



Vision of Smart Home

The Role of Mobile in the Home of the Future



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Foreword

Over the past decade, consumers the world over have rapidly embraced mobile telecommunications; connectivity has allowed them to stay more and more in touch with their friends and colleagues. Now, the addition of connectivity to home appliances and the arrival of new online energy management tools are creating the right environment for a new market in smart home services.



These services address consumers desire to manage their home environment while becoming greener through lower energy consumption and greater awareness of their CO2 footprint. The smart home concept, while it is still in its infancy, is set to become one of the most significant consumer lifestyle developments of this decade.

The smart home market is forecast to exceed \$44bn in five years' time, bringing with it new opportunities for mobile network operators and the rest of the mobile ecosystem. The ubiquity of mobile networks makes them indispensable for connecting smart home devices and home energy management gateways, just as mobile phones are emerging as the main interface for home energy management applications.

We recognise, however, that the conversion of a home to a "smart" ecosystem is not going to happen without collaboration and cross-industry effort. Before the smart home concept bridges the gap from a niche and luxury service to something that addresses mass-market consumers, new business models need to emerge; interoperability between diverse home devices needs to be established, and regulatory requirements for privacy and security need to be satisfied.

The mobile industry, along with other sectors that supply devices and services to homeowners, is also reliant on vibrant marketplace as well as an interoperable and scalable platform to support new services. We need these in order to attract third party developers and encourage the creation of innovative and value-added applications.

Our experience with mobile handsets and smartphones has taught us that the mobile industry has an important role in promoting the potential for embedded mobile devices and facilitating a collaborative, cross-industry business climate. These are in fact the goals of the GSMA's existing Embedded Mobile program. The program itself is the result of a strategic review carried out three years ago when the GSMA and its operator members designated the market for connected devices and services as a strategic priority for the mobile industry.

If the smart home concept is to progress beyond its infant stage, business and institutional organisations need to embrace a long-term vision of the smart home, the services concepts that will emerge and the capabilities needed to support these services on a commercially viable basis. This report is the first step toward communicating the mobile industry's vision to our current and future partners.

Alex Sinclair

Chief Technology and Strategy Officer, GSMA

Executive Summary

In the smart home of the future, connectivity will be pervasive and embedded in virtually all household devices. The combined revenue from the smart metering, home automation and home energy management (HEM) segments is forecast to be worth more than \$44bn in 2016. The overall revenue potential of the smart home, however, will be considerably higher as devices from the entertainment, health and home security sectors also become connected. Mobile connectivity will be a crucial ingredient in bringing together the different parts of the smart home puzzle.

Today, connectivity is generally regarded as a high-end novelty in home devices, such as utility meters, thermostats, security cameras, TVs and Blu-ray players, rather than a feature for the mass-market. This view will become out-dated as we move to a future where connectivity is pervasive and embedded in virtually all household devices. Many analysts believe that the smart home of the future is likely to contain 15 to 30 connected devices and sensors, all linked via a home area network and connected to service providers' back-end systems and the Internet. Connected devices will range from ordinary household appliances through to solar panels and electric vehicle charging infrastructure that both consume and generate electricity.

The combined revenue from the smart metering, home automation and home energy management (HEM) segments will be worth more than \$44bn in 2016, according to the combined forecasts from market analyst companies ABI and Berg Insight. The overall revenue potential of the smart home, however, will be considerably higher as devices from the entertainment, health and home security sectors also become connected.

Mobile connectivity will be a crucial ingredient in bringing together the different parts of the smart home puzzle. Without mobile networks' extended coverage, smart home services will only be available in limited locations and will miss the mass-market opportunity. The mobile handset is emerging as a key interface and consumers' constant companion for remote monitoring and control of smart home services. With deep expertise in technology change management and a long-term technology roadmap, mobile operators are attractive partners for smart device and service providers.

The smart home services market is not an entirely new opportunity. Home automation and home energy management companies already cater to wealthier niches of the overall market. However, in order to put together a package of smart home applications for the mass-market, different providers of devices and services will need to collaborate.

In some areas, companies from different sectors see themselves competing for "ownership" of the consumer: utilities companies have a route to the customer via smart meters; telcos can base their proposition on broadband hubs and set-top boxes; security companies can leverage connected security systems; and gaming providers can develop new applications for connected set-top boxes. But many of these companies will also need to co-operate to realise the full potential of smart home services. In fact, collaboration will be a must for the success of the smart home services market.

The role of mobile operators

For mobile operators, the near term opportunity stems from the provision of network access and connectivity for core services within each of the four key verticals (utilities, mobile health, home security and entertainment) discussed in this report. There is a further opportunity in the area of enabling services such as remote device monitoring, firmware updating, and data management and analytics, for example. These services are essential to masking complexity from the householder and delivering a high-quality and robust user experience. Mobile operators are well placed to offer large scale and cost-effective platforms to serve these requirements.

In order to promote cross-industry collaboration, there is a need for a common understanding of the market opportunity across mobile- and adjacent-industry participants. The GSMA has launched a program of activities to support this goal. The GSMA has also issued a call for action to organisations in adjacent industries, to foster collaboration in the four areas of regulation, standardisation, market research and technology development. These aspects of market development, perceived as critical by mobile operators, will need to take place over the next 6 to 18 months. These proposed actions are as follows:

Area for action	Proposed actions
Regulatory	Discussions between main regulatory bodies in different sectors need to take place, to uncover major barriers to the growth of smart home services. Utilities and healthcare are two strictly-regulated sectors that can benefit from such discussions with the communications industry, in order to create opportunity for such services as elderly care and assisted living. An initial dialog has started taking place between the FDA and FCC in the US, for example.
Standardisation	Relevant standards from adjacent industries need to be reviewed and gaps established. For example, work on the smart grid standards, which has been launched by CEN-CENELEC-ETSI in Europe (conducted by the Smart Grid Coordination Group) needs to take into consideration the requirements of healthcare industry. Interoperability and security need to be prioritised in all such discussions.
Market research and business model analysis	A number of market development initiatives need to take place, for example: <ul style="list-style-type: none"> ■ Launch of market research projects to test new business, operational and technical concepts for the smart home; ■ Joint development of smart home business models and value propositions for the mass market, with market studies and proofs of concept. These would improve consumer awareness of smart home services and industry understanding of the main drivers behind the mass market adoption of these services. ■ Joint development of social media strategies to educate householders about smart meters and assuage concerns around the installations of smart meters and smart home systems.
Technology	Work on interoperability of smart home devices, for example, HEM interop events, needs to be ramped up, to achieve large scale for the smart home services.

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Introduction

Without mobile, smart home services will lack the reach and coverage required for the mass-market, and an omnipresent interface for remote monitoring and control.

The existing niche home-automation market is being transformed by the mass-market availability of connected smart devices that enable a wide variety of new smart home services. Both the utilities and communications sectors are playing a significant role in this transformation.

On the one hand, utilities companies are widely deploying smart meter and smart grid technology, driven by public policy commitments in Europe and North America. This development is taking place in parallel with a growing consumer awareness of the need to consume energy responsibly and the potential to use new technologies to control household expenditure. In some countries, the growing adoption of home electricity generation capabilities and home charging points for electric vehicles is leading to the use of a wider range of smart utility devices in the home.

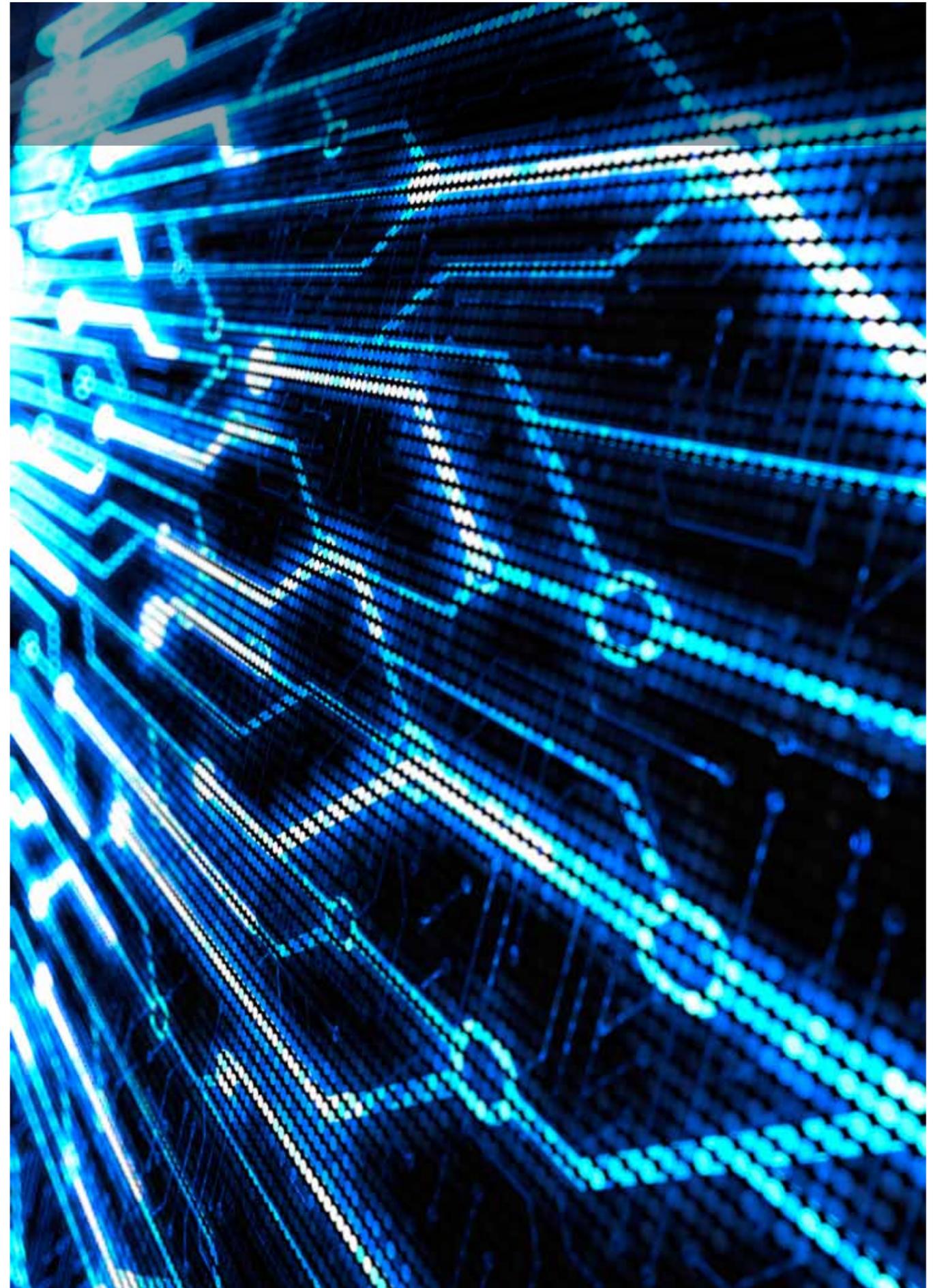
At the same time, a sharp decline in the cost of broadband connectivity and embedded chipsets, and the emergence of low-power technologies for home area networking, are providing an expanding technological platform for the proliferation of smart home devices.

Mobile connectivity will be a crucial piece of the smart home puzzle. Without mobile, smart home services will lack the reach and coverage required for the mass-market, and an omnipresent interface for remote monitoring and control.

This report outlines a vision for the mobile-enabled smart home of the future. It is intended to foster a common understanding of the smart home market opportunities and the associated challenges for companies and regulatory bodies from both the mobile and the utilities industries. We explore the capabilities of mobile technologies and the mobile ecosystem that will be crucial for enabling companies from utilities, home security, mobile health and entertainment industries to design and deliver viable and valued smart home services.

In addition, the report contains information about an array of emerging service providers, competing and cooperating in delivering smart home systems, as well as an overview of the emerging smart standards and technologies. It also outlines the GSMA's plan of action to accelerate market development.

The information and analysis provided in this report is based on industry interviews and workshop discussions carried out by the GSMA with a range of mobile, IT and utilities companies.



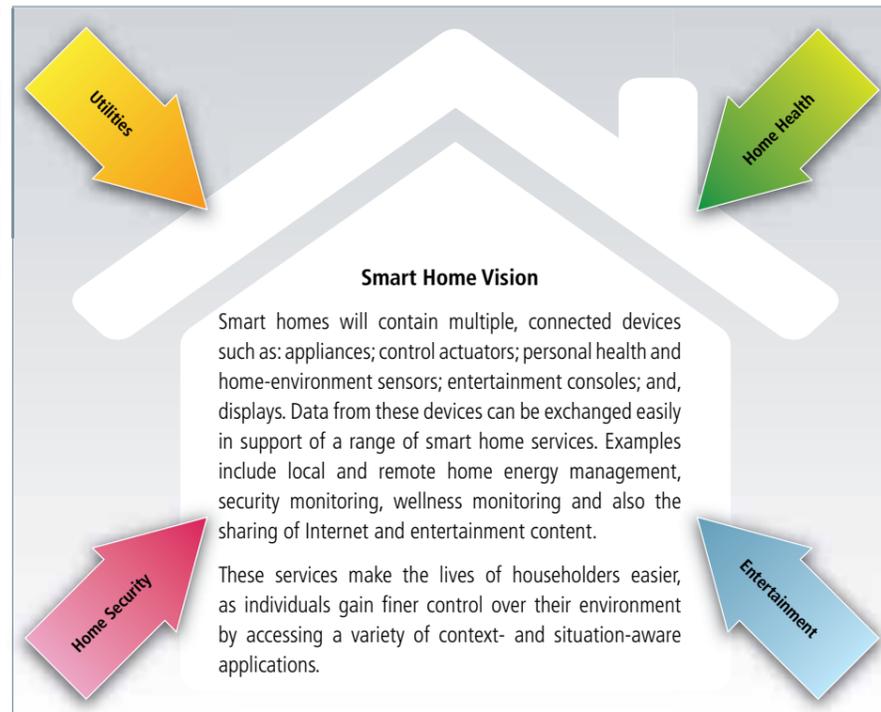
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Smart Home Vision

The smart home of the future will deliver a range of innovative services to homeowners using a variety of intelligent, connected devices.

These devices will range from utility meters that measure energy, gas and water consumption to household appliances, solar panels and electric vehicle charging infrastructure that both consume or generate electricity, together with other connected devices from the entertainment, health and home security sectors. It will be the combination of these devices, the data they provide and the control actions they enable that will contribute to a rich array of smart home services, as illustrated below.

Exhibit 1 Smart Home Vision Driven by Four Key Industry Segments



Compared to the home of today, the smart home of the future will contain far more connected devices. Market research house Parks Associates, for example, forecasts that the number of connected devices and sensors in an average US home will increase from four today to sixteen in 2015. At that time, 13% of all US households are forecast to have energy management systems installed and nearly 20% are expected to have monitored security systems in place – up from 2% and 18% today respectively. In the smart home of the future, these devices will be integrated into intelligent, interconnected and interoperable systems.



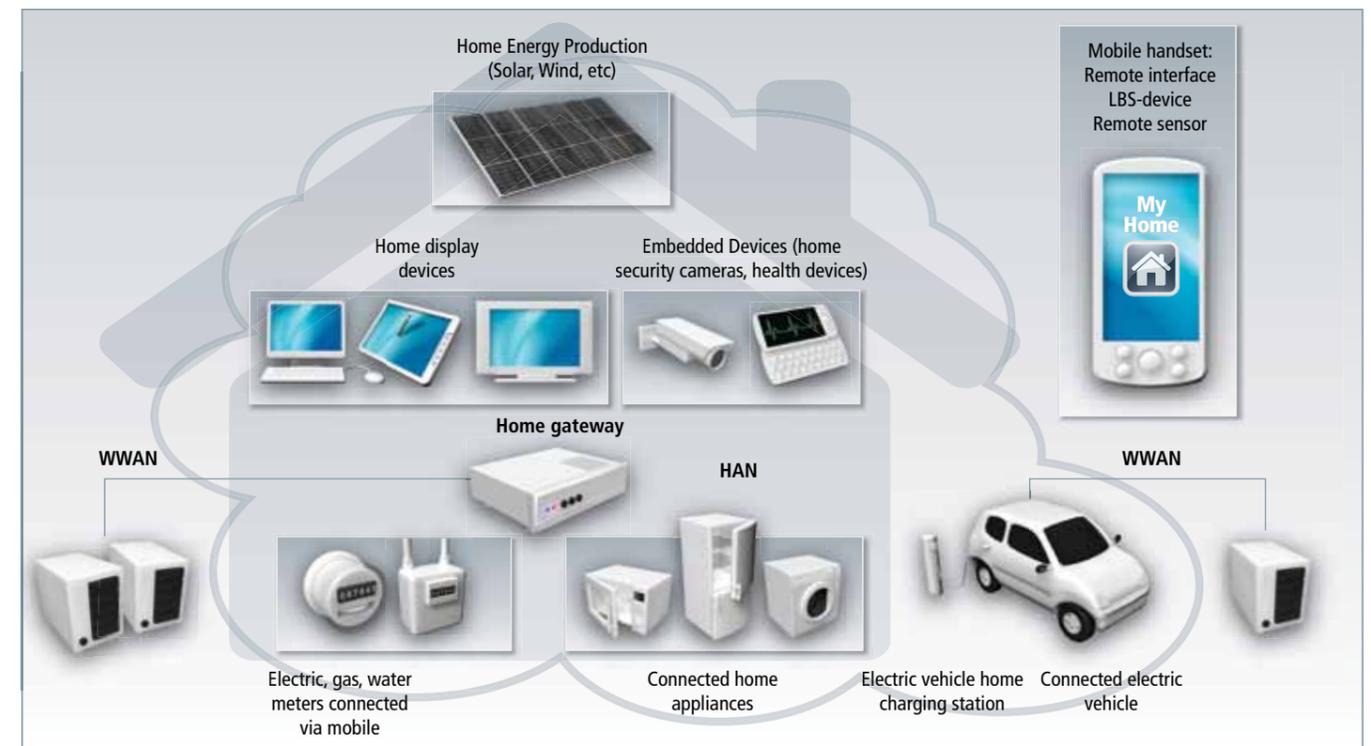
3.1. Smart Home Services

For consumers, the main value of smart home services will be in having information and control of connected devices in the home no matter where they are. Consumers will be able to monitor and control multiple in-home devices on different display units ideally using a same, easy-to-read interface, with the mobile handset serving as the primary device for remote access to the home information. For full mass-market reach, the smart home ecosystem will rely on a combination of mobile and fixed networks to provide both primary and back up connectivity for smart meters and home gateways.

The core smart home services briefly outlined below are only a small sample of what will be possible in the homes of the future:



Exhibit 2 Smart Home Services: Enabled by Mobile





- Utility providers will track usage of electricity, water and gas and provide this information to households to help customers track their current and historical consumption patterns, as well as the amount of energy being generated by solar panels and wind turbines, and the charging status of electric vehicles. Householders will want to ensure that they are appropriately reimbursed for any power their home is feeding into the grid. They will also be able to access information about the cost of electricity and other utilities services, taking advantage of any incentives for energy efficiency. Householders will be able to monitor all of this information remotely using their mobile handsets.
- Smart home energy gateways will be integrated with connected devices, such as security cameras, remote health monitoring devices and sensors, and electric vehicles charging infrastructure, to enable householders to control this equipment remotely. Consumers will be able to control their use of electricity and other utility services, by switching on and off various white goods, lighting or heating appliances, not just from inside the house, but also from the office or during the commute home. Mobile handsets that are aware of their location will be able to automatically trigger events, such as turning off the central heating system when a consumer leaves the proximity of their home.
- Smart meters, home energy management systems and assisted living systems will all be part of the integrated home solutions. HEMs will be able to regulate the usage of household appliances and charging of electric vehicles based on the time of the day or dynamic prices for electricity. Gas, electricity and water sensor readings will be able to provide advanced analytics to enable householders to become more efficient.

The value proposition behind these smart home services is a better quality of life and more energy efficient living that will bring with it some financial savings for households. Connectivity will also make it simpler to install and use household appliances. Having bought a new device, consumers will be able to connect it and download all the needed drivers online, similar to how they download apps from App Stores today, and then view the performance of this device, along with the others they own, in a single online “home place”.

With the householder’s permission, information about connected devices and the ability to control them will also be available to various businesses. Notwithstanding recognized issues around privacy and security of personal data, we expect that businesses will be able to derive considerable value and deliver innovative new services from such data, for example:

- Demand-response functionality will enable utilities companies to improve the operation and efficiency of their networks by switching household appliances on or off to manage the overall load on the utility network, subject to agreements with individual households. By accessing information about ancillary power generators, such as solar PVs and electric vehicles, utilities will facilitate the settlements of payment and also anticipate and control any unanticipated power surges that may damage distribution networks or compromise the regulated quality of services.
- Asset monitoring will allow device manufacturers and retailers to monitor the performance of household devices and save costs by running remote diagnostics and maintenance. They will also be able to use the information gathered to inform their research and development activities.



Mobile networks are enabling the connected devices environment in the home, while supporting the design and delivery of new services, as described in Case Study 1¹ below.

For companies that currently focus on single-category services such as energy supply, entertainment or security monitoring, the emerging smart home market will create an opportunity to widen their service offering and extend their relationship with householders. Gaming providers, for example, may add wellness monitoring to their service portfolio, while communications providers could become primary suppliers of home-security and energy demand management services.



Case Study 1

Home Energy Management and Demand Response for Smart Homes

Recent launches of demand response and home energy management services in the USA go beyond automatic meter reading (AMR)/ advanced metering infrastructure (AMI) projects. After initially rolling out its SmartWorks pilot program to 100 residential and small commercial customers, Fayetteville Public Works Commission (PWC), the largest municipal electric provider in the state of North Carolina, has now extended the demand response/home energy management service commercially. PWC is aiming to reduce coincident peak energy demand, create capacity reserves, address renewable energy

requirements and supplement service offerings for its customers.

In homes and small business premises, PWC has replaced the traditional meter and thermostat with a smart meter with integrated gateway module and a programmable communicating thermostat. Measurement and control devices are installed in the building’s heating and air conditioning system, water heater, pool pump and other appropriate devices. Jointly, these appliances typically account for 40-60% of the home energy consumption at peak times.

Consumers set up their energy-use profile via a web portal accessed on internet-enabled devices, such as smart phones, laptops and tablets. The home measurement and control devices communicate

in real-time using ZigBee technology with a smart energy gateway embedded in a smart meter, which is connected to PWC’s data centre via 3G or 4G modems connected to Verizon’s mobile network. Using mobile networks allows PWC to control appliances in real-time, with delays measured in milliseconds -- a significant improvement on the traditional data communication that takes place every 15 minutes.

The utility company uses the meter data readings for billing and uses the aggregated data for demand management and load resources; remotely cycling home appliances off to shed the peak electricity load during times of high demand within guidelines established by the consumer’s energy profile. The initial

results have shown that PWC’s consumers saved as much as 15-20% of their overall electricity usage, compared to previous years.

In addition to enabling the control of home appliances, energy retailers are able to introduce innovative tariffs, such as time-of-use pricing. Predictive models allow utilities to determine the future level of consumption and minimize demand uncertainty. The service also establishes a home area network (HAN) for the delivery of future innovative smart energy services.

1 For further details of the solution, see the Consort Virtual Peak PlantSM Solution Case Study on http://www.gsmaembeddedmobile.com/resources/case_studies



3.2. Stages in the Evolution of Smart Home Services

The full vision of smart home services will be realised in progressive stages. At present, embedded connectivity is a novelty in a few high-end home devices. At some point in the future, connectivity will be pervasive and a feature of virtually all household devices. Smart home services will go through at least three distinct stages of market evolution as illustrated below:

- Stage 1 - Connected Standalone Devices
- Stage 2 - Connected Service Silos
- Stage 3 - Integrated Smart Home

Stage 1 – Connected Standalone Devices

The main characteristics of this stage include:

- Connectivity of various standalone devices to the service provider’s back-end systems and the Internet;
- A separate control and interface function for different devices.

There will be many cases where monitoring and control of standalone devices will be the end-game: For example, there may be limited demand for relatively expensive HEM systems in emerging markets, so utilities companies will push ahead installing smart meters and potentially using these for a variation of demand response and demand side management services. Some utilities companies are reluctant to allow inter-connection between their smart meters and consumer-controlled devices, choosing to restrict access to the smart metering data. Similarly, regulatory restrictions for some health monitoring devices will not allow them to be connected to other home systems. But a majority of smart home vertical solutions would benefit from being inter-connected.



Stage 2 – Connected Service Silos

The main characteristics of this stage include:

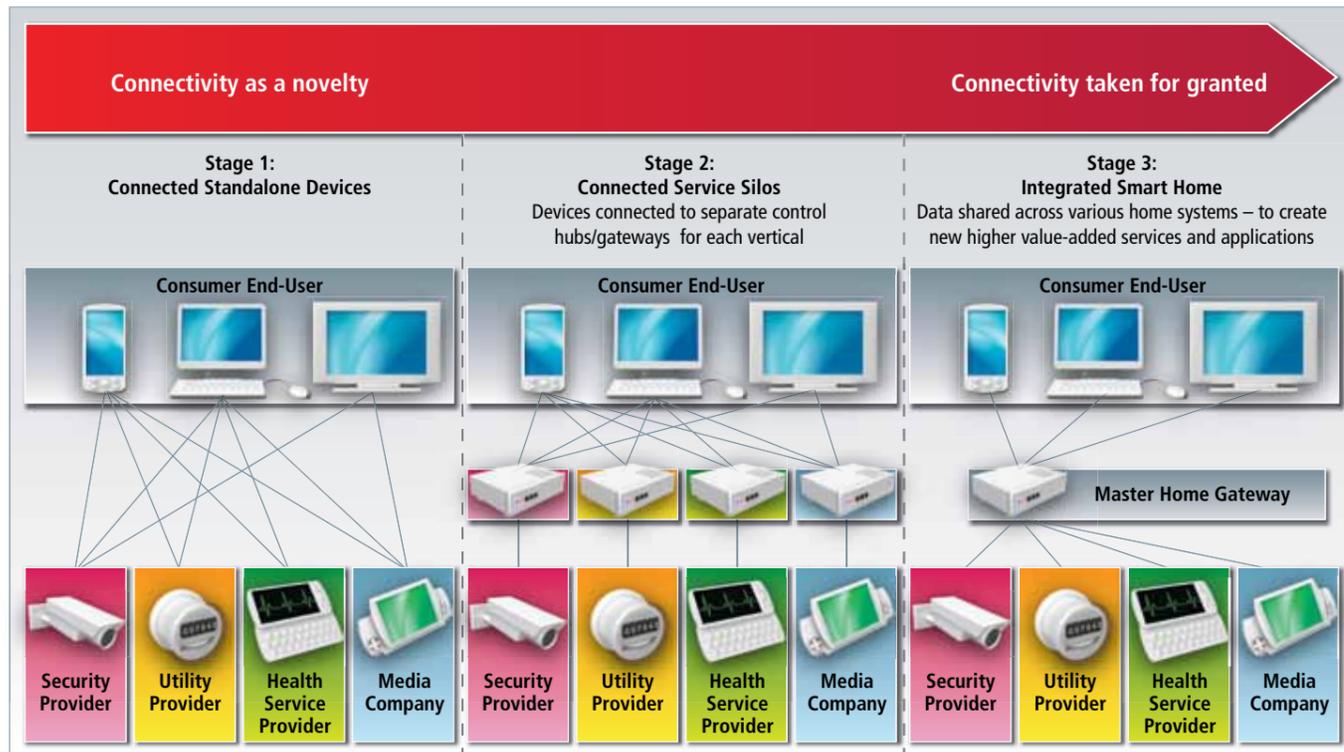
- Device connectivity and data management via dedicated control hubs, separate for each vertical;
- A relatively-sophisticated range of service capabilities due to data sharing and limited point-to-point connectivity between devices.

At this stage, a wide variety of devices, spanning entertainment, energy management, security, health and wellness, in the household will include some level of IT capability designed to support smart services. Some of these devices will have complementary functions, making a strong case for the convergence of smart home services.

As they use a growing number of connected services, consumers will value being able to use a single “My Home” place to view the performance of and control their home devices. Tighter integration will also potentially enable enhanced functionality: For example, an assisted living service could integrate data gathered from remote medical sensors with the readings from utility appliances for enhanced care management.

Similarly, service providers may desire to economize on connected hardware or to enable better information integration to deliver new services or an enhanced user experience. Historically, consumers have been reluctant to pay significant premium fees for home automation services. It will be crucial to find a service “leader” for the smart home, which will create an end-user pull for other services. Among the most likely candidates for such service leaders are broadband and security services. Home security monitoring is already bundled with home energy services as part of home control and monitoring packages. Broadband service providers, on the other hand, are exploring the concept of a partitioned home gateway, which can offer broadband internet connectivity to end-users, and allow a utility provider to use the same hub to deliver home energy management services.

Exhibit 3 Smart Home Services Evolution Scenario



These stages are not necessarily consecutive. In some areas, such as home automation, suppliers are already linking multiple connected devices to deliver solutions in vendor-specific silos. New and potential market entrants can nevertheless map their strategies to several notable characteristics of each stage.

Stage 3: Integrated Smart Home

The main characteristics of this stage:

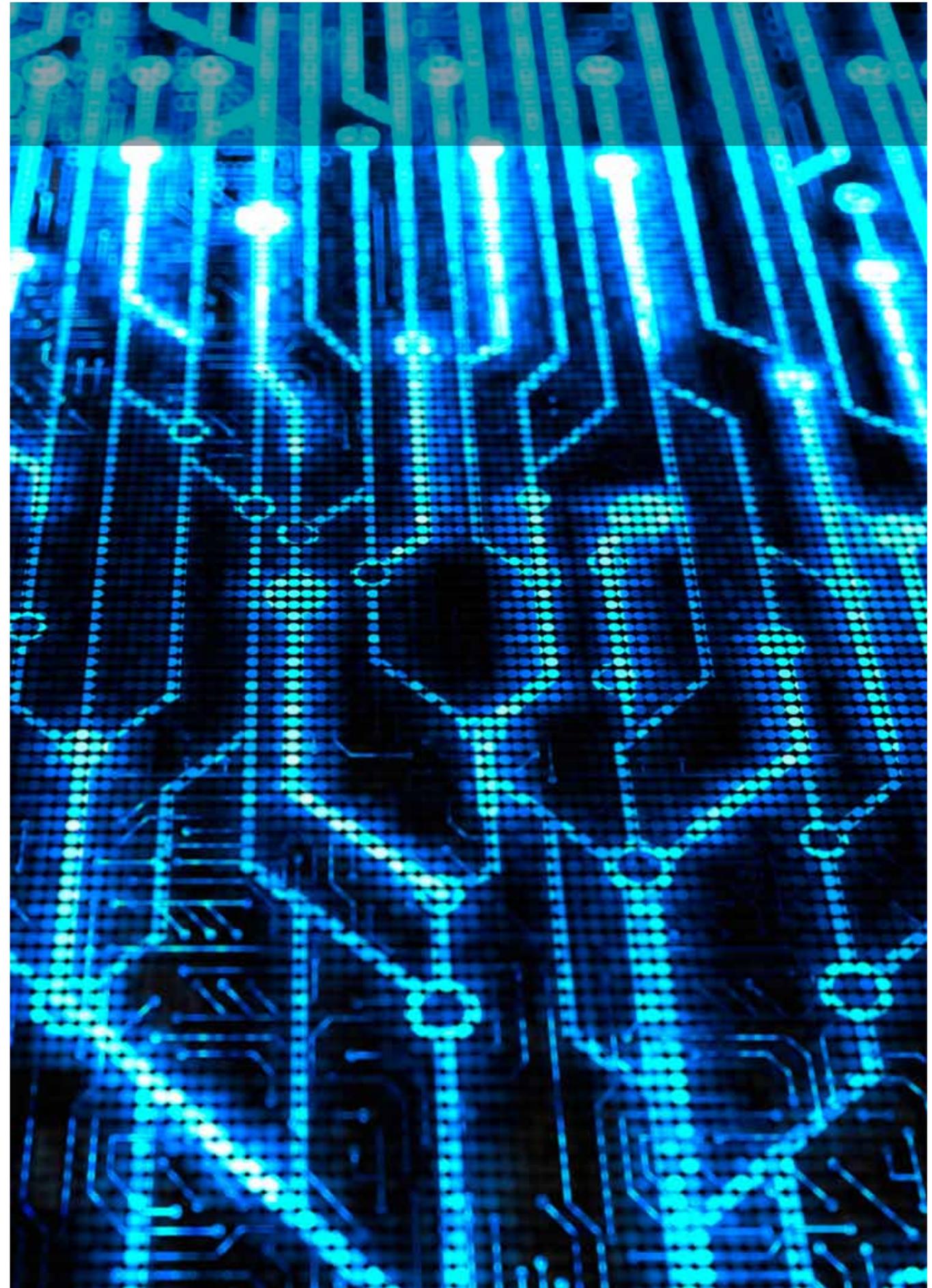
- Sharing of data between different smart home devices and systems;
- Existence of a single mobile-enabled home gateway or integration point as a platform for supporting different smart home applications.

The key feature of this stage is the creation of an environment where data from different application areas can be integrated to deliver a richer set of smart home services. These may be application-oriented services such as comprehensive energy management. They may also be support services, such as a central point of control to define security and access control policies across multiple devices related to the home.

It is increasingly apparent that fully-integrated smart home services can deliver a lot of value to consumers and businesses alike. They help deliver a higher quality of life for the former and make business operations more efficient for the latter.

Alongside the many opportunities, however, there also remain several challenges to the emergence of an integrated smart home. New business models and cross-industry partnerships need to be developed and implemented; consumer benefits in the form of cost savings and personal privacy need to be articulated in a manner that gains their trust; and, technical standards need to be designed to encourage interoperable and scalable solutions.

Many of these challenges can be addressed by organisations in the mobile sector working with companies from each of four key adjacent industries: utilities, home security, mobile health and entertainment. Mobile connectivity has a pivotal role to play in linking the devices and sensors within a home to the sophisticated data analytics systems and intelligent applications that service providers will create through cloud- or back-end systems. The remainder of this report discusses the issues that need to be addressed, current market developments and the GSMA's plan of action to address the main challenges within its scope of influence.



4

Smart home landscape

Future smart home services will build on the capabilities of a wide range of devices, services and technologies that exist in today's market.

The success of smart home services cannot be driven by a single company, or even a single sector. In order to put together an attractive package of smart home applications, there needs to be collaboration among companies that often view each other as competitors for the "ownership" of consumers. Collaboration will be crucial for the success of smart home.

Smart home services providers also need to be aware of emerging market segments and technologies that are gaining critical mass. This section provides an introduction to:

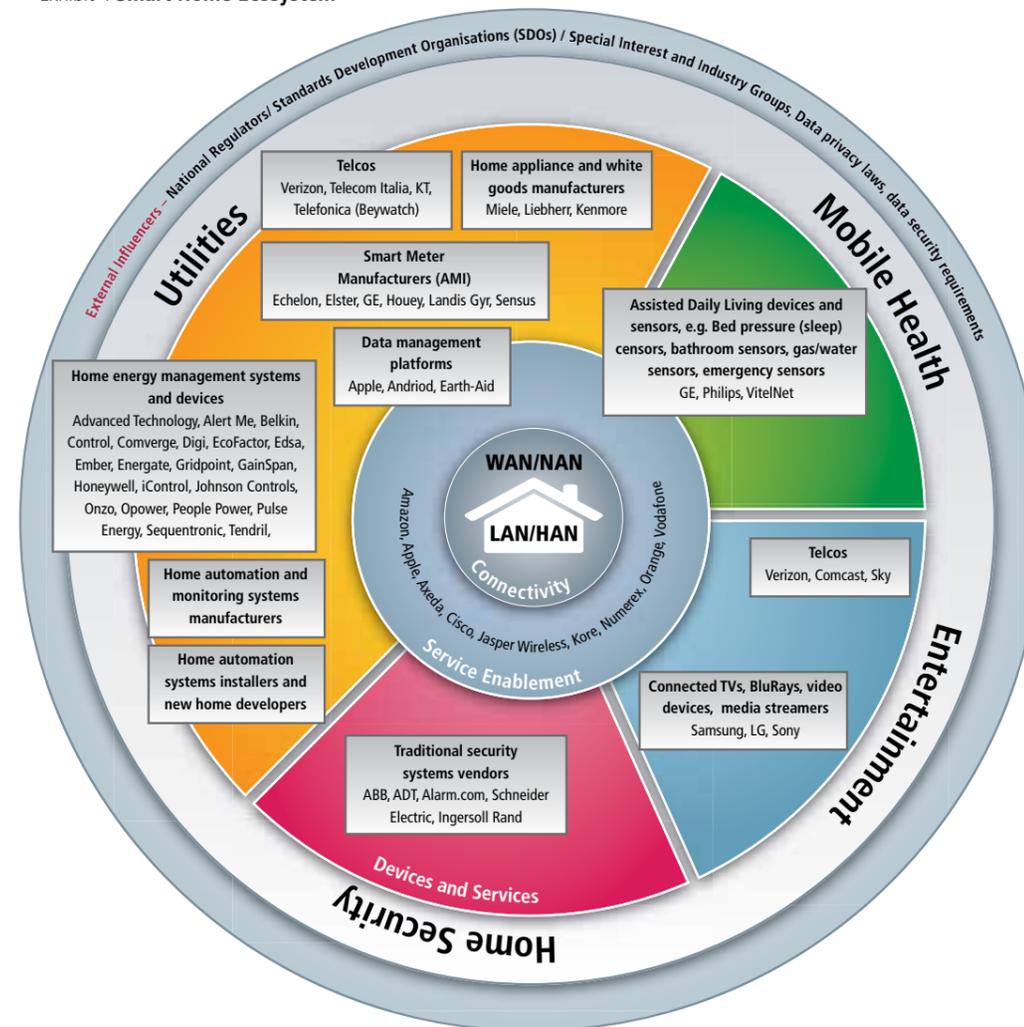
- the diverse ecosystem of suppliers, and the co-operation/competition dynamics between these companies;
- technologies and standards that will co-exist in the smart home of the future;
- the views of market research firms on the size and direction of important service segments.

4.1 Supplier Ecosystem

Many of the initial smart home service concepts will be an extension of existing service offerings from companies in four key adjacent industries to the mobile sector - utilities; home security; entertainment; and, health and wellness sectors. Some of the key organisations that are active in each of the four sector-quadrants are shown opposite



Exhibit 4 Smart Home Ecosystem



The delivery of smart home services will be supported through several layers of technologies as illustrated above.

- Firstly, wide-, local- and home-area connectivity technologies will need to be integrated into a range of devices and services.
- At the next level, service enablement technologies will allow services to be customised and delivered to a robust level of quality. Examples of these enabling technologies include connectivity management, provisioning of new features, device and firmware management etc.
- The outer-most level corresponds to the individual devices and sensors that consumers interact with.



Several candidates are vying for the role of a leader introducing smart home services to the mass market. Historically, connected home services were led by home automation system manufacturers and installation companies, but new contenders are emerging among the utilities companies, telcos, home energy management providers and even gaming companies.

Smart meter technology is a strong candidate to initiate the smart home services for the mass-market. This is because regulatory mandates in Europe and North America have given smart metering rollouts significant momentum: A quarter of all homes globally will have smart meters by 2016, according to IDC. A number of electricity providers² have already heavily invested in the development of demand response and home appliance controls to balance loads³, and many more are planning to launch such services in the future.

However, the deployment of the demand side management services by utilities depends on regulation and consumer buy-in to the deployment of smart meters to their home. In some markets such as Sweden, where smart meters are installed in 100% of all homes, utilities companies are technically ready to offer demand side management services, but are waiting on regulatory clearance. In some countries, there are openings for HEM start-ups, telcos and security companies to introduce competing home control and monitoring services.

Home energy management presents an attractive new growth opportunity for the established security products and services sector, which has traditionally grown at 7-9% annually worldwide, according to Berg Insight. Bundles of home energy monitoring and security services are now sold directly to householders, via home automation system installers or new home developers.

At the same time, most home energy management providers offer complete solutions, consisting of connected devices, such as thermostats, smart plugs, in-home displays (IHDs) and energy control hubs, backend systems and end-user portal software. Some of these companies sell directly to consumers, while others sell exclusively to the utilities. No dominant player has emerged in this sector to date. US-based Opower, for example, is currently one of the biggest providers of home energy management tools in terms of reach, working with 53 utilities and providing energy reports to 2 million homes.

The telecommunications sector has also begun to address the smart homes opportunity. Many of the early service launches have been based on fixed-line access, taking advantage of telcos' existing base of home broadband gateways and IP TV set top boxes to add home control and monitoring tools. Smart home services have been dubbed the "fifth play", added to telco service portfolios alongside voice, data, TV and mobility.

Mobile operators, providing mobile broadband connectivity to complement fixed broadband, will also be able to leverage femtocells to provide a home gateway to control smart home devices. Examples of the different approaches being taken by telecoms companies are summarised in Exhibit 5 below.

Exhibit 5 Communications Service Provider Activity in the Smart Homes Market

Communications Service Provider	Connectivity	Type of service/Details
AT&T	Fixed and mobile	Xanboo (home automation)
Bouygues Telecom	Fixed and mobile	Communications services to support home energy management for ERDF
France Telecom/Orange	Mobile	M2O city project with Veolia Water
KT	Mobile and Fixed	Smart Green Service
Rogers Communications	Mobile and Cable	Smart Home Monitoring service
Telecom Italia	Fixed and Mobile	Energy@Home
Telefonica O2	Fixed and Mobile	Beywatch
Telenor	Mobile	Home Alarm and monitoring systems, Smart Meters, Health monitoring/remote disease management solutions, EV services.
Verizon	Fixed, with plans for mobile-based service	Home Control & Monitoring Service (utility management and home security, with plans to also cover independent living and mobile health)
Vodafone	Mobile	British Gas smart meter initiative

Other companies that could provide a smart home communication hub include gaming providers. Some of the connected gaming devices could build on the existing fitness games, for example, on Wii Fit and PS3 Move consoles, and become gateways for a variety of health and wellness information.

To a large extent, the ability of all the above mentioned providers to lead the introduction of smart home services will also depend on existing market regulation, which varies according to the application area. Home automation and home energy management services are largely unregulated, which could simplify their adoption by consumers. Others, such as smart meters and remote healthcare services, are typically subject to supervision from national energy and healthcare authorities respectively.

Specific regulatory scrutiny and intervention is likely in the following areas:

- Integration with the smart grid will impose tight end-to-end security and stringent regulatory requirements.
- Data privacy regulations will govern third-parties' access to residential consumption data of electricity, gas and water.
- Energy efficiency of smart home devices.
- Assurance of essential public services.
- Medical device regulation: In the USA, all medical devices need to be registered and listed with FDA, and are subject to various monitoring and approval regulations.

² Some examples of the utilities companies that invested heavily into the development of demand response services include Pacific Gas & Electric, Southern California Edison and Florida Power & Light (USA; Source: Zpryme, Smart Grid Insights: Top 10 U.S. Utilities by DSM Investment| March 2011), and SEAS-SVE-Panasonic in Denmark. Other potential providers include Honeywell, which reaches 150 million homes and 10 million buildings with demand response services in the US, providing equipment and managing about 1 million of direct load control devices.

³ A few providers of high-end home appliances are beginning to test the market for connected appliances. Kenmore Connect washers and dryers carry remote diagnostics capabilities; similarly, Wi-Fi-enabled Miele@Home devices can be monitored and controlled remotely, and can also communicate to each other via powerline technology. Liebherr HomeDialog systems allow end-users to control temperature alarms and door alarms from a monitor on a fridge/freezer via a PLC system.



The success of smart home services will hinge on the ability of service providers from the key segments – utilities, mobile health, home security, entertainment and mobile - to work together to create a compelling value proposition for smart home services, and differentiate by bundling a wide variety of services from different vertical sectors.

Regulatory requirements are likely to delay the introduction of smart metering and health monitoring services, and complicate the connection of smart meters and remote healthcare gateways to other consumer controlled devices.

Ultimately, the success of smart home services will hinge on the ability of service providers from the four key segments to work together to create a compelling value proposition for smart home services, and differentiate by bundling a wide variety of services from different vertical sectors. Collaboration between companies from different industries, such as telcos and utilities, will be required to bring smart home services to the mass-market.

The mobile industry is uniquely positioned to enable such collaboration. Mobile operators already partner with various potential participants in the future smart home ecosystem depicted in Exhibit 4. For example, mobile connectivity is already used to enhance home security and home energy management services, as well as to connect millions of smart meters. In the smart home, mobile connectivity can become an integration point and the glue that binds together services and applications from other service providers in the ecosystem.

4.2. Technology and Interoperability Landscape

Mobile technology is not expected to be used universally to connect each and every type of connected device. The price point and application requirements for many devices and sensors will be adequately satisfied with personal- or home-area wireless technologies. Mobile technology will, however, play a significant role in providing wide-area connectivity; this will be both for individual devices and also as a gateway to connect home area devices and sensors.

Based on current market trends, several different wireless technologies will need to co-exist in the smart home. Many connected devices and sensors are early-generation offerings designed from a hardware cost-minimisation standpoint. Typically, these employ low power-budget technologies and unlicensed spectrum, including Bluetooth and ZigBee, as well as a number of proprietary protocols, such as Z-Wave. Bluetooth is widely used in consumer electronics and mHealth devices, while ZigBee has emerged as an early technology leader for home automation, energy management and smart meter devices.

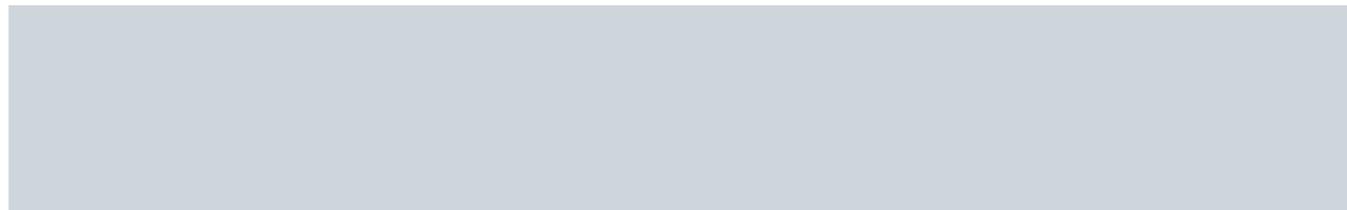
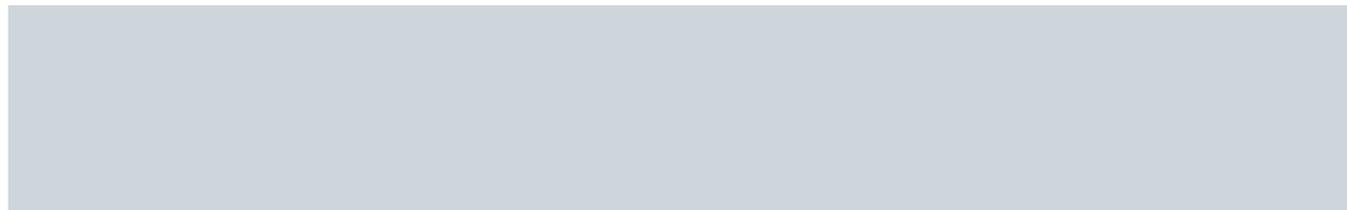
In the home area network (HAN) arena, no single technology dominates with WiFi, HomePlug AV, MoCA and Ethernet all being used for in-house connectivity. The most common access technologies currently used in connection with smart home services are summarised opposite in Exhibit 6.



Exhibit 6 **Wide- and Home-Area Networking Standards**

Technology	Verticals classification	Key design/ application features	Network Type	Technology classification
Mobile WAN	General purpose	Secure, high-scale wide area connectivity	WAN	3GPP technology standards; Connectivity
Femtocell	General purpose	Extension of mobile connectivity into the home	LAN/HAN	Connectivity
Wi-Fi	General purpose	Local-area connectivity	LAN/HAN	802.11a/b/g/n; Branded standard for wirelessly connecting electronic devices
Bluetooth	Multiple depending on Bluetooth profile	Low power wireless protocol for Personal Area Networking, high levels of security	PAN	Technology standard 2.40 – 2.48 GHz
Bluetooth Low Energy	Healthcare	Subset of Bluetooth v4.0 For very low power applications running off a coin cell	PAN	As Bluetooth
DECT/CAT-iq 2.0	General purpose	Next generation of DECT technology. For smart home and m2m applications	LAN/HAN	Connectivity
ZigBee	Multiple. Dominant in the smart energy verticals: smart metering and home automation	Low power wireless protocol for Personal Area Networking	PAN	Low power communication protocol, wireless network standard; operates in ISM (868MHz/915MHz/2.4GHz)
HomePlug. Multimedia over Coax (MoCA), Home PNA	Home entertainment, smart metering and home appliances	Wired home networking	HAN	IEEE 1901. Powerline communications standard; Connectivity
Wireless M-Bus	Smart metering	Connectivity between smart meters and head-end	NAN	Connectivity
6LoWPAN i.e. IPv6 over Low power WPAN	Smart objects that are IP enabled – extending the Internet of Things	Simplifies IPv6 connectivity, defining very compact header formats and taking nature of wireless network characteristics (e.g. packet loss, congestion etc.) into account.	PAN	Standard

Note: WAN, LAN, NAN, and HAN correspond to wide area, local area, neighbourhood area and home area networks respectively.



Several networking protocols have been developed to control home appliances, lighting and home energy systems. Among these are Zigbee Home Automation, ZigBee Smart Home 2.0, and the privately-developed Z-Wave and LonWorks. Both Z-Wave and LonWorks have sizeable installed bases, but are proprietary in nature. The home-entertainment ecosystem is leading the development of interoperability in a world where home users wish to share media content between a growing number of devices. The key interoperability technologies, consortia and standards are summarised in Exhibit 7 below.

Exhibit 7 Interoperability Developments and Standards

Industry Initiative	Verticals classification	Key design/ application features	Technology classification
UPnP and DLNA	Consumer	For in-home media sharing among consumer devices. UPnP is for connectivity between standalone devices and PCs from different vendors.	Software (primarily over Wi-Fi)
Continua	Health/Wellness, Independent Living	Interoperability standards based on ISO/IEEE 11073 Personal Health Data standards and Bluetooth LE (low power mobile devices) and ZigBee (networked low-power sensors) for its forthcoming v2 Design Guidelines.	Design Guidelines & Certification Program
SEP 2	Smart energy	Smart Energy Profile 2.0, specification for home energy management in home devices.	An Application Profile, design framework for a smart energy sector
Home Automation	Home automation	Home automation profile, specification for controlling appliances and systems in the home.	An Application Profile, design framework for a home automation sector
IEEE 1905	Home entertainment	An abstraction layer that manages a blend of physical network layers (Wi-Fi, Powerline, Ethernet and coax).	Home networking standard for a blend of physical layers
G.hn	Home entertainment, Smart energy (home automation, demand-side management)	A universal physical interface designed to integrate coax, power lines, Wi-Fi and Ethernet into a single physical network (on the same chipset).	Home networking standard for a blend of physical layers

In addition to the standards referenced above, Google recently announced that it is positioning Android@Home as an open platform for a variety of home services. It is not yet clear which technology will be used for the home area network of Android@Home, but the strong uptake of Android-based devices by consumers will mean that Google's choice of technology could strongly influence the future shape of the smart home HAN market.

4.3. Smart Home – Growth Prospects in Vertical Segments

The total smart home market, encompassing the four key vertical segments discussed above, presents a growth opportunity for service and communications providers and equipment vendors alike. The current market emphasis on single-purpose or silo solutions is evident in the available market forecasts; no single analyst firm provides a coherent and consolidated view of the whole smart home devices and services market.

In 2010, the global combined market for smart meters, home energy management and home automation was worth more than US\$8 billion⁴. By 2016, the combined revenue from these sectors is forecast to exceed US\$44billion, according to ABI and Berg Insight. However, the total opportunity, also encompassing home security and healthcare services, is much bigger.

Two of the key sectors in the smart home -- HEM and home automation -- are still dominated by bespoke, expensive solutions, and are far from reaching the mass-market. In 2011, 1.8 million home automation systems were shipped globally, according to ABI, which forecasts that 12 million such systems will be shipped in 2016. Similarly, only about 1 million homes worldwide will use HEM this year, rising to 13 million for 2015, according to Pike Research.

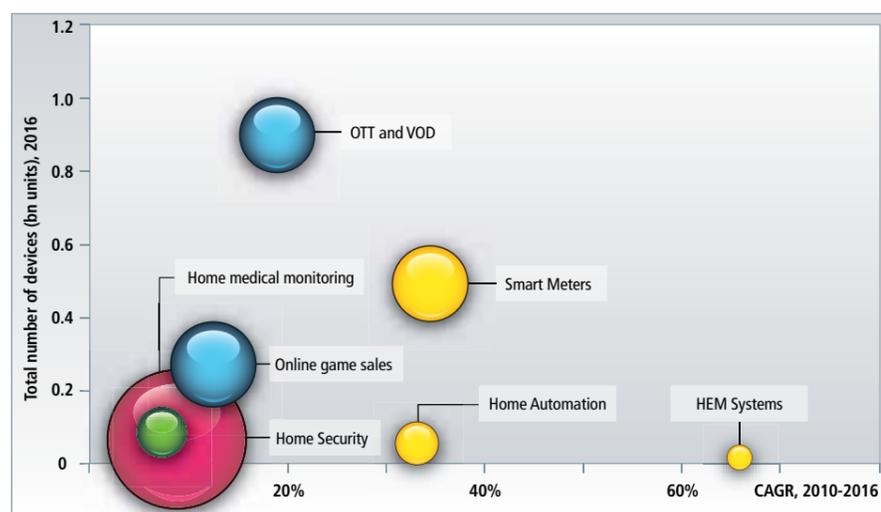
Connecting home automation and HEM to smart meters is one way to grow the market. According to IDC, nearly 90 million smart meters were installed globally at the end of 2Q 2011; and their number is forecast to increase by more than five times to 490 million in 2015. At present, the majority of the installed smart meters perform only basic data reading functions and are not connected to other home energy management devices or systems. In the future, however, smart meters will become the gateways between the smart home and smart grids, linking utilities networks to HEM systems and supporting the delivery of demand response and demand side management.

For a consolidated analysis of the market potential, we have combined data from several different analyst firms to put the different device categories in context and to visualize potential clusters of opportunity.



⁴ Combined forecasts from such analyst houses as ABI, Berg Insight, Machina Research, IMS Research and DFC Intelligence

Exhibit 8 Connected Home Devices and Revenue, 2016



Smart Metering	Smart Metering	Home Automation	HEM	Home medical monitoring	Home Security	OTT & VOD	Online game sales
CAGR, 2010-2016	34%	33%	65%	7%	8%	20%	12%
Revenue, USD\$, 2016	\$33bn	\$9.50bn	\$2bn	\$12.4bn	\$110bn	\$31bn	\$37.9bn
Units, 2016	490mn	~50mn systems	12mn home systems	2mn connected home monitoring systems	60mn units	900mn connected TVs	260mn connected consoles

Note: Size of the bubble represents the size of the opportunity in revenue terms (USD \$bn)
 Source: ABI, Berg Insight, IMS Research (OTT and VOD), Informa (connected TVs and game consoles), DFC Intelligence (gaming)

Today, consumers readily spend their income on security, TV and media content (combined sales of video over the internet (OTT), video on demand (VOD) and online games), as well as broadband services (global broadband revenue reached \$274bn in 2010⁵). Estimates for home medical monitoring vary widely, but the revenue opportunity is forecast to be equally sizeable.

However, making smart home services attractive to the mass-market will require considerable effort on the part of service providers. In order to convince the consumers pay a monthly premium for smart home services, service providers will need to consider how to improve the value proposition of smart home services for the mass-market, potentially bundling these services with others, such as broadband and security. The entertainment sector might provide some valuable lessons: The introduction of double- and triple-play service packages by broadband providers, for example, created strong demand for rich media and TV services. As Exhibit 9 indicates, consumers will need to be provided with much more than just connectivity if they are to pay for any services.

⁵ Disruptive Analysis, http://www.disruptive-analysis.com/new_bband_bus_models.htm

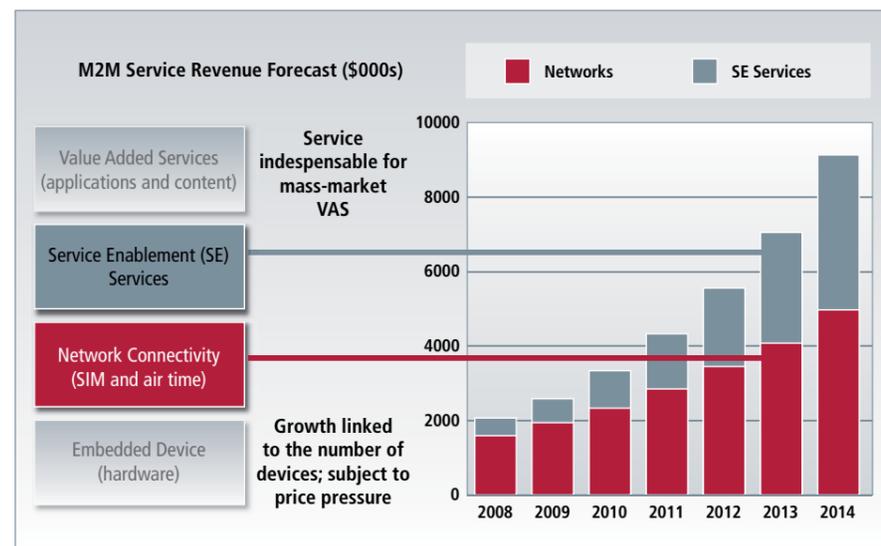
Exhibit 9 Smart Home: Major Segments, Key Drivers and Value Proposition

Segment	Sub-Segment	Key Drivers	Key Value Proposition for End-users
Smart Utilities	Smart metering	Regulatory initiatives Drive for efficiency Incorporation of electric vehicles and renewables into the smart grid	Access to historical and current energy and utilities service consumption; Financial incentives
	Home energy management	Regulatory initiatives Growing consumer interest in energy efficiency New interfaces for energy consumption tracking	Life-style improvement, convenience Ability to remotely manage home devices; Energy efficiency
Security and safety	Home alarm and monitoring systems	New functionality: wireless/ M2M capabilities	Increased safety and security; Remote monitoring of the home
Audio-visual and entertainment	Connected TVs, Blu-rays, game consoles, media players	Supply-side push: broadband penetration; new IP-based/OTT media services; viewing devices (smart phones, tablets)	Content packaging and bundling
Healthcare	Assisted Living	Aging population, growing cost of healthcare, need to improve healthcare industry	Access to remotely monitored physiological statistics Life-style improvement, safety and security

In order for communications service providers to capture a greater share of the overall market for smart home services, they first have to enable the companies that deliver services to end-users – a B2B2C service delivery value chain. This involves targeting the B2B portion of the value chain, which requires dedicated network equipment and enabling services, such as managed connectivity, security and software services. These services are effectively a stepping stone towards targeting revenues associated with consumer services, the B2C portion of the value chain.

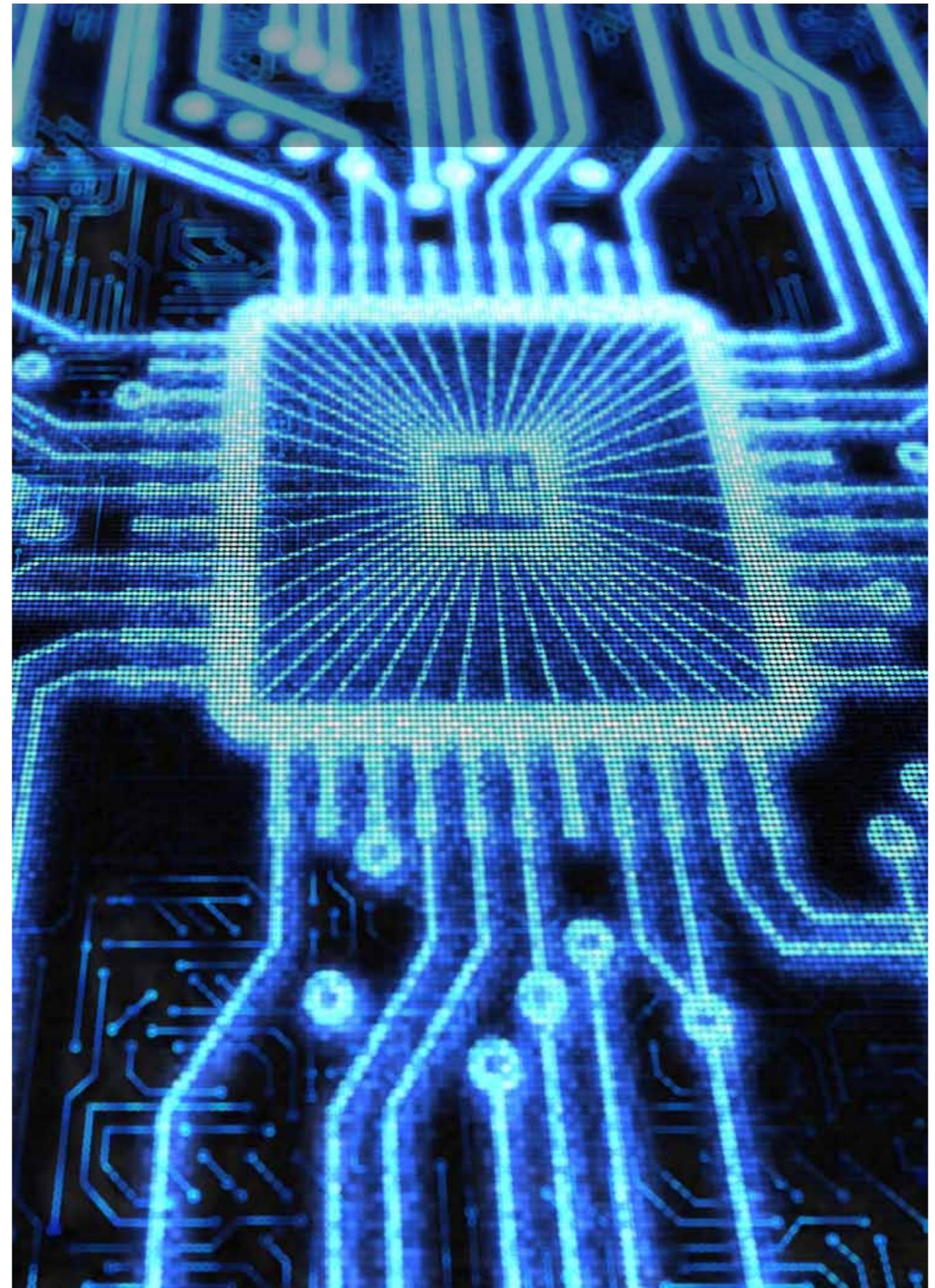
The importance of enabling services is that they allow the complexity of a high-quality user experience to be managed systematically using automated tools to control service delivery costs. These enabling services correspond to a second revenue category for communications service providers, in addition to providing connectivity. Beecham Research forecasts that revenues for service enablement will grow at a compound annual growth rate of over 40%, and the total revenue potential in 2014 is comparable to that offered by connectivity (see Exhibit 10).

Exhibit 10 Smart Home Enabling Services and Revenue Potential



Source: Beecham Research, Telco2.0 Executive Brainstorm – "M2M – Beyond Connectivity", (2010)

Mobile operators are already moving to provide several of the basic enabling services. As the value of applications that make use of the information from smart home devices becomes more apparent, mobile operators will be well placed to play a growing role in providing both the connectivity and enabling services.





Smart Home Services and Requirements

Smart home services must be designed to address the needs of the mass market consumer: Affordability, reliability and usability.

The addition of basic wireless connectivity to a device is typically a significant step forward in product innovation. However, our long-term vision of smart home services extends far beyond basic connectivity.

We believe that many product and service developers have yet to imagine the new kinds of services that will appear in the future smart home. These will be enabled through the adoption of interoperability standards, which will foster greater collaboration amongst communications and service providers, utilities and health sector representatives and also a new breed of service and technology providers with strong data analytics capabilities.

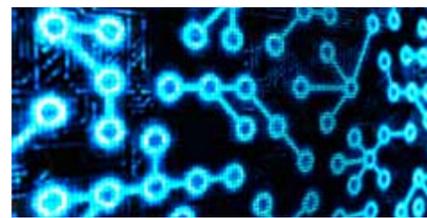
Each of the different types of organisation will need to address a mix of technical, operational and functional requirements, driven in part by the emergence of new business models, partnering arrangements and regulatory factors. This chapter outlines some of these key requirements in relation to future smart home services.

5.1. Smart home services

Smart home services must be designed to address the needs of the mass market consumer: Affordability, reliability and usability. The production of large volumes of devices will provide the economies of scale necessary to drive down equipment costs and deliver affordable solutions; this has been repeatedly demonstrated over the history of the mobile communications industry. This leaves two service requirements to be addressed:

- **Usability** – Usability will be a key attribute of intelligent services that make use of sensor data and control connected devices, such as the supply of smart meter and sensor information to homeowners to enable remote control of smart appliances and security systems, or the gathering and analysis of data used in assisted-living applications. Many of these services will initially be delivered in silos, independently of one another; over time, interoperability technologies and data aggregation capabilities will allow more sophisticated services to be provided. Designers need to consider the user interface and quality of integration across different silo functions. Of equal importance will be the consumer's initial experience of installing and configuring smart home devices: The economics of mass-market solutions dictate that consumers will have to self-install many of their connected devices so a positive out-of-the-box experience is an important usability goal.
- **Reliability** – The challenge of delivering reliable end-user services can be addressed through a largely hidden category of enabling services. These are sometimes referred to as horizontal or platform services and their aim is to ensure a trouble-free end-user experience. They ensure suitable home- and wide-area connectivity, including device provisioning, registration, authentication, data transfer, content and rights management, etc. Enabling services also encompass maintenance functions, such as application and device status monitoring, remote repair, firmware updates etc. These are typical functions associated with any well-designed ICT-based service.

The requirements associated with smart home service categories are considered in more detail below.



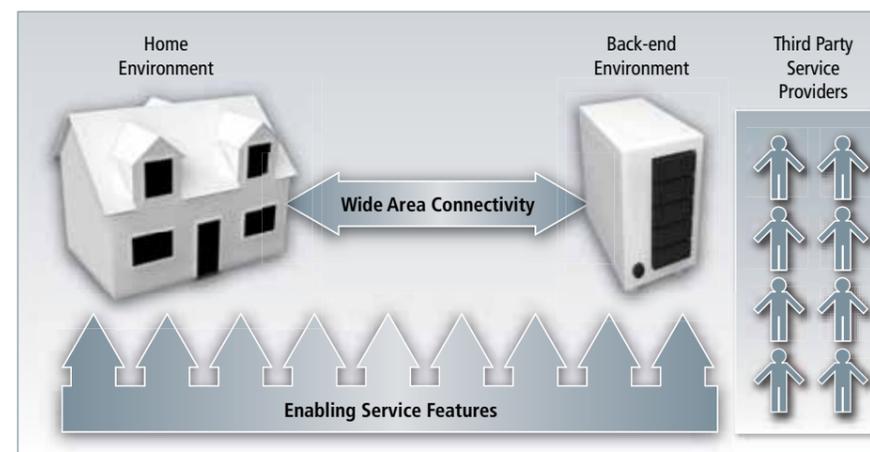
5.2. Smart home service delivery requirements

In the future smart home, devices and sensors will need to be connected via secure, reliable, high-bandwidth wide-area networks. Scalable and interoperable IP-based communications protocols will be required for both wide area networks and home area networks to facilitate the sharing of content and to permit interoperability of home devices, therefore encouraging innovation and the creation of value-added new services. Ideally, information from multiple devices needs to be accessible through a single user interface or portal. Robust back-end systems are required to gather and process data from sensors and connected devices, and open APIs are needed to allow the development of innovative smart home applications. Last but not least, the business ecosystem needs to evolve.

We have identified six key components of the smart home system that address these needs as illustrated in Exhibit 11 below:



Exhibit 11 Smart Home Ecosystem Requirements



Case Study 2

The Demise of PowerMeter and Hohm and the challenges of HEM

In quick succession, on 24 June and 1 July, Google and Microsoft, two trailblazers of home energy monitoring tools, announced that they would discontinue their competing products (PowerMeter and the Hohm) as of 16 September 2011 and 31 May 2012 respectively, due to the lack of significant uptake.

In hindsight, several factors contributed to the demise of the two products, among them the limited functionality of the online HEM tools offered by Google and Microsoft, lack of automated real-time readings of utilities data, and no integration with other home devices. Neither product was able to offer consumers a clear value proposition, burdening them with complex configuration procedures without a significant financial reward.

Despite the failure of PowerMeter and Hohm products, Google and Microsoft helped other companies in this market by starting to educate householders about these types of products. Both Google and Microsoft created attractive graphical interfaces accessible on the internet.

The release of APIs to device manufacturers by Google in 2010 allowed viewing the PowerMeter HEM data on a variety of devices. Google is now focusing on the aforementioned Android@Home, and other online portals, such as EarthAid, are emerging to provide free online HEM tools for consumers.

1. Home Environment – the home environment needs to accommodate a wide range of connected devices, each using different wireless technologies in both dedicated and shared spectrum bands. A home gateway will be needed to control and monitor devices, connected via a mix of wired and wireless backhaul technologies. The gateway will be used to connect a smart home HEM to a smart grid, while allowing remote control over heating and ventilation appliances; the charging of electric vehicles; and, in-home energy production sources.

The smart meter and the home energy gateway may be integrated into a single device or be two separate physical devices, depending on specific local market factors. In some markets smart meters will have to conform to strict regulatory specifications resulting in a dual-gateway architecture. In some cases, this could mean the emergence of two types of home energy gateways – one owned by the utilities to control home appliances, electric vehicle charging and renewables to balance electric grid load (similar gateways could also be owned by healthcare and security providers); the second one owned by home users, would be used to aggregate information about various connected devices, control them and potentially pay for them. The latter gateway should be able to interface with a range of devices that gather information and control home appliances; therefore, it needs to include an open standards-based component and easy-to-use APIs to support different applications, most likely from different service providers.

Either type of gateway must have stringent security features to deal with the threats of cyber-hacking and energy fraud, while controlling end-user access and information privacy.

Although there are now a large number of home energy monitoring devices on the market, the delivery models and business models have not evolved clearly. From the householder's perspective, HEM systems need to be plug-and-play and connectable to other devices in the home, with automatic control of energy consumption, linked to the time of use prices, where these have been introduced. The decision by Google and Microsoft to withdraw their HEM tools from the market illustrates the difficulties service providers face (see case study below).

2. Wide Area Connectivity – the wide-area network (WAN) connectivity requirement is for a two-way system of communications, capable of connecting large numbers of devices simultaneously. It needs to provide the widest possible coverage and availability for urban and rural homes alike. WANs also need to be able to evolve to address the needs of future smart home services and applications. For example, future service requirements will progressively impose a need for more frequent and higher bandwidth communications on the underlying transport medium.

Utility companies are asking for a 10 to 20 year life-cycle for the communication systems connecting smart meters; other home appliances, such as refrigerators and washing machines, could have a replacement cycle of 7-8 years. It must therefore be possible to manage large-scale technology upgrades with minimal system disruption and un-planned costs, ideally using over-the-air upgrades, or through easy replacement of modular communication components. As the value of information in smart home applications increases, end-to-end security will become an increasingly essential feature.

3. Back-end Environment – back-end systems are required to gather and analyse data readings from smart home devices and then trigger control events. In the first instance, these systems need to provide information in a form that is useful to home monitoring and control service providers (such as utility, security and healthcare companies) and also to householders. The growing number of connected households and devices means it is critical that these back-end systems are both robust and scalable. The back-end systems need to be dimensioned for millions of households per country, accommodating the 30 sensors per household that may be necessary to make a home monitoring system comprehensively meaningful to occupants.

In addition to gathering and hosting large volumes of data securely, back-end systems will also be required to provide access to external service providers; this may be because data from different providers – utility, home appliances, ancillary electrical appliances, among others - need to be integrated in delivering smart home control and monitoring services.

4. Enabling Service Features – The smart devices in a household need to be managed in ways that deliver a high quality user experience while masking technical complexities. Device management services, for example, will need to support service activation, configuration, virus protection, remote diagnostics and firmware updates. The communication process between household devices, a gateway and provider back-end systems also needs to be managed. Basic management functions include formal delivery-acknowledgement or store-and-forward processes, for example. For more sensitive data, encryption and message-acknowledgement features will be increasingly important. The management of network connectivity has to ensure high levels of availability under normal operating conditions and to manage failure situations in ways that do not overwhelm wide-area networks and back-end systems.

5. Third Party Service Providers – The number and diversity of suppliers across energy, mobile health, home security and entertainment sectors means the supplier ecosystem for connected devices will be highly fragmented. There will be a need for applications and services that help device vendors and household occupants to manage their lifestyle and energy consumption in aggregate.

New business models need to emerge to allow service providers to gain access to data for use in developing new services and applications. Data analytics service providers, for example, may seek access to the back-end system so they can offer reliability analysis, predictive maintenance or even social networking applications designed to help households to benchmark their consumption patterns within their local neighbourhood. In the UK's smart metering sector, a Data Communications Company (DCC) will be established to provide data rights and access to control management functions, in addition to translation services, to facilitate access to data by independent value added service providers.

6. Business, Ecosystem and Technology Environment – smart systems in the home will require the marriage of expertise from the communications and IT sectors with that of the utilities, home security, mobile health and entertainment sectors. Partnerships and cross-sector collaboration are to be encouraged. Such partnerships will need to create a trusted service delivery environment in the eyes of regulators and consumers. They will also need to encourage the development of service and application developer communities, and address the differences in their expectations for technology evolution, service life-cycles and control of the customer relationship.





The home gateway will become an aggregation and transit point for significant amounts of information about households, their consumption patterns and payment characteristics; therefore, it will be essential to ensure that consumers develop a sense of confidence in a trusted service-delivery environment. Trust and accountability will be important in facilitating access to usage and payments-settlement information amongst different business partners.

The business and technology ecosystem will also need to support innovation, affordability and scalability. The success of gaming applications and app stores in the mobile market, for example, demonstrate the power that can be unleashed with the backing of a large developer community.

Last but not least, the communications and the adjacent vertical industries have dramatically different life-cycles for their services: from 3-5 years for fast-moving mobile and IT industries to 15-20 years for entrenched utilities services. These differences need to be reconciled, and a clear technology roadmap needs to be apparent to the adjacent vertical industries. This is necessary in order to build trust and set the right expectations, and to encourage investment in the infrastructure needed to support smart home services.

Mobile network and IT technologies are highly unlikely to remain static for 15-20 years. Communication networks and their upgrade paths need to be planned to meet future growth, innovation and service quality requirements.

The key requirements to support the smart home vision of the future are summarized in Exhibit 12.

Exhibit 12 Smart Home Services – Key Requirements

Market Factor	Key Requirements
Home environment	<p>Home area network connectivity:</p> <ul style="list-style-type: none"> - Ability to access and connect appliances from different suppliers potentially using different radio access technologies - IP-based communication protocols to enable interoperability of devices - Support end-to-end security (open end points/radio access portion should not jeopardize the overall security of the network) <p>Usability requirements:</p> <ul style="list-style-type: none"> - Ease of installation and configuration of connected devices; the mass-market goal implies some degree of self-installation - Intuitive and easy-to-use interfaces <p>Home devices requirements:</p> <ul style="list-style-type: none"> - Central hub – this may be a smart meter or home energy gateway that provides private, secure and authenticated access to connected appliances and service-provider back-end systems for information, control and payments functions. - Smart meter: needs to have modular communication architecture that is easy to upgrade or replace. Such a meter may be a regulated device in some markets



Market Factor	Key Requirements
	<p>Home energy management (HEM) gateway requirements:</p> <ul style="list-style-type: none"> - Open platform component to host diverse energy management applications which may expand to include entertainment, health and wellness applications over time. - Connected appliances: plug-and-play, easily configurable and interoperable with HEM gateway (and smart meter if this acts as the aggregation hub in the home)
Wide-area Connectivity	<ul style="list-style-type: none"> - Two-way communications capability that can be applied to very large scale deployments (multi-million connected devices) - Coverage and availability in urban and rural areas alike; this may involve a combination of WAN technologies (e.g. wireless + fixed, mesh, PLC) - Support end-to-end security - WAN technologies need to accommodate long life-cycles of some devices (e.g. 10-20 years for smart meters; 7-8 years for home appliances. This would require a credible, long-term technology road-map including improvements in technical features to support future applications and bandwidth needs, either via over-the-air upgrades, or through easy-to-replace communication module design)
Back-end Systems	<ul style="list-style-type: none"> - Secure, automated capture and storage of home sensor data - Highly scalable (rising data volumes in line with frequency of data readings) - Interfaces to permit utility company, household and third-party service provider access to data with appropriate authentication, privacy-control and payment settlement mechanisms
Enabling Services	<ul style="list-style-type: none"> - Remote device and service activation - Remote gateway and smart appliance management (configuration, firewall, virus protection, diagnostics and repair, firmware updates etc.) - Managed data delivery (delivery confirmation, encryption, content back-ups etc.) - Connectivity status monitoring - Gateway and device registration during recovery from network outages
Third-party Service Providers	<ul style="list-style-type: none"> - Availability of standardized interface technologies to provide secure access to data from different connected devices; this applies to back-end systems (data storage, policy servers, usage and billing systems etc) and also to the home energy gateway (for in-home applications)
Business, Ecosystem & Technology	<ul style="list-style-type: none"> - Cross-industry partnerships spanning financially-viable communications, IT and vertical sectors - Trusted service-delivery environment - Active application developer and service provider ecosystem - Long-term technology road-map and suppliers with expertise in technology change management

The set of requirements summarised in Exhibit 12 illustrates that the key to unlocking the smart home services market is much more than a matter of technology. Cross-industry partnerships and the design of compelling services that integrate data from different connected devices will have a big impact on market adoption rates. Last but not least, customer acceptance built on usable designs, affordable price points and trust based on data security and privacy policies will be of over-riding importance.

In the next section, we analyse the role mobile industry can play in supporting these requirements.

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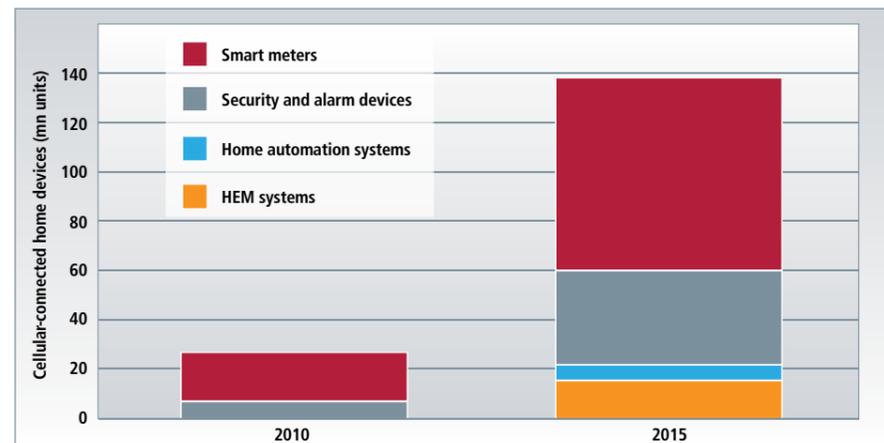


The Value and Role of Mobile

There is little doubt that mobile operators and technologies will play a significant role in the smart home.

Mobile networks will connect a growing range of devices from smart meters to security cameras and gaming consoles in the home (see Exhibit 13). Meanwhile, mobile handsets and tablets will provide a screen and an interface for monitoring and controlling smart home devices from anywhere with mobile coverage. Inside the walls of a smart home, mobile networks will coexist with various short-range wireless technologies. Moreover, suppliers from the mobile ecosystem will also contribute sophisticated functionality and service applications, building on their established consumer applications expertise.

Exhibit 13 Cellular-connected home devices, 2010-2015



Source: Berg Insight, Beecham Research

In the chapter below, we review the assets the mobile industry can bring to the smart home, as well as the roles mobile operators could potentially play in the future.

6.1. The value of mobile

Mobile connectivity brings a number of business and technical capabilities that will be crucial for the successful uptake of smart home services: The mobile industry delivers each of the following:

- **Wide-area coverage** at cost points which are far more attractive than those offered by satellite, fixed- and private-wireless networking alternatives.
- **A dependable communications platform** - a recent pilot⁸ in Ireland with a mix of access technologies, including GPRS, RF mesh and PLC found that GPRS delivered the most reliable performance for meter readings, compared to alternative approaches, by a significant margin.
- **Trusted brands well known to consumers** - phones, smartphones and tablets have reached the status of being 'constant companions' for most consumers.

- **Commercially-viable and credible partners** for companies in adjacent industries – the mobile industry includes numerous large and financially robust communications- and equipment-suppliers that are comparable in size to utility, health and entertainment providers from adjacent industries. The mobile industry has also shown itself to be adept at managing rapid technology change, a capability that many adjacent industries will also need to master.
- **Complementary technologies to enhance the functionality of smart home services.** Mobile operators' capabilities include billing, authentication and security control, providing context, situation-aware and location information, as well as distributing smartphone and tablets as complementary devices for user-interface and remote control functionality.

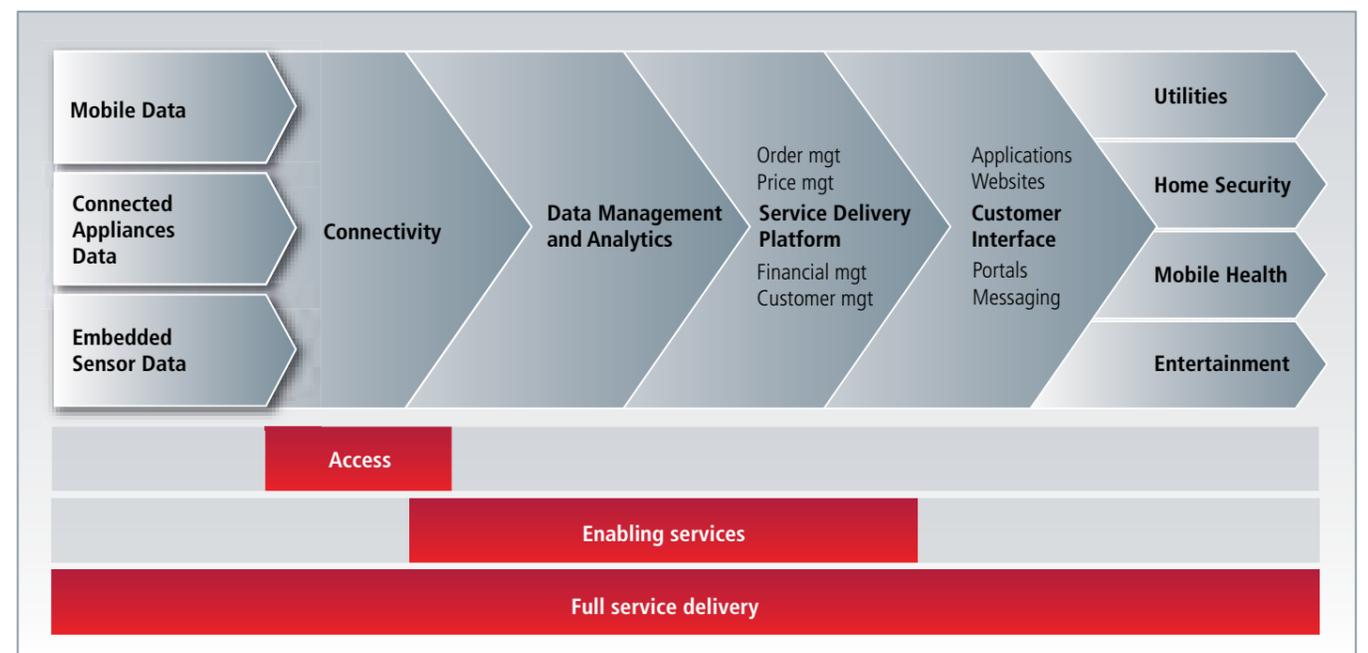


6.2. The role of mobile

The exact role that will be played by mobile operators in the future smart home 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 operator.

Exhibit 14 below shows a generic service delivery value chain and describes the way in which data from multiple sources is applied in delivering a range of smart utilities, security, health and entertainment services.

Exhibit 14 Smart Home Value Chain



Source: Accenture, Smart Mobile Cities report, 2011

The role of mobile operators in this value chain can vary from that of:

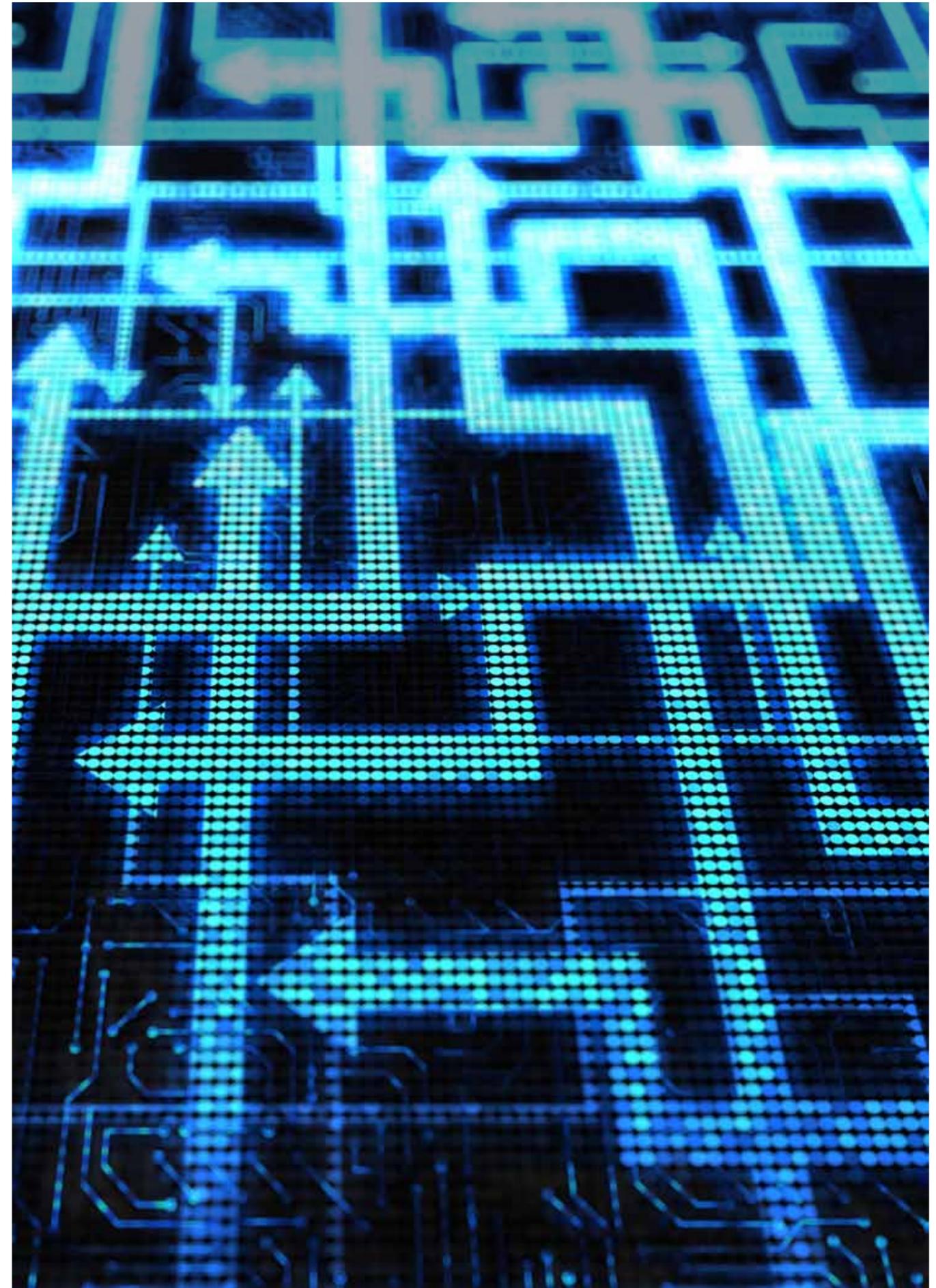
- access provider for connectivity services alone
- enabling services provider
- full service delivery where the mobile operator has a direct customer relationship

On a practical level, mobile operators may need to adopt specific commercial structures to participate in the smart home services market. Regulatory conditions, such as limitations on the use of consumer data, may enforce a strict business separation between the connectivity, data management and service delivery platform elements of a communications service provider, for example. The U.K. is currently developing this kind of regulatory framework for the utilities market where multiple connectivity providers, supported by a single data management company, is envisaged.

In cases, where a mobile operator and an utility provider are partnering to deliver smart home services, for example, the question of which company manages the customer relationship is a recurring theme. Some utilities companies, which are strategically focused on energy production and distribution, place a low priority on managing the customer relationship, while others wish to be the only entity dealing with the consumer.

New smart home services will not necessarily fit cleanly into communications or utility categories in the minds of consumers. The need to combine mobile and utilities expertise may well favour a joint-venture style of business model to target this market. There are precedents for this kind of approach in the mobile money sector where financial institutions are partnering with mobile operators. Several mobile operators have started to recruit executives from adjacent industries to expand their role in the embedded mobile market.

It is clear that mobile networks, mobile operators and other suppliers in the mobile ecosystem can provide considerable value to companies looking to add connectivity to their devices and services and target the emerging market for smart home services. While the building blocks are all present, there does remain some further work to facilitate cross-sector collaboration, to implement new business models and to encourage interoperability standards. These are discussed in the next chapter.





Roadmap for Market Development

To develop the smart home market and promote cross-industry collaboration, there is a need for a common understanding of the market opportunity across mobile- and adjacent-industry participants.

The market for smart home services is at an embryonic stage of development with many companies working in parallel on new service concept testing, technology development and partnering between vertical-sector specialists and communications providers.

Much work remains to be done to develop the market opportunity. In order to promote cross-industry collaboration, there is a need for a common understanding of the market opportunity across mobile- and adjacent-industry participants. In practice that means:

- the development of a cross-industry lexicon for business- and service-models;
- support for key technical enablers aimed at interoperability and scalability;
- guidelines to assist non-mobile companies to add connectivity to their devices and services over the short- and long-term;
- cross-industry service development and testing involving both suppliers and service providers;
- management of key messages to consumers and regulators about the benefits and inherent safeguards associated with new smart service concepts.

Exhibit 15 Smart Home Market Development: Proposed Actions for the next 6-18 months

Area for action	Proposed actions
Regulatory	Discussions between main regulatory bodies in different sectors need to take place, to uncover major barriers to the growth of smart home services. Utilities and healthcare are two strictly-regulated sectors that can benefit from such discussions with the communications industry, in order to create opportunity for such services as elderly care and assisted living. An initial dialog has started taking place between the FDA and FCC in the US, for example.
Standardisation	Relevant standards from adjacent industries need to be reviewed and gaps established. For example, work on the smart grid standards, which has been launched by CEN-CENELEC-ETSI in Europe (conducted by the Smart Grid Coordination Group) needs to take into consideration the requirements of healthcare industry. Interoperability and security need to be prioritised in all such discussions.
Market research and business model analysis	A number of market development initiatives need to take place, for example: <ul style="list-style-type: none"> - Launch of market research projects to test new business, operational and technical concepts for the smart home; - Joint development of smart home business models and value propositions for the mass market, with market studies and proofs of concept. These would improve consumer awareness of smart home services and industry understanding of the main drivers behind the mass market adoption of these services. - Joint development of social media strategies to educate householders about smart meters and assuage concerns around the installations of smart meters and smart home systems.
Technology	Work on interoperability of smart home devices, for example, HEM interop events, needs to be ramped up, to achieve large scale for the smart home services.



The GSMA's primary call for action to organisations in adjacent industries is to collaborate on the four areas outlined in Exhibit 15 opposite. These aspects of market development, perceived as critical by mobile operators, will need to take place over the next 6 to 18 months.

Representing the interests of mobile operators worldwide, the GSMA is uniquely positioned to support the development of connected services for utilities, healthcare and automotive sectors, and has recently launched an Embedded Mobile Programme (see Exhibit 16) that aims to address some of the four areas outlined above.

The GSMA's Embedded Mobile programme has committed to the following market development activities:

- Raise cross-industry awareness of the emerging smart home service opportunities – this "Vision for Smart Home Services" presents a framework to help develop a cross-industry lexicon and raise the level of collaboration among organizations from different market segments.
- Specify gateway requirements ideally leading to the design of an interoperable technical architecture that accommodates the connectivity capabilities of different wide- and home-area wireless technologies as well as the information handling needs of different industry-specific providers
- Implementation guidelines – the GSMA has published and maintains a set of module design guidelines which are intended to help device manufacturers consider the different issues related to embedded connectivity. To address longer-term design decisions, the GSMA will be publishing a Technology Road-map outlining the long term intentions and capabilities of mobile network technologies. This is particularly important for companies that provide long service-life devices or which are reliant on advanced capabilities associated with newer generations of mobile networks.
- Industry representation in regulatory and standards bodies – the GSMA participates in several standardization bodies, such as CEN-CENELEC-ETSI's Smart Grid Co-Ordination Group to contribute to the development of new smart grid standards, to learn about new market developments, and to disseminate new information amongst its members and to represent the interests of the mobile industry.
- Industry promotion – the GSMA participates in international exhibitions to present the results of its market research and relay key messages about the market potential for smart home services. In addition to these in-person activities, the GSMA also hosts research webinars and maintains several web portals dedicated to the consumer electronics, health and utilities sectors.

Exhibit 16 GSMA Embedded Mobile Programme



8

Conclusions

Service providers need to address several market challenges, such as the need to design for interoperability and integrate existing standards from different applications domains.

There is clearly a very promising future for smart home services. The current avenues of development are in smart energy (prompted by a policy mandate for smart meters coupled with new connected devices in the home ranging from appliances to electric vehicle charging points and local generation) and entertainment (home area networking).

The long-term direction of the smart home involves numerous connected devices— as many as 30 smart sensors and devices by some estimates – which share a common information highway. This would enable the delivery of a range of value added services to meet consumer lifestyle needs (home energy management, allows security, assisted living etc.).

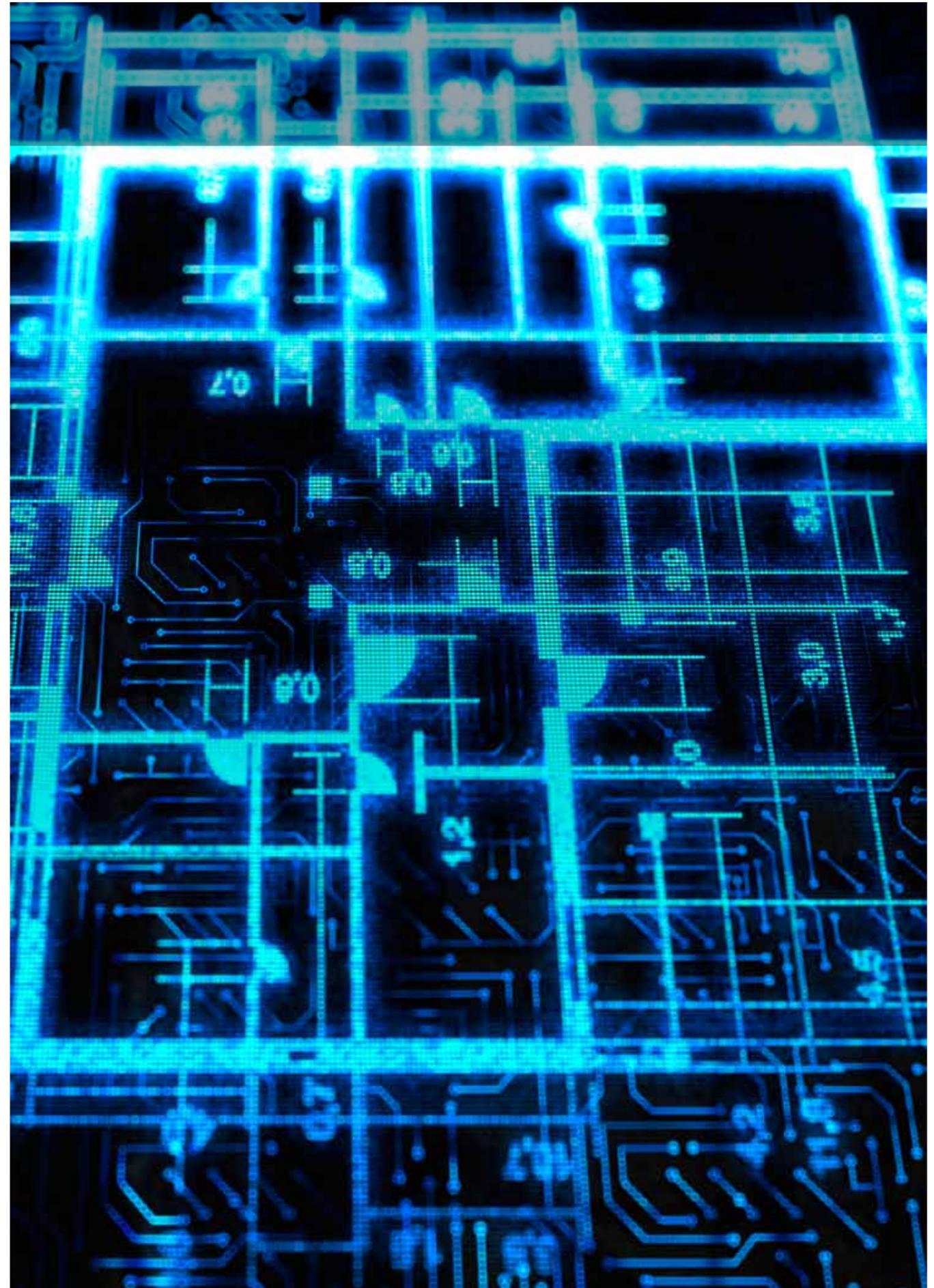
The mobile industry has an important role to play in several respects. Firstly, mobile devices are the most readily-accepted connected consumer devices in the world; most consumers are familiar with mobile devices and their sophisticated, yet intuitive, user interface functions.

Secondly, the mobile industry is experienced in managing and masking technology complexity. Many of the new smart home services will depend on managed service capabilities encompassing connectivity, data integrity, remote device management or security.

Thirdly, companies in the utility sector will want to partner with financially-viable counterparts from the communications and IT sectors. The mobile industry is not only financially robust, but it has a long-term technology road-map that will accommodate the planning horizon and future smart grid service needs of the utilities industry.

In order to facilitate the emergence of the smart home, service providers need to address several market challenges, such as the need to design for interoperability and to consider how best to integrate existing standards from different applications domains.

The GSMA has outlined a strategy to address these challenges and provide much-needed market intelligence about new service opportunities, regulation, technology dependencies and new business models. These activities will lay the basis for a common lexicon for smart home services that can be used by mobile and non-mobile organisations to promote a common interest in developing the smart home services market.



Annex A – Mobile Assets for the Smart Home

Mobile Assets	Key Characteristics
Coverage, availability and resilience	<p>A variety of fixed and wireless technologies have been tested and used in delivering connected services to the home. In developed markets, copper and fibre-based solutions have been in the forefront of delivering entertainment and Internet services; in other markets, the lack of infrastructure means that fixed-line technology does not offer a credible mass-market solution. Mobile solutions, through their unrivalled reach and global presence, represent a standards-based platform for wide area connectivity with a technology evolution path that can accommodate future application and service opportunities.</p> <p>For smart homes users who do not have fixed lines – people in emerging markets, those with second homes and mobile-only households – mobile networks offer convenience and in some cases may be the only connectivity option.</p> <p>Mobile networks have been built to ensure high availability with multiple redundancy mechanisms. These are important attributes for widely-deployed and large installed-base application scenarios. A recent pilot in Ireland with a mix of access technologies, including GPRS, RF mesh and PLC indicated that GPRS was better able to deliver meter readings than alternative approaches, by a significant margin.</p> <p>Mobile technology is not appropriate for small, inexpensive, low-power sensor devices, but it does have a role in larger and higher price-point device formats, suited to mass-market applications where connected appliances from different suppliers would need to be registered to an access point.</p>
Enhanced functionality of smart home services	<p>One of the most attractive features of smart home services is remote monitoring and control of home devices. Mobile will also be crucial to adding context- and situation-awareness to the services and applications. With location-based functionality added, interesting new applications might evolve: for example, triggering a specific home profile, with specific heating and lighting settings, when residents are near their home. A smartphone, with built-in accelerometers, can also itself become a sensor providing inputs into home automation systems.</p>
Authentication and Security	<p>Every mobile customer is used to the experience of turning on their mobile phone and being assured that the network recognises them and will route calls made to their phone number correctly. To do this, the network and the device have to establish a trust relationship that can be relied upon. This is done by using encryption algorithms and network-generated ‘challenges’ to the customer’s phone so that the network can be sure that the device (and more importantly, the phone number and associated subscription) is who it says it is.</p>
Billing	<p>Sophisticated billing systems go hand-in-hand with the authentication and security mechanisms of a mobile operator’s network. To offer prepaid data services, for example, mobile operators have developed appropriate real-time charging mechanisms. The addition of NFC functionality to mobile phones will enable operators to also bill for services in devices, such as electric vehicles.</p> <p>By using the mobile operator’s billing systems to generate charges and to understand the data usage of individual devices, third parties can pass on charges where applicable, or be assured that the charges being levied by the mobile operator are accurate. The integrity that has been built into mobile operators’ billing systems can be used by businesses outside of the traditional mobile telecoms value chain to understand a great deal about their customers’ usage patterns.</p>

Mobile Assets	Key Characteristics
Subscription and Device Management	<p>The mobile operator has a responsibility to manage its customers’ subscriptions correctly, so that the customer receives all services that they are entitled to and equally does not receive (and as a result, is not charged) for services that they do not subscribe to. If necessary, this functionality can be provided to third parties, such as home appliance manufacturers, who do not currently have direct relationships with customers.</p>
Customer Care and Customer Support	<p>Traditionally, customer support has been carried out via call centres, but is increasingly moving to online support as a cheaper, more efficient option. The expertise that mobile operators have in being able to provide consumers and corporate customers with advice and support on matters relating to both their services and related devices has considerable value, which can be extended to include support for services that are in the embedded mobile sphere.</p>
Business, Ecosystem and Technology Environment	<p>Utility providers, which are typically large, technologically-conservative and safety-oriented organizations are facing disruptive changes to their operating models with the advent of smart meter and smart grid infrastructure. These organizations want to deal with partners that are financially stable, that are likely to be in business two decades from now and which can outline a services vision and technology roadmap that can adapt to future market needs. The mobile industry meets all of these criteria and its supplier and service provider ecosystem constitutes a significant source of value for utility and other sector companies.</p>



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September 2011