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Benefits Analysis of GSMA Embedded SIM Specification on the Mobile Enabled M2M Industry

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GLOSSARY AND READING GUIDANCE

GSMA – GSM Association

M2M – Machine to Machine

MNO – Mobile Network Operator

OEM – Original Equipment Manufacturer

SIM – Subscriber Identity Module

UICC – Universal Integrated Circuit Card

eUICC – embedded Universal Integrated Circuit Card

Note that when used the phrase “**changing operators**” implies changing operators at the end of the contract



PART 1: OVERALL eUICC OPPORTUNITY

1. INTRODUCTION

The traditional SIM card (Subscriber Identity Module) has contributed significantly to the growing success of the mobile handset market. However, it is not ideal for the M2M market. In order to address the challenges created by the SIM card in the M2M market, the embedded SIM (eUICC– embedded Universal Integrated Circuit Card) has been introduced and the GSMA has published a Technical Specification. To examine the best way forward with this, Beecham Research was commissioned by the GSMA to seek the views from leading MNOs (Mobile Network Operators) internationally, the main SIM suppliers, the wireless module suppliers and from leading business users in key market segments. This report presents the findings and recommendations from that process.

2. BRIEF OVERVIEW ON THE STATUS OF THE M2M MARKET

The M2M market is rapidly gaining momentum across a wide range of application sectors. The use of machine to machine 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 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 levels of technical support to implement. The M2M market started with this category of applications but the connectivity is typically added in the field by service providers in relatively small

volumes today. As a result, this does not appear to be a category where eUICCs can drive substantial new market growth at present. However, this does not preclude the fact that retro-fitting in the future could be used to derive new revenue opportunities. Compared with these, Regulatory/Government applications are created by 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 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 SIM cards very challenging and costly, while the eUICC is ideal.

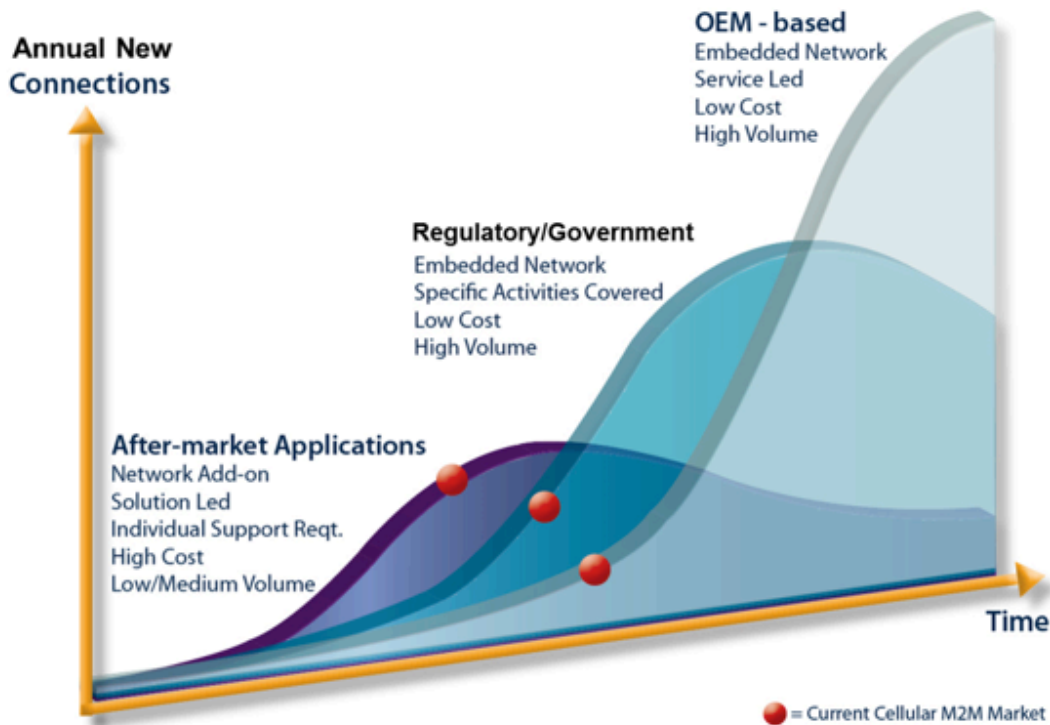


“ The OEM category in particular is still at an early stage, with extraordinary prospects for growth over the next few years. It is this category, more than the others, that will drive new cellular connection volumes in the M2M market.

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 OEM category in particular is still at an early stage, with extraordinary prospects for growth over the next few years. It is

this category, more than the others, that will drive new cellular connection volumes in the M2M 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. The Line Fit OEM-based segment is at an earlier stage and will increasingly be the driver for growth in the M2M market.

To reflect this, the Automotive and Consumer Electronics segments in the OEM category represent key prospects for eUICC and are examined in detail in this report. The Utilities/Smart City segment in the Regulatory category is also a prospect for eUICC.



Source: Beecham Research

Figure 1.1: M2M Application Categories and Their Impact on Future Market Growth

3. INTRODUCING eUICCs AND THEIR ROLE IN THE M2M MARKET

The evolution towards the LineFit-OEM category requires a major focus on data and software in order to develop services that sit on top of connected devices and connectivity. This also implies the need for a higher degree of flexibility in the management of connected devices.

Conventionally, SIM cards are manufactured in the ISO 7816-1 shape, rectangular with a corner cut-off and designed for the handset market. For many M2M applications, this form factor has several challenges, such as:

- The removable SIM card system is designed for inserting the card in the device at the point of use. This introduces logistical issues for M2M applications, especially for high volumes, as the devices may be anywhere in the world.
- Once the 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 those that are accessible, there is a high risk of theft.
- There are associated costs with having a card holder and physical connectors
- For some applications, those physical connectors can be affected by vibration and other physical conditions such as high/low temperatures and humidity. This is particularly relevant for connected devices with long life cycles, such as automobiles.

- The size of the card can reduce the degree of freedom in design.

These challenges are particularly acute for applications in the Regulatory and, especially, the OEM categories. In order to address them, the cellular M2M industry is moving towards a new approach for M2M cellular SIM – the eUICC (embedded Universal Integrated Circuit Card). With this concept, the SIM is integrated as part of the manufacturing process of the device. There is also a remote provisioning system that enables changes to the data on the SIM over the air. This approach not only addresses the disadvantages of the SIM card highlighted above, it also introduces a high degree of flexibility on the SIM that, in turn, also enables new business benefits for the M2M ecosystem. The following part of this report examines the evolution of eUICC solutions, the opportunity that the GSMA Embedded SIM Specification for eUICC represents in the market and the benefits it offers for different M2M stakeholders.

4. THE STATUS OF DEVELOPMENT OF EMBEDDED SIMs

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 could be considered a turning point in the history of embedded SIMs because it tries to harmonize different ideas market players have introduced in the M2M space in order to move from a traditional SIM approach to an embedded SIM approach.

In recent years operators have only been able to launch remote provisioning solutions using proprietary solutions from SIM vendors. While addressing the challenges identified above and demonstrating the positive effects of embedded SIMs, proprietary solutions are not compatible with each other and



have therefore tended to fragmented the market opportunity.

The industry soon perceived that a standard architecture for remote provisioning of eUICCs was very important. ETSI (European Telecommunications Standards Institute) started working towards a standardisation process for eUICCs 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 for eUICC with the December 2013 publication, but also involving different stakeholders, M2M players and OEMs, in the process.

Currently, the M2M marketplace sees the coexistence of proprietary solutions and the GSMA Embedded SIM Specification. However, the perception that one overall solution is necessary to maximise the opportunity for cellular in the rapidly-developing M2M market is now strong. The M2M industry is moving towards the GSMA Embedded SIM Specification becoming a de facto standard for eUICCs in the M2M market. The following sections explore the benefits of eUICCs and of the GSMA Embedded SIM Specification becoming the worldwide, de facto standard for the M2M market.

5. BENEFITS OF eUICCs FOR M2M MARKET STAKEHOLDERS

The adoption of the GSMA Embedded SIM Specification for eUICCs brings to the market several benefits for the entire M2M ecosystem, but also specific ones for different stakeholders.

5.1 Benefits for the Entire M2M Industry

These are the key benefits of the GSMA Embedded SIM Specification for the entire M2M industry:

1. The smaller size form factor available for eUICCs offer streamlining of the manufacturing process for mass volume. This is especially needed for consumer devices
2. Potentially low production and distribution cost – enabled by late stage provisioning of profiles and single stock keeping units.
3. Over-the-air remote provisioning, since these devices cannot be returned to a retail outlet to change SIM card as in the handset market. A visit to each site is not cost effective.
4. As well as streamlining the manufacturing process, the eUICC also streamlines the retail process and considerably widens the possible routes to market compared with a product fitted with a removable SIM. GSMA Embedded SIM Specification is expected to aid market growth internationally considerably more strongly than proprietary solutions.
5. As in the case of the existing SIM card, low power consumption – for battery cost and lifetime considerations.

GSMA
Embedded SIM Specification is expected to aid market growth internationally considerably more strongly than proprietary solutions.

Source: Mobile Network Operator

6. THE IMPACT OF eUICCs IN THE M2M MARKET

The impact of eUICCs designed around the GSMA Embedded SIM Specification are expected to accelerate the overall adoption of cellular M2M connections. This is because Automotive OEMs are more likely to move towards using eUICCs throughout their whole range as a standard if they are based on the GSMA



The GSMA Embedded SIM Specification will also aid the development of the second hand market more easily than proprietary solutions, ensuring that eUICC investments in the car are better utilised throughout the car's life.

Source: Auto OEM

Embedded SIM Specification as an open de facto standard, rather than proprietary solutions. The GSMA Embedded SIM Specification will also aid the development of the second hand market more easily than proprietary solutions, ensuring that eUICC investments in the car are better utilised throughout the car's life.

For Consumer Electronics OEMs, the opportunity is to develop the inter-

national market more quickly. While proprietary versions can be used for national markets, without severely limiting the choice of operator it is considerably more difficult to use proprietary eUICC solutions to develop the international market.

The following sections detail the expected forecasts for eUICCs in the Automotive sector, the Consumer Electronics sector and other sectors in order to show how the overall market forecast is made up. The detail associated with the forecast for the Automotive sector is covered in Part 2 of this report and for the Consumer Electronics sector in Part 3.

6.1 Impact of eUICCs in the Automotive Sector

Figure 1.2 below shows the projected growth rates worldwide to 2020 for embedded SIMs in the Connected Car market. These projections are based on a growing percentage of new car registrations being connected at the point of sale. The growth rates are therefore dependent on the number of new car registrations per year and

the increasing penetration of these being connected. The base in 2013 assumes 10% of new registrations being connected, with different overall penetration rates for the three different scenarios. The assumption is that Automotive suppliers are more likely to implement eUICCs throughout their ranges using the GSMA Embedded SIM Specification compared with a slower rate using proprietary solutions. The reason for that slower rate for proprietary solutions is an expectation of changing to a standard at some point in the future and wishing to minimise the complexity of operating multiple solutions.

The forecasting approach of the automotive sector is based on three scenarios:

- (1) The market is served by proprietary solutions with one SIM per vehicle.
- (2) GSMA Embedded SIM Specification is the standard de-facto with one SIM per vehicle.
- (3) Multiple embedded SIMs are used all based on the GSMA Embedded SIM Specification.

The growth rate increases moving from scenario (1) to scenario (3) along the period 2013-2020. In the third scenario, the number of M2M SIM connections for connected cars is expected to reach 250 million worldwide in 2020, compared with the first scenario of reaching 160m with proprietary solutions.

Scenario 3 is an option for using multiple SIMs in a vehicle for different services paid for by different parties where split billing for the connectivity is not available, such as infotainment paid by consumer and auto diagnostics paid by auto supplier. In this case, it is preferable to use one specification for multiple SIMs in one vehicle

We have used scenario (2) for the basis of our forecast to provide a clear comparison with scenario (1).



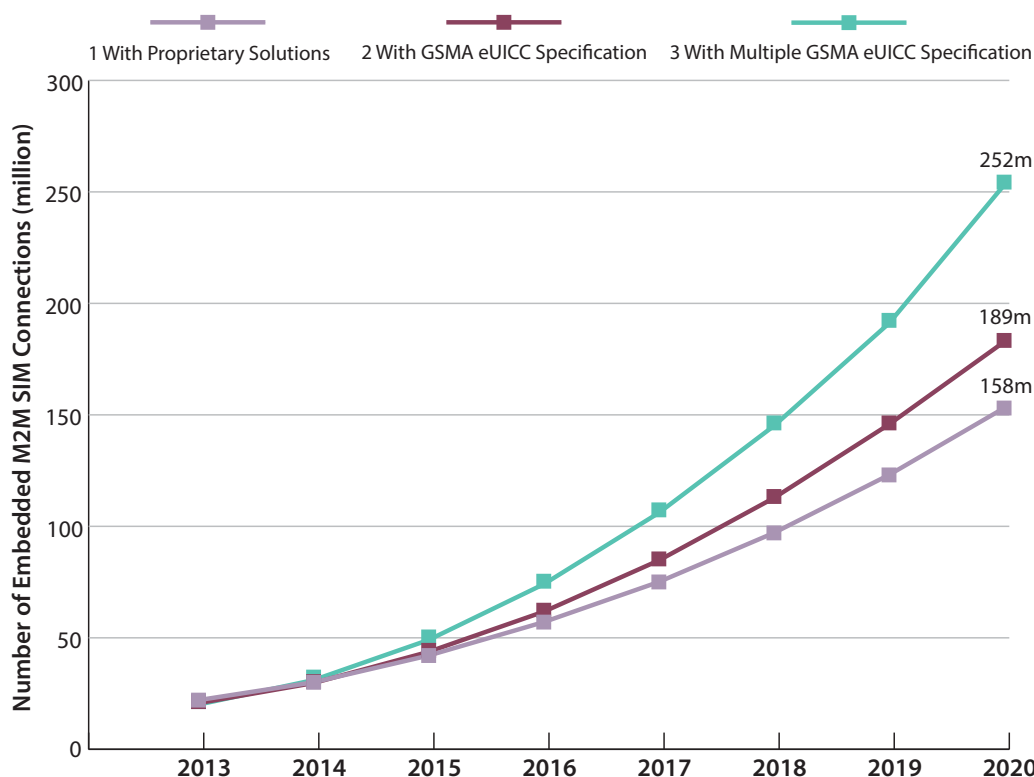


Figure 1.2: Projected Connected Car Connections worldwide with alternative scenarios

	2013	2014	2015	2016	2017	2018	2019	2020
1 With Proprietary Solutions	27,669	35,708	47,183	62,163	80,716	102,912	128,822	158,519
2 With GSMA eUICC Specification	27,669	36,780	50,420	68,680	91,651	119,424	152,093	189,755
3 With Multiple GSMA eUICC Specification	27,669	38,924	56,894	81,715	113,520	152,447	198,635	252,225

6.2 Impact of eUICCs in the Consumer Electronics Sector

The impact of eUICCs for the Consumer Electronics market is analysed using three different scenarios: the market will use removable SIMs, the market will use eUICC proprietary solutions, and the market will use GSMA Embedded SIM Specification. The three scenarios are illustrated in the Figure 1.3 below.

Emerging consumer device segments such as wearable devices, connected cameras, and connected bikes will start to become important in the period. Proprietary solutions are less likely to ensure the global penetration of such products. Instead, GSMA Embedded SIM Specification provides an easy route for global adoption of all products. The chart below shows the impact that the GSMA Embedded SIM Specification is expected to have on the total installed base of M2M connections in the consumer electronics sector globally between 2013 and 2020.



Between 2013 and 2015, it is assumed that the GSMA Embedded SIM Specification and proprietary solutions have not been adopted by the consumer electronics sector yet. Therefore, the growth rate is the same as the scenario with removable SIMs. In 2016, the consumer electronics sector is expected to start bringing to market the GSMA Embedded SIM Specification or proprietary solutions. As a result, the growth rate for that scenario receives a substantial boost to growth that is reflected in the chart. The differential between the two eUICC-based scenarios is then expected to increase over the period 2016-2020 due to the global penetration of new product segments better supported by the GSMA Embedded SIM Specification.

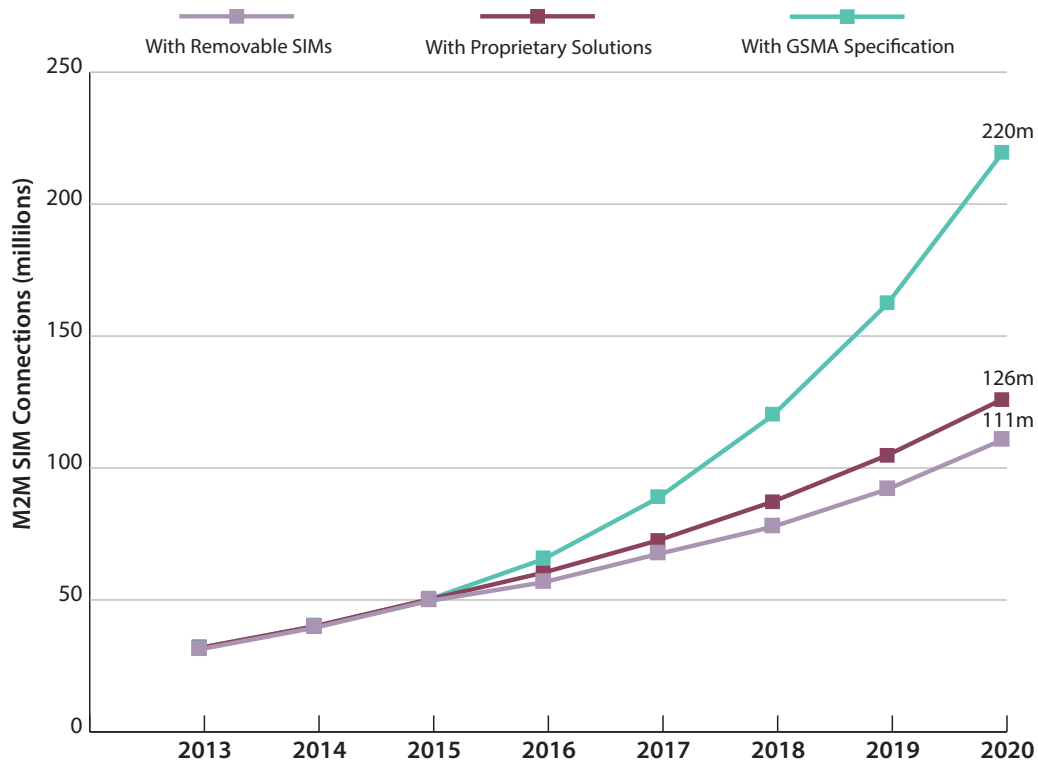


Figure 1.3: Projected Consumer Electronics Connections worldwide with alternative scenarios

	2013	2014	2015	2016	2017	2018	2019	2020
With Removable SIMs	32,586	40,733	50,916	58,008	68,710	79,017	93,240	111,888
With Proprietary Solutions	32,586	40,733	50,916	61,099	73,319	87,982	105,579	126,695
With GSMA eUICC Specification	32,586	40,733	50,916	66,191	89,357	120,632	162,853	219,852



6.3 Impact of eUICCs in Other Sectors

Other sectors are also expected to be impacted by the introduction of eUICCs. Chief among these is Utilities, where some countries are standardising on one cellular connection per smart meter. This is by no means universal so does not represent as large a single opportunity as either the Automotive or Consumer Electronics sectors. Figure 1.4 below shows the expected breakdown of Other sectors in 2020, for a total Others volume of 229m GSMA eUICCs worldwide in 2020, or 194m proprietary solution eUICCs.

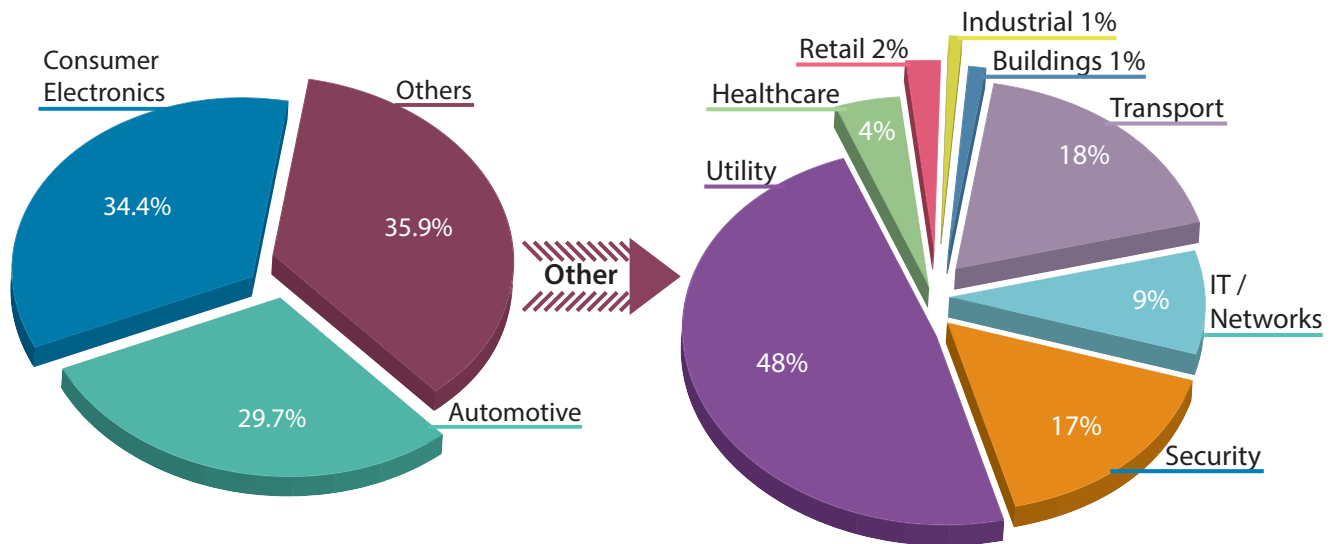


Figure 1.4: Breakdown of M2M Connections per Sector in 2020 in the Case of GSMA Embedded SIM Specification

	(million)
Automotive	190
Consumer Electronics	220
Others	229

	(2020)
Transport	42
IT/Networks	20
Security	37
Utility	111
Healthcare	10
Retail	5
Industrial	2
Buildings	2

6.4 Overall eUICCs Market Opportunity

Taking forward the forecasts shown in the sections above to an overall market forecast, Figure 1.5 below compares two forecasting scenarios. In the first one, eUICCs are based around proprietary solutions. The second scenario is based around the assumption that GSMA Embedded SIM Specification is the de facto standard for eUICCs.

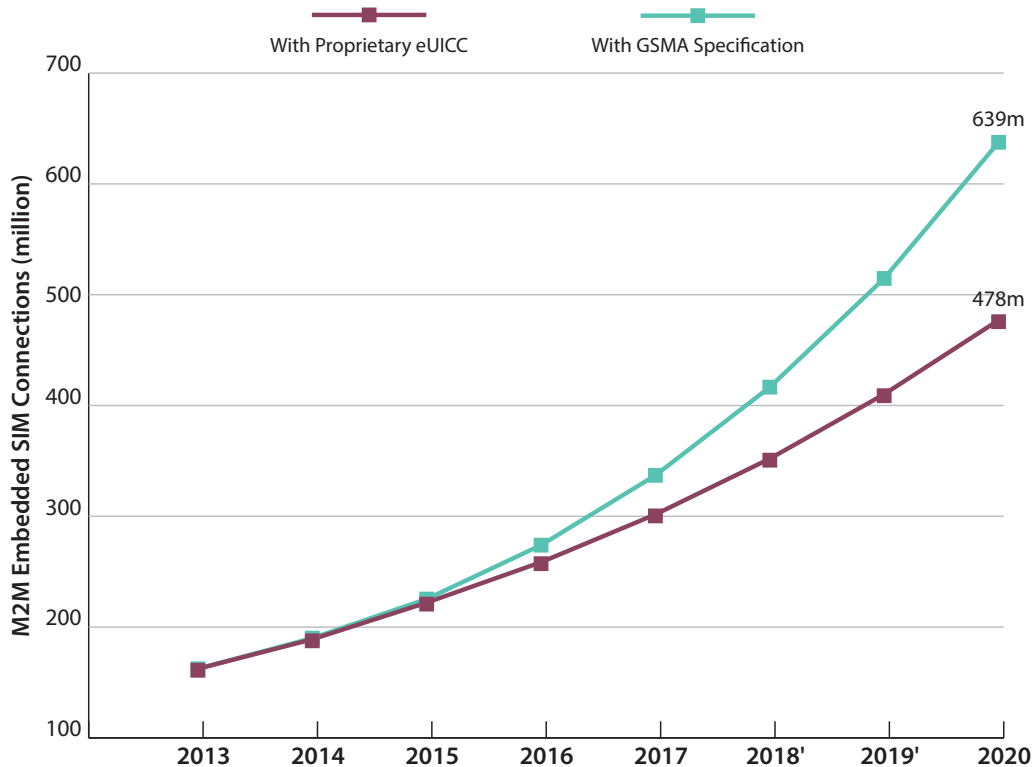


Figure 1.5: Overall M2M Connections Forecast 2013-20, GSMA Embedded SIM Specification versus Proprietary eUICC

	2013	2014	2015	2016	2017	2018	2019	2020
With Proprietary eUICC	164,258	190,842	223,942	260,431	303,547	353,864	412,038	478,838
With GSMA Specification	164,258	191,914	227,179	275,814	338,864	418,433	516,514	639,393

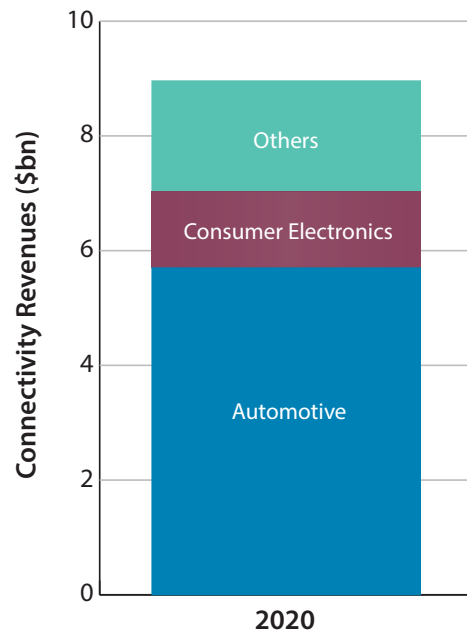
At the end of 2020, the M2M SIM connection market could reach 639 million globally if GSMA Embedded SIM Specification is adopted as de facto standard during 2014-15, or 479 million using proprietary eUICC solutions.

The automotive sector is at the forefront of the adoption, particularly during the period 2014-2016. During the period 2016-2020, consumer electronics can become the largest adopter of GSMA Embedded SIM Specification eUICCs and this is the reason why the GSMA Embedded SIM Specification forecast in the chart accelerates more quickly. The acceptance of the benefits that the GSMA Embedded SIM Specification can bring will be recognized by a range of sectors and subsequently drive new consumer product segments globally particularly during 2018 to 2020. The GSMA Embedded SIM Specification will also be adopted in other sectors and for different applications. For example connected bikes, particularly in China, is an area that can benefit from eUICCs. In the “with GSMA Specification” scenario, smart metering can also adopt eUICCs.

The described growth pattern in terms of M2M SIM connections can be also be reflected in revenue terms. Average Revenue Per Device on a monthly basis is subject to contract negotiations between OEMs and MNOs, are confidential and also highly variable depending on the precise circumstances. As a result, the values included in this analysis are typical wholesale rates, and in the range \$0.5 to \$2.5 per month for different products and services. At this level, the connectivity revenues for MNOs could reach \$8.96bn during 2020 alone for those devices connected using the GSMA Embedded SIM Specification. This is a recurring revenue, growing annually. Automotive represents the largest opportunity, followed by Other sectors and Consumer Electronics as shown in Figure 1.6. With reference to Figure 1.4 above, Auto-

motive represents the largest revenue opportunity in 2020, whereas Consumer Electronics is expected to become the largest number of connections. It should be noted that these Other sectors do not include Smart Home devices beyond security alarms and smart meters, which have their own requirements for using cellular connectivity.

The value of eUICC component sales alone is expected to be of the order of \$4.7bn over the period 2014-20 with subscription management services providing additional revenue that cannot be readily quantified at this time.



Connectivity Revenues	(\$bn)
Automotive	5.70
Consumer Electronics	1.33
Others	1.93
Total	8.96

Figure 1.6: Breakdown of Connectivity Revenues per Sector in 2020 in the Case of GSMA Embedded SIM Specification



Finally, it is important to highlight that the connectivity revenues represent typically 5 – 10% of the overall revenue opportunity. The service revenue to end users is considerably larger than the network revenue and precisely which market players will gain this revenue is not yet determined. It certainly represents an additional opportunity for MNOs.

More detailed analysis of these opportunities is presented in Automotive and Consumer Electronics sections of this report

In summary, the GSMA Embedded SIM Specification is expected to enable and drive new product segments with a global reach. This will happen particularly during the last period of the forecast (2018-2020) when the adoption of GSMA Embedded SIM Specification in consumer electronics has moved from its initial stage, as outlined in section 6.2 above. The adoption, use and acceptance of the GSMA Embedded SIM Specification is highly likely to then spread to other vertical sectors and applications. Take, for example, the Bicycle industry, where 132 million bicycles around the world are sold per year. We are now beginning to see connected bicycle product concepts taking into account the use of embedded SIMs. These will not reach the market during the period 2014-2016, but later.

The trend in adoption of the GSMA Embedded SIM Specification is expected to start within the automotive industry worldwide. Once other vertical sectors can see the value that the GSMA Embedded SIM Specification has brought in terms of cost savings/opportunities to the automotive industry, it is expected that key players like OEMs in other vertical sectors will be encouraged to adopt and implement the Specification widely.

MAIN CONCLUSIONS

1. The OEM category of applications represents the most important driver for growth in the M2M market over the next years. Compared with other options, the GSMA Embedded SIM Specification reduces logistical challenges for manufacturing processes, particularly for the manufacture of larger assets like cars. In this way it reduces costs compared with other alternatives.
2. The GSMA Embedded SIM Specification also streamlines customer delivery and after sales service processes, particularly for larger assets like cars. These help to reduce costs compared with other alternatives and enhance convenience for customers.
3. In addition to these, the GSMA Embedded SIM Specification also helps to streamline the retail process and increase routes to market, particularly for consumer electronics products. In this way, it has considerably greater potential to drive sales growth of such products internationally compared with other alternatives.
4. The GSMA Embedded SIM Specification also aids the development of the second hand market for connected products and related services considerably more effectively than other alternatives. This is particularly the case for the Auto market, where second hand models are often shipped to other countries and regions.
5. Proprietary remote provisioning solutions have been introduced quickly to the market in response to customer demand for the technology. However, they do not provide the same opportunity for market growth



as the GSMA Embedded SIM specification and are unlikely to be accepted as an industry standard.

6. Compared with proprietary solutions, the GSMA Embedded SIM Specification enables the service flexibility for operators to be best placed to offer comprehensive remote provisioning services across the widest range of applications
7. In order to provide the best environment for rapid growth in the M2M market, the GSMA Embedded SIM Specification should be implemented as soon as possible. The likely cost of not doing so will be the growth of proprietary solutions in the market, which will add complexity and cost for market players and is likely to slow potential market growth.
8. In this regard, it is interesting to note that the GSMA Embedded SIM Specification has particular benefits both for Automotive OEMs who are manufacturing large assets with long life cycles and for Consumer Electronics OEMs who are manufacturing small, often portable devices typically with relatively short life cycles. These are not necessarily the same benefits, so does indicate that the GSMA Embedded SIM Specification is relevant for a very broad range of OEMs. This is a significant factor in support of overall market development.



DEPLOYING THE GSMA EMBEDDED SIM TECHNICAL SPECIFICATION

GSMA EMBEDDED SIM ARCHITECTURE AND DEPLOYMENT

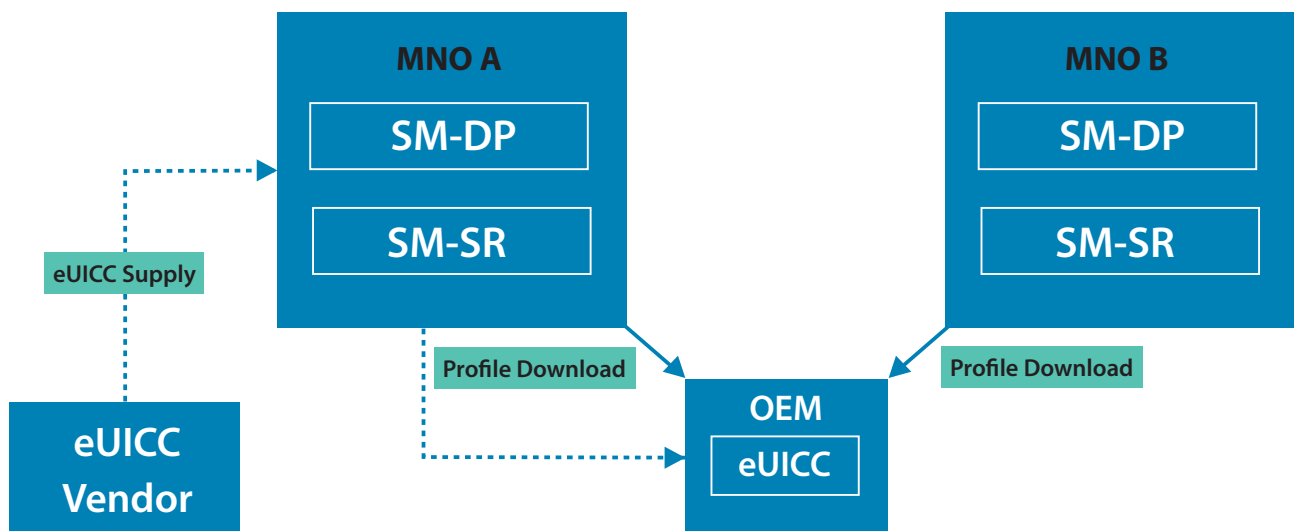
The deployment of GSMA Embedded SIM Specification depends on two key elements of the GSMA Embedded SIM Architecture, the SM-SR and the SM-DP. SM-DP stands for Subscription Management Data Preparation. The SM-DP stores the network profiles. The SM-SR, Subscription Management Secure Routing, manages the over-the-air provisioning mechanism. Identifying the right type of organisation for running the SM-SR and the SM-DP is pivotal for the deployment of the GSMA Embedded SIM Specification. Note that the SM-DP and SM-SR may be implemented separately or in a single platform.

THE KEY ROLE OF MNOs IN DEPLOYMENT

The SM-SR and the SM-DP are subscription management functions, and managing subscriptions is the key activity of mobile network operators. Mobile network operators work all the time on authentication algorithms between the SIM and the network, network selection and reselection parameters stored on the SIM and dependent upon the network, short message service centre and other required network addresses on the SIM, SIM file contents and SIM applications. Mobile network operators also have long-standing experience updating SIM information in a secure manner over the air. Additionally, mobile network operators can ensure worldwide connectivity coverage for different M2M applications either through their networks or through roaming agreements.

A TYPICAL DEPLOYMENT MODEL

In light of this, mobile network operators and SIM vendors are both important in the deployment of the GSMA Embedded SIM Specification. Operators have the option to provide their own subscription management platform or to use a solution hosted on their behalf by a SIM vendor.



Legend:

- - - - - ▶ Hardware Supply
- — — — — ▶ Software Supply

The typical deployment model is based on the following steps:

1. The OEM purchases the eUICC from MNO A
2. The OEM contracts MNO A for remote subscription management on the eUICCs
3. MNO A creates a profile and downloads to the eUICC to enable the subscription and manage the eUICC during the duration of the connectivity contract.
4. At the end of contract and if the OEM desires to change contract and move to MNO B, the profile for MNO B can be downloaded to the existing eUICC after acknowledgement of MNO A and a well-defined process handled by both MNOs. As soon as the process is complete and certified by both parties, management of the eUICCs is transferred to MNO B officially.

In order for the OEM to have wide coverage across the globe MNO A provides local coverage within its service footprint but will also support roaming across a large number of operators globally, for a period of time or indefinitely depending on the business requirements. MNO A can be also represented by an alliance of operators that is able to provide local coverage in larger regions. If the OEM product needs to be served by local connectivity then the profile can be remotely provisioned to a local operator that has a partnership relationship with MNO A, subject to contract. This deployment model also allows tight connectivity between an operator's connectivity platform and the subscription manager, which may allow for can facilitate smoother swapping of profiles within operator groups or alliances.



PART 2: BUSINESS BENEFITS OF eUICC FOR THE AUTOMOTIVE SECTOR

1. INTRODUCTION

This section explores the overall impact of the use of the GSMA Embedded SIM Specification for eUICC and proprietary solutions within the automotive sector, primarily for automotive OEMs. The section is structured in three parts. The first part explores the business benefits of embedded SIMs in the automotive sector. A significant number of these benefits are intangible as they stand, so we provide a quantitative assessment looking in particular at the cost savings. The second section explores the effect that the adoption of embedded SIMs will have in the automotive sector. The third section provides the conclusions we have drawn.

2. BUSINESS BENEFITS ANALYSIS FOR THE AUTOMOTIVE SECTOR

As illustrated in Part 1 of this report, the OEM category of M2M applications represents the most important driver for new connection volumes in the immediate future. Within that category, the automotive sector is currently the most dynamic in the M2M market. The concept of Connected Cars as on-the-move intelligent in-door spaces for a wide range of connected applications and services is becoming a strong commercial reality. The role of cellular connectivity is fundamental in this evolution and any improvements that increase flexibility and enable new services are of interest to the industry. For this reason, the automotive sector has already shown substantial interest in the use of eUICCs. This interest lies in some key benefits that eUICCs can bring to automotive OEMs and these benefits are discussed in the following section. Some of them are then quantitatively assessed.

2.1 Discussion on Business Benefits for the Automotive Sector

The following are seen as the main benefits for Automotive OEMs:

1. An eUICC that can be used in all markets worldwide without change means having a Single Stock Keeping Unit (SKU), which brings the following main benefits:

“An eUICC that can be used in all markets worldwide without change means having a Single Stock Keeping Unit (SKU)”

Source: Auto OEM

- a) One component build that works anywhere worldwide.
 - b) There is no need for local logistics, as required for SIM cards. The cost of these logistics is considerably more than the cost of the SIM card components
 - c) Simplifies the manufacturing process, thereby further reducing costs.
2. The use of GSMA Embedded SIM Specification introduces a strong degree of flexibility such as the ability to switch between mobile network operators on contract expiry and in accordance with policy rules implementation.
 3. As the Connected Car market develops, more services will be introduced. This is expected to create a situation in the vehicle where different services are paid for by different parties, such as infotainment paid by consumer and auto diagnostics paid by auto supplier. For Auto OEMs split billing, where one connection can be used for both such services, would be preferable. If that facility is not available, then multiple SIMs in one vehicle is an alternative. It would then be preferable to use one specification if there are multiple SIMs in one vehicle.

4. The GSMA Embedded SIM Specification may be more cost effective than roaming alternatives for high volume of data. As a result, it is likely to help accelerate use of high bandwidth services such as information.
5. The use of embedded SIMs can also be important in handling changes to government regulation. Considering that regulatory framework changes country by country, the use of the GSMA Embedded SIM Specification provides the means for adapting the same solution to those different frameworks over time.
6. The use of the GSMA Embedded SIM Specification also opens the second-hand car market for connected car services. A used car is not limited to being resold in a specific country: it may be resold in any one of a number of countries worldwide. This is likely to require a change in MNO to operate in the local market to ensure that the connected car services built into the car can actually be used by the new owner at reasonable cost.

2.2 Assessment of Business Benefits for the Automotive Sector

This section examines the approach used to identify cost savings and development of new sales, based on the table below that shows the benefits when using the GSMA Embedded SIM specification versus when using removable SIM and proprietary remote provisioning solutions.

Table 2.1: Cost and Sales Elements for Business Benefits Analysis – Automotive Sector

Variable and Definitions	Value
Manufacturing Cost Savings GSMA Specification vs Removable SIM (\$ per car)	\$210
Cost Savings GSMA Specification vs Removable SIM (\$ per car)	\$530
Cost Savings GSMA Specification vs Proprietary eUICC (\$ per car)	\$265
New GSMA Specification Connected Cars in 2013 (million)	4.4
New Proprietary eUICC Connected Cars in 2013 (million)	4.4
GSMA Specification Connected Cars 2014-2016 (million)	68.7
Proprietary eUICC Connected Cars 2014-2016 (million)	62.2
GSMA Specification Connected Cars 2017-2019 (million)	152.1
Proprietary eUICC Connected Cars 2017-2019 (million)	128.8
Scenario I - All cars will change contract (3 year contract)	
Cost of Changing of Contract of all Proprietary eUICC installed base (2014-2016) (million \$)	\$16,483
Cost of Changing of Contract of all GSMA Specification installed base (2014-2016) (million \$)	0*
Cost of Changing of Contract of all Proprietary eUICC installed base (2014-2019) (million \$)	\$34,132
Cost of Changing of Contract of all GSMA Specification installed base (2014-2019) (million \$)	0*

* This is a zero incremental cost, as detailed in the section below.



Scenario II - 40% of all cars will change contract (3 year contract)		
Cost of Changing of Contract of 40% of Proprietary eUICC installed base (2014-2016) (million\$)		\$6,593
Cost of Changing of Contract of 40% of GSMA specification installed base (2014-2016) (million \$)		0*
Cost of Changing of Contract of 40% of Proprietary eUICC installed base (2014-2019) (million \$)		\$13,653
Cost of Changing of Contract of 40% GSMA specification installed base (2014-2019) (million \$)		0*
Change Ratio		40%
Second Hand Market (Assuming only one change of ownership)		
Second Hand Cars 2015-2020 with Proprietary eUICC Solutions (million)		32.5
Cost of Changing of Contract of all Second Hand Cars with Proprietary eUICC Solutions (million \$)		\$8,613
Cost of Changing of Contract of all Second Hand Cars with GSMA Specification (million \$)		0*

2.2.1 Definition of Variables and Related Costs

In this section of the table, a number of variables have been identified and quantified using a combination of secondary and primary data. Primary data comes from interviews conducted with the automotive sector. Forecast data has also been included to illustrate potential total industry cost savings.

Manufacturing Cost Savings GSMA Specification vs Removable SIM (\$ per car)

This variable shows the impact GSMA Embedded SIM Specification has in terms of reducing manufacturing and supply costs for an automaker. The cost of using a GSMA Embedded SIM Specification will be a very low portion of the entire manufacturing cost of a car. Assuming average costs per car, the actual manufacturing cost of the car is in the region of 30% of the total cost. The cost of having a GSMA Embedded SIM Specification embedded during manufacture is then about 0.005% of the manufacturing cost. In case of the removable SIM, the cost of inserting a SIM into the car is 10 times the cost of a GSMA Embedded SIM Specification. There are different ways of achieving this but essentially this cost is high because a SIM card holder must be built into a secure area of the car – which must not be readily accessible – and a production SIM then inserted for testing purposes. At the point of delivery to the customer, a SIM with the correct profile must then be procured and manually inserted into that secure area of the car by the dealer and then tested. These are not trivial procedures and have been verified and checked during the interviews. The cost of having a GSMA Embedded SIM Specification is estimated to be around \$21, but in the case of removable SIM the cost is typically \$210 or more.

This indicates why the removable SIM card is not best suited for the Connected Car industry. From these figures, if the connected car market using only removable SIMs were to reach the size in volume of the connected car market forecast using GSMA Embedded SIM Specification (see forecast in Section 3 below – 152 million in 2019), it is estimated that there would be an additional cost of production and distribution of \$31.9bn in that period. These costs would need to be borne by car purchasers, which would inevitably have a strong, negative impact on development of the Connected Car market.

* This is a zero incremental cost, as detailed above.



Cost Savings GSMA Specification vs Removable SIM (\$ per car)

This variable relates to the replacement of the SIM in order to change MNO. In the case of a removable SIM, this cost involves not only the shipping of the new SIM with the correct profile, together with the man hours of labour for installing the new SIM, but also the software provisioning and testing. The cost of software provisioning and testing has been compared with the cost of car reflashing, where cars need to be returned to the dealers in order to fix electronics problems. This cost comes from a real case. Recently, Toyota had to recall almost 3,000,000 vehicles worldwide. The estimated cost of reflashing those vehicles varied from \$265 to \$1000 per car depending on the type of car, the location of the car (urban or rural, how remote), the personal arrangements for the owner during the recall (for example, the provision of a replacement car for the day) and whether the car is due for a service or not. For this analysis, the lower cost of \$265 has been used and is therefore a conservative estimate. In the case of replacing the SIM, we have doubled this cost of reflashing to take into account the additional tasks required to procure the correct SIM and the labour cost of inserting and testing it in

GSMA Embedded SIM Specification eliminates all of that cost and all of the inconvenience caused to the car owner, a very important further factor for automakers looking to gain customer loyalty.

Source: Auto OEM

the car. As a result, the total cost per car becomes very high at \$530. GSMA Embedded SIM Specification eliminates all of that cost and all of the inconvenience caused to the car owner, a very important further factor for automakers looking to gain customer loyalty.

Cost Savings GSMA Specification vs Proprietary eUICC (\$ per car)

This variable relates to a change of MNO for an embedded SIM in a car already on the road. For proprietary eUICC solutions, the actions required are similar to a car reflashing exercise, in that typically a board change or firmware change of the embedded SIM will be required. The cost used for this analysis is therefore the cost of car reflashing, at \$265 per car as described above. As also noted above, GSMA Embedded SIM Specification eliminates all of that cost and all of the inconvenience caused to the car owner.

New GSMA Specification Connected Cars 2013 and New Proprietary eUICC Connected Cars 2013

These two variables represent the new car registrations that were connected in 2013 globally, 4.4 million. The number of cars connected in a year is derived from a percentage of new car registrations in that year.

GSMA Specification Connected Cars 2014-2016 and Proprietary eUICC Connected Cars 2014-2016

These two variables represent alternative scenarios for the total number of connected cars (installed base) with GSMA Embedded SIM Specification and Proprietary solutions during the period 2014-2016. For a discussion on the methodology applied to this number, refer to the forecasting analysis below.

GSMA Specification Connected Cars 2017-2019 and Proprietary eUICC Connected Cars 2017-2019

These two variables represent alternative scenarios for the total number of connected cars with GSMA Embedded SIM Specification and Proprietary solutions respectively during the period 2017-2019. For a discussion on the methodology applied to this number, refer to the forecasting analysis below.



2.2.2 Scenario I – All cars will change contract (3 years contract)

In this scenario, it is assumed that the entire installed base of connected cars changes contract – meaning, changes MNO. The contracts with each OEM are assumed to be three years. This may well be five years in practice but the principles are similar irrespective of the period. In this way, it is assumed that there is a change of contract in early 2017 for all the cars connected in the period 2014-2016. In the case of eUICC proprietary solutions, changing MNO would almost certainly require changing or reflashing the eUICC itself in the whole base or accepting that the installed base of cars is locked to the initial contracted MNO for life.

As described in the variables above, this can be achieved at no additional cost with GSMA Embedded SIM specification but not with proprietary solutions, as detailed above for the variable, Cost Savings GSMA vs Prop. That cost is \$265 per car. This value is then multiplied by the Prop. Connected Cars 2014-2016 (million). The total cost saving is \$16,483 million.

It should be noted that this comparison of costs between proprietary solutions and GSMA Embedded SIM Specification does not take account of SIM vendor service charges. This is because these are expected to be similar in both cases, so cancel each other out in terms of incremental cost for either approach.

The same approach has been used comparing GSMA Embedded SIM Specification versus proprietary solutions for the period 2017-2019. The cost saving per car is \$265 per car. The total cost saving is \$265 multiplied by Prop. Connected Cars 2017-2019 (million), which is \$34,130 million.

2.2.3 Scenario II – 40% of all cars will change contract (3 years contract)

In this second scenario, it is assumed that only 40% of the installed base of connected cars will change contract (and therefore MNO) at the end of the 3 year contract period. This can be done at zero cost with GSMA Embedded SIM Specification but not using proprietary solutions. Therefore, using GSMA means cost savings that are measured using the variable, Cost Savings GSMA vs Prop. That cost is \$265 per car. This value is then multiplied by 40% of Prop. Connected Cars 2014-2016 (million). The total cost saving is \$6,593 million.

The same approach has been used comparing GSMA Embedded SIM Specification versus proprietary solutions for the period 2017-2019. The cost saving per car is \$265 per car. The total cost saving is \$265 multiplied by 40% of Prop. Connected Cars 2017-2019 (million), which is \$13,652 million.

2.2.4 Second Hand Market

GSMA Embedded SIM Specification will also positively impact the second hand car market. The last part of the table shows the cost savings for changing contract once a car changes ownership. The second hand car market operates worldwide, to the extent that a car sold in one European country may well end up being sold in another, or even in a different region worldwide. The need for changing contracted MNO is therefore very strong. Without being able to economically make such a change, it is quite possible that Connected Car services pre-installed in the car from the factory will either not be usable at all or only at high cost, which would then affect the value of that car.



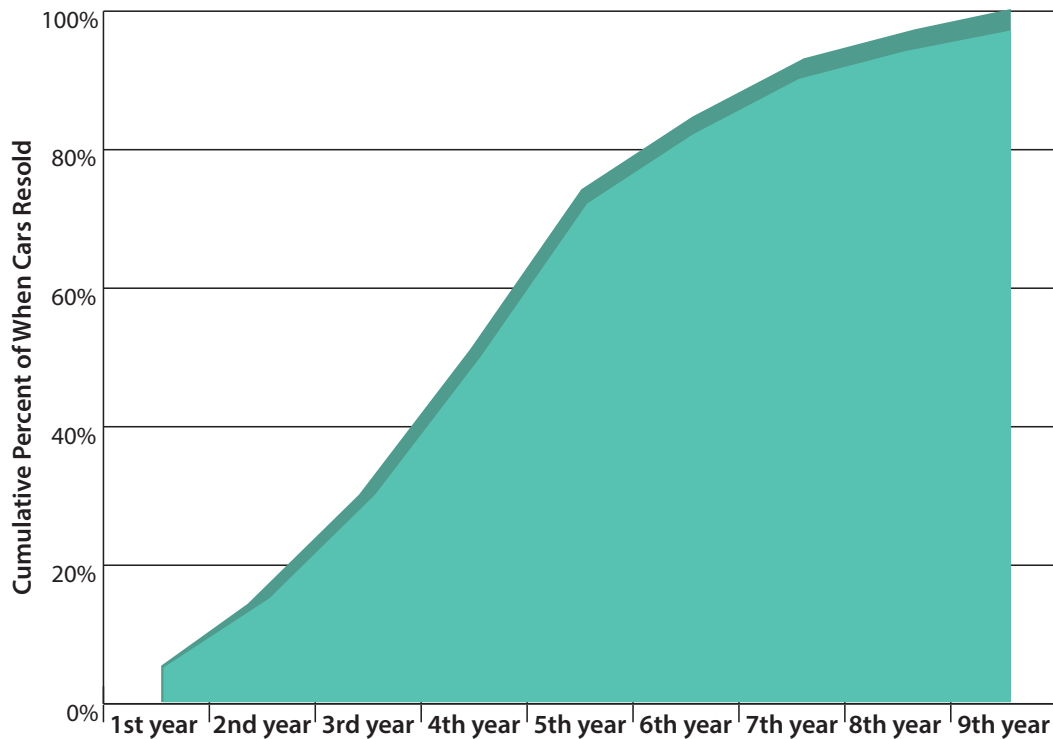


Figure 2.1: Distribution of age from initial purchase cars resold once

Our cost estimates for the second hand car market are based on a distribution as shown in Figure 2.1 where 5% of new cars sold are then resold within one year, 15% within two years, 30% within three years, etc. Our estimates assume just one change of car ownership for those sold in the forecast period, whereas in practice some cars are likely to change ownership several times in the period. This is therefore a conservative estimate of the number of times new cars sold in the period will subsequently be resold. It is then assumed that each connected car resold will require a change of MNO to enable the connected car services to be used economically by the new owner.

From this calculation, it is estimated that there will be at least 32.5 million second hand cars equipped with eUICCs between 2015 and 2020. We also assume that in the period there will be only one change of ownership. Performing that change with GSMA Embedded SIM Specification is at zero cost. Doing it via proprietary solutions requires a car reflashing. The cost saving is the Cost Savings GSMA Specification vs Proprietary eUICC, at \$265 per car. Therefore, the total cost saving is \$265 times 32.5 million, which is \$8,612 million.

Another option for second hand cars is that they are not reconnected when sold, so that the Connected Car services become stranded assets. As outlined with the costs above, this is considerably more likely to happen with

proprietary eUICC solutions than with the GSMA Embedded SIM Specification solution. This means that the actual installed base of connected cars for proprietary solutions is likely to be much less than the forecast, since the forecast assumes no loss of base. The cost of conversion as above is so high that many new owners are likely to opt not to change and effectively be disconnected.

3. IMPACT OF eUICCS FOR THE AUTOMOTIVE SECTOR

The business benefits analysis reveals that the eUICC is crucial for the development of the Connected Car market. We expect the adoption of the GSMA Embedded SIM Specification to have two additional effects.

Use of the GSMA Embedded SIM Specification as the de facto standard in the Automotive sector is expected to drive market growth faster than using other alternatives.

1. Use of the GSMA Embedded SIM Specification as the de facto standard in the Automotive sector is expected to drive market growth faster than using other alternatives.
2. Standardising on the GSMA Embedded SIM Specification can facilitate the adoption of multiple SIMs in the car for different services.

These effects of embedded SIMs and of the GSMA Embedded SIM Specification on the Connected Car market are illustrated in the following chart showing projected connection growth rates worldwide. These projections are based on a growing percentage of new car registrations being connected at the point of sale. The growth rates are therefore dependent on the number of new car registrations per year and the increasing penetration of these being connected. The base in 2013 assumes

10% of new registrations being connected, with different overall penetration rates for the three different scenarios. The assumption is that Automotive suppliers are more likely to implement eUICCs throughout their ranges using the GSMA Embedded SIM Specification compared with a slower rate using proprietary solutions. The reason for that slower rate for proprietary solutions is an expectation of changing to a standard at some point in the future and wishing to minimise the complexity of operating multiple solutions.

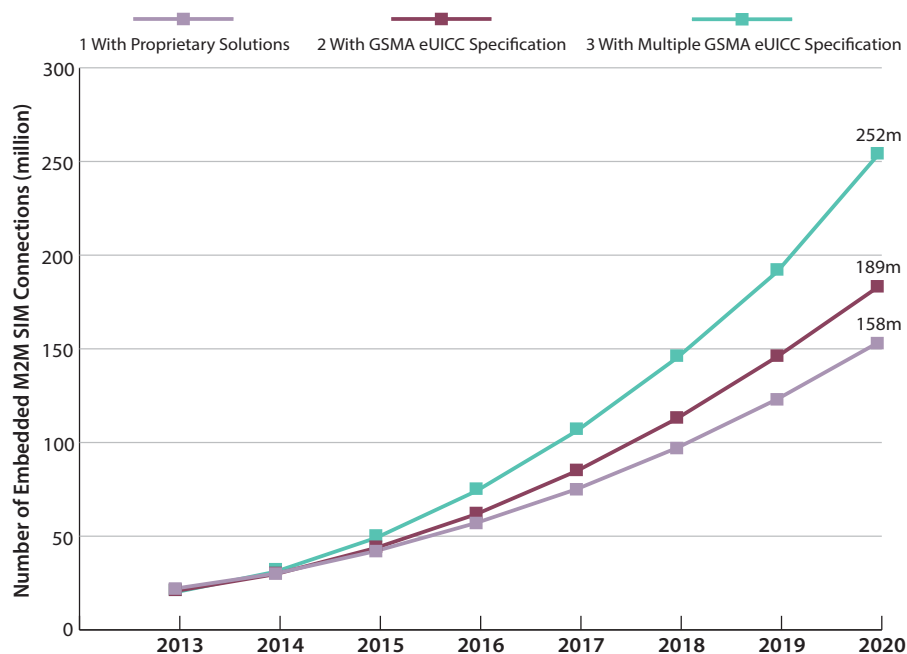


Figure 2.2: Projected Connected Car Connections worldwide with alternative scenarios

	2013	2014	2015	2016	2017	2018	2019	2020
1 With Proprietary Solutions	27,669	35,708	47,183	62,163	80,716	102,912	128,822	158,519
2 With GSMA eUICC Specification	27,669	36,780	50,420	68,680	91,651	119,424	152,093	189,755
3 With Multiple GSMA eUICC Specification	27,669	38,924	56,894	81,715	113,520	152,447	198,635	252,225

The forecasting approach of the automotive sector is based on three scenarios:

- (1) The market is served by proprietary solutions with one SIM per vehicle.
- (2) GSMA Embedded SIM Specification is the standard de-facto with one SIM per vehicle.
- (3) Multiple embedded SIMs are used all based on the GSMA Embedded SIM Specification.

The growth rate increases moving from scenario (1) to scenario (3) along the period 2013-2020. In the third scenario, the number of M2M SIM connections for connected cars is expected to reach 252 million worldwide in 2020, compared with 158 million in scenario 1.

4. CONCLUSIONS

It is clear from this analysis that the traditional removable SIM adds cost and service issues for the Connected Car market that make it less appropriate than an embedded SIM solution.

While proprietary eUICC solutions offer a considerable improvement on the removable SIM for manufacturing purposes, contract changes requiring a change of MNO are problematic both in the new car market and the second hand market.

On the other hand, the GSMA Embedded SIM Specification offers not only the manufacturing process improvements, but also minimal cost for change of MNO at contract expiry.



PART 3: BUSINESS BENEFITS OF eUICCs FOR THE CONSUMER ELECTRONICS SECTOR

1. INTRODUCTION

This section explores the overall impact of the use of the GSMA Embedded SIM Specification for eUICC and proprietary solutions within the consumer electronics sector. The section is structured in three parts. The first part explores the business benefits of embedded SIMs in the consumer electronics sector. A significant number of these benefits are intangible as they stand, so we provide a quantitative assessment of some of those. The second section explores the effect that the adoption of embedded SIMs will have in the consumer electronics sector. The third section provides conclusions.

2. BUSINESS BENEFITS ANALYSIS FOR THE CONSUMER ELECTRONICS SECTOR

2.1 Discussion on Business Benefits for the Consumer Electronics Sector

Currently, the attention on eUICCs for consumer electronics is generally not as strong as for automotive. It is likely to take a few years longer before the sector fully embraces eUICCs. However, we believe that after that time it is the sector that will most dramatically drive the adoption of eUICCs in terms of volumes. The reason of that strong penetration rate lies in the following key business benefits for the consumer electronics stakeholders.

Streamlining of the retail process, opening up the prospect of sales of cellular-connected devices through many more routes to market.

1. Simplification and streamlining of the manufacturing process and related cost reductions due to component changes.
2. Streamlining of the retail process, opening up the prospect

of sales of cellular-connected devices through many more routes to market.

3. The GSMA Embedded SIM Specification will enable the selection of mobile network operator contract and the change of profile at contract change, if required.
4. The use of one SIM solution only for the global market will drive big volumes. The GSMA Embedded SIM Specification can play a critical role in that.
5. The smaller size form factor eUICCs will have a positive impact on device design. It should also enable additional functionalities such as waterproofing for wearable devices.
6. Coupled with this, the eUICC is expected to drive the launch of many new devices in the market.
7. The eUICC will improve security aspects for the SIM, as it can be sealed within the product.

In summary, the use of the GSMA Embedded SIM Specification is expected to drive strong sales of existing products (including tablets) and of new products (including wearable devices).

2.2 Assessment of the Business Benefits for the Consumer Electronics Sector

The benefits discussed are mainly drivers of new sales. The manufacturing reduction costs are relevant for manufacturers' profitability, but they do not represent the strongest argument in favour of the GSMA Embedded SIM Specification.

The stronger effect of adopting the GSMA Embedded SIM Specification is around driving new product sales. The use case is based around a consumer purchasing a



consumer electronic device with embedded SIM from an OEM, either directly or via a retail channel. The OEM offers a service to the end user that includes connectivity. The OEM arranges the relationships with MNOs (mobile network operators) and SIM vendors.

Proprietary eUICC solutions enable the provisioning that can be done directly at retail level and therefore avoid the problem associated with the SIM card of limiting the number of retail outlets that can be used. This can accelerate sales.

On the other hand, the use of proprietary eUICC solutions has two main disadvantages:

1. Changing solution is potentially problematic when using a proprietary offering as it is likely to mean changing the eUICC or its firmware. In practice that is most likely to mean a board change within the device.
2. There are also limitations in developing an international market for the product. Should there be a need to establish agreements in different countries with different MNOs or national operations, that could only be achieved if each used the same proprietary eUICC. In practice this would most likely lead to limitations in coverage or the OEM paying

higher tariffs in international markets, or both.

“ Although the manufacturer also benefits from lower process costs as outlined above, the greater business benefits of adopting GSMA Embedded SIM Specification are measured in new sales.

The GSMA Embedded SIM Specification overcome all of these problems highlighted by the previous two approaches.

Therefore, the expected acceleration of sales with GSMA Embedded SIM Specification is stronger than in the previous two solutions. Although the manufacturer also benefits from lower process costs as outlined above, the greater business benefits of adopting GSMA Embedded SIM Specification are measured in new sales. This, in turn, can be expressed through the forecasts of M2M SIM Connections in consumer electronics as outlined below.

3. IMPACT OF eUICCS FOR THE CONSUMER ELECTRONICS SECTOR

The impact of eUICCs for the consumer electronics market is analysed using three scenarios: the market will use removable SIMs, the market will use eUICC proprietary solutions, and the market will use GSMA Embedded SIM Specification. The three scenarios are illustrated in Figure 1.3.

Emerging consumer device segments such as wearable devices, connected cameras, and connected bikes will start to become important in the in the forecast period 2014-20. Proprietary solutions are less likely to ensure the global penetration of such products. Instead, GSMA Embedded SIM Specification provides an easy route for global adoption of all products. Figure 1.3 shows the impact that the GSMA Embedded SIM Specification is expected to have on the total installed base of M2M connections in the consumer electronics sector globally between 2013 and 2020.

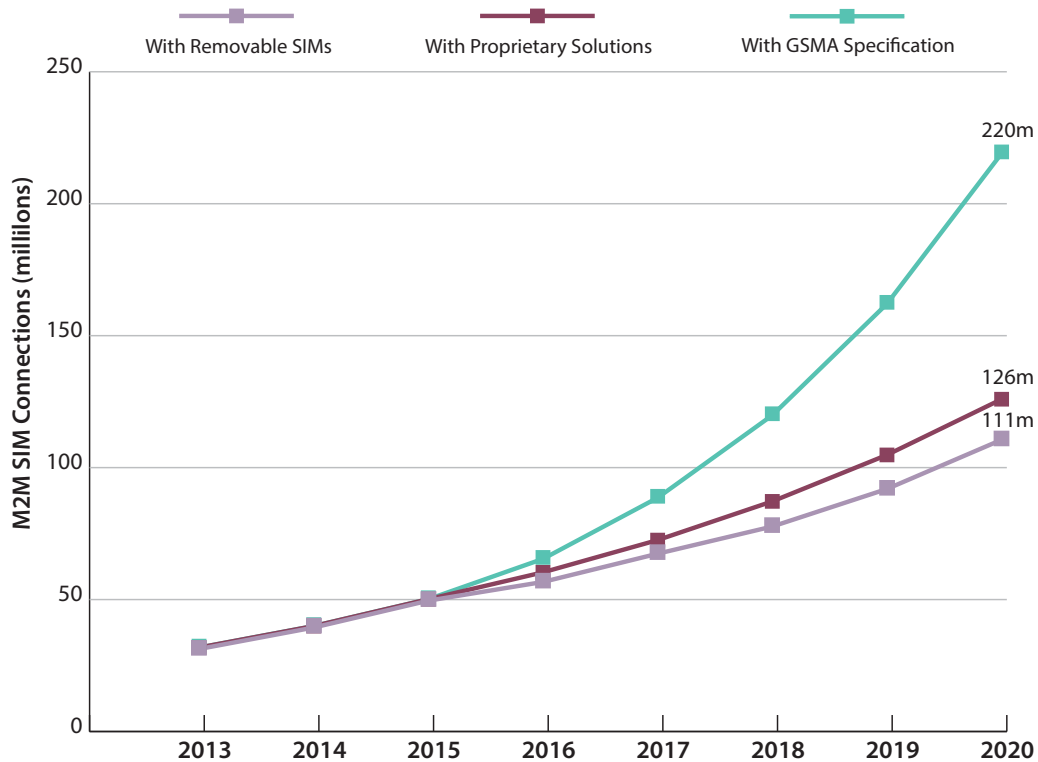


Figure 3.1: Projected Consumer Electronics Connections worldwide with alternative scenarios

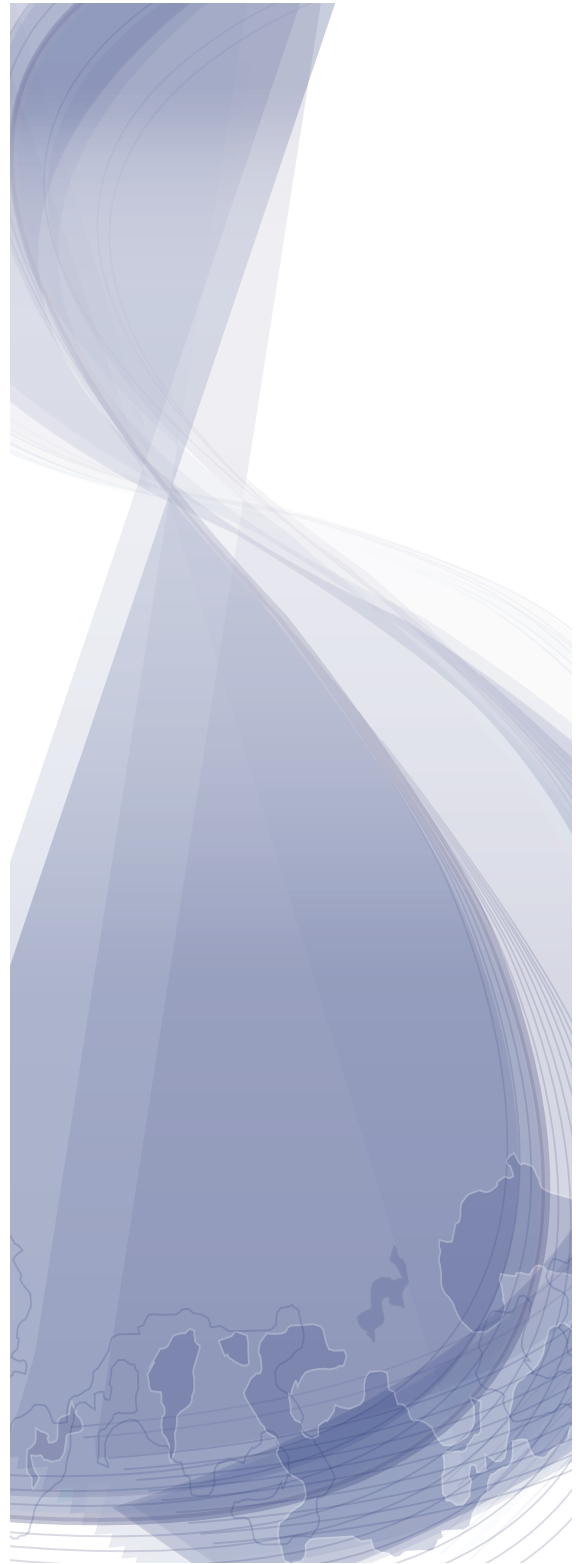
	2013	2014	2015	2016	2017	2018	2019	2020
With Removable SIMs	32,586	40,733	50,916	58,008	68,710	79,017	93,240	111,888
With Proprietary Solutions	32,586	40,733	50,916	61,099	73,319	87,982	105,579	126,695
With GSMA eUICC Specification	32,586	40,733	50,916	66,191	89,357	120,632	162,853	219,852

Between 2013 and 2015, it is assumed that the GSMA Embedded SIM Specification and proprietary solutions have not been adopted by the consumer electronics sector yet. Therefore, the growth rate is the same as the scenario with removable SIMs. In 2016, the consumer electronics sector is expected to start adopting the GSMA Embedded SIM Specification or proprietary solutions. The differential between the two eUICC-based scenarios will increase over the period 2016–2020 due to the global penetration of new product segments better supported by the GSMA Embedded SIM Specification.

4. CONCLUSIONS

It is clear that using traditional SIM cards for consumer electronic products limits the number of retail outlets and therefore the sales. This has been a constant issue to date and one of the key reasons why sales of cellular connected consumer electronics devices has never developed internationally. Instead, more focus has been placed among OEMs on WiFi connectivity.

The role of eUICC solutions in consumer electronics devices is crucial in changing this. However, for forecasting purposes, this will not substantially impact the forecast period 2014-2015. Consumer electronics is expected to become a strong adopter of embedded SIMs in the subsequent period. The GSMA Embedded SIM Specification has the potential to become the preferred solution for new connected products with a worldwide market ambition.



ABOUT BEECHAM RESEARCH

Beecham Research is a leading market analyst and consulting firm that has specialized in the development of the rapidly-growing M2M/Internet of Things market worldwide for over a decade, since 2001. Based in London and Cambridge UK and in Boston US, we actively participate in initiatives aimed at achieving M2M market development and growth. Recent research has included two market-leading and widely supported studies on M2M Cloud-Based Platform Services and a study of the worldwide Satellite M2M market contracted by the European Space Agency. Ongoing research includes new business models for the Internet of Things, Healthcare and other vertical sectors.

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ABOUT THE GSMA

The GSMA represents the interests of mobile operators worldwide. Spanning more than 220 countries, the GSMA unites nearly 800 of the world's mobile operators with 250 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and Internet companies, as well as organisations in industry sectors such as financial services, healthcare, media, transport and utilities. The GSMA also produces industry-leading events such as Mobile World Congress and Mobile Asia Expo.

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

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