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Benefits of GSMA Embedded SIM Specification for the Utilities Sector

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OVERVIEW

The GSMA Embedded SIM Specification is now established in the M2M/IoT market and has been successfully introduced to the automotive sector. It is evident that the Utilities sector can also benefit greatly from this technology.

Part 1 of this report explores the opportunities of the GSMA Embedded SIM Specification for the Utilities ecosystem, including partners and suppliers to the Utilities. Part 2 then assesses the business benefits of the GSMA Embedded SIM Specification exclusively for Utilities by means of specific use cases.

In researching this report, views were sought from Utility ecosystem partners and suppliers including smart meter manufacturers, leading MNOs (Mobile Network Operators), SIM suppliers and cellular module suppliers as well as from a variety of Utilities with different roles in the Utility market. The focus of the research has been primarily on electricity supply, but the benefits identified and analysed are also relevant for gas, heat and water supply.

In this report the potential benefits of this technology were explored in the context of 5 important Utility use cases and 14 significant benefits of the GSMA Embedded SIM Specification have been identified, grouped into four categories:

- Improving Reliability and Reducing Site Visits.
- Improving Security and Trust.
- Reducing Cost and Complexity.
- Reducing Commercial Risk and Increasing Commercial Flexibility.

Some of these benefits have also been quantified.

Utilities are encouraged to explore these benefits that the GSMA Embedded SIM Specification and the eUICC deliver for their particular businesses and use cases. Our study of the Utility IoT use cases included smart metering, demand response, energy data management, distributed energy resource management and we found that Utilities benefit from:

- Licensed radio spectrum, scalable networks, mature standards-based technology, embedded security, and wide ecosystem support when they specify mobile connectivity solutions for their IoT devices.
- A sustainable reduced total cost of ownership, greater whole life device security and a common industry solution which provides scalable, reliable and trusted connectivity when they utilise the GSMA's Embedded SIM Specification and the eUICC.
- Higher reliability, increased commercial flexibility and from simplified logistics when utilising the GSMA Embedded SIM specification. This allows over the air management of operator subscription profiles without the need for a physical change of SIM, for example, enabling late operator binding, solving the problem of operator lock-in and reducing the need for site visits.
- Reduced commercial risk and from proven security features, as described in the GSMA IoT Security Guidelines, when using the eUICC. These include tamper-resistance and the ability to enhance trust and confidence through maintaining data integrity.

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PART 1 - eUICC: NEW IoT OPPORTUNITIES FOR UTILITIES

1. INTRODUCTION

The traditional removable SIM card (Subscriber Identity Module) has contributed significantly to the growing success of the mobile handset market for many reasons. This has included its inherent network security features as well as the ability to select and change the mobile operator the user wants at the point of sale in a retail outlet. However, it is not ideal for the M2M/IoT (Machine to Machine/ Internet of Things) market and particularly not for applications like smart metering in the Utilities sector. The majority of Utility applications are not purchased through retail outlets, so matching up the SIM card and device often occurs on site, which introduces new and sometimes costly logistical issues. In addition, if there is a need to change the mobile operator during the life of the application, then a site visit is required to change the SIM card. Even when on site, the card may be physically difficult to access. It may, for example, be up a lamppost. It may be in a small cabinet out of easy reach. Or if it is easy to access and in a public location, it may then be open to tampering and even theft. Such issues and more all add cost and further logistical challenges in the use of removeable SIM cards for M2M/IoT applications.

The M2M/IoT market, including the Utilities sector, is set to grow at a fast pace over the next decade, with an ever-growing number and diversity of devices and applications requiring communications capability. To address the challenges posed by the traditional removable SIM card in this market, a new type of SIM called an eUICC (embedded Universal Integrated Circuit Card) has been introduced and the GSMA has published the Embedded SIM Technical Specification covering both the eUICC and the Remote SIM Provisioning for M2M specification. The eUICC[2] is a small electronic chip inserted onto the circuit board of a device during manufacture. As such it is embedded in the device and cannot be physically removed. It is updated with network operator and other data over the air using the Remote SIM Provisioning for M2M specification.

> " A new type of SIM called an eUICC (embedded Universal Integrated Circuit Card) has been introduced. It is updated with network operator and other data over the air using the Remote SIM Provisioning for M2M system. "

A previous report by Beecham Research, commissioned by the GSMA and published in September 2014, assessed the business benefits of the GSMA Embedded SIM Specification for the Automotive and Consumer Electronics sectors[1]. This new report has been commissioned by the GSMA working with ESMIG, the European voice of smart energy solution providers, and the SIMalliance and continues this work by examining the business benefits of GSMA Embedded SIM Specification for Utilities and their supporting ecosystem partners and suppliers.

2. M2M / IoT MARKET CONTEXT

The M2M market is rapidly gaining momentum across a wide range of application sectors. The use of connected device technologies is transforming the way organizations operate and creating new revenue opportunities.

To appreciate where and to what extent eUICCs can be particularly effective in the M2M market, it is useful to categorize M2M applications according to their market dynamics. Firstly, **After-Market** applications usually involve retrofitting connectivity to products already installed and working in the field, for example connecting vending machines and equipment for monitoring environmental conditions. They tend to automate operations already running and are typically introduced to gain operational cost savings. These applications occur in all business sectors and often require high

[1] See Benefits Analysis of GSMA Embedded SIM Specification on the Mobile Enabled M2M Industry, September 2014

[2] This report focuses on the soldered eUICC. Other removable eUICC designs & form factors are available; for further information including physical dimensions, see:
- https://www.emnify.com/2016/01/29/euicc-what-it-is-and-why-it-matters/
- http://www.etsi.org/deliver/etsi_ts/102600_102699/102671/09.00.00_60/ts_102671v090000p.pdf
- http://www.statschippac.com/packaging/packaging/waferlevel/wlcsp.aspx

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levels of technical support to implement. The IoT market started with this category of applications but, because the connectivity is added after manufacture, they are not usually prime candidates for eUICCs.

> " Connectivity is also added during manufacture. This will tend to be introduced by OEMs for whole product lines, and the products themselves may be used anywhere in the world. This makes the logistics of current removable SIM cards very challenging and costly, while the eUICC is ideal."

Compared with these, **Regulatory/Government** applications are created by the need for compliance with the introduction of new regulations or government requirements, usually associated with particular applications. Road pricing for Heavy Goods Vehicles in Germany and congestion charging in London and other cities are typical applications, as are smart metering applications in a growing number of countries. We are also now seeing Smart City and Smart Grid applications in this category. These applications tend to be national or city based and have lengthy gestation periods and design cycles. Connectivity is usually designed-in during manufacture, so that unit costs are kept low with high initial volumes until the base of units required has been installed. The installation volumes then drop to the annual number of new devices supplied to the market. These applications are prime candidates for eUICCs because the connectivity is added during manufacture and the volumes can be high.

Line Fit/OEM-based applications, on the other hand, are most often driven by product manufacturers, acting either in concert with partners or on their own, to create new service opportunities related to their products. Connectivity is designed-in to minimize unit costs for high volumes. These applications can apply to almost any product in any sector, so the opportunities are particularly broad. These applications are prime candidates for eUICCs since the connectivity is also added during manufacture. More than this, they will tend to be introduced by OEMs (Original Equipment Manufacturers) for whole product lines, so the quantities can be global in scale and the products themselves may be used anywhere in the world. This makes the logistics of current removable SIM cards very challenging and costly, while the eUICC is ideal.

The chart shows that each of these categories has different prospects for growth. Whereas the After-Market category is a relatively mature market, it is also fragmented with opportunities still arising in virtually any business sector. Regulatory and OEM are both considerably more recent entrants to the market. The chart also shows a schematic representation of the relative growth prospects for the three categories. The red dots show their estimated current positions – given that there is wide variation across the application sectors. This shows that the Regulatory segment has entered the growth phase.

To reflect this, the Utilities segment in the Regulatory category represents a prospect for eUICCs and is the subject of this report.

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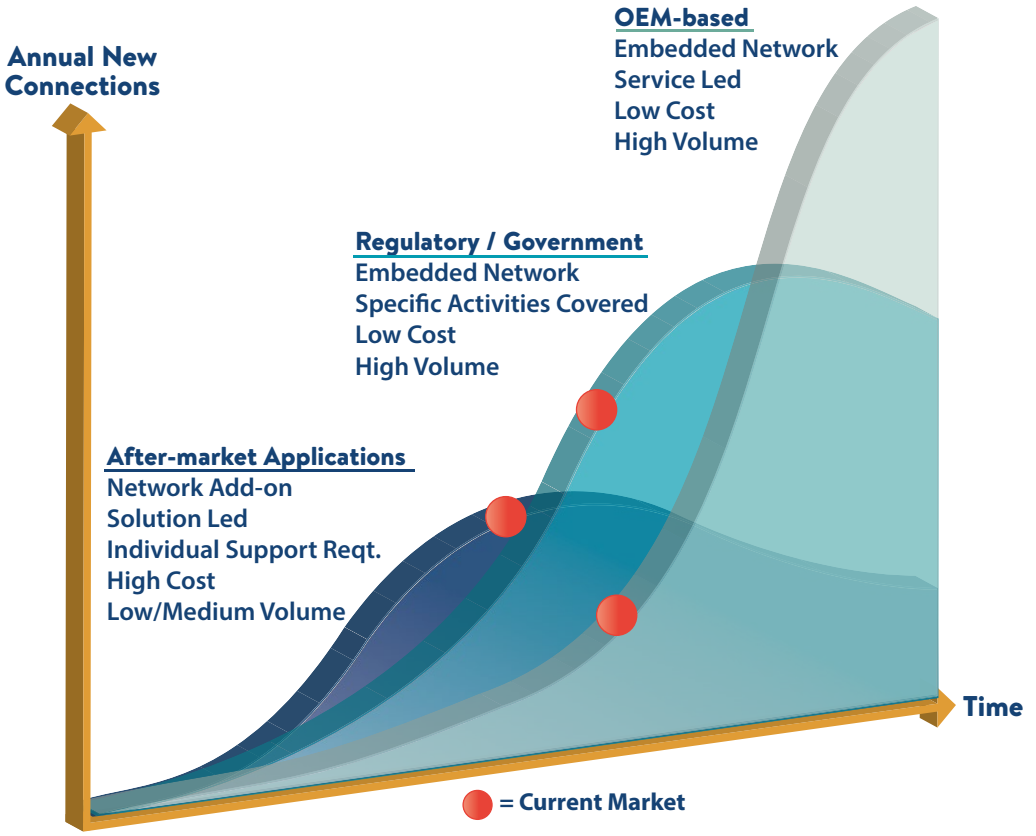
Figure 1.1: IoT Application Categories and Their Impact on Future Market Growth



Source: Beecham Research

3. UTILITIES AND THE ENERGY SECTOR

The Internet of Energy (IoE) represents the key areas within the worldwide energy sector that are already or soon will be affected by IoT. The chart in Figure 1.2 shows the main sub-sectors of the Internet of Energy as petals, with each petal then showing at the outer edge the typical IoT touchpoints relevant to the activities in that sub-sector.

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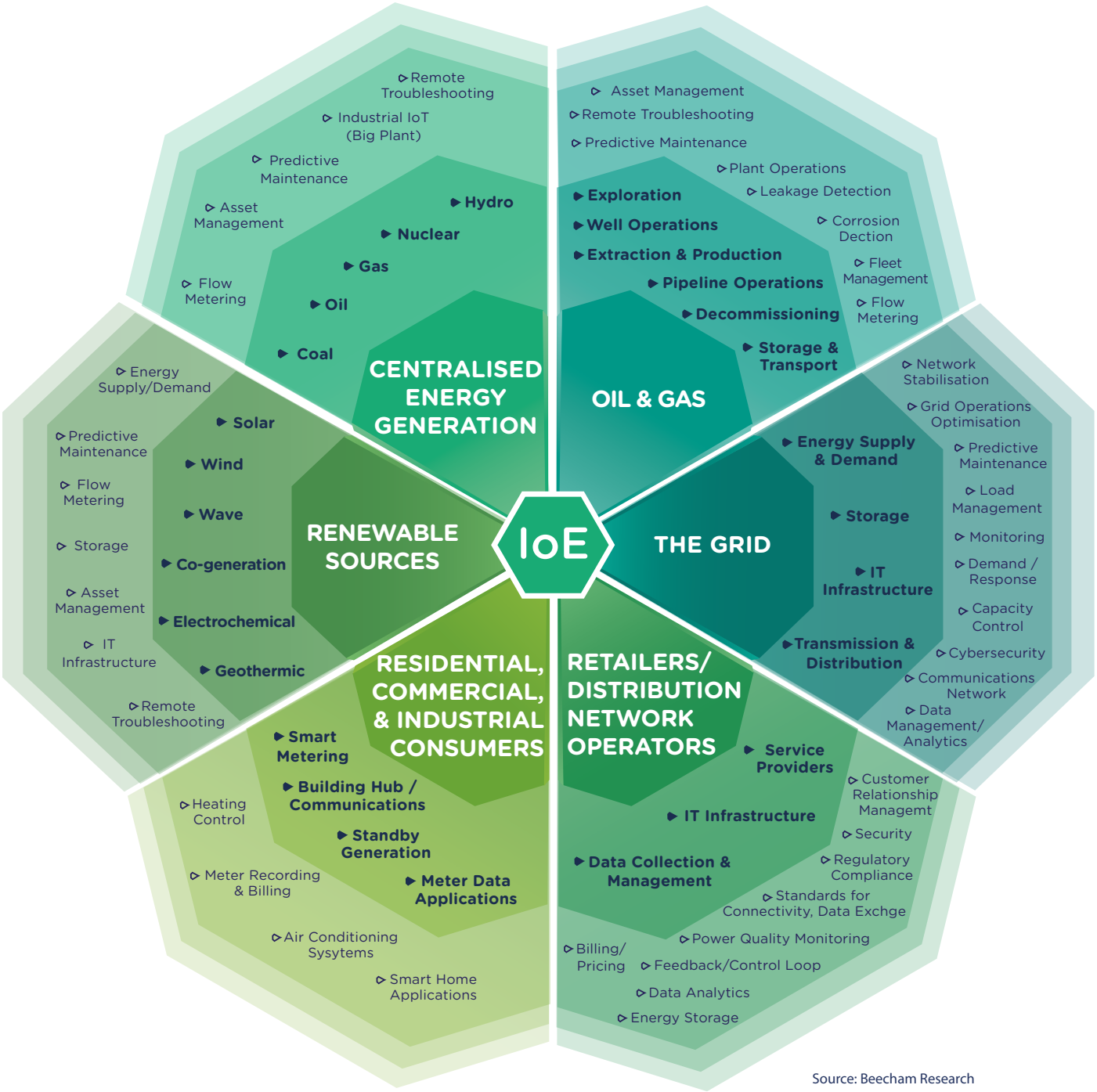
Figure 1.2: Internet of Energy (IoE) showing typical IoT Touchpoints for each sub-sector



Source: Beecham Research

> " It is clear from this that the activities of Utilities are a major factor in 5 out of 6 of the sub sectors within the Internet of Energy and these have many potential IoT touchpoints."

As is evident in Figure 1.2, Utilities are a major presence in all energy sub sectors and therefore of huge significance throughout the Internet of Energy. While their involvement is typically less in the Oil & Gas subsector, which is primarily associated with the discovery, extraction and transportation of fossil fuels, nevertheless even here some Utilities like Centrica are evident. For the purposes of this report and the potential benefits of eUICCs, the roles of Utilities within Centralised Energy Generation, The Grid for Transmission and Distribution, and Retailers/DNOs are of primary interest. The use cases explored in Part 2 then also include benefits for Utilities regarding Renewable Sources at the edge of the grid and also regarding Commercial/Industrial and Residential customers in the other two sub sectors.

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It is clear from this diagram that the activities of Utilities are a major factor in 5 out of 6 of the sub sectors within the Internet of Energy and these have many potential IoT touchpoints, as shown at the outer edge of each sub sector. Turning specifically to the GSMA Embedded SIM Specification and to the cellular connectivity implied by its use, the focus of these activities is around smart meters and smart grids.

4. eUICC IN THE UTILITIES ECOSYSTEM

The introduction of smart metering and the development of smart grids create the need for connecting large numbers of devices in order to generate data for a range of new services. This also implies the need for a higher degree of flexibility in the management of connected devices. Currently, this flexibility cannot easily be achieved using a traditional cellular removable SIM card because changing the physical SIM card is practically difficult and not cost-effective.

Conventionally, removable SIM cards are manufactured in a rectangular shape with a corner cut-off and designed for the handset market. For Utility applications, this form factor has several challenges, such as:

- The removable SIM card system is designed for inserting the card into a device at the point of use, typically a retail outlet. This introduces logistical issues for Utility devices, especially in high volumes, as these devices are not sold through retail outlets, are in fixed locations anywhere within the Utilities services territory so cannot be moved and may be sourced from anywhere in the world.
- Once this type of device is installed, changing the SIM card with another one can be very difficult, if not impossible. Most times it is necessary to visit the device on site. Often it is then not readily accessible, for example in a cabinet with little access space.
- For those that are accessible, there is a high risk of theft of the removable SIM card itself.
- In order to use a removable SIM card, there are device design challenges and costs associated with having a card holder and physical connectors.
- The size of the removable SIM card can also reduce the degree of freedom in the device design.

> “ Currently this flexibility cannot easily be achieved because changing the physical SIM card is practically difficult and not cost effective. ”

- In some situations, those physical connectors can also be affected by physical conditions such as high/low temperatures, vibration and humidity. There is also a potential risk where the device is intended to be used in a hazardous environment.

In order to address these challenges, the cellular IoT industry has moved towards a new approach for IoT cellular SIM – the eUICC (embedded Universal Integrated Circuit Card). With this concept, the SIM is integrated as an electronic component on the device’s circuit board and soldered in as part of the manufacturing process. There is also a remote provisioning system (Remote SIM Provisioning for M2M) that enables changes to the data on the eUICC over the air, allowing even a complete change of network operator if desired. This approach not only addresses the disadvantages of the removable SIM card highlighted above, it also introduces a high degree of flexibility that, in turn, also enables new business benefits for the Utilities ecosystem.

5. BENEFITS OF eUICC FOR THE UTILITIES ECOSYSTEM

The adoption of the GSMA Embedded SIM Specification (version 3.1), including the eUICC, brings to the market several benefits for the Utilities ecosystem as a whole, including suppliers and partners, as outlined below:

1. Over-the-air remote provisioning means Utility devices with cellular connectivity can be shipped directly to site and installed. When switched on, the eUICC embedded in the device is connected over the air to the Remote SIM Provisioning for M2M system and the correct network operator profile for that device downloaded to it. It is then fully connected and working. This facility is termed Late Operator Binding, where the network operator selection is now possible after purchase and upon deployment of a Utility device. This overcomes the significant logistical problems associated with removable SIM cards, where they typically have to be shipped separately to each location and individually installed.

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2. If it becomes necessary to change the network operator, the data for this can also be downloaded to the device remotely over the air at any time and the change instigated. This functionality is particularly relevant for connected Utility devices in fixed locations, as they cannot be returned to a retail or other outlet to change SIM card as in the handset market. They may also be physically difficult to access on site. This may be necessary more than once during the lifetime of a device, particularly a smart meter with a typical 10-15 year life.

3. This remote, over the air update facility avoids the need for a site visit to instigate an operator change. Changing a removable SIM card requires a site visit, which typically costs between €25 and €80[3] per visit. In addition, changing operator to a large number of devices at once is currently logistically complex and time-consuming, with the right SIM card needing to be matched to the right device. The over the air capability of the eUICC overcomes these issues.

4. Integrating the eUICC during manufacture also streamlines the production process and lowers the bill of materials, with the eUICC chip replacing both the removable SIM card and the SIM card holder and removing the physical connections associated with that. As a result, it lowers the cost of production compared with use of a traditional removable SIM card by up to $0.50 per device.

5. The eUICC offers a smaller, embedded form factor designed for mass volume. This is especially appropriate for residential smart meters as well as related consumer devices in the home.

6. Some forms of eUICC may be optimised for low power consumption, making them appropriate where battery life is important. This is particularly the case for smart metering of gas, heat and water supply where a power supply is often not available.

7. The eUICC brings with it all of the security benefits of mobile networks, which have been proven to be successful over the past 25 years of operation. A particular feature of this success has been device and network authentication, ensuring that only authorised devices can be connected and this has been continually improved to become even stronger . The availability of this technology offers lower cost and risk of security breaches in Utility device networks.

8. The issue of trust and confidence in data provided from connected devices should also be considered. The main purpose of connecting devices like smart meters is to obtain data that can then be used for a variety of purposes, including billing and new services related to that. In addition, it can be used for fault finding in the network. All of this requires trust and confidence in the data used – that it has not been corrupted in any way – and mobile networks together with the eUICC offer this reassurance.

9. In addition to these network and data security benefits, the eUICC offers physical security. Because it is soldered onto the circuit board of the connected device and there is no slot for removing it, as there is for a removable SIM card, it is not physically possible to steal it and use it in a mobile handset. This situation does occur with removable SIM cards, where fraud has been reported[4], which could result in reputational damage for the Utility.

10. The eUICC is also tamper-resistant. Since it is embedded in the device, it also enables the device itself to be waterproof and ruggedized for use in tough physical environments.

11. The eUICC is also safer to use in hazardous environments than a removable SIM card, such as where gas leaks are possible. This makes them particularly appropriate for gas meters.

12. While removable SIM cards and holders are reliable, they have physical connections that can deteriorate to a greater degree than eUICCs, particularly if subjected to temperature changes, high humidity or vibration. When they fail, they need to be replaced. That is not a major issue for mobile handsets as they can easily be exchanged or repaired at a retail outlet. A failure in a smart meter or any other ulitity device requires a costly site visit. The use of eUICCs reduces the need for site visits.

13. The GSMA Embedded SIM Specification (version 3.1) enables full interoperability of eUICCs from different vendors with components[5] of the Remote SIM Provisioning for M2M specification procured from alternative suppliers. This ensures that Utilities retain commercial flexibility.

[3] From two separate interviews with Utilities in this study (UK and Netherlands)

[4] Click to see for example http://www.theregister.co.uk/ and http://www.joburg.org.za/

[5] For an explanation of these components, see for example white paper by Sierra Wireless: "The eUICC Opportunity: How to Harness the Power of eSIM in the IoT" page 8. See also explanation of remote provisioning architecture for eUICC technical specification in 2016, which references:
- SIMalliance eUICC Profile Package: Interoperable Format Technical Specification Version 2.0 and ASN.1 Module
- SIMalliance eUICC Profile Package Interoperable Format Test Specification Version 2.0
- GlobalPlatform's eUICC Test Specification (v3.1) Compliance Test Suite v2.0

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6. EVOLUTION OF GSMA EMBEDDED SIM SPECIFICATION

In December 2013, GSMA published "Embedded SIM Remote Provisioning Architecture Version 1.1" offering to the market an architecture of reference for eUICCs. That document, which references the SIMalliance eUICC Profile Package: Interoperable Format Technical Specification v1.0.1, could be considered a turning point in the history of eUICCs because it aimed to harmonize different ideas market players had introduced in the IoT space in order to move from a traditional removable SIM approach to an eUICC approach.

In previous years SIM vendors had launched proprietary solutions, opening the pre-GSMA technical specification era. While addressing the challenges identified above and demonstrating the positive effects of eUICCs, proprietary solutions are not compatible with each other and have therefore tended to fragment the market opportunity. This has locked each user to one specific solution and hampered a high degree of flexibility, an essential prerequisite for strong market growth.

The industry soon perceived that a standard architecture for eUICCs was very important. ETSI (European Telecommunications Standards Institute) started working towards a standardisation process and the work ended with the publication of ETSI TS 103 383 Release 12 – 2013/02. GSMA accelerated the process towards the definition of one solution with the December 2013 publication, but also involving different stakeholders, IoT players and OEMs in the process.

Currently, the M2M/IoT marketplace sees the coexistence of proprietary solutions and the GSMA Technical Specification. However, the strong perception is that one overall solution is necessary to maximise the opportunity for cellular in the rapidly-developing M2M/IoT market. The industry is now moving towards the GSMA Technical Specification becoming a de facto standard in the market and this is being continually improved further, with version 3.1 released in May 2016[6]. The following sections explore the benefits from the GSMA Embedded SIM Specification becoming the worldwide, de facto standard for the Utilities market.

7. SIGNIFICANCE OF GSMA EMBEDDED SIM SPECIFICATION FOR CRITICAL INFRASTRUCTURE

With the growing importance of M2M/IoT to national economies in the future, national governments are now taking a closer look at both mobile networks and Utility networks. These are both designated as Critical Infrastructure and it is likely that there will, in future, be new regulatory issues that need to be introduced in the market. These are likely to require network updates. The GSMA Embedded SIM Specification, offering over the air update of data in remote connected devices, provides a system that should be able to cater for these at lowest cost. In this regard, the following key points are significant for Utility networks:

1. Many governments (national and international, such as the EU) are working to establish security standards for critical infrastructure including Utility networks that could be subject to cyber attack in relation to IoT. This will encompass holistic, end-to-end solutions and not just individual elements.

2. Security issues on such networks are not just an issue for Utilities now. Governments are also involved and are likely to regulate in future to protect against the:

   - Threat of power failure for both residential and industrial users.
   - Threat of potential standstill of economy and population.
   - Threat to digital economy.

3. As a result, high security across all such networks will become increasingly important, with new capabilities imposed by national governments.

4. Since the device vendor can purchase the eUICC from many different suppliers, some countries may have issues with its origin and require their IoT device vendors to source locally, or to a single standard.

5. Location of the provisioning system may be required to reside in-country.

6. Not directly related to Government requirements, the need for end-to-end solution security within IT and IoT markets is increasing very strongly.

[6] Including remote provisioning architecture for embedded UICC technical specification, in 2016 which references:
- SIMalliance eUICC Profile Package: Interoperable Format Technical Specification Version 2.0 and ASN.1 Module
- SIMalliance eUICC Profile Package Interoperable Format Test Specification Version 2.0
- GlobalPlatform's eUICC Test Specification (v3.1) Compliance Test Suite v2.0

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While SIM cards have always been secure in themselves, the complete solutions being delivered in future will require more overall end-to-end security. The GSMA Embedded SIM Specification has a particular strength in that area compared with alternatives, not only in provisioning but also in remediation to recover from a successful exploit should that ever happen. The complete solutions being delivered in future will require more overall end-to-end security.

8. MOBILE IoT TECHNOLOGIES AND THE eUICC IN UTILITIES ECOSYSTEM

The growing usage of connected devices, machines and vehicles is making organisations more effective and enriching the lives of individuals. To support the development of this IoT, the mobile industry has developed and standardised a new class of low power wide area (LPWA) technologies that help network operators to tailor the cost, coverage and power consumption of connectivity for specific IoT applications. The opportunity this offers is reduced total cost of ownership for low power, low data rate applications such as smart metering. When coupled with eUICCs with their low power consumption and lower cost of ownership for use in smart meters compared with removable SIM cards, this approach is particularly appropriate for smart meters physically located in remote locations where there is no power available and where the meters themselves may even be underground. This includes use for gas, heat and water meters.

Three low power wide area network (LPWA) solutions operating in licensed spectrum bands – Extended Coverage GSM for Internet of Things (EC-GSM-IoT), Long Term Evolution Machine Type Communications Category M1 (LTE-MTC Cat M1) and Narrowband IoT (NB-IoT) – have emerged to address the diverse requirements of the IoT market. In this paper we refer to LTE MTC Cat M1 technology as "LTE-M". Mobile network operators (MNOs) are implementing these technologies, which have been standardised by 3rd Generation Partnership Project (3GPP) in its Release 13, through the modification of their cellular networks. These modifications are, in most cases, software upgrades that can be updated remotely and, as a result, some mobile operators are already executing pilots.

A big advantage of 3GPP-standardised LPWA solutions, compared to proprietary technologies, is

" A big advantage of 3GPP-standardised LPWA solutions, compared to proprietary technologies, is that they have the support of a huge ecosystem with more than 400 individual members."

that they have the support of a huge ecosystem with more than 400 individual members. 3GPP stipulates that standardised technologies deliver a minimum level of performance, regardless of the vendor. Standardisation also ensures interoperability across vendors and mobile operators. As a result, the standardised LPWA technologies possess several characteristics that make them particularly suitable for Utilities and the ecosystem supporting them:

- Low power consumption (to the range of nanoamp) that enables devices to operate for 10 to 15 years on a single charge.
- Low device unit cost.
- Deep rural and deep indoor penetration coverage compared with existing wide area mobile technologies.
- Secure connectivity and strong authentication.
- Optimised data transfer, supporting small, intermittent blocks of data and infrequent larger data transfers such as firmware upgrades and patches.
- Low to medium latency: 10 seconds for control use case; 60 seconds for data collection.

As a result, these characteristics together with eUICCs are considered particularly suitable for:

- Gas, Electric and water metering, including smart meter consumption tracking and pipeline monitoring.
- Microgeneration, monitoring status of generation equipment (solar, wind, thermal) with sensors.
- Smart grid, monitoring energy infrastructure.
- Overall smart urban infrastructure control, for example smart street lighting.

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PART 2 - eUICC: NEW BUSINESS BENEFITS FOR UTILITIES

1. INTRODUCTION

Part 1 of this report provided an introduction to and background of the GSMA Embedded SIM Specification, the eUICC and the Remote SIM Provisioning for M2M system and identified 14 key benefits of these for the Utilities ecosystem. The expectation of an increasing role by national governments in protecting critical infrastructures like Utility networks from cyber attack was also explored and that it is considered increasingly inevitable that governments will regulate in this area. As a result, methods for remotely updating these critical infrastructure networks to meet the needs of such regulations will be required and the GSMA Embedded SIM Specification is at the forefront of network security arrangements and remote update techniques. Part 1 also covered new developments of low power Mobile IoT cellular connectivity expected soon in the market in conjunction with eUICCs and their significance to the overall Utilities market.

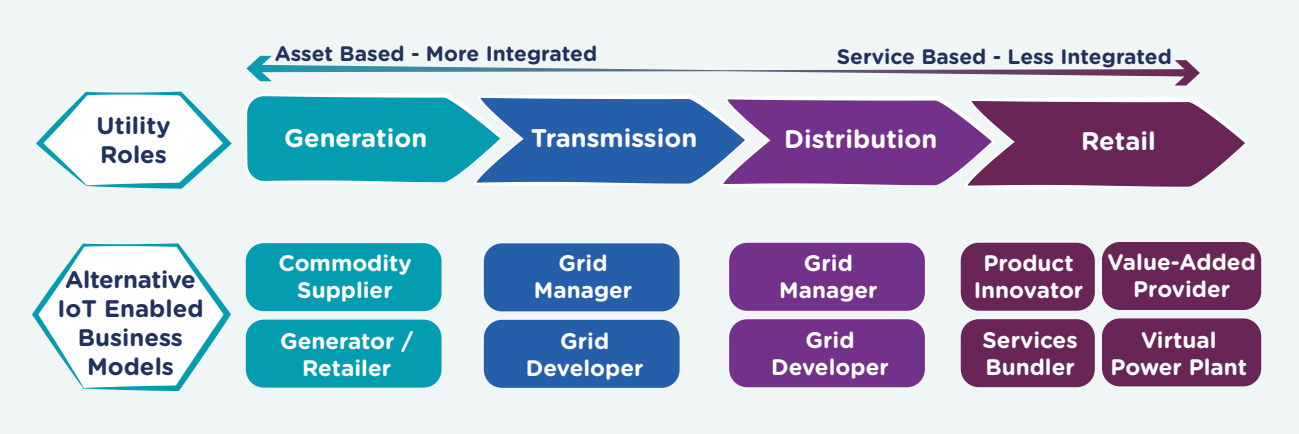
Part 2 focuses specifically on the opportunities and business benefits these technologies offer for Utilities themselves. This covers the roles of Utilities in the Energy sector and matches these with specific use cases. It then identifies the business benefits of the GSMA Embedded SIM Specification for each of these use cases.

2. UTILITY BUSINESS MODELS AND MARKET ROLES

Utilities are undergoing a period of disruption. Significant transformations in the industry are creating revolutionary change in the way electricity is generated, distributed, stored and marketed. The traditional centralized model where one organisation provided all these services is changing into a decentralised one where new businesses are taking on individual roles and competing in an open market.

The different activities now developing in the market are illustrated in Figure 1.2 in part 1 of this report. For Utilities themselves, the 4 key roles are Centralised Generation through traditional power stations, Transmission at the High Voltage (HV) and Medium Voltage (MV) levels for longer distances, Distribution at the Medium and Low Voltage (LV) levels for shorter distances and supply to customers, and Retail services to customers. Figure 2.1 shows these roles and alternative business models applicable to each of these different businesses. Such business models are known by many different names. For the purposes of this report, we have used definitions offered by PWC.

Figure 2.1: Utility Roles in the Energy market and their Alternative Business Models



Source: PWC

Within the Generation role, Commodity Suppliers own and operate generator assets and sell power into competitive wholesale markets at market clearing prices. On the other hand, Generator/ Retailers both

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own generator assets and sell retail energy for example to high energy consuming industrial users. Transmission and Distribution roles are similar but for different voltage levels for either long distance transmission on the core network or shorter distance distribution to sub-stations and to end customers. Grid Developers are in the business of acquiring, building, owning and maintaining transmission assets that connect generators to distribution system operators. Grid Managers, on the other hand, operate transmission and distribution assets and provide generators and retail service providers with access to their networks.

For all of these business models, highly efficient asset optimisation together with use of M2M/IoT technologies is becoming increasingly vital to ensure profitability.

In the Retail role, there is already an increasing amount of innovation and opportunity in new areas, especially those that involve use of data and technology directly with customers. Smart grids, microgrids, local generation including standby generators and local storage all offer new ways for working with and selling energy to customers. The Product Innovator model includes offering electricity and a range of "behind the meter" products and services, such as electric vehicle charging services and the management and integration of local generation such as solar. The Service Bundler model includes aligning with other firms – such as OEMs, marketers and technologists – to address future customer needs by offering a range of new energy-related services: life-cycle EV battery change out, home related convenience services such as service setup coordination and management of sales of home-produced energy to the grid. The Value-added Provider model leverages capabilities for information management, big data and online applications. The Virtual Power Plant model then aggregates the generation from distributed systems and acts as an intermediary with energy markets.

In practice, any one Retailer will most likely use more than one or even all of these models to offer a wide range of services to their customers. For these too, the use of M2M/IoT technologies and services is becoming increasingly important and with it the benefits of using eUICCs together with cellular connectivity. These benefits are explored in more detail in Section 4 below.

3. INVESTIGATION OF UTILITY USE CASES

3.1. Selection of Use Cases

In an earlier report[7] by IDC Energy Insights for the GSMA, 18 potentially high value Utility use cases were identified:

Customer facing

1. Building energy management for Commercial and Industrial customers (C&I Energy Data Management).
2. Customer engagement.
3. Demand Management (Demand Response).
4. Electric vehicle charging station management.
5. Home energy management (Home Energy Data Management).
6. Revenue protection.

Combined asset and customer facing:

7. Distributed energy resource management.
8. Smart metering.
9. Distribution automation.
10. Leakage reduction.
11. Quality control sensors.
12. Remote asset surveillance.
13. Sensor-based asset diagnostics and maintenance.
14. Substation automation.
15. Weather sensors.

Workforce facing:

16. Fleet management.
17. Remote workforce management.
18. Sensor-based staff identification.

Of these, the following 5 use cases were chosen from the list above to investigate further with regards to the benefit of eUICC, although the complete list was also kept in mind:

- Commercial & Industrial (C&I) Smart Metering and Residential Smart Metering.
- Demand Response.

[7] http://www.gsma.com/connectedliving/wp-content/uploads/2015/11/cl_utilities_report_10_15-002.pdf , GSMA Connected Living, October 2015

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- Distributed Energy Resource Management.
- Home Energy Data Management.
- C&I Energy Data Management.

3.2. Description of Chosen Utility Use Cases

The 5 use cases are described as follows:

Commercial & Industrial Smart Metering, Residential Smart Metering

Smart meters are manufactured with an embedded eUICC delivering cellular connectivity. Once installed and switched on, the network profile for the agreed mobile operator is downloaded to the eUICC remotely over the air and the connection for metering data established. Should it become necessary to change the network operator, this is also carried out remotely over the air. There is never a need to visit the smart meter on site for this purpose.

Smart meter data is available for both Utility companies and users for billing purposes and related services – see for example below covering Energy Data Management. For Utility companies, smart meter data can be used to help identify the location of faults in the Utility low voltage network.

Demand Response

Managing peak demand is a key concern for Utilities. To help address this, a business user with high energy usage can take part in a Demand Response scheme. There are several types , one form includes an agreement to switch off or reduce consumption at a point in time in response to a grid event, or peak load.

For example, a manufacturing company operating 24x7 has a standby generator that is used for emergencies. When it goes off grid, the generator kicks in. That generator is therefore not being utilised when on grid. The company can sign up to a Demand Response scheme that says when the Utility expects demand to outstrip supply, they can take the company off the grid and switch on the company's generator. This effectively reduces the load on the network at a peak time by bringing additional generation on-stream. Cellular connectivity is sometimes already used for this. If an eUICC is already installed in the smart meter, the signal can be sent to that to switch on/off the generator.

For residential users, this is particularly appropriate where there is a need to control a large numbers of appliances simultaneously. An example of this that is expected to increase quickly over the coming years is electric vehicles (EVs) and the growing need to control the charging period for these.

Demand response applications typically require very low latencies and very reliable and resilient connectivity solutions. 3GPP Mobile IoT technologies like LTE-M provide the level of reliability required by such real-time applications.

Distributed Energy Resource Management

As grids become less centralised, with more generation in renewables, the management of distributed energy generation like small solar farms, wind farms, and other generators is becoming increasingly important for Utilities. These may need to come online/offline depending on grid events to balance supply with demand. When the demand on the grid is increasing, an increasing number of assets need to be brought into the network and being able to control those is important. This is an opportunity for cellular communication delivered through an eUICC, as it is ideal for monitoring of usage and status of such assets as they typically do not have a particular low latency communication requirement.

While the High Voltage network is well monitored and very visible, Medium Voltage and Low Voltage parts of the network are typically not so well instrumented and the development of relatively low cost IoT devices with cellular connectivity provides the ability to connect more assets in the lower voltage parts of the network, ultimately helping to deliver visibility, control and situational awareness. Further analysis of the number of such assets in a typical network is provide in section 6 below.

Home Energy Data Management (EDM)

Smart meter and smart appliance data may be shared with a service provider, which could be a Utility, who delivers a variety of products and home energy management services. A wide variety of such services are possible and may, for example, enable the home owner to:

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- Remotely monitor and control home appliances.
- Monitor and manage their energy usage.
- Monitor and control their home environment.
- Monitor and control their home security systems.

Some of the applications and services may be delivered through internet enabled mobile smartphone apps giving the home owner additional flexibility to monitor, manage control their home from almost any location.

Commercial & Industrial Energy Data Management

The business version of Home EDM, as above. This is used by commercial and industrial customers who want to control their energy cost and carbon footprint by monitoring and controlling the performance of their assets on a site or across a number of sites. The underlying IoT and communications technology is similar to that used in Home EDM, with the software applications typically being considerably more sophisticated.

4. BUSINESS BENEFITS IDENTIFIED FOR UTILITIES

The methodology adopted for this study was to research the potential business benefits for Utilities of the GSMA Embedded SIM Specification in these 5 selected use cases. This work commenced with identifying all key benefits for Utilities and then relating these to the 5 use cases. This involved two sets of interviews. The first set was with ESMIG and SIMalliance members to gain their views of the key benefits, with a particular emphasis on the 5 use cases. The findings from these interviews together with other research were then used as the basis for a second set of interviews with key representatives among Utilities who are familiar with IoT opportunities in the Energy sector. Further analysis of the findings from the research then led to identifying which benefits of the GSMA Embedded SIM Specification are considered to be of most value for Utilities.

Taking the first part of this process, the key benefits for Utilities of the GSMA Embedded SIM Specification were identified as follows. These have been grouped under headings that describe the main objectives of the benefits:

Improving Reliability and Reducing Site Visits

1. **Late Operator Binding.** Over-the-air remote provisioning means Utility devices with cellular connectivity can be shipped directly to site and installed. When switched on, the eUICC embedded in the device is connected over the air to the Remote SIM Provisioning for M2M system and the correct network operator profile for that device downloaded to it. This overcomes the significant logistical problems associated with removable SIM cards, where they typically have to be shipped separately to each location and individually installed.

2. **Operator Change.** If it becomes necessary to change the network operator, the data for this can also be downloaded to the device remotely over the air at any time and the change instigated. This is particularly relevant for connected Utility devices in fixed locations, as they cannot be returned to a retail or other outlet to change SIM card as in the handset market. This may be necessary more than once during the lifetime of a device, for example a smart meter with a typical 10-15 year life. This avoids the need for a site visit to instigate an operator change. This capability removes the commercial risk known as "operator lock in".

3. **Reliability.** While removable SIM cards and SIM card holders are reliable, they have physical connections that can deteriorate to a greater degree than eUICCs, particularly if subjected to temperature changes, high humidity or vibration. When they fail, they need to be replaced. That is not a major issue for mobile handsets as they can easily be exchanged or repaired at a retail outlet. A failure in a smart meter or any other Utility device requires a costly site visit. The use of eUICCs reduces the need for site visits.

Improving Security and Trust

4. **Low cost and risk of security breaches.** The eUICC brings with it all of the security benefits of mobile networks, which have been proven to be successful over the past 25 years of operation. A particular feature of this success is network authentication which verifies the identity of all devices attached to the network and ensures the integrity of the network. The availability of this technology offers lower cost and risk of security breaches in Utility device networks.

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5. **Trust and confidence in data collected.** The main purpose of connecting devices like smart meters is to obtain data that can then be used for a variety of business purposes, including billing and fault identification. This requires trust and confidence in the data used – that it has not been corrupted in any way. Industry security implementations, mobile networks and the eUICC offer this reassurance.

6. **Theft proof.** In addition to these network and data security benefits, the eUICC offers physical security. Because it is soldered onto the circuit board of the connected device and there is no slot for removing it, meaning it is not physically possible to steal it and use it in a mobile handset. This situation has occurred with removable SIM cards, where significant fraud has been identified[8].

7. **Tamper-resistant.** Because the eUICC is embedded in the device, it is tamper-resistant and has less vulnerabilities from a security perspective. It also enables the device itself to be waterproof and ruggedized for use in tough physical environments.

Reducing Cost and Complexity

1. **Late Operator Binding,** as above, also relevant under this heading.

2. **Operator Change**, as above, also relevant under this heading.

8. **Lower cost**. Integrating the eUICC during manufacture streamlines the production process and lowers the bill of material, with the eUICC chip replacing both the removable SIM card and the SIM card holder and removing the physical connections associated with that reducing complexity. As a result, it lowers the cost of production compared with use of a removable SIM card by up to $0.50 per device.

9. **Small form factor.** The eUICC offers a smaller, embedded form factor designed for mass volume that is 12 times smaller than the conventional removable SIM card. This is especially appropriate for Utility devices with high production volumes, such as residential smart meters and related consumer devices in the home.

Reducing Commercial Risk and Increasing Commercial Flexibility

1. **Late Operator Binding**, as above, also relevant under this heading.

2. **Operator Change**, as above, also relevant under this heading.

10. **Low power consumption.** Some forms of eUICC are optimised for low power consumption, making them particularly appropriate where battery lifetime considerations are important and new Mobile IoT communication technologies are preferred. This is particularly the case for smart metering of gas, heat and water where a power supply is often not available.

11. **Safety in hazardous environments.** The eUICC is safer to use in hazardous environments than a removable SIM card, such as where gas leaks are possible. This makes them particularly appropriate for gas meters and other Utility devices in hazardous environments.

12. **Certification** of gas meters and other IoT devices in hazardous areas is easier and quicker using eUICCs compared with removable SIM cards because they are an intrinsically safer option in such areas.

13. **Ubiquitous cellular communications.** There are no geographical restrictions for cellular and availability will be enhanced by the introduction of Mobile IoT communication services, as outlined in Part 1 Section 8. Quick to install and flexible siting with eUICC means no roll out restrictions and fast high volume deployment opportunities.

14. **Cross vendor interoperability.** The GSMA Embedded SIM Specification (version 3.1) enables full interoperability of eUICCs from different vendors with components of the Remote SIM Provisioning for M2M specification procured from alternative suppliers. This ensures that Utilities retain commercial flexibility.

[8] Example: http://www.theregister.co.uk/2011/05/02/stolen_sim_woman_jailed/ This example also referenced in Section 5, Part 1.

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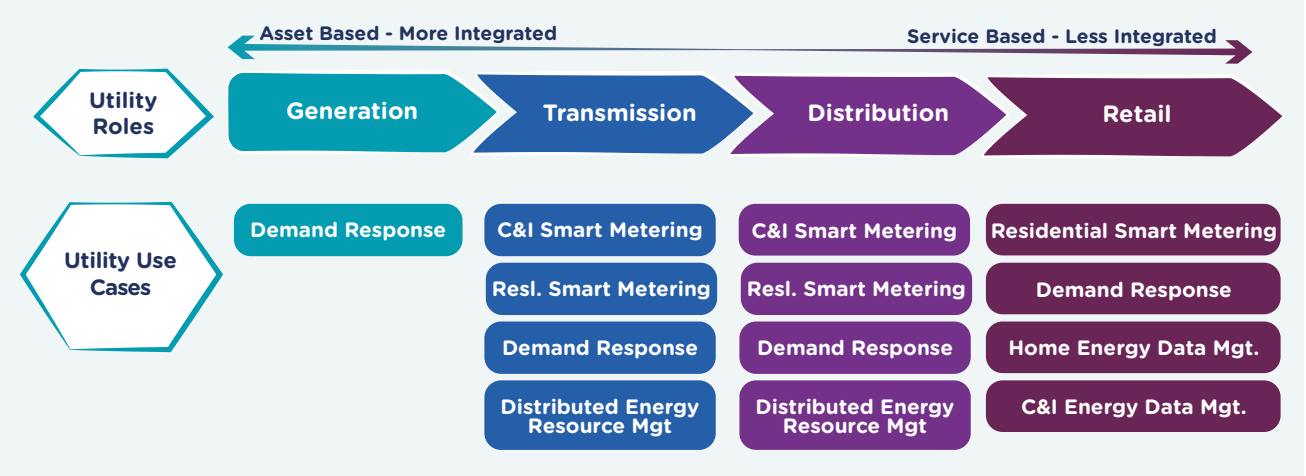
5. MATCHING BENEFITS TO USE CASES

Having identified all the key benefits of the GSMA Embedded SIM Specification for Utilities in Section 4, in this section those benefits are matched to the 5 use cases and the use cases matched to the Utility roles identified earlier.

5.1. Matching the 5 Use Cases to Utility Roles

Supplier and Utility interviews established which of the 5 use cases were most relevant to the different Utility roles of Generation, Transmission, Distribution and Retail. Figure 2.2 below shows the result of this.

Figure 2.2: Matching Use Cases To Utility Roles



It is certainly not the case that all use cases are relevant for each Utility role. As can be seen from the figure, only Demand Response is considered relevant to the Generators. Transmission and Distribution companies within the network are interested in direct contact with Commercial and Industrial users and in gaining smart meter data from both them and from Residential users. This is particularly for Demand Response purposes and also for Distributed Energy Resource Management. However, it is also clear from Utility interviews that smart meter data is increasingly being used with data analytics techniques to locate Utility network faults. Retailers, on the other hand, are more likely to be interested in residential smart metering data and in home energy data management opportunities. In some geographies, demand response is highly appropriate for controlling energy intensive appliances during peak periods, such as immersion heaters and air conditioning systems. While demand response for industrial users is a matter of working with a relatively small number of large energy users, in the home market it means working with a large numbers of relatively small energy users, this requires automation and efficient reliable communications.

5.2. Matching Benefits to the 5 Use Cases

Figure 2.3 shows which benefits are considered to be most relevant for each of the use cases. The benefits in the two groups Improving Reliability/Reducing Site Visits and Improving Security/Trust are all important for all use cases as they are closely related to the provisioning and operation of the connectivity itself. The core benefit of the Remote SIM Provisioning for M2M is eliminating site visits for this, both for setting up the connectivity with a mobile operator and if there is a need to change the mobile operator during the life of the device. Similarly, maintaining a high level of security for the connectivity is of the utmost importance throughout the device life.

The group Reducing cost/complexity is important for all devices but is particularly important for the Smart Metering use case as it applies to a very high volume of connected devices.

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Figure 2.3: Matching Benefits With Use Cases

GROUP HEADINGS	BENEFIT OF GSMA EMBEDDED SIM SPECIFICATION	USE CASES: Smart Metering (E-Electric, G-Gas, W-Water, H-Heat)	Demand Response	Distributed Energy Resource Mgt.	Home Energy Data Mgt.	C&I Energy Data Mgt.
Improving Reliability / Reducing Site Visits	Late Operator Binding	(ALL)	●	●	●	●
	Operator Change	(ALL)	●	●	●	●
	Reliability	(ALL)	●	●	●	●
Improving Security and Trust	Low cost/risk of security breaches	(ALL)	●	●	●	●
	Trust/Confidence in data collected	(ALL)	●	●	●	●
	Theft proof	(ALL)	●	●	●	●
	Tamper-resistant	(ALL)	●	●	●	●
Reducing Cost & Complexity	Lower Cost	(ALL)				
	Small Form Factor	(ALL)				
Reduce Commercial Risk, Increase Commercial Flexibility	Low Power Consumption	(G, W, H)				
	Safety in Hazardous Location	(G, W, H)		●		
	Certification	(G, W, H)		●		
	Ubiquitous Cellular Comms	(ALL)	●	●	●	●
	Cross Vendor Interoperability	(ALL)	●	●	●	●

In the final group Reducing Commercial Risk/Increasing Commercial Flexibility, the benefits are more broadly spread. Low power consumption is of particular significance for remote smart meters where there is no power and battery operation over very long periods is required. This is particularly important for gas, heat and water meters. Safety in hazardous location and certification, such as where there may be inflammable material or gases, are important benefits for smart meters that need to be in such locations. Similarly, this may extend to remote renewable resources in some circumstances. It is unlikely to be a major requirement for the other use cases. Ubiquitous cellular communications is a key benefit for all use cases as the devices that need to be connected could be anywhere.

6. QUANTIFYING THE BENEFITS

It is possible to partially quantify some of these benefits in order to give an indication of potential value. This section explores these further.

6.1. Enhanced Reliability and Reducing Site Visits

This section assesses the cost to a Utility of an onsite failure, such as a removable SIM Card/Holder failure where the result is no data being returned from a smart meter.

It is fairly common for Utilities to demand a 10 year lifetime warranty and 0.97 reliability for smart meters and other similar devices. This means that after 10 years in service only around 30 failures per 1000 devices would be expected.

If we assume that compared with removable SIM card/Holder, an eUICC improves the reliability of a device by 1% to 0.98, what would this mean in reduced cost for the Utility? It would mean that after 10 years in service only around 20 failures per 1000 devices would be expected. For a Utility with 1 million meters or devices this translates to 10,000 less failures. The cost of a failure is assessed in Figure 2.4.

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Figure 2.4: Calculation Of In Service Failure Cost To Utility

Cost of Failure	Any Currency
Customer Contact	Fixed Small
On-site Inspection	1 Truck Roll
Remove	1 Resource Hour
Replace (Device)	Device Cost
Return - Logistics	0.1 Truck Roll
Rma -fault Identification	2 * Device Cost #
Rework Or Scrap	Device Cost #
Admin + Overheads	Device Cost
Customer Payment	?
Contract Penalty	No Penalty Within Contract Terms #
Reputation	?
TOTAL COST to Utility	2 * Device Cost + 1.1 Truck Roll

Typically an equipment supplier cost

Each Utility will have different device costs and truck roll costs however what is clear is that a small improvement in reliability will have considerable benefits to a Utility and to their customers.

What is the impact of 1 truck roll on the bottom line? As an example, British Gas supply energy to around 8.33m UK customers[9] and reported profits in 2015 of £574 million[10]. The profit per customer in 2015 is therefore about £70 per annum, which is also about the cost of a device failure. This means that a device failure requiring a site visit and device replacement in a customer premise effectively wipes out the profit that an energy supplier would make from that customer for the next 12 month period.

Regarding cost of Operator Change for smart meters with removable SIM cards. From Utility interviews during the course of this work, it is estimated that a typical site visit in Western Europe costs in the region of €25 to €80. This varies by country and region, and also whether the site visit is scheduled with others nearby (usual practice) or a one off. One off visits can be considerably more expensive.

Historically a Utility contemplating a change to their mobile communications service provider faced the prospect of organising thousands of site visits to exchange removable SIM cards. This would incur costs running into millions and for that reason very rarely happened. The alternative using the GSMA Embedded SIM Specification is the modest cost of the subscription management service to achieve the operator change over the air, a small fraction of the historical cost. Such services are automated, so that the time taken is controllable and optimised.

6.2. Identification of Network Faults.

It is reported[11] that Utilities in the UK alone dig over 4m holes per annum excluding those related to construction projects. Some 63% (2.5m) of these are dug in roads, often causing considerable inconvenience to the public. This is all Utilities and for all purposes, but it is reasonable to assume that a proportion of these are to rectify faults in the electricity network. It is also the case that parts of electricity networks are above ground where holes are not dug but other costs are incurred in rectifying faults.

[9] https://www.centrica.com/sites/default/files/2015_css_final_17022016.pdf
[10] http://www.itv.com/news/update/2016-02-18/british-gas-reports-574-million-profit-last-year/
[11] See this link from the Energy Network Association in UK

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If data analytics using data from smart meters and network assets can be used to more accurately locate faults then this should reduce costs, improve customer service and reduce inconvenience to the public. If this were to reduce the number of holes dug by Utilities in the UK by 1%, then that is equivalent to 40,000 holes in the UK alone. The cost per hole varies greatly but on a labour plus overheads only basis is estimated at a minimum of €150, meaning that an annual saving of around €6m could be expected.

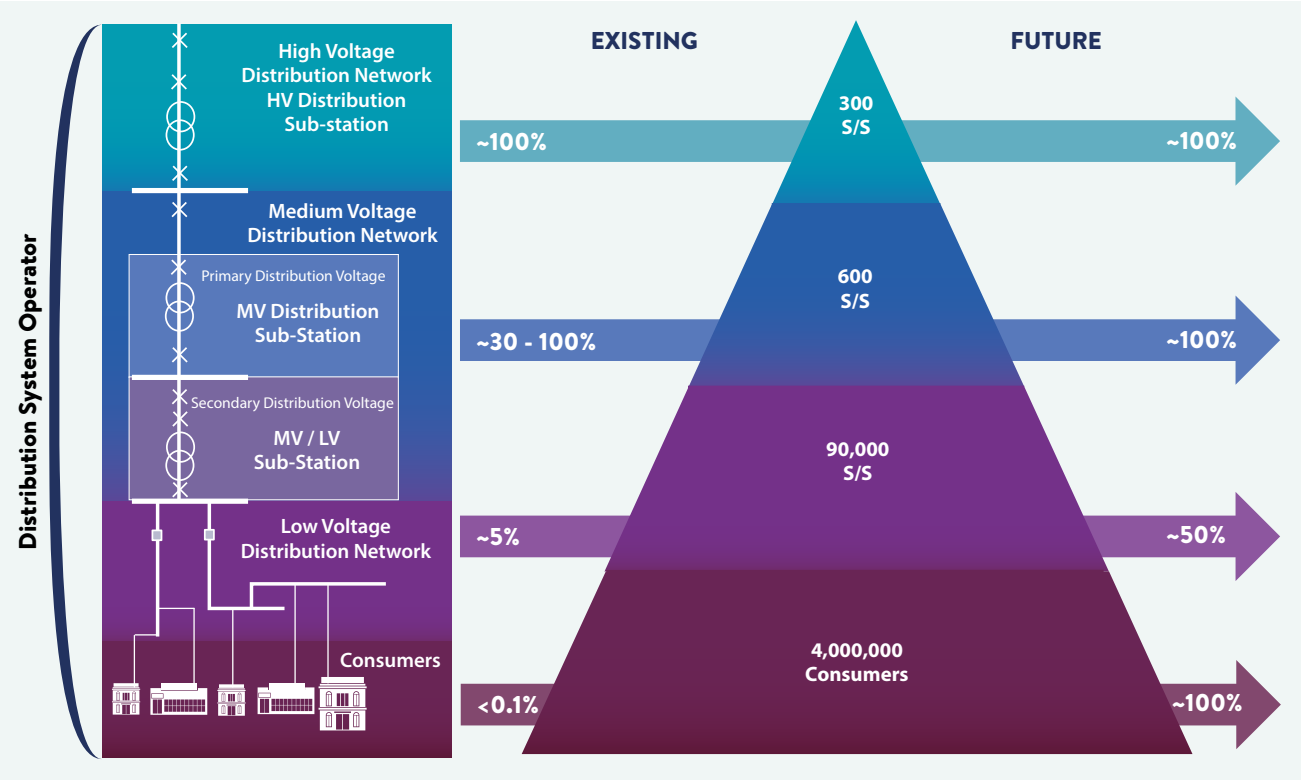
6.3. Monitoring Network Assets in the Grid

High voltage assets in Utility networks are usually already connected and are monitored. However, this is typically not the case for medium and, especially, low voltage assets. There is a growing case for connecting these assets both to gain more information about a failure as it occurs, but also to accurately pinpoint where a fault is so it can be rectified as quickly as possible. See also Distribution Automation in Section 7 item 7 below.

Figure 2.5 shows what are considered to be typical proportions of network assets at each level in the grid. As such, it shows the relationship between the number of consumers (smart meters) and the substations (Low Voltage - LV/Medium Voltage - MV/High Voltage - HV) in a typical power Utility network in Europe. The figure also shows the typical percentage of these currently monitored and the expected penetration of monitoring in the 'future', for which 2020 should be assumed.

In addition to the substations there are reclosers, switches, fuses and other assets located on the MV and LV networks which are not yet monitored. Typically, a Utility of this size is expected to have approximately 40,000 MV (10,000 per 1m Consumers) switches and 400,000 LV feeder cables (100,000 per 1m Consumers). All of these are potential points for control or data gathering.

Figure 2.5: Proportion of Network Assets at each stage in the Grid



Source: Mott Macdonald

It should be noted that this is not based on a specific power Utility, it is an average across typical networks as calculated in a private study. The size of the geographic area and mix of urban, suburban and rural areas will also affect the mix of voltages and number of installations.

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For this scenario:

- Total substations per 4 million consumer meters = 90,900, with an assumed 50% penetration by 2020.
- Total switches and cables per 4 million consumer meter = 440,000, with an assumed 10% penetration by 2020.
- This suggests that for every 4 million consumer meters, the number of end-point connections by 2020 is 90,900 x 50% = 45,450 + 440,000 x 10%.
- This equates to about 25,000 potentially new connected IoT devices for every million meters.
- UK Example: There are approx. 30 million customer meters (homes and businesses). So in the UK, the number by 2020 is some 750,000 potentially new connected IoT devices.

7. MAIN POINTS ARISING FROM UTILITY INTERVIEWS

As part of the study, interviews were conducted with Utilities in Europe and North America. These were focused on contacts who are in a position to assess the opportunities that M2M/IoT has for their companies in the future. These were qualitative interviews and not intended to be a representative sample. Interviews were conducted with representatives of each of the 4 Utility roles, with Distribution and Retail being most represented. The main points arising from these were as follows:

1. There was a general lack of awareness of either the GSMA Embedded SIM Specification or eUICCs and the opportunities offered by cellular connectivity in the future. This was particularly the case for US-based Utilities. However, there was an expectation that this area is of interest and was expected to be covered as part of the planning horizon within the next 12 to 18 months.

2. In Europe, interviews were conducted in France, Germany, Netherlands, Sweden and UK, where the opportunities for use of cellular and the GSMA Embedded SIM Specification were better understood. eUICCs are seen as a substantial improvement over removable SIM cards because of Remote SIM Provisioning for M2M and this was expected to considerably aid the case for implementation of cellular connectivity.

3. A major issue for all Utilities is security, both physical and via the network. The potential for removable SIM cards to be stolen and used for calls in mobile handsets was widely recognised as a concern. The eUICC was seen as a more secure solution, although general awareness of this and its implications for Utility networks was not well understood.

4. A barrier for cellular is the availability of suitable network coverage, particularly in-building and underground where meters can be located. There was little or no awareness of new Mobile IoT technologies coming to the market soon.

5. A further concern about cellular was the churn of technologies. For example, one Utility in Germany was concerned that the approval cycle for a smart meter can be long, particularly when the regulator gets involved. An underlying concern for Utilities is that devices in the field connected using mobile technology might become stranded if the technology moves to a new generation. However, for Mobile IoT Technologies, in order to address this issue the plan is that any technology evolution will be delivered over the air.

6. Utilities are very cost sensitive. Opportunities to reduce operating costs while enhancing service to customers are of great interest. While knowledge among interviewees of unlicensed proprietary LPWA technologies was high, and some are working on projects related to those, their awareness of Mobile IoT technologies and their benefits was low.

7. The 5 use cases were recognised and all were considered to be relevant. Direct interest depended on the Utility role of the interviewee's company as follows:

    - **Demand Response** for 'peak shaving' was of generally highest interest particularly for those in the Distribution role, although one Utility in Netherlands uses incentives rather than switching off customer premise devices remotely. The use of Electric Vehicles to help smooth out peak demands in the future is expected to grow quickly in importance. Utilities are looking at this now in conjunction with Demand Response to move the charging period outside of peak times.

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- **Distributed Energy Resource Management** is increasingly important to monitor and bring in renewable resources at appropriate times. It was also confirmed by several interviewees that the monitoring of network assets would be valuable, primarily to provide more data on network status. Medium Voltage and Low Voltage assets in particular are often not visible at all and more real time data on these would be valuable. See Distribution Automation below.

- **Smart Metering** data can be used to identify faults in the network because it also provides current levels in addition to usage data. Usage data also provides the means to offer other Energy Data Management services, particularly for Retailers.

- **Commercial & Industrial Energy Data Management** was seen primarily as a way of helping to manage peak loads on the network and therefore of interest.

- **Home Energy Data Management** was of particular interest in Germany and largely a future opportunity. For some Retailers it is the only use case they were interested in.

8. The other use cases introduced in Part 2 Section 3.1 in this report were also shown to interviewees. Those considered to be of most interest were as follows:

   - **Electric vehicle (EV) charging station management.** Charging station management is a new revenue opportunity for Utilities at a time when EV charging is becoming an increasingly important issue for Utilities, particularly in regard to peak demand planning.

   - **Distribution Automation.** The aim of this is real-time adjustment to changing loads, generation, and failure conditions of the distribution system, usually without operator intervention. This necessitates control of field devices, which implies enough IoT development to enable automated decision making in the field and relaying of critical information to the Utility control centre. This is seen as particularly important for the Low Voltage part of the network, which has low visibility at present.

   - **Sensor-based asset diagnostics and maintenance.** The purpose of this is to provide more data on the status of network assets and is closely tied to distribution automation.

   - **Substation automation.** This is also an extension of distribution automation above, for automatic handling of faults at sub-stations.

   - **Leakage reduction for gas.** Automated methods to reduce gas leakage including monitoring of pipes and accurate location of gas leaks.

   - **Remote workforce management.** This use case is about workforce management – for example tracking current location and proximity to faults. It may also cover equipment available to the local workforce.

8. OTHER RESEARCH FINDINGS

8.1. Smart Meter Deployment in Europe

The smart metering deployment projects in the EU member states have been supported by detailed cost-benefit analysis studies. The analysis of those studies shows that the average cost per metering point is €223 and the average benefit per metering point is €309[11]. There are several benefits in having smart metering; among those, easing the process of changing suppliers.

The use of eUICCs can improve the average cost-benefit analysis for smart metering deployments. The use of eUICCs can reduce smart metering cost but, most importantly, it can increase the benefits enabling supplier switching, improving logistic processes and driving new services. Over the next few years, the availability of eUICC technology and the GSMA Embedded SIM Specification and Mobile IoT technology is expected to have an impact in increasing the penetration of cellular communications within Utility networks.

8.2. The Impact of eUICCs on the Outdoor Smart Lighting Market

As an example of the use of eUICCs in an adjacent market to smart meters, the outdoor smart lighting market revolves around replacing existing public street lights with LED-based lighting that is also connected using eUICCs and cellular connectivity.

[11] Study on Cost Benefit Analysis of Smart Metering Systems in EU Member States

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The eUICCs are integrated during manufacture of the individual lights. This enables centralised control over each individual light, so the light intensity can be changed. This is required not only for energy savings, but also increasingly to reduce light pollution at night. In the UK, for example, there are 7.4 million street lights[13]. Globally, there are an estimated 200 million street lights. It is also important to consider that street lights have a long life cycle (15+ years). However, smart street lighting and the opportunity for eUICCs should be envisaged within a Smart City vision where other activities such as smart parking, pollution monitoring, bin monitoring and other applications are also relevant.

9. CONCLUSIONS

1. The GSMA Embedded SIM Specification is now established in the M2M/IoT market and has been successfully introduced to the automotive sector. It is evident that the Utilities sector can benefit from this technology. However, we found that awareness of the technology and its potential benefits is generally low in this sector.

2. Awareness of unlicensed proprietary LPWA technologies was generally high. However, the awareness of Mobile IoT technologies and their benefits was generally low.

3. Utilities are undergoing a period of disruption, with significant transformations in the industry creating revolutionary change in the way electricity is generated, distributed, stored and marketed. As a result, there are mounting pressures on Utilities to monitor and automate more elements of their networks to reduce fault times and balance rapidly changing demand with rapidly changing sources of supply. At the same time, there is an increasing need to create new services and value for their customers.

4. This report has identified 14 significant benefits of the GSMA Embedded SIM Specification for Utilities, in four categories:
   - Improving reliability and reducing site visits.
   - Improving security and trust.
   - Reducing cost and complexity.
   - Reducing commercial risk and increasing commercial flexibility.

5. These benefits can be quantified to some extent but calculations need to be associated with the particular Utility networks in order to be meaningful. Some indications of how this can be achieved are explored in the report and indicate large potential cost savings are possible at the same time as increasing service opportunities and value for customers.

6. In interviews with Utilities, two areas stood out. The first area is the absolute need to balance supply and demand within the network. This is becoming a more complex task, due to new challenges including more distributed generation and changing patterns of demand, such as with Electric Vehicles. The second area, which is closely related to the first, is the high priority for data on the network, some of it in real time for load balancing and some in near real time, for example for fault diagnosis and location.

7. As a result, the most important use case explored with Utilities was demand response, followed by distributed energy resource management and then smart metering. The first two were related to balancing supply and demand. Smart metering was very important as in addition to underpinning the "meter to cash process" the data provides visibility and insight to the status of the low voltage network. Use of smart metering data for services to consumers was of interest mainly to retailers, who are not concerned about load balancing. For them, energy data management using smart meter usage data was of primary interest.

8. Regarding key benefits, of the 14 identified those related to reducing or eliminating site visits and those related to security were considered the most important. As data from IoT devices within the network becomes increasingly important, the need to ensure the provenance, validity and trust level of that data increases.

In summary, Utilities are encouraged to explore the benefits that the GSMA Embedded SIM Specification and the eUICC deliver for their particular businesses and use cases. Our study found that Utilities benefit from:

- Licensed radio spectrum, scalable networks, mature standards-based technology, embedded security, and wide ecosystem support when they specify mobile connectivity solutions for their IoT devices.

[13] Highways England

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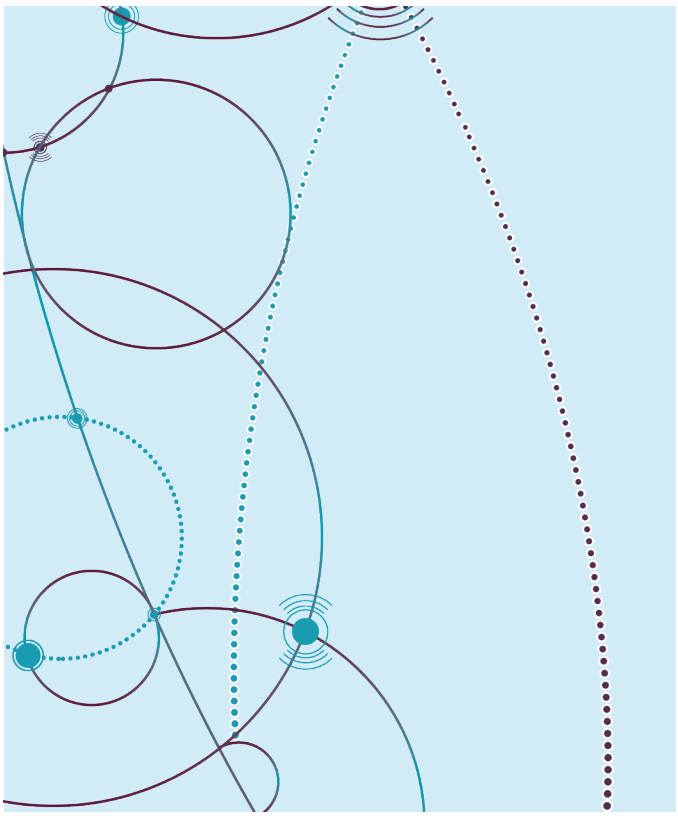
- A sustainable reduced total cost of ownership, greater whole life device security and a common industry solution which provides scalable, reliable and trusted connectivity when they utilise the GSMA's Embedded SIM Specification and the eUICC.

- Higher reliability, increased commercial flexibility and from simplified logistics when utilising the GSMA Embedded SIM specification. This allows over the air management of operator subscription profiles without the need for a physical change of SIM, for example, enabling late operator binding, solving the problem of operator lock-in and reducing the need for site visits.

- Reduced commercial risk and from proven security features, as described in the GSMA IoT Security Guidelines[14], when using the eUICC. These include tamper-resistance and the ability to enhance trust and confidence through maintaining data integrity.



[14] http://www.gsma.com/connectedliving/future-iot-networks/iot-security-guidelines/

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The GSMA represents the interests of mobile operators worldwide, uniting nearly 800 operators with almost 300 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and Internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces industry-leading events such as Mobile World Congress, Mobile World Congress Shanghai, Mobile World Congress Americas and the Mobile 360 Series of conferences.

For more information please visit the GSMA corporate website at www.gsma.com.

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SIMalliance is the global, non-profit industry association which simplifies aspects of hardware-based device security to drive the creation, deployment and management of secure mobile services. The organisation promotes the essential role of a dedicated tamper resistant hardware module in delivering secure mobile applications and services across all devices that can access wireless networks. By identifying and addressing related technical issues, and both clarifying and recommending existing technical standards relevant to the implementation of hardware security, the SIMalliance aims to facilitate and accelerate delivery of secure mobile applications globally.

SIMalliance members represent 88% of the global SIM card market. As such, the SIMalliance's membership is responsible for delivering the most widely distributed secure application delivery platform in the world (UICC/SIM/USIM).

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