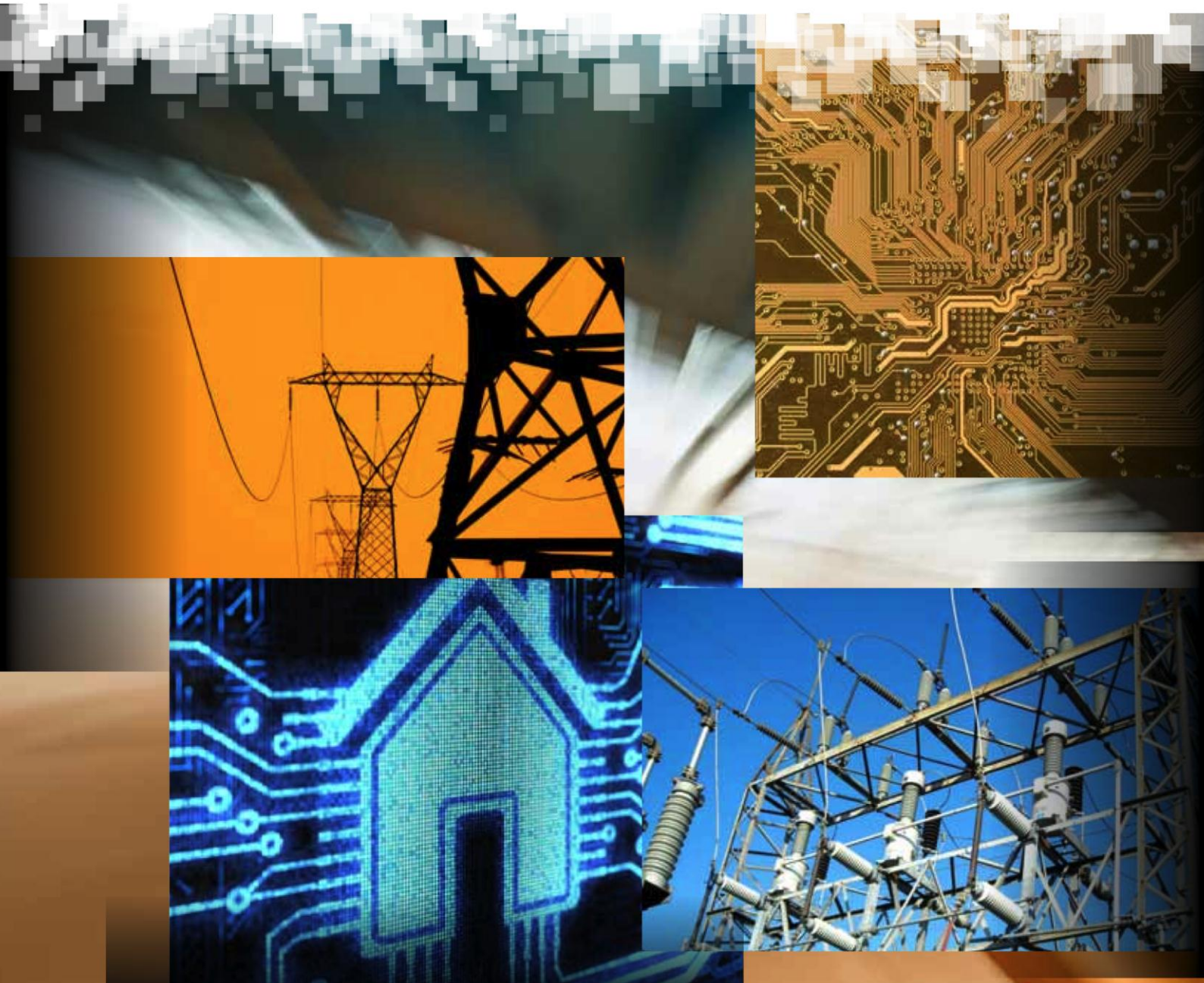
Utilities

Home Energy Gateway Requirements

Release 1
October 2011



Embedded Mobile Utilities Work Stream
Home Energy Gateway Requirements
October 2011

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1 Introduction

1.1 Overview

This document has been created by the GSMA Embedded Mobile Utilities work stream. It discusses requirements for a "home energy gateway", which will be used to create a home area network for the delivery of home energy management (HEM) services, home monitoring and control, demand response, and other innovative future services.

Home energy management systems are deployed in order to provide greater visibility into residential energy consumption patterns and enable more sophisticated energy management capabilities, such as remote control of home appliances and other connected devices. HEM systems can complement advanced metering infrastructure (AMI), or be installed independently. An home energy gateway device is an essential component to support the monitoring and control functionality for all devices connected via short-range technologies.

The purpose of this paper is to define the architecture and key requirements of the embedded mobile home energy gateway device. This paper aims to define the role that will be played by mobile network operators (MNOs) in the delivery of smart home services, establish a home gateway as an open platform that encourages the creation of new energy management services and applications, and provide design guidance to set-top box manufactures and ODMs, thus facilitating the deployment of large-scale home energy management services by MNOs and third party providers.

A further intent is to facilitate the creation of common standards and processes for managing the flows of data on energy consumption, and to prevent fragmentation across the industry.

This is the first release of the Home Energy Gateway Requirements. Further updates of the requirements might be necessary, as the market for home energy management matures.

1.2 Problem Statement

Connected devices are on a strong growth trajectory, but the market for home automation and HEM services is currently highly fragmented. The majority of the existing solutions are bespoke, and are based on proprietary protocols and technologies. The resulting complexity and high cost inhibit end-user choice and create a barrier to the mass market adoption of smart home services and applications.

Many of the existing home automation and home energy management systems are controlled from proprietary gateways. The ability to share data between such systems is limited, creating a barrier to the development of innovative new services and applications.

Some initial discussions about establishing open common APIs are starting to take place in the home automation industry. However, in order to encourage innovation in the smart home sector, there is a need for an open platform to host and manage energy consumption data, channelling readings from embedded sensors in a variety of home appliances to end-users and to third parties. The establishment of such an open platform would further incentivise home automation systems companies to leverage its capabilities and evolve towards a more open system approach.

A set of requirements for such an open platform, agreed upon by the mobile industry, will enable the development of affordable embedded mobile home gateways for the mass market.

1.3 Approval

This document has been formally approved by the Smart Utilities working group (GSMA Embedded Mobile Programme).

1.4 Scope

Two types of home gateway devices currently exist on the market. A "regulated" gateway is owned by the utilities companies and is part of utilities infrastructure. An "unregulated" gateway is owned by telcos, or third party service providers; it is used for the monitoring and control of home energy management devices, and acts as a broadband/Internet access point for various smart home devices/appliances. Such gateways may or may not be co-located with a home broadband gateway and smart meter.

This document:

- Establishes a reference architecture for the home gateway,
- Outlines major use cases and establishes the role of MNOs in the smart home,
- Defines the requirements for functionality, interfaces and security around the residential home energy gateway. The focus of this white paper is on the “unregulated” gateway, however, the majority of the requirements for “unregulated” and “regulated” home gateways will be similar.

The requirements for smart meters and building automation systems are out of scope of this document.

1.5 Definition of Terms

The table below will be extended to define various Smart Energy and Home Energy Management terms.

Term	Description
AMI (advanced metering infrastructure)	Infrastructure consisting of advanced metering hardware and software to measure, collect and analyse energy usage and related information.
Demand response	Management of customer consumption based on supply conditions and/or the energy price.
Embedded Mobile	Used to denote combinations of devices and services, supported by an embedded 3GPP network access capability, which have not traditionally been considered mainstream mobile network devices. Mobile connected cameras, automobiles and laptop computers are examples.
EMP (Embedded Mobile Programme)	The GSMA’s Embedded Mobile Programme
Home Automation End Device	Device with additional functionalities enabling consumers to interact with their home environment.
Head End System	Central Data System collecting data from meters in its service area via the AMI. It communicates directly with the meters via a WAN.
Home Energy Management Gateway	Device/hub connecting smart meters, displays and home automation end-devices to the Internet.

Home Energy Management System	Consists of a control gateway/hub and end-devices.
Load Control	Adjustment of energy, hot water and domestic appliance consumption based on variations in the daily/seasonal cost of power and grid load.
M2M	Machine to Machine, normally applied to services, such as utility metering, in which a traditional user or user interface isn't involved. Such services are expected to operate on a stand-alone basis and physical access by MNOs and service providers is often limited.
SEP (Smart Energy Profile) 2.0	Smart Energy Profile 2.0 is a specification for IP-based control of advanced metering infrastructure and home area networks, developed by the ZigBee Alliance. In addition to all devices and services supported by SEP version 1, SEP 2.0 will feature control of plug-in electric vehicles (PEV), charging, installation, configuration and firmware download for HAN devices, prepay services, user information and messaging, load control, demand response and common information and application profile interfaces for wired and wireless HANs.
Smart Meter	Meter with data communication functionality.
Subscription	Describes the commercial relationship between the subscriber and the service provider.
UPnP	Software to support in-home media sharing among consumer devices, and home device discovery. UPnP also offers local management functionalities using UPnP DM(Device Management)

1.6 Document Cross-References

Ref	Document Number	Title
1	ISO/IEC 15045	Residential Gateway, Part 1: A Residential gateway model for HES Part 2: Modularity and Protocol
2	ISO/IEC 18012	Home Electronic System – Guidelines for Interoperability
3	ISO/IEC 29104	Home Electronic System – Residential gateway, Part 2: Modularity and protocol (JTC 1/SC 25 N 1733) – to be finalised on 31-12-2011
4	ETSI TS 102 689	ETSI M2M Service Requirements
5	ETSI TS 102 690	ETSI M2M Functional Architecture
6	HGI-RWD017-R3	Home Gateway Initiative – Requirements for Home Energy Management and Control Service
7	HGI-RD008-R3	Requirements for Software Execution Environment
8	CENELEC/CEN - EN 50090	Home and Building Electronic Systems (HBES, KNX) prTS 50090-6-4: Residential gateway model for a home and building

Ref	Document Number	Title
9	CENELEC/CEN - EN 50491 series	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS).
10	GSMA white paper	Embedded Mobile Guidelines – Release 2, March 2011
11	IEEE P1901-2010	IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications
12	ITU G.9660	G.hn: Unified high-speed wire-line based home networking transceivers - System architecture and physical layer specification
13	ITU G.9661	G.hn Unified high-speed wire-line based home networking transceivers - Data link layer specification
14	ITU G.9955 (draft)	G.hnem: Narrow-band OFDM power line communication transceivers - Physical layer specification
15	ITU G.9956 (draft)	G.hnem: Narrow-band OFDM power line communication transceivers – Data link layer specification
16	IEEE P2030	Smart Grid Interoperability of Energy Technology and Information Technology Operation
17	TR-069	CPE WAN Management Protocol, Issue 1 Amendment 3. Broadband Forum, November 2010.

2 Home Gateway developments in the standards and industry bodies

Home gateway and home networking requirements are being developed in a number of standards and industry bodies, including CEN-CENELEC, ETSI, IEC, IEEE, ITU and the Home Gateway Initiative (HGI).

CEN/CENELEC

CEN/CENELEC developed the residential gateway model for a home and a building, as part of the Home and Building Electronic Systems, CENELEC/CEN - EN 50090 series and CENELEC/CEN - EN 50491 series.

CENELEC defines the home gateway as a residential set-top box, combined with a dedicated framework platform and multimedia home platform (MHP). It is an access box plus network-based "service gateway" (virtual gateway).

ETSI M2M Gateway

ETSI's M2M Converged Gateway is developed by ETSI TC m2m. The gateway is a standards-based M2M platform described in ETSI TS 102 690 – Functional architecture. It serves as a link between the "internal" home/enterprise capillary networks and the "external" access/core/transport networks.

The M2M Gateway belongs to the M2M device domain, defined as "Equipments using M2M Capabilities to ensure M2M Devices interworking and interconnection to the Network and Application Domain. The M2M Gateway may also run M2M applications. M2M Gateway functionality can be co-located with M2M Device(s).

"As an example, a M2M Gateway may implement local intelligence in order to activate automation processes resulting from the collection and treatment of various information sources (e.g. from sensors and contextual parameters)."

Service requirements pertaining to M2M Gateways are described in ETSI TS 102 689 M2M Service Requirements. ETSI TS 102 689 also lists use cases for home automation.

Work on API definition to map to the various LAN systems is ongoing.

Home Gateway Initiative (HGI)

The Home Gateway Initiative (HGI) is an industry forum of broadband service providers and home network equipment manufacturers. The HGI sets technical requirements for devices and services in the digital home, with a focus on home gateways and home networks. The HGI has produced requirements for home gateways including QoS, and software modularity (HGI HGI-RD008-R3) that can serve as a basis home energy management and other services.

The HGI is working on the requirements for a home energy gateway function. It has published a set of use cases for home energy management and control service (HEM). Associated requirements are an ongoing working item at the HGI. The HGI plans to finalise technical HEM requirements during 2011 and run the HGI test event in 2011/2012.

According to the HGI, the energy gateway may or may not be integrated within the home gateway: either in the broadband home gateway, a dedicated box or in relationship with the meter. The home energy gateway function communicates with a range of home devices, such as smart appliances, smart meters, and displays, as well as information portals in the cloud.

International Electrotechnical Commission (IEC)

The IEC SC25 Working Group1 developed a standard for a residential gateway (RG) as part of the work on the home electronic system (HES).

ISO/IEC 15045 defines the RG as a device in the HES that connects home network domains to network domains outside the house. It supports communication among devices within the premises and systems, service providers, operators and users outside the premises.

The RG enables service and content providers to deliver services, such as entertainment, video and broadband digital streams, monitoring for health care, security and occupancy, home appliance control and preventive maintenance, remote metering, and energy management. The RG specified by this standard does not imply the use of any particular protocol, such as IP, and it recognises that many forms of the RG will exist using many types of data, such as analogue video and broadband digital streams. However, when IP is used, requirements of this standard exclude IP6 and higher.

In addition to the standardisation of home gateway devices, work on home network interoperability is taking place in the IEEE and the ITU.

The IEEE - Convergent Digital Home Network Working Group: The IEEE 1905 working group is developing the first standard for hybrid home networks to simplify network setup by providing common setup procedures for adding devices, establishing secure links, implementing QoS and managing the network. A P1905 network will include combinations of stationary home networking devices, such as set-top boxes (STBs), home gateways, Blu-ray disc players and televisions, and mobile devices, such as laptops, tablets and mobile phones.

The IEEE P1905 standard will provide an abstraction layer to established powerline, wireless, coaxial cable and Ethernet home networking technologies; IEEE P1901/HomePlug AV, Wi-Fi, MoCA and Ethernet. The standard is designed to enable consumers and service providers to combine the capabilities of otherwise disparate networks to maximize a home network's overall performance and reliability. The IEEE P1905's abstraction layer common interface will allow applications and upper layer protocols to be agnostic to the underlying home networking technologies.

IEEE – P1901 is the Broadband Powerline Standard ratified on 30 September, 2010, defining a physical interface for powerline networks. It provides specifications for the HomePlug AV standard and Home Plug Green Phy (GP) standard, initially developed and published by the HomePlug Powerline Alliance. The HomePlug Green Phy standard is a sub-set of HomePlug AV standard, offering low-power design for smart grid systems on powerline.

ITU-T – G.hn (SG15. Home Network architecture): ITU-T's SG15 designed G.hn (G.9660 / G.9661) as a universal physical interface to integrate coax, power lines and Ethernet into a single physical network (on the same chipset).

ITU-T – G.hnem (SG 15 Home Network Architecture): ITU-T SG 15 designed G.hnem (G.9555 (draft) /G.9556 (draft) to facilitate PLC (power line carrier) networking.

3 Use Cases

This section describes the use cases for the embedded mobile home energy gateway.

No.	Use case clusters	Description
1	Core/primary utilities services: 1.1. Information	1.1.1. Current consumption: Provision of information to customers on their current consumption of electricity, water and gas, collected from smart meters, as well as smart home appliances and smart devices. Home owners access an information portal, associated with their home gateway, to view current consumption and status information for a variety of home appliances that are connected to the gateway. The information portal may be accessible via an interface on the home gateway or via an alternative device, such as a PC, tablet or smartphone. 1.1.2. Historical and statistical information on usage and costs. Homeowners are able to retrieve and view historical consumption data for one or more metered utility services. This data includes consumption amounts, as well as charges associated with all services that are linked to the home gateway. 1.1.3. Tariff information for prepaid and postpaid plans: In this use case, home owners can request information about tariffs for different connected utility services that are linked to their home gateway. Tariffs specific to a locality and the incumbent provider may be obtained by the user specifying a location or by the gateway automatically indicating its location. 1.1.4. Market information around prices for utilities services, and information on the incentives for energy efficiency. In this use case, home owners may search for and request tariff information from multiple providers and in each utility segment for their neighbourhood. Homeowners can also request information from consumer-advocacy and local government agencies about energy efficiency incentives. Both classes of information request may be enabled directly via the home gateway user interface or a linked PC/tablet/smartphone device
	1.2. End-User Control	1.2.1. Remote control of home appliances. Home owners can program their home gateway to control each of the connected devices associated with the gateway. Control functions may be implemented through pre-set rules (time-of-day, threshold or alarm driven etc.). They may also be implemented using remotely-issued commands delivered via a SMS message, for example, from the homeowner to change the home temperature setting, possibly overriding an existing control rule. 1.2.2. Prepayment for utilities services. In this use case, the home gateway functions as a pre-paid controller for individual utility services. In the case of electricity, for example, the home owner may have credited the household account. The gateway monitors ongoing consumption, sends alerts when certain thresholds are reached and then suspends electricity supply when the credit amount has been exhausted. The gateway user interface may allow the credit level to be topped-up directly. It may also include an emergency indicator to allow a certain level of over-consumption according to criteria set by the utility provider based on the homeowner's credit history.
	1.3. Utility Control	1.3.1. Demand response. For a homeowner who has enrolled in a demand response programme, the home gateway responds to control signals from the utility company to curtail the power being consumed by the household. Control is exerted over devices such as HVAC (heating, ventilation, air-conditioning), lights, pool pumps, appliances, etc. that are connected to the home gateway. In some situations, demand

No.	Use case clusters	Description
		response may be used to encourage consumption, or local storage, when the average load on the grid is sub-optimally low. 1.3.2. Load curtailment inquiry. This use case is similar to demand response. Homeowners are offered financial incentives to reduce their energy use when the utility provider determines it is needed. When the homeowner receives an advance notice of a price that is to their advantage, they can then pledge an energy reduction. The homeowner then takes steps to reduce his consumption, using the rule-based functions in the gateway, for example. Usage data is monitored via the home gateway to calculate the potential and actual reduction in use and to provide the information for any payment settlement. 1.3.3. Mobile provider switching. In this use case, a utility provider supplies the home gateway to its customers. The gateway is provided in a form where it has been provisioned on a particular mobile operator's network. At a later point in time, the utility can switch to a different mobile operator through a physical replacement of the card or through a remote switching command that implements the switching functionality in an embedded SIM. Other mechanisms for remote switching include roaming SIM/UICC, and the use of multiple UICCs on board. 1.3.4. Application, policy or configuration update. The utility provider uses an over-the-air command to modify or update applications, policies or configuration parameters in the home gateway. This functionality can be applied to the gateway itself and to suitably-configured connected devices linked to the gateway.
2	In-home energy production	2.1. Information for utilities. Homeowners with local electricity generation capabilities that are configured for feed-in to the grid will have this information monitored by the home gateway. The collection of this information, suitably protected by anti-fraud safeguards, is fed back to the utility for its accounting purposes. 2.2. Payment/settlement information for utilities. Payment or settlement information relating to a homeowner's consumption and feed-in to the grid is made available via the home gateway or via the interface of a related device. 2.3. Control of distributed renewable energy sources (solar, EV, wind) to manage network load. This use case is similar to the demand response use case, but it focuses on control over sources of renewable energy to manage feed-in loads and also to facilitate frequency regulation. 2.4. Control of distributed renewable energy sources in response to real-time prices. This use case is similar to load curtailment, but deals specifically with sources of renewable energy. 2.5. Emergency use case: Information about solar panels provided to third parties, such as fire-fighters in case of fire, to implement emergency shut-down. The home gateway in this scenario has an emergency mode of operation whereby key information relating to connected devices in the household can be made available to the emergency services in the case of a fire, for example. Key information may be relayed back to the utility provider or a specially-designated emergency services address based on local alarms (e.g. triggering of a fire alarm or home security alarm).
3	Electric vehicle services	3.1. EV charging infrastructure - EV charge control by EV owners. Households with an in-home charging station for an electric vehicle can have this charging station linked to the home gateway. This centralises the monitoring of usage information and control, in the case of demand management type applications. 3.2. EV charging infrastructure - Payment/settlement information for end-users. In this use case the home gateway and user interfaces handle payment and settlement information for electric vehicle charging. The configuration of this capability can be

No.	Use case clusters	Description
		more or less sophisticated depending on the quality of the home gateway. In complex scenarios, for example, the set-up should permit different accounts to be handled if the household has more than one car and if the household charging station is used by a visiting car. 3.3. EV charging control by utility. This use case is similar to the demand response use case, with the home gateway providing control over equipment related to electric vehicle charging.
4	Assisted Living services	Assisted living is one class of health applications that may involve the use of connected devices in the home. For more complex applications, the home gateway may act as an information aggregation point for multiple devices and sensors; this may be possible because of the on-board processing and data security capabilities in the gateway. The gateway could also permit information from multiple manufacturer sensors to be combined in order to deliver more complex or higher value services.
5	Security services	5.1. Remote monitoring of home security devices. In this use case, the home gateway forms a part of the home security system. It integrates inputs for different connected sensors, provides a user interface for configuration commands and includes a secure link (for example, fall-back modes to maximise the success rate in reporting alarms) to report any security-related incidents. 5.2. Automated control of home security devices. The home gateway, which forms a part of the home security system, provides a user interface and also hosts applications related to the configuration of the home security system.
6	Third party services	6.1. Third party access to the information on home smart devices. Smart devices in the home are likely be supplied by several different manufacturers. In this use case, the home gateway acts as an aggregation point for home area connectivity to different smart home devices, and provides access to the information about these devices to their manufacturers. This may be for the purpose of remote status monitoring and diagnostics as well as higher level applications. 6.2. Third party access to the home gateway to manage home smart devices via an energy management system. This use case variant allows the home gateway to have energy management control over smart devices from different manufacturers. This depends on standards for interoperability, as well as an agreed protocol to implement management and control functions over in-home devices. 6.3. A single home gateway for devices connected/serviced by different MNOs (e.g. MNO A for energy management, MNO B for security services). In this use case, the home gateway is capable of being partitioned or shared for the purpose of supporting services provisioned on multiple different mobile operator networks. An example of this could involve smart utility services supported on one operator network and electric vehicle services supported on a second operator's network. The service provider on each network must have full control over its connected devices. In the case of very similar applications, such as household energy and electric vehicles, for example, the gateway needs to facilitate cooperation across the multiple applications.

4 Smart Energy Home Role Definitions

This section defines the main roles in the delivery of Smart Energy services for domestic customers.

No.	Role	Description
1	Application provider	Provides variety of smart home applications, such as a web interface to display home energy usage.
2	Data management company	Collects meter and other device data for the utility company and/or energy retailer. May host and manage data on behalf of third parties.
3	Home gateway device manufacturer	Supplies embedded-mobile home gateway devices, communication hubs, in-home displays (IHD) and home appliance control panels.
4	Energy management company	Measures, monitors and controls energy consumption by end-users remotely. This could be the utility company or a third party.
5	End-user	Domestic consumer or prosumer of energy services.
6	Home appliance manufacturer	A manufacturer of home appliances and white goods, such as thermostats, refrigerators, washing machines or air conditioning units.
7	Home area network (HAN) provider	Provides communication services to their customers within the end-user home area.
8	Home energy management service provider	Offering home energy management services to the consumer. Interacts directly with the home automation end device.
9	Machine-to-Machine service provider (M2M SP)	A type of enterprise subscriber which provides machine-to-machine services for business customers and consumers.
10	Mobile network operator (MNO)	Provides communication services to their customers through wide area wireless networks.
11	Neighbourhood area network (NAN) provider	Provides neighbourhood network communication services.
12	Smart meter manufacturer	Supplies smart meters.
13	Utility company	Entity that offers contracts for the supply of energy to an end-user and bills the customer for the use of electricity. May also be referred to as a supplier or a retailer.
14	Wireless wide area network provider (WWAN)	Provides wireless WAN connectivity between home premises. Typically an MNO.

5 High Level Architecture

This section describes the high-level architecture for an home energy gateway.

5.1. Connected Home Architecture

We make a distinction between two types of energy management gateways:

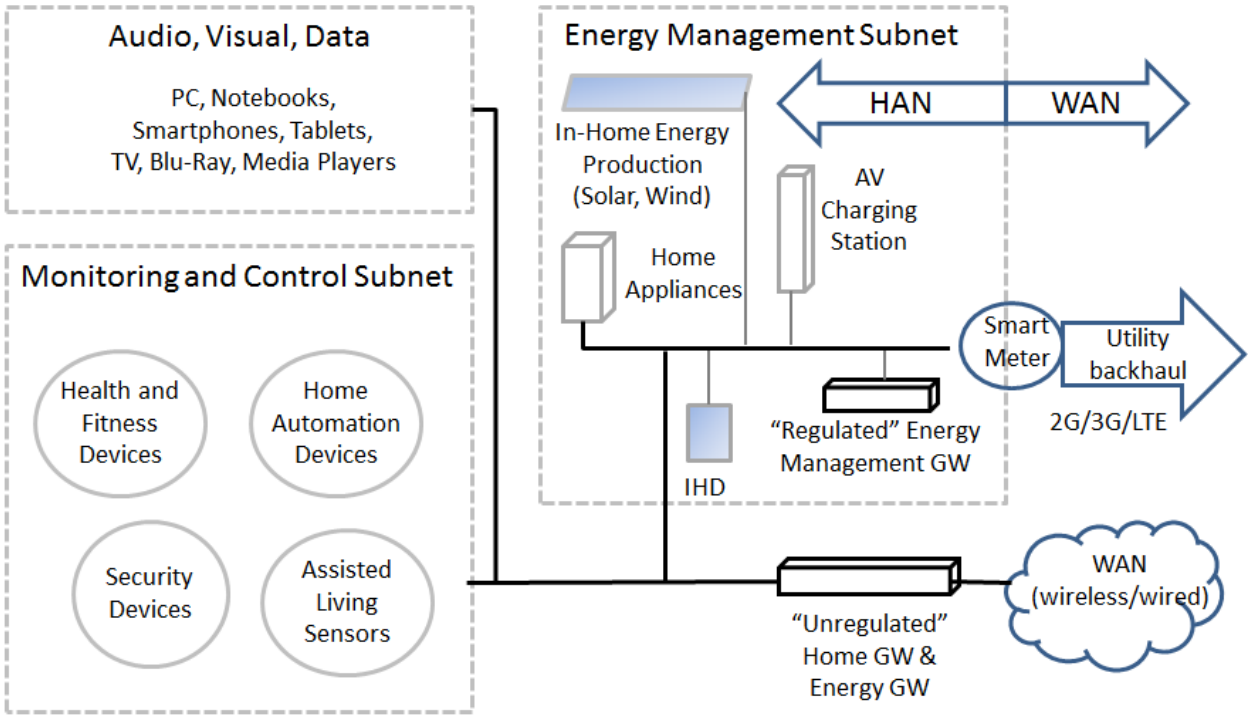
- **A "regulated" gateway:** Owned by utilities companies, this gateway will be part of the smart metering/smart grid infrastructure. This gateway will be essential for the delivery of such use cases as utility-control services (use case 1.3 described in section 3), in-home production use (use cases 2.3, 2.4 and 2.5), and EV charging control (use case 3.3).
- **An "unregulated" gateway** could be either a standalone home energy management gateway, or it could be co-located with a smart meter. An "unregulated" energy gateway is the device for which the key requirements are described in this white paper. It can be owned and controlled by MNOs/telcos, utilities companies or home energy management service providers. This gateway can provide private, secure and authenticated access to connected appliances and service-provider back-end systems for information, control and payments functions.

  This gateway can be used to aggregate data from in-home sensors and connected devices, and support the delivery of various third-party control and monitoring services, such as home security and assisted living.

  An "unregulated" gateway can be either a standalone home energy management gateway, or it can be co-located with a broadband home gateway.

This white paper focuses on the "unregulated" energy gateway, however, the requirements of the "regulated" gateway have also been considered in-depth by the GSMA, and we encourage collaboration between utilities and mobile companies to further discuss such requirements.

Exhibit 1 Connected Home High-Level Architecture



5.2. Functional Requirements

The main functions of the home energy gateway are to serve as a modem for connected devices in the monitoring and control subnet, and enable third-party applications to run in an application execution environment.

Key functional requirements for the home energy gateway consist of the following:

- WAN Control
- Security
- QoS (for example, downstream/upstream QoS, and intra-home data flows)
- Traffic control for WAN and intra-home data flows

5.3. Hardware Architecture

The home gateway device contains a processor core, memory, DMA controllers, embedded module, UICC and peripheral I/O interfaces.

Some of the functional components, such as UICC, power supply and antenna can be integrated into the embedded module or be housed on the gateway device. An application execution environment may run on a processor embedded in the embedded module's baseband, or it may run on a separate standalone processor.

The I/O interfaces: the home energy gateway needs to support the most widely-used home networking interfaces, which include Ethernet, Home Plug (powerline), DECT, USB devices, G.hn, G.hnem and WLAN, as well as the most widely-used broadband interfaces, such as Mobile Broadband, DSL, cable and FTTH.

The home energy gateway also needs to communicate with various connected devices, such as home automation end-point devices and healthcare end-point devices for assisted

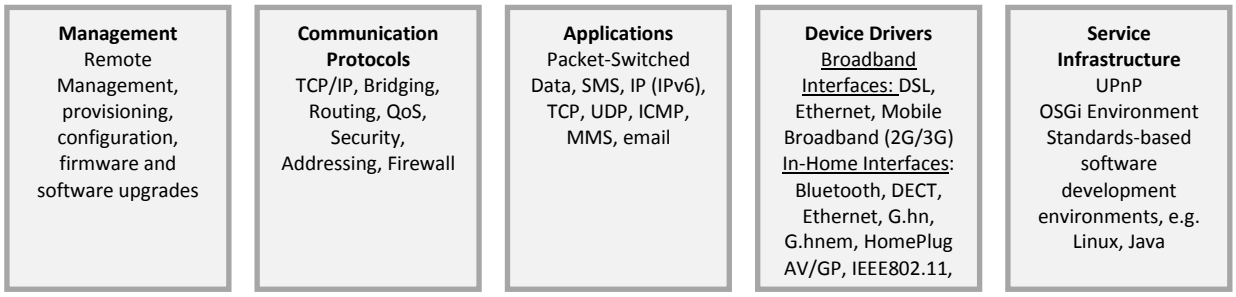
living services; thus, the home energy gateway will also need to support the most widely-used technologies for such devices, including Bluetooth, ZigBee and Wireless M-Bus.

5.4. Software Architecture

The home energy gateway software architecture is comprised of the following components:

- **Communication protocol stacks** for routing, bridging, address management, quality of service (QoS), security (firewall), remote and system management
- **Application service delivery software stacks.** These should provide standards-based development environments. The home energy gateway is a platform for developing new services by third parties; this functionality can be enabled by the use of an OSGi environment, which provides an open platform for service deployment and life-cycle management. It might also be necessary to support home device configuration via UPnP, however, the need to use UPnP will be determined by the home energy gateway form factor: it will, for example, be required for energy management gateways co-located with home broadband gateways, but not necessarily for standalone gateways dedicated solely to home energy management. [1]
- **Device drivers.** The home energy gateway needs to provide device drivers for all on-board and on-chip physical interfaces, including interfaces for a variety of broadband technologies and technologies used by HAN devices.
- **Management protocols.** The home energy gateway needs to be a managed device. The remote end-device management protocols that can be considered for this purpose are TR-069 CPE WAN Management Protocol developed by the Broadband Forum, and OMA DM Gateway Management Object protocol.

Exhibit 2 Home Energy Gateway: Software Components



[1] HGI specifies such requirements in HGI-RD008-R3, HG Requirements for Software Execution Environment

6 Role of Mobile Network Operators in the Smart Home

Several key roles have now emerged in relation to the home energy gateway, including delivering WAN and HAN connectivity for the gateway and other connected end-devices, providing enabling services and interfacing with customers.

6.1. Home energy gateway connectivity to the service provider's back-end systems, via WAN, can be provided by a number of wireless and wireline network operators. Mobile connectivity is an increasingly key requirement in this market:

- Primary connectivity for home energy gateways, smart meters and home automation end-devices will often be provided via 2G/3G/LTE networks. The usage of mobile technologies will be required for, but not limited to, the homes and areas where wireline broadband connectivity is not available for geographic coverage reasons. In addition, many people may not be able to justify maintaining a wireline broadband connection, for example, for second and holiday homes, and student accommodation. Mobile technologies will also be required to serve the elderly and others who may not have installed broadband connectivity in their homes.
- Mobile technologies will also provide back–up connectivity for home energy gateways, smart meters and home automation end-devices connected via other types of networks, such as wireline and wireless. Such additional connectivity is required by utilities companies to ensure reliability and availability of smart metering systems.

In both the above scenarios, mobile technologies will co-exist and be complemented by other wireless and wireline technologies.

A variety of short-range technologies will be used for home area network connectivity. Mobile will also have a role to play in this arena, with femtocells potentially being used to create a local or home area network.

6.2. In addition to connectivity, MNOs may provide a host of enabling services for home energy management, including:

- Subscription and device management services, such as service activation, configuration, virus protection, remote diagnostics and firmware updates.
- Customer interface; For example, the first line of support for calls related to problems with the home gateway equipment.
- Data management and storage services, including:
    - Authentication and security, for example, formal message delivery-acknowledgement, store-and-forward processes
    - Billing
    - Data hosting

6.3. Customer interface:

- Display of smart home information on a mobile handset/tablet display
- Smart home information and event control and monitoring via a mobile handset/tablet display:

- Remote access to information, monitoring and event control
- Enhanced functionality: e.g. location–based services, m-payments, using the mobile handset as a sensor.

The exact role that will be played by MNOs in the future smart home and provision of home energy management is yet to evolve, and will vary from market to market, depending on the evolution of smart home services and the strategy of each individual MNO.

If a MNO, for example, is part of an integrated fixed-mobile operator, home energy management services could be integrated into the operator's overall broadband service proposition.

7 Requirements

The following are key requirements for the home energy gateway:

- Hardware and interface requirements
- Communication requirements
- Software and application environment requirements
- Security/privacy requirements
- Design considerations

7.1 Hardware/Interface Requirements table

High-Level Requirements

A home energy gateway needs to support connectivity for a variety of devices in the home to the back-end systems of utilities companies, home energy management, home automation and security service providers, as well as, potentially, healthcare companies providing assisted living services.

Considerations

The market for connected home devices is still at a nascent stage. A number of different technologies have been rolled out by home automation installers and energy management systems manufacturers. ZigBee, for example, is widely used in smart meters and in home automation devices, while healthcare devices currently use Bluetooth and ZigBee.

Until, and unless, a clear single HAN technology emerges for connected devices, a home energy gateway should support interfaces for those short-range technologies that are most widely-used in the market, including Bluetooth, DECT, Ethernet, HomePlug AV/GP, IEEE802.11, Wireless M-Bus , G.hn, G.hnem and ZigBee. It might be impractical and cost-prohibitive to support all these interfaces on a single device; further discussions will be necessary to define a narrower set of core interfaces to be supported by the home energy gateway.

No.	Requirement
HW1	Interfaces for major broadband technologies: mobile broadband (GPRS/WCDMA/HSPA/LTE) and wireline broadband technologies (DSL, FTTx, PLC)
HW2	Interfaces for major home networking technologies: Bluetooth, DECT, Ethernet, HomePlug AV/GP, Wireless M-Bus, G.hn, G.hnem and ZigBee.

7.2 Communications Requirements Table

High-Level Requirements

The home energy gateway should allow direct connection of end-devices via a variety of access technologies and support peer-to-peer connectivity between in-home devices. It should be always-on.

Considerations

In order to support such applications as demand response, home alarm and security, the home energy gateway needs to be always-on, with sleep and stand-by modes available for energy efficiency.

The home energy gateway needs to be connected via a high bandwidth broadband connection, in order to accommodate high data volumes and high throughput requirements of various applications.

Utilities companies are requesting multiple-technology and multiple network operator connectivity, in order to improve the reliability and the availability of connected devices. Thus, home energy gateways, in which wireline is a primary connectivity, will still need to have mobile-connectivity for back up purposes. Equally, mobile broadband would need to be complemented by various wireline broadband technologies.

It should be possible to switch network provider using over-the-air commands, without replacing an entire home energy gateway device, or replacing a communication module in this device. Some of the market solutions enable switching of network providers via roaming UICCs, or use multiple UICCs on the board.

In the future, such functionality will also be enabled through the use of an embedded SIM. Developed by the GSMA, an embedded SIM is a hardware-based UICC that supports remote management of operator credentials. It enables subscribers to switch operator during product life cycle, and permits removal of MNO credentials from a SIM card and the re-use of a device/eUICC on the same or another network. Technical requirements of the embedded SIM are under consideration at ETSI and are expected to be standardised by the end of 2011.

No.	Requirement
C1	Always–On
C2	Mobile broadband connectivity based on 3G and higher
C3	Mobile Broadband used as back up for wireline technologies, such as DSL and FTTx
C4	Ability to switch network providers using over-the-air commands, without replacing the gateway device or entire communication module

7.3 Software and Application Environment Requirements Table

High-Level Requirements

The home energy gateway needs to provide device drivers for all on-board and on-chip physical interfaces, including interfaces for a variety of broadband technologies and technologies used by HAN devices.

The home energy gateway needs to provide an application development environment for third-party companies to encourage development of innovative energy management applications.

The home energy gateway software needs to have well-defined interfaces to integrate with the underlying hardware and use well-defined and documented APIs for application development. Usage of common APIs allows a number of applications to directly access the embedded module at the same time.

Considerations

The application environments used by embedded devices are diverse. It is recommended that a home energy gateway supports standards-based development environments. For example, the Linux environment can be supported for writing open-source applications.

The home energy gateway is an open service platform, with many service components running over it, which can be used to build complex new services and applications. This can be simplified through the use of established service platforms, such as the OSGi framework. The OSGi framework was developed in the home automation industry; it enables modularity and use of third-party components in applications, and uses standardised management APIs to simplify the integration of OSGi technology into existing systems.

The home energy gateway needs to be a managed device. The remote end-device management protocols that can be considered for this purpose are TR-069 CPE WAN Management Protocol developed by the Broadband Forum, and OMA DM Gateway Management Object protocol.

The Smart Energy Profile (SEP) is the smart energy application level standard widely supported by the industry and approved for smart grids by standards bodies, such as the US-based National Institute of Standards and Technology (NIST). SEP 2.0 has gained broad support in the US and Europe, and it is expected that SEP 2.0 will be ratified by the end of 2011. In some markets, such as the UK and Australia, devices with SEP 1.x are still being deployed. Home energy gateways in these markets might therefore need to support SEP 1.x. However, SEP 1.x has a number of limitations: for example, it is deemed less secure and it applies to a ZigBee application only, unlike SEP 2.0, which is physical layer-agnostic.

In parallel, there is widespread support among home automation systems manufacturers and installers for the use of the Home Automation Profile. The use of the next generation of this profile is recommended on an home energy gateway.

No.	Requirement
SW1	Provide device drivers for physical device interfaces, including broadband technologies, such as Mobile Broadband (2G/3G/LTE), Ethernet and DSL, and interfaces for HAN technologies, such as HomePlug AV/GP, IEEE802.11, USB, ZigBee, Wireless Mbus, G.hn, G,hnem and Bluetooth.
SW2	Use standards-based software development environments, such as Linux or Java.
SW3	Use well-defined interfaces, and well-defined and documented APIs for application development.
SW4	Support for SEP 2.0 (Smart Energy Profile), which is physical layer agnostic.
SW5	Use of the next generation of Home Automation Profile
SW5	Use IP communication between the gateway and remote servers, as well as with the home automation devices. The use of IPv6 is encouraged (for example, use of IPv6 will be necessary to support the use of SEP 2.0), although backward compatibility might be necessary for the installed base of devices that use IPv4.

7.4 Security / privacy requirements table

The home energy gateway needs to reassure both end-users and third party service providers that their data is fully secure. It needs to be part of an end-to-end security system, providing secure and automated capture of data from home sensors and devices, storage of this data and its transfer to remote servers. The gateway should support appropriate authentication and privacy control mechanisms, and be capable of providing firewall and virus protection.

Some of today's short-range technologies currently use AES 128 encryption. The use of next generation encryption, such as AES 256, is recommended for the home energy gateway device.

No.	Requirement
S1	Strong two-way authentication, message authentication and integrity (such as using HMAC);
S2	Next–generation security: X.509 certification; elliptic curve encryption; AES 256

7.5 Design considerations

The home energy gateway is intended to be a mass-market device, and should, therefore, be designed with the following considerations:

- **Interoperability:** An home energy gateway needs to be interoperable with other end-point devices in the home, as well as the "regulated" energy management gateway and smart meters. Interop events organised by standards organisations and industry bodies, such as the Home Gateway Initiative, should be used for testing and improving interoperability between connected home devices.
- **Ability to support multiple display clients:** End-users should be able to access home energy management data on a variety of displays, such as smartphones, tablets, PC and TV displays.

8 Document Management

Document History

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