limited independence of the generic operation of the Home-DR system, when communication links are temporarily down or not activated, since the DR-Adapter/Router may offer a "best practice" offline-mode, which may be pre-programmed by the El.-SP to avoid regular peak pricing consumption.

5.3.1.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Electric Network SP	Service Provider		Is responsible for the residential homes (smart) metering. Depending on local laws. This yields also the advantage that the branching from the residential homes primary power supply can be utilised in front of the homes fuse box, even from the outside, if the electricity is delivered above ground via poles.
Telco Operator	Operator		Will provide the public wireless data service (2G/3G/4G or private wireless data service) to the DR adaptor/GW while meeting the high consumer requirements. Will provide communication N/W of low cost such as wired or wireless such as ZigBee® and Z-Waves® etc. Data security and encryption requirement are moderate in this part of communication N/W.
DR SP			Providing DR services through their DR communication N/W which is independent of that of smart metering communication N/W.
Electricity-SP (El.-SP)	Service Provider		Receives LV-Grid capability, control and pricing information from the Local El.-N/W-SP. Electricity SP may provide DR services.

5.3.1.4 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML
 Figure 5.3.1

5.3.2 Home Energy Management (HEM)

5.3.2.1 Scope and Objectives of Use Case

Scope and Objectives of Function
It consists of sending energy information from the electrical home network to an energy gateway. The energy gateway communicates the electrical data information to an energy platform (M2M) for aggregating and processing the data. Services are developed from this data collection and sent to either the end users equipment or Business to Business market.

5.3.2.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
It manages the energy consumption at home so that consumers can be aware of their daily home energy consumptions and also be able to command the evolution of this consumption by remote actions on home appliances.
Complete description
This use case focuses on home energy gateway Performs a first step in the treatment of data received from various sources (sensors, context): aggregating the data in order to obtain processable information • Processes the obtained information: - sending some information to the remote service platform e.g. sending alerts through the operator platform - using some information locally for immediate activation of some actuators/appliances • Is connected (wirelessly or via wireline) to home devices, including the home electrical meter, for information on global or individual consumption of the appliances • Provides displayable consumed energy-related information to the end-user terminals (PC, mobile phone, tablet, TC screen, etc.)

5.3.2.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Consumers	Person		• Reporting consumption via a web portal which allows to follow the consumption, observe peaks, and better understand the impact and eco-responsibility. • Modifying energy consumption according to information from service provider e.g. Load management discouraging non-essential usage during peak hours. • Comparison of consumption: Within a secure & privacy network, neighbours or friends with similar homes can create a social network around the energy. • Fault detection: when a peak appears the user can detect which home equipment is responsible to the event, avoid damage and then troubleshoot it quickly. • Real time Alerting : raise alerts remotely possibly by sms on the mobile in case of fault or failure at home.

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Service provider	Business		• Deployment of sensor networks for third parties: to measure the electrical information, (and also air quality, humidity, pollution) and send that information to partners. • Ability to share anonymous data with energy partners: provide special fares via partnership with energy players. • Connecting Smart meters e.g. providing AMI (Advanced Metering Infrastructure). • Provide a secure remote access to home for partners: example DSOs to operate remotely in case of failure. This access need to be compliant with Data Privacy & Data Protection requirements, directive. • Provide an energy gateway specifically to collect & transmit securely « energy information (electricity, water, or gas)".
Telco operator	Communication		• Any equipment could be connected to the gateway via any protocol (ZigBee®, Bluetooth®, PLC…). • Ensure a secure transport of energy data. • Provide enough privacy mechanism to allow end to end energy services in respect of applicable regulations. • Provide privacy: depending on the level of privacy required (Data considered "personal" or not) and user consent the information could be stored either on the energy gateway or in the remote platform.

5.3.2.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Privacy in the telco communication sector	Privacy: depending on the level of privacy required the information could be stored either on the energy gateway or in the remote platform. • If Personal data is involved: access to such data should be secure and under user control, unless user opts out or, gives explicit consent to access the data to an entity for a specific purpose, or national security/emergency is compromised. • Data may be aggregated, and made anonymous and then transmitted and shared securely.	

5.3.2.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

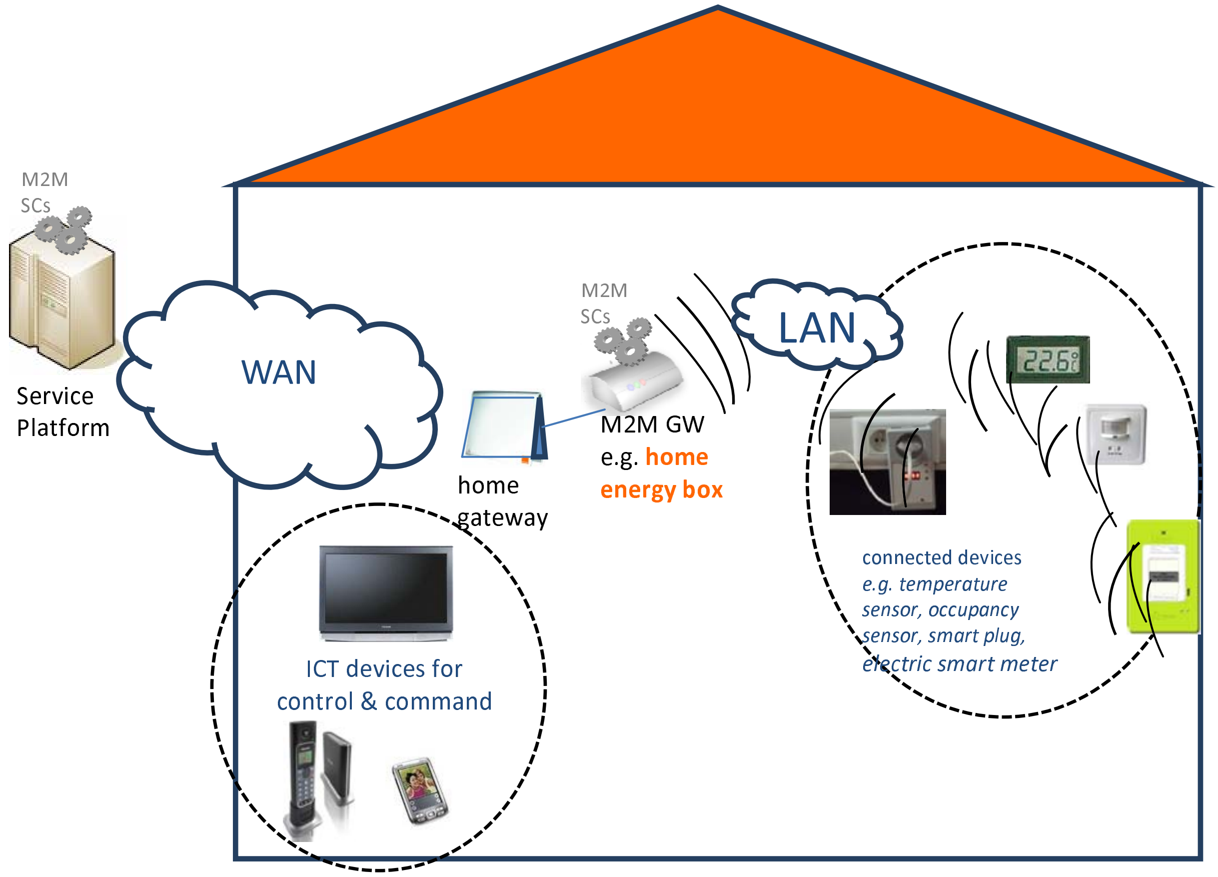


Figure 5.3.2

5.3.3 Submetering

5.3.3.1 Scope and Objectives of Use Case

Scope and Objectives of Function
This function allows landlords, property management firms, condominium associations, homeowners, association, and other multi-tenant property to bill tenants for individual measured utility usage The approach makes use of individual meters. This is typically used in situations where the local utility cannot or will not individually meter the utility in questions. This is often the case due to the fact that utility companies are often reluctant to take on metering individual spaces due to the fact that rental space tenants tend to be more transient and are more difficult to collect from. Furthermore, By billing only the owner, they can place liens on real property if not paid (as opposed to tenants the utilities also generally prefer not to have meters beyond their easement (i.e. the property boundary), since repairs to a service line would be before the meter and could be of less concern to a property owner. Other reasons include difficulty in getting access to meters for reading.

5.3.3.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
This is a residential application that allows a multi-tenant property to be bill individual units in the event that the utility has installed a single meter for the entire property. This allows better allocation of rental costs per unit. And shifting costs to tenants
Complete description
In this use case, each unit in a multi-tenant unit gets a private meter that allows the property owner to read the individual consumption for every unit. The property in this case has a master meter that belongs to the utility and the property owner is billed based on the master meter. The property owner manages the individual meters in the individual units. And can bill each tenant according to his own consumption The individual meters can be read using Automatic Meter Reading (AMR). This technology is used to get from meter reading to billing by an automated electronic means. This can be by hand held computers that collect data using touch wands, walk or drive-by radio, fixed network systems where the meter has a transmitter or transceiver that sends the data to a central location, or transmission via WI-FI, cellular, or internet connection.

5.3.3.3 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actor Name Selection List	Actor Type Selection List	Actor Description Selection List	Further information specific to this Use Case
Consumer	Person		Users of electricity in individual units
Consumer	Person or property management firm		Uses of electricity for the entire unit who have to collect individual readings from each unit equipped with a meter

5.3.3.4 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
Audit issues	No data privacy in collection	Some regulations require landlords to provide third party energy audit to validate rent charges related to sub metering costs. Some regulations may also guide eviction notices related to unpaid rent that can be traced to submetering expenses.

5.3.3.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML
Not Applicable

5.3.4 Smart Grid/Metering Service Layer

5.3.4.1 Use Scope and Objectives of Use Case

Scope and Objectives of Function
The CEN/CENELEC/ETSI SMCG functional reference architecture for smart metering systems (V0.4.3) contains two optional functional entities 1) The Local Network Access Point (LNAP) and 2) The Neighbourhood Network Access Point (NNAP) These optional and other mandatory functional entities may be mapped to functional entitles in various communication networks. This use case describes a number of deployment scenarios that may influence the system designer on the use of if these optional functional entities and the choice of communications technology for the Wide Area Network (WAN) and Home Area Network (HAN) It is assumed that for Smart Grid, similar reference architecture will be developed that at least for Customer Domain will reuse the same functional entities.

5.3.4.2 Narrative of Use Case

Narrative of Use Case
Short description - max. 3 sentences
Optional and the mandatory functional entities may be mapped to functional entitles in various communication networks.
Complete description

Communications Technology	Central communication system / AMI Head End System (HES)	Local Network Access Point (LNAP)	Neighbourhood Network Access Point (NNAP)	Metering end devices	Home automation	Consumer external displays
E-UTRAN/GERAN/UTRAN/ GPRS/SMS [i.2]	Message centre	Home Base station	Macro Base station	Coms module	Coms module	Coms module
Long Range Radio (LRR) [i.3]	Network Access Point	Communications Hub	Base station	Coms module	Coms module	Coms module
TISPAN NGN [i.4]		Customer Network Gateway (CNG)	Access Node	Coms module	Coms module	Coms module
802.11 Wi-Fi [i.8]		Access Point (AP)		Coms module	Coms module	Coms module
802.16 WiMAX [i.9]						
ZigBee® **[i.6]**						
PLC						

Narrative of Use Case
Short description - max. 3 sentences
Scenario1: Devices in Hard to reach locations from the perspective of the WAN provider
Complete description
The most convenient location chosen by the householder/HAN Service Provider for the Home Gateway in Figure 5.3.3 (Home Energy Use Case Architecture overview) may make it hard to reach from the WAN provider's infrastructure. One possible architectural option is for 'direct-to-meter' for these hard to reach locations [Interface G1and C]. This will require a WAN module in the meter itself configured in a way that allows the battery life requirement of, for example, BS EN 62055-31, clause 5.11.2 and Annex D [i.5] to be met.

Narrative of Use Case
Short description - max. 3 sentences
Scenario 2: In Home Displays a long distance from meter e.g. meters at the end of long gardens or top floor flats with meters in the basement
Complete description
For some meter types e.g. water meters, the location may be at the end of a long garden. While the direct to meter WAN connection will address part of this scenario, the HAN connection to the In Home Display (IHD) may still be problematic for some technologies. A possible solution to this 'meter at the end of the garden' issue would be a direct-to-meter wireless solution with the frequency band optimised for distance and building penetration. The same technology would then be used to send updates to the IHD inside the property. If say e.g. ZigBee® [i.6], is used at these distances, then data can hop through the ZigBee® MESH. Also for some meter types, a high rise dwelling may also be problematic, as meters are generally located in the basements of such buildings. While the direct to meter WAN connection will address part of this scenario, the HAN connection to the In Home Display may still be problematic for some technologies Again, a possible solution to this ‘meter in a basement' issue would be a direct-to-meter wireless solution with the frequency band optimised for distance and building penetration. The same technology would then be used to send updates to the IHD in the flat at the top of the property. If say e.g. ZigBee®, is used at these distances, then data can hop through the ZigBee® MESH. The use of hard-wired connections to the IHD may also need to be considered for some property types.

Narrative of Use Case
Short description - max. 3 sentences
Scenario 3: Devices in close Proximity
Complete description
When the devices in the home are in close proximity, the technology used on local interfaces is likely to be ZigBee®. However, Power Line Communications (PLC) could be used to provide wired HAN connections, [interface M] However, SE2.0 is adopted by PLC as well as RF associations to provide a wide range of media choice - Homeplug, ZigBee®, Wi-Fi etc. NOTE: ZigBee® SE1.1 & SEP2.0 are both specifications for Smart Energy but based on different communications models and application frameworks. SE1.1 is a ZigBee® specification using the ZigBee® network layer and SE1.x application profile. SEP2.0 is an industry specification shared with WiFi Alliance™, HomePlug® and other alliances and is based on an IP network layer and CIM application data model. The ZigBee® website has a good overview of the differences [i.10] and [i.11].

Narrative of Use Case
Short description - max. 3 sentences
Scenario 4: Meter is for Electricity
Complete description
COSEM [i.7] is likely to be adopted for electricity communications in the UK. NOTE: While DLSM/COSEM may be adopted for the UK, there are other equivalent protocols and data models that are appropriate as well and currently already used in various countries. In the UK, the HAN 'M' interface may require standardisation of the electrical interface such as KNX®, LonWorks® or ZigBee® supporting a DLMS/COSEM stack on top. However, this is currently not a requirement outside of the UK.

Existing protocols such as DLMS/COSEM, C.12 or OSGP may be used to collect metering data and replicate it in concentrator nodes, or to propagate data updates and notifications from concentrator nodes to meters. The concentrator usually stores data in the form of XML structures and data tables which are read and manipulated by the utility back-end IT systems. Such communication typically uses leased lines, DSL lines or GPRS. Different back-end IT systems may read and access different tables, therefore selective data access is a desirable feature of these protocols. However, at present, back-end to concentrator communications uses proprietary protocols, as standard protocols are not defined for such use. A protocol is therefore required that:

- Enables real-time bidirectional communication between an IT back-end and concentrators
- Is capable to transport XML documents, or any table formatted data structure, and provide selective read-write access to these structures
- Is capable of providing selective read/write access to data structures, and selective subscribe/notify primitives
- Secure, i.e. cryptographically protected, and authenticated

Narrative of Use Case
Short description - max. 3 sentences
Scenario 5: Meter is for Gas
Complete description
Likely to be implemented with ZigBee® SEP1.1+ to the communications hub and tunnelled over the WAN wireless technology.

5.3.4.3 Issues: Legal Contracts, Legal Regulations, Constraints and others

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
The Smart Grid security threats, and then security requirements, depending on which domain is looked at: either the "energy domain", which is the domain situated "before" the smart meter (i.e. energy production, transport and distribution), or the "home domain", which is situated "after" the smart meter (i.e. within homes). Therefore preventing future security breaches differentiation between the both domains should be performed	Customer Domain service and security profiles: Concerning its connectivity, in the Customer Domain • The customer has final control and responsibility, no sufficient protection from misuse is possible. - There is direct customer access to infrastructure possible - There is guarantee on the delivery of the service dependable on SLA, if managed - There is service dependant variable reliability level - There is service dependant variable security level. Customer may decide how to protect his ▪ confidentiality, ▪ data authenticity, ▪ data integrity and ▪ Privacy. • Signature or authentication or encryption is optional • There is a transfer time ≤ 10 s for command and alarm signals • There is a transfer time ≤ 5 min for energy measuring, supply management • There is Connection/disconnection of single loads typically < 3 kW (see note)	
NOTE: Maximum power consumption of typical household appliances.		

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
The Smart Grid security threats, and then security requirements, depending on which domain is looked at: either the "energy domain", which is the domain situated "before" the smart meter (i.e. energy production, transport and distribution), or the "home domain", which is situated "after" the smart meter (i.e. within homes). Therefore preventing future security breaches differentiation between the both domains should be performed	Concerning its connectivity, in the smart metering/smart grid Energy Domain. • There is high sensitive responsibility for successful delivery. To meet this responsibility, management of this domain should be mandatory and fixed SLAs, together with possible contractual penalties should accompany such responsibility. • Due to the danger of potential attacks against the energy network, with the effect of destabilizing it: - there should be a guarantee on undisturbed operation without danger of tampering of exchanged data, intrusion or blocking of the service - There should be high to very high reliability level - There should be no physical interconnection to the home automation domain due to the potential attacks made possible in case of available interconnection. ▪ To make the white goods manageable, customer access could be performed securely via web services through third party services over Internet (using e.g. HTTPS) ▪ Local unidirectional wireless meter readout could be made possible (SRD Band) • To protect confidentiality and authenticity, signature and authentication and encryption should be mandatory • There may be a secure actor contact to start and stop decentralized generation • There should be a Transfer time ≤ 2 s for command control, load shedding and peak shaving • There should be a Connection/disconnection of single loads typically > 100 kW (see note)	
NOTE: Typical power consumption of devices with noticeable net impact.		

Issue - here specific ones	Impact of Issue on Use Case	Reference - law, standard, others
There may be an impact on the ETSI Machine- to- Machine communications (M2M); Functional architecture (Release 1) TS 102 690 [i.24]	1) Metering end devices, Local Network Access Point (LNAP), Home automation and consumer displays may need to be addressed as a simultaneously as group using secure messaging 2) Acknowledgments to simultaneous group messages may need to be processed using the Store and Forward functionality specified in TS 102 690 [i.24] 3) The M2M service layer may need to support hop by hop through communication technologies e.g. the ZigBee® MESH. 4) Integrity validation may need to be supported in the M2M gateway and NSCL 5) M2M service layer security may need to be bootstrapped from both HAN and WAN access network credentials	TS 102 690 [i.24]

5.3.4.4 Referenced Standards and / or Standardization Committees (if available)

Relevant Standardization Committees	Standards supporting the Use Case	Standard Status
CEN/CENELEC/ETSI SMCG	[i.1] CEN-CENELEC-ETSI TR 50572 "Functional reference architecture for communications in smart metering systems"	Published
3GPP	[i.2] http://www.3gpp.org/	In development
ETSI	[i.3] http://sensus.co.uk/documents/10303/259817/UK-licensing-brochure.pdf	In development
ETSI	[i.4] http://portal.etsi.org/portal/server.pt/community/TISPAN/339	In development
IEC	[i.5] http://webstore.iec.ch/preview/info_iec62055-31%7Bed1.0%7Den.pdf	
ETSI	[i.6] http://www.zigbee.org/	In development
IEC	[i.7] Companion Specification for Energy Metering IEC 62056-21, IEC 62056-42, IEC 62056-46, IEC 62056-47, IEC 62056-53, IEC 62056-61, IEC 62056-62	
IEEE	[i.8] http://standards.ieee.org/develop/project/802.11.html	
IEEE	[i.9] http://standards.ieee.org/develop/project/802.16.html	
ETSI	[i.10] http://www.zigbee.org/Standards/ZigBeeSmartEnergy/Overview.aspx	In development
ETSI	[i.11] http://www.zigbee.org/Standards/ZigBeeSmartEnergy/Version20Documents.aspx.	In development
CEN/CENELEC/ETSI Joint Working Group	[i.12] Final report of the CEN/CENELEC/ETSI Joint Working Group on Standards for Smart Grids, 04 May 2011	
NIST	[i.13] NIST Special Publication 1108, NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0	
ANSI	[i.14] http://www.nema.org/Standards/Pages/American-National-Standard-for-Utility-Industry-End-Device-Data-Tables.aspx	
ETSI	[i.15] http://portal.etsi.org/portal/server.pt/community/OSG/355	
IEEE	[i.16] http://standards.ieee.org/develop/project/1377.html	

5.3.4.5 Drawing or Diagram of Use Case

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

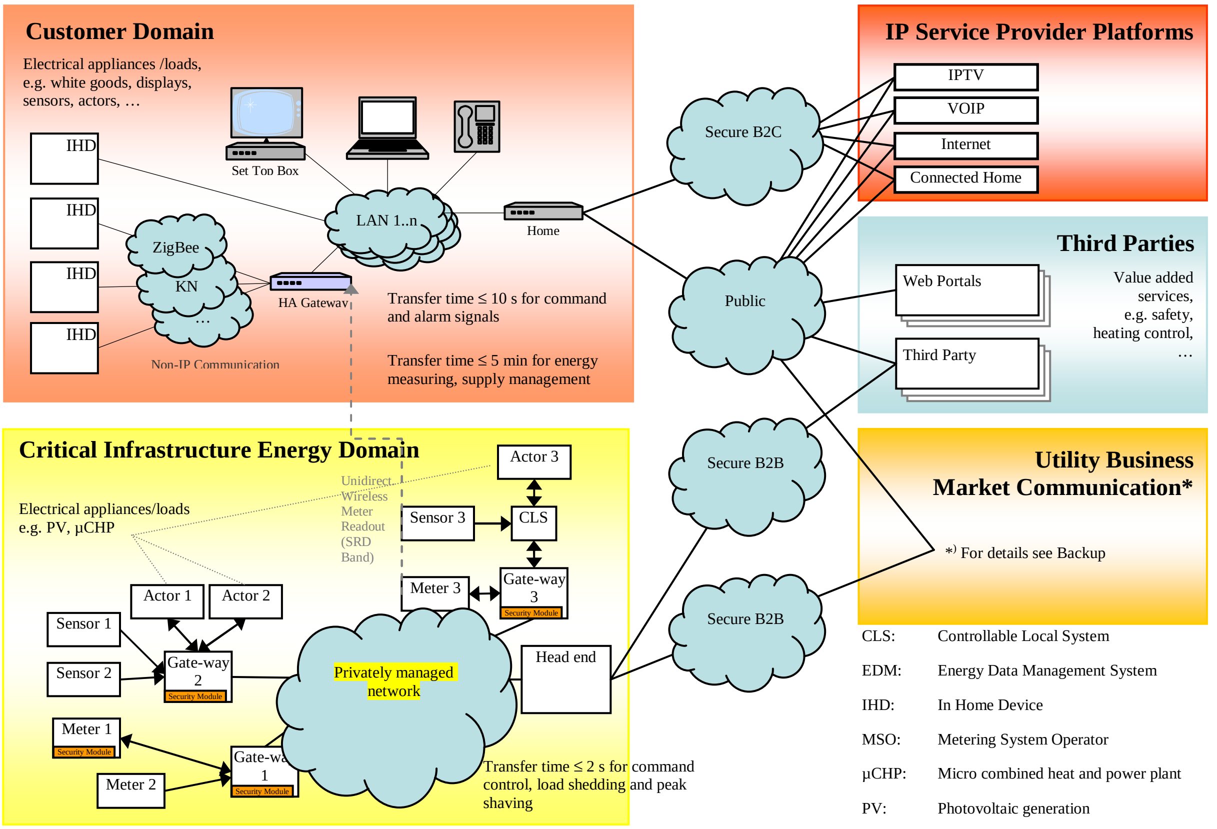


Figure 5.3.3: Displaying Regular Utility Business Market Communications in context of smart

Drawing or Diagram of Use Case - recommended "context diagram" and "sequence diagram" in UML

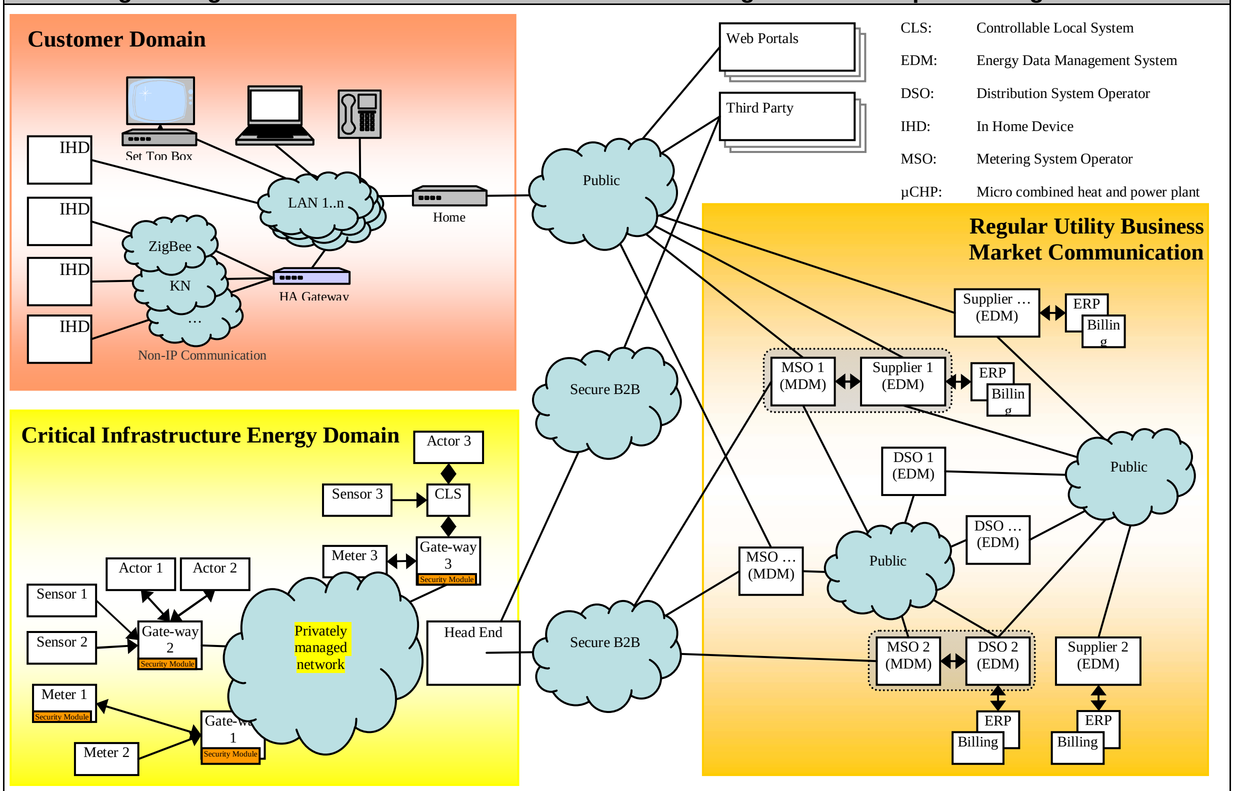


Figure 5.3.4: Metering/smart grid and home automation domain in more detail

Impact on TS 102 690 [i.24]:

- Metering end devices, Local Network Access Point (LNAP), Home automation and consumer displays may need to be addressed as a simultaneously as group using secure messaging.
- Acknowledgments to simultaneous group messages may need to be processed using the Store and Forward functionality specified in TS 102 690 [i.24].
- The M2M service layer may need to support hop by hop through communication technologies e.g. the ZigBee® MESH.
- Integrity validation may need to be supported in the M2M gateway and NSCL.
- M2M service layer security may need to be bootstrapped from both HAN and WAN access network credentials.

6 Applicability of M2M architecture to Smart Grids

This clause describes one way to use M2M architecture to Smart grid networks. The Smart grid is composed of 3 plans with the functions described in clause 4.1, figure 6.1 shows the 3 main domains of applicability:

1) **Energy Layer** needs at least sensors all over the four main block of energy (production, distribution, transmission and consumption). Amongst those sensors could be the M2M devices (i.e. smart meters) specified for this energy plan. Those sensors could be deployed as a pool of M2M device and related to an energy gateway (i.e. M2M gateway). **The migration of Smart meter to Smart grids needs to be further analysed and studied.**

2) **Control and Connectivity Layer** provides control function and connectivity to the energy, service Layer. The M2M core and the M2M capabilities specified in ETSI could provide this functionality especially the coverage and accessibility (i.e. GSM, any IP network), quality of service (i.e. policy control), security (i.e. NSEC and GSEC), privacy (i.e. Device authentication, confidential addressing with NRAR) and reliability (high availability of network infrastructure). **The match of a M2M core network and M2M capabilities need further study for impacts.**

3) **Service Layer** provides all services related to the Smart grids use, and a M2M Application server with sufficient APIs for Smart grids network is applicable. **Hence, an M2M platform is relevant to be incorporated to Smart grids networks and further impact need to be further studied.**

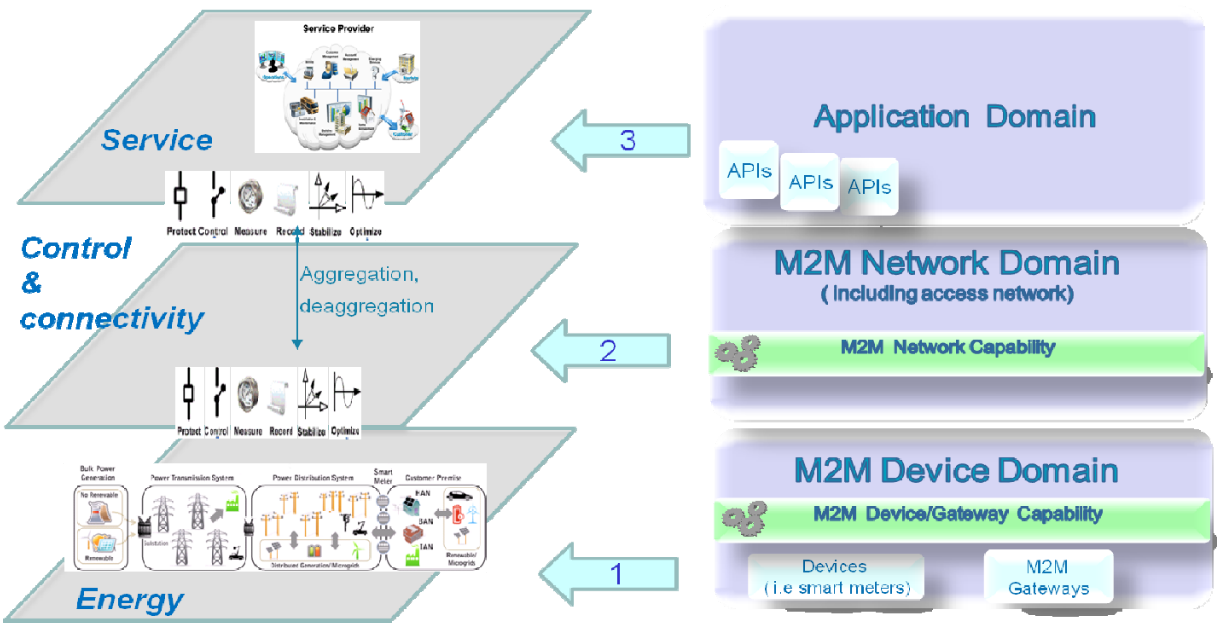


Figure 6.1: Smart grids concepts & M2M architecture

This clause describes the initial interaction within ETSI TCs regarding the Smart grids activities such as Internet Of Thinks, grids, etc.

7 Proposed New Requirements

7.1 Service Layer Security Requirements

Context of the use case:

The Smart Grid has security threats, and then security requirements, depending on which domain is looked at: either the "energy domain", which is the domain situated "before" the smart meter (i.e. energy production, transport and distribution), or the "home domain" (or "consumer domain"), which is situated "after" the smart meter (i.e. within homes). Therefore preventing future security breaches differentiation between both domains should be performed.

Customer Domain service and security profiles:

Concerning its connectivity, in the Customer Domain:

- The customer has final control and responsibility, no sufficient protection from misuse is possible:
  - There is direct customer access to infrastructure possible.
  - There is guarantee on the delivery of the service dependable on SLA, if managed.
  - There is service dependant variable reliability level.
  - There is service dependant variable security level. Customers may decide how to protect their:
    - confidentiality;
    - data authenticity;
    - data integrity; and
    - privacy which requires control over personal data and information transferred outside the customer domain.
- A standardized applicative framework should be available in the customer domain (e.g. on smart meter or gateway), providing functionalities for secure remote download, installation, execution and deletion of third-party applications, and ensuring respect of confidentiality of code and data between independent service providers.
- Signature or authentication or encryption is optional.
- There is a transfer time ≤ 10 s for command and alarm signals.
- There is a transfer time ≤ 5 min for energy measuring, supply management.
- There is Connection/disconnection of single loads typically < 3 kW.

NOTE: Maximum power consumption of typical household appliances.

7.2 Energy Layer Security Requirements

Concerning its connectivity, in the smart metering/smart grid Energy Domain:

- There is high sensitive responsibility for successful delivery. To meet this responsibility, management of this domain should be mandatory and fixed SLAs, together with possible contractual penalties should accompany such responsibility.

- Due to the danger of potential attacks against the energy network, with the effect of destabilizing it:
  - There should be a guarantee on undisturbed operation without danger of tampering of exchanged data, intrusion or blocking of the service.
  - There should be high to very high reliability level.
  - There should be no physical interconnection to the home automation domain due to the potential attacks made possible in case of available interconnection:
    - To make the white goods manageable, customer access could be performed securely via web services through third party services over Internet (using e.g. HTTPS).
    - Local unidirectional wireless meter readout could be made possible (SRD Band).
- To protect confidentiality and authenticity, signature and authentication and encryption should be mandatory.
- There may be a secure actor contact to start and stop decentralized generation.
- There should be a Transfer time ≤2 s for command control, load shedding and peak shaving.
- There should be a Connection/disconnection of single loads typically > 100 kW.

NOTE: Typical power consumption of devices with noticeable net impact.

7.3 Energy Layer Requirements

Use cases below in the Energy layer:

- Electric Vehicle charging and Power feed
- DER, DR/Microgrid Control

Have generated potential protocol requirements that:

- Enables real-time bidirectional communication between an IT back-end and injection/consumption points, in the potential presence of NAT.
- Is capable to transport XML documents, or opaque data structure, and provide selective read-write access to these structures.
- Is capable of providing selective read/write access to data structures, and selective subscribe/notify primitives.
- Is capable of interfacing with legacy industrial, building and automation control protocols.
- Secure , i.e. cryptographically protected, and authenticated.

7.4 Service Layer Requirements

Use cases:

"Meter for Electricity" and "Device in Close Proximity" have generated potential requirements which are listed below:

- Enables real-time bidirectional communication between an IT back-end and injection/consumption points, in the potential presence of NAT.
- Is capable to transport XML documents, or opaque data structure, and provide selective read-write access to these structures.
- Is capable of providing selective read/write access to data structures, and selective subscribe/notify primitives.
- Is capable of interfacing with legacy industrial, building and automation control protocols.
- Secure, i.e. cryptographically protected, and authenticated.

8 Recommendations for future work

This clause describes relevant recommendation for future work in ETSI M2M related to Smart grids.

8.1 ETSI

Include requirements identified in clause 7 into the appropriate TS in M2M.

Maintaining co-ordination between Smart Grid M/490 [i.17] and Smart Metering M/441 [i.20].

8.2 Input to External Organisations

More uses cases specifically referencing communication layers i.e. M2M architecture is needed for SG-CG sustainable process report.

Annex A: Bibliography

ETSI TS 102 689 (V1.1.1): "Machine- to- Machine communications (M2M); M2M Service Requirements".

History

Document history		
V2.1.1	September 2012	Publication