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Economic aspects of embedded SIM for the telecommunications consumer segment

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Economic aspects of embedded SIM for the telecommunications consumer segment

– Paper prepared for the 28th ITS European Conference Passau, Germany, 30th July - 2nd August 2017 –

Keywords: Mobile, strategy, technological change

Abstract:

After having been developed for Machine-to-Machine (M2M) communication, standardised embedded SIM (eSIM) solutions are about to be launched in the telecommunications consumer segment. At this early market stage, various details of eSIM implementation have not been fixed yet. Our paper aims to generate a well-founded understanding of characteristics and potential use cases and their likely impact on existing processes and market structures. Overall, eSIM seems unlikely to become a game changer in the mobile market in the short run. It offers, however, some potential to ease existing processes, improve customer satisfaction and generate new sources of revenues at different stages of the value chain.

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1 Introduction

After having been developed for Machine-to-Machine (M2M) communication, standardised embedded SIM (eSIM) solutions are about to be launched in the telecommunications consumer segment. The substitution of replaceable SIM (Subscriber Identity Module) cards by fixed and soldered eSIM represents a fundamental change to the industry and particularly to key processes such as provisioning and operator switching.

eSIM has the potential to ease provisioning processes, enable a large variety of mobile connected products and thus to improve customer satisfaction and generate new sources of revenues in the mobile consumer market. It may impact the mobile value chain and offer opportunities to enhance the scope of services and products. In the long run, eSIM solutions could potentially replace traditional SIM cards in mobile devices.

Our paper intends to generate a well-founded understanding of characteristics and potential use cases based on the technical architecture and their likely impact on existing processes and market structures. These generic findings aim at providing an early assessment of potential consequences of the emerging eSIM solutions in order to highlight core aspects that need to be taken into account by regulatory and political authorities.

The focus of our paper is to analyse eSIM's potential impact on market structures and competition. As the development of eSIM is still in its very early stage, our paper applies an exploratory research design. In order to develop a solid understanding of the context and derive likely scenarios, we have conducted interviews with selected experts of regulators, operators and other stakeholders. Moreover, we have studied existing literature, which is limited however.¹

Our paper is structured as follows: In chapter 2, the main characteristics of the eSIM concept are explained and distinguished from existing SIM solutions. A definition of eSIM is provided, use cases in the consumer segment are outlined and a reference to the current state of standardization is given.

¹ See, e.g. Mc Kinsey (2015): E-SIM for consumers - a game changer in mobile telecommunications?, September 2015, available for download under <http://www.mckinsey.com/industries/telecommunications/our-insights/e-sim-for-consumers-a-game-changer-in-mobile-telecommunications>;
MacKee, Diego (2016): Navigating the eSIM revolution as an MNO - Embedded SIM - a game changer in mobile telecom, presentation by Arthur D. Little, Oslo, February 4th 2016, available for download under <http://telcohub.io/wp-content/uploads/2016/02/Keynote-Diego-MacKee>;
EY (2015): Embedded SIM Study, September 2015 update, available for download under [http://www.ey.com/Publication/vwLUAssets/EY-mobile-network-operator/\\$FILE/EY-Embedded-Sim-Studdy-White-Paper-September-2015.pdf](http://www.ey.com/Publication/vwLUAssets/EY-mobile-network-operator/$FILE/EY-Embedded-Sim-Studdy-White-Paper-September-2015.pdf).

Chapter 3 addresses the potential implications of eSIM solutions on relevant market players. We conduct a generic SWOT-analysis for Mobile Network Operators (MNOs), Mobile Virtual Network Operators (MVNOs)/Service Providers and Device Manufacturers in order to derive opportunities and threats for the main stakeholders in the mobile market.

Building on these results, potential future directions of eSIM development are discussed in Chapter 4. In particular we address the likely scenario of eSIM penetration, its effects on competition and end users as well as potential policy implications at this early stage.

Our paper closes with some conclusions in Chapter 5.

2 Characteristics of embedded SIM solutions

eSIM² solutions have been initially developed for M2M communications in order to save costs by easing production and manufacturing processes and make devices more resistant against environmental conditions such as heat, water or cold.

Although the number of consumer devices with embedded SIM functionalities is limited yet, a strong growth of this market segment is expected by market players³ and market analysts⁴ in the near future.

This development might have large consequences on various aspects of the consumer mobile market, including core processes in the customer lifecycle such as activation, authentication and switching between different operators as well as potential new business models and sources of revenues driven by multi-connected devices. Thereby, eSIM has the potential to impact both the value chain and the balance between the main actors. In the long run, eSIM solutions could finally replace existing SIM solutions completely.

eSIM therefore needs to be studied from different points of view: It enables new applications, it governs important processes in the customer lifecycle and thereby has the potential to impact the market in a significant way.

2.1 The role and relevance of SIM cards for mobile telecommunications

SIM cards play a significant role for secure mobile communication since the emergence of the mobile market in the early 90s. Although traditional (removable) SIM cards have become smaller over time, their core functions have remained the same. In particular they are used for identification and authentication purposes via IMSI (International Mobile Subscriber Identity), MSISDN (Mobile Subscriber International ISDN Number), PIN (Personal Identification Number) and PUC (Personal Unblocking Code). Moreover, they represent an important link between customer and connectivity provider as switching processes are realized by the replacement of one SIM card by another.

The introduction of devices with eSIM cards, which are soldered into consumer devices, puts forward a new set of technical and procedural requirements. First of all, they require over-the-air provisioning mechanisms in order to realize clearing and authentication processes. Most importantly, new processes for operator switching need to be employed, as the traditional switching process, which is characterized by the

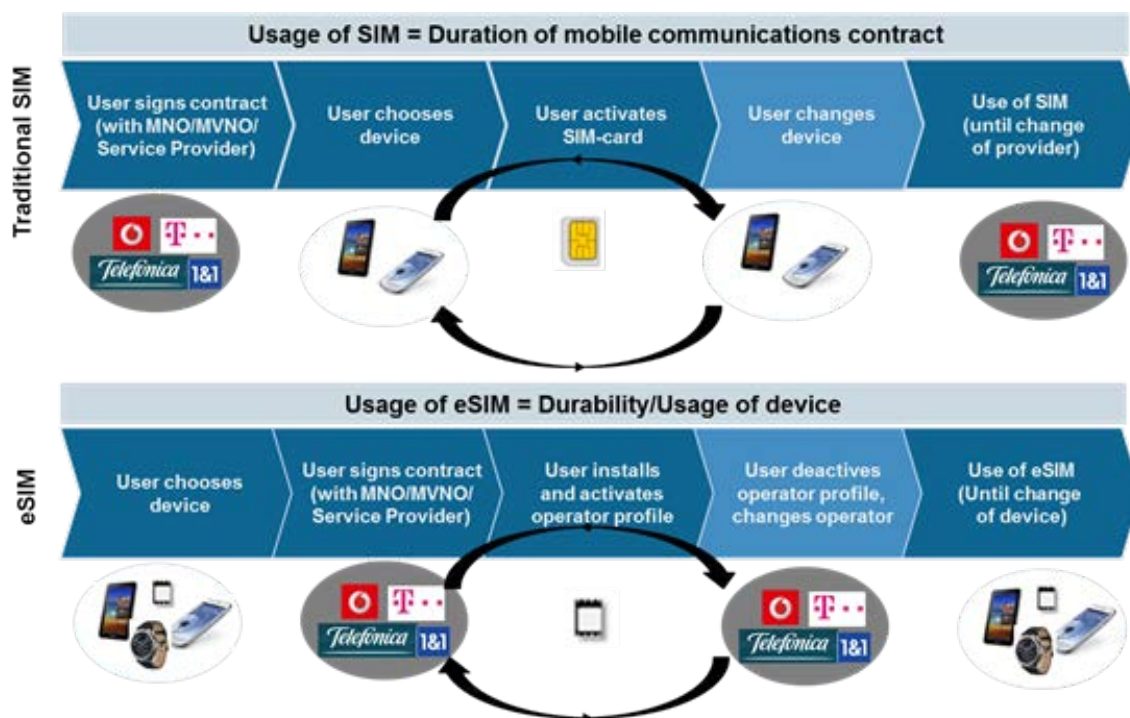
² also known as eUICC (Embedded Universal Integrated Circuit Card)

³ See Heitmann, Guido (2017): „Das Schönste haben wir noch vor uns“ – Interview with Telefónica CEO Markus Haas in Süddeutsche Zeitung, 15.02.2017, available for download under <https://blog.telefonica.de/2017/02/interview-in-der-sueddeutschen-zeitung-das-schoenste-haben-wir-noch-vor-uns-ceo-markus-haas/>.

⁴ See MacKee, Diego (2016): Navigating the eSIM revolution as an MNO - Embedded SIM - a game changer in mobile telecom, presentation by Arthur D. Little, Oslo, February 4th 2016, available for download under <http://telcohub.io/wp-content/uploads/2016/02/Keynote-Diego-MacKee>.

replacement of one SIM card by another is omitted. This has implications for the customer lifecycle, too. Traditionally, the SIM card represented a strong link between the user and the contracting partner. On the contrary in an eSIM scenario, the eSIM lifecycle equals the durability of the device. Traditionally, it was easy to change a device within a given contract by replacing a SIM card. The new environment with eSIM shifts towards more flexibility in terms of changing the provider for a given device instead (see Figure 1).

Figure 1 Typical usage process of SIM and eSIM



Source: WIK.

These circumstances could create a new competitive situation, if the full potential of eSIM would be exploited on a large scale. Whether this will actually happen, depends, however, on the concrete implementation of eSIM solutions (e.g. by maintaining consumer choice) and on operator strategies regarding the bundling of subsidized handsets and contract durations.

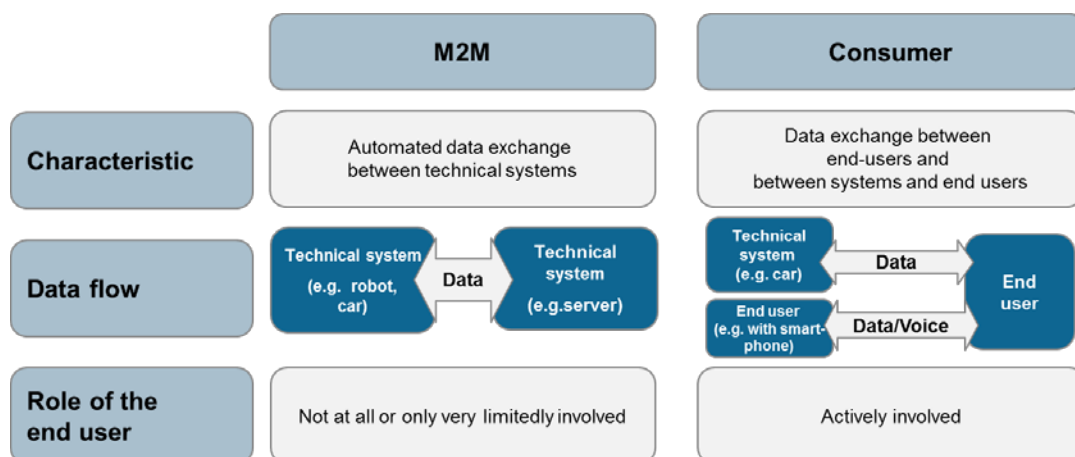
2.2 The definition of eSIM

The technical requirements for eSIM in the M2M and the consumer segment are similar. The processes, however, differ significantly: In the M2M segment, business to business contracts are usual, i.e. the contracting partner of an MNO (or a M2M solutions provider) is the manufacturer of the device, in which the eSIM module is soldered. The

end user is not involved in the contract relation.⁵ Consequently, the end user has no influence on the choice of the connectivity provider, e.g. when using a connected car. Any change of the provider is initiated by the device manufacturer. Connectivity contracts are typically long-standing and exclusive. In the consumer segment instead, the possibility to switch the operator is a fundamental consumer right, monitored by regulatory and competition authorities.

For our purpose, the two segments are distinguished mainly based on the role of the human users:⁶ Different from the M2M sector, the consumer segment is characterised by an active role of a human user in the communication process. It covers communication between a machine and a consumer (consumer Internet of Things (IoT) in form of a wide range of products) as well as between one or more consumers (e.g. via smartphone).

Figure 2 Differences between M2M and Consumer Segment



Source: WIK.

Until today no common understanding or definition of eSIM has been established. The de facto-standardised eSIM (based on GSMA⁷ specification) is characterised by the fixed integration into the consumer device combined with an over-the-air provisioning mechanism. So far, no devices with a standardized eSIM have been launched.

Proprietary solutions have been implemented by device manufacturers who took the initiative to push eSIM from M2M to the consumer segment. These devices deploy

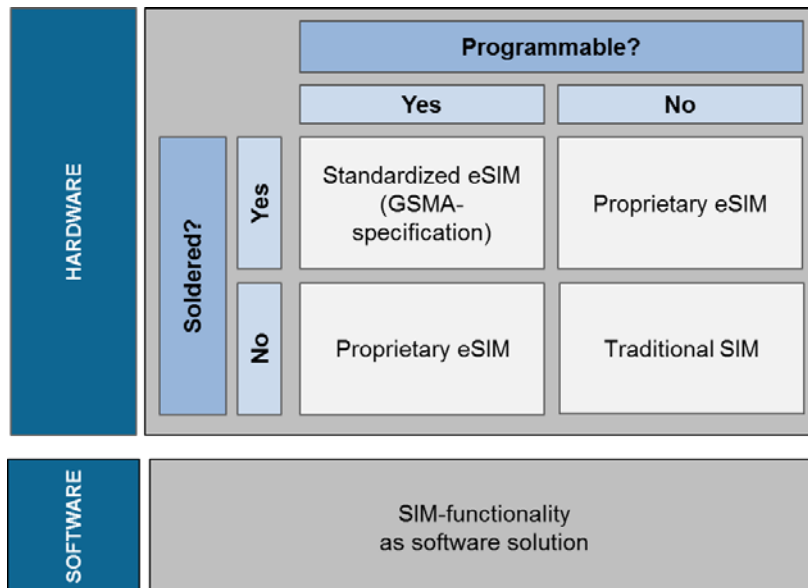
⁵ See for the typical contracting process in M2M communications Beecham Research (2014): Benefits Analysis of GSMA Embedded SIM Specification on the Mobile Enabled M2M Industry, September 2014, p. 15, available for download under <http://www.gsma.com/iot/wp-content/uploads/2014/10/Benefits-Analysis-GSMA-Embedded-SIM-Specification.pdf>.

⁶ See also BEREC (2016): Report Enabling the Internet of Things, BoR (16) 39, 12. February 2016, pp. 5-6, available for download under http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/5755-berec-report-on-enabling-the-internet-of-things.

⁷ GSM Association, <https://www.gsma.com/>

solutions that cannot be removed or programmed. E.g., Apple launched a removable SIM card for some iPad models that could be programmed for different providers⁸ and Samsung deployed a soldered SIM card offering only one operator profile with no guaranteed option for reprogramming⁹.

Figure 3 Definition of embedded SIM (eSIM)



Source: WIK.

In the context of this paper, we focus on soldered hardware in the form of standardized and proprietary eSIM solutions on the consumer market and depict the standardized eSIM development in more detail. SIM-functionality as software and proprietary solutions which are not soldered are beyond the scope of our paper.

2.3 Overview on eSIM-based products for the consumer segment

eSIM was developed in order to adapt the traditional SIM to the specific needs of M2M-communication, as a growing amount of SIM cards has been deployed for mobile connections between machines.¹⁰ Many M2M applications benefit from smaller and more robust SIM cards that provide a long life span and withstand extreme conditions of vibration, temperature and humidity.¹¹ Specifically designed for these needs, eSIM

⁸ See for an overview on models and providers <https://www.apple.com/ipad/apple-sim/>.

⁹ At least the first products available e.g. in Germany did not guarantee an operator switch, see <https://www.vodafone.de/hilfe/mobiles-telefonieren/esim.html#kann-ich-esim-geraete-mit-allen-netzbetreibern-nutzen>.

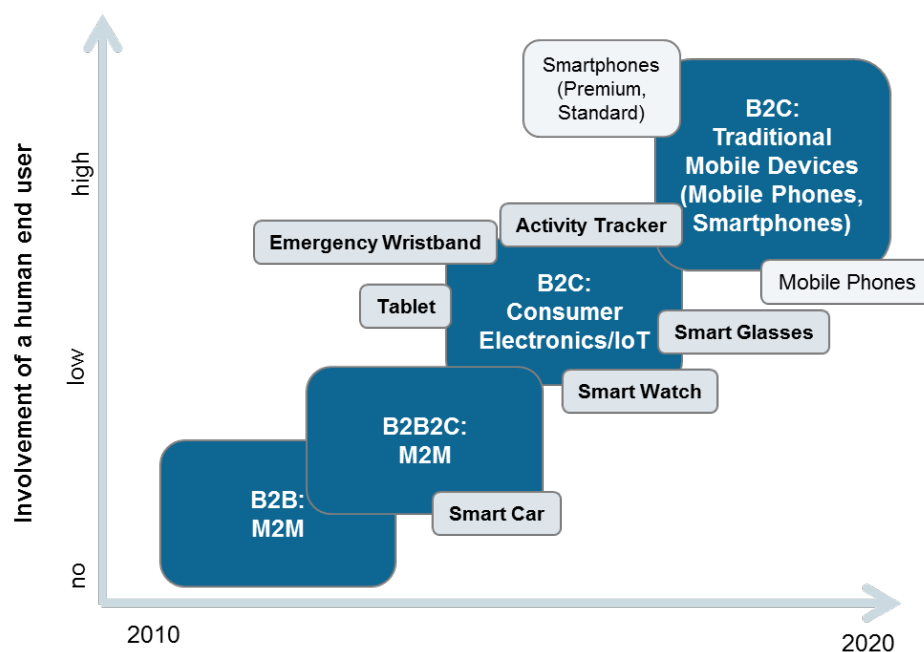
¹⁰ E.g. in Germany M2M accounted for 6% of all SIM cards in the market in 2016, see Bundesnetzagentur (2017): Jahresbericht 2016, Bonn, p. 58, available for download under https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2017/JB2016.pdf?__blob=publicationFile&v=1.

¹¹ See also Beecham Research (2014): Benefits Analysis of GSMA Embedded SIM Specification on the Mobile Enabled M2M Industry, September 2014, available for download under

enables new options for the construction of devices. At the same time, over-the-air provisioning is required to manage operator profiles. In most areas of M2M communication, traditional SIM cards are still deployed. Nevertheless, the share of eSIM in M2M has been increasing significantly. Smart car is one of the most important deployment areas.

The first eSIM applications in the consumer segment were showcases for consumer IoT products like tracking devices and smart watches (see Figure 4). So far these applications have been deployed by traditional SIM cards or run via Bluetooth links. By now, smartphones with integrated eSIM solutions have not been launched yet. However, our expert interviews suggest that they can be expected by end of 2017.

Figure 4 Launch stages of different eSIM products



Source: WIK.

The steps taken to introduce eSIM solutions to the market tend to be similar across the world, mainly due to the global activities of leading device manufacturers. Nevertheless, different characteristics regarding relevant factors such as customer needs, willingness to pay, mobile market structures and distribution channels also have impact on their time to market.

Among the first eSIM products in the consumer segment was the E-Book-Reader Amazon (Kindle) Fire HDX, launched in 2013 and produced by Prime View International from Taiwan (see Table 1). In 2014, Apple delivered its tablet iPad Air 2 with an Apple

SIM, allowing consumers to choose pre-selected providers for mobile connections (e.g. Deutsche Telekom in Germany). In 2016/2017 the first smartwatches with eSIM were launched in selected countries across the world (e.g. Singapore, Croatia, Italy, Germany).

Table 1 Overview of eSIM products in the consumer segment (2017)

	Product Category	Hardware Manufacturer	MNOs (Examples)	Product Launch
Amazon (Kindle) Fire HDX	E-Book-Reader	Prime View International, Taiwan	Vodafone	2013
iPad Air 2	Tablet	Apple	Deutsche Telekom (Germany)	2014
Gear S2	Smartwatch	Samsung	Telefónica	2016
Huawei Watch 2	Smartwatch	Huawei	Hrvatski Telekom (Croatia)	March 2017

Source: WIK.

It has to be emphasized that all consumer eSIM products, which have been launched until today, deploy proprietary solutions. They are characterized by strong limitations regarding the choice of providers and do not include options for switching the connectivity provider.

2.4 The state of standardization

An important step towards standardization of eSIM was reached by GSMA in 2016, backed by 800 mobile operators and 300 companies from the broader mobile ecosystem. The GSMA released its first version of a specification that allows consumers to activate their embedded SIM in devices such as smart watches, fitness bands or tablets from a remote location in January 2016. A second version of the specification with more extended features and descriptions was completed in summer 2016.¹² The specification has been continuously enhanced and adopted. It can be regarded as a framework of choice for the implementation and claims to reach at least the level of security comparable to the traditional SIM.¹³

¹² See GSMA (2016): RSP (Remote SIM Provisioning of Devices) Architecture, Version 2.0, 23 August 2016, available for download under http://www.gsma.com/rsp/wp-content/uploads/docs_new/SGP.21_v2.0-Architecture and GSMA (2016): RSP (Remote SIM Provisioning of Devices) Technical Specification, Version 2.0, 14 October 2016, available for download under http://www.gsma.com/rsp/wp-content/uploads/docs_new/SGP.22_v2.0-Technical_Specification.pdf.

¹³ See GSMA (2016): RSP (Remote SIM Provisioning of Devices) Architecture, Version 2.0, 23 August 2016, p. 13, available for download under http://www.gsma.com/rsp/wp-content/uploads/docs_new/SGP.21_v2.0-Architecture.

Overall, the technical architecture of the eSIM includes two new roles:

New role in the core of the eSIM architecture:

- The **Subscription Manager Data Preparation (SM-DP+)** securely packages, encrypts, and binds profiles to devices/eUICCs and provides these profiles for download onto the eSIM. In principle, this role can be taken by any company. However, SIM manufacturers are very well positioned to act as subscription managers and are among the first players certified for this function.

New role in the consumer device:

- The **Local Profile Assistant (LPA)** is a new function that has to be implemented by the device manufacturer into the consumer device. It consists of the Local User Interface (LUI), Local Profile Download (LPD), and Local Discovery Service (LDS). It interoperates with the subscription management (SM-DP+) and the eSIM. Once triggered, it initiates the profile download and controls the execution of the respective profile management actions on the eUICC.

Other relevant actors in the eSIM environment have the following functions:

- The end user is the decision-maker who triggers the RSP procedure.
- The SM-DP+ acts on behalf of an operator only.¹⁴ Therefore, the MNO keeps a key function in the eSIM environment. Service Providers cannot directly interoperate with the SM-DP+.
- The eSIM manufacturer issues the eSIM for a specific device.
- The device manufacturer integrates the eSIM into the device.

Since the end of 2016, certificates have been granted for the production of eSIM and the related new role of subscription management.¹⁵ The latter is currently implemented by a couple of SIM manufacturers (Gemalto, Oberthur, Morpho).¹⁶

As of yet, it is difficult to foresee how the concrete implementation will look like. Roles and functions defined by the GSMA specification can be deployed in different ways. Its current version allows only one operator profile to be active at each time, even if several

¹⁴ See GSMA (2016): RSP (Remote SIM Provisioning of Devices) Architecture, Version 2.0, 23 August 2016, p. 28, available for download under http://www.gsma.com/rsp/wp-content/uploads/docs_new/SGP.21_v2.0-Architecture.

¹⁵ See for the certificates and related requirements and procedures GSMA, <http://www.gsma.com/aboutus/leadership/committees-and-groups/working-groups/fraud-security-group/security-accreditation-scheme>.

¹⁶ An overview on certified companies is available on the GSMA website under <http://www.gsma.com/aboutus/leadership/committees-and-groups/working-groups/fraud-security-group/security-accreditation-scheme/sas-accredited-sites-list>.

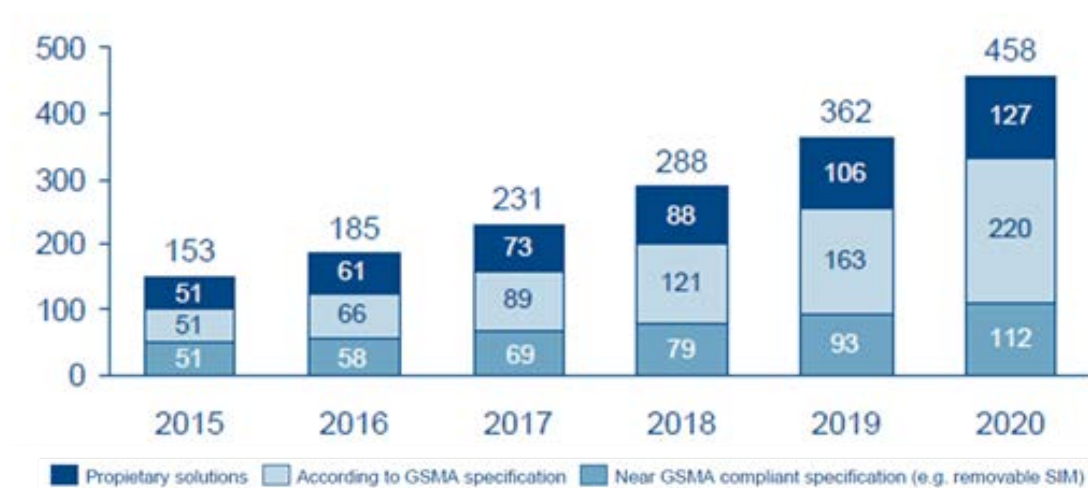
profiles are installed. This raises questions regarding how a very flexible provider change could be realized from a technical point of view. Furthermore, it restricts use cases such as national and international roaming.

One crucial point with regard to the propagation speed of eSIM will be the share and relevance of proprietary solutions. The usage of eSIM devices would benefit from a broad adoption of common standards. It is obvious that MNOs, MVNOs as well as consumers and regulatory and political authorities will have a strong interest in common standards (despite different reasons for this claim). Standardised solutions have numerous significant advantages, among them the realization of cost savings and the maintainance of operator switching opportunities.

This alignment of interests might further the GSMA specification to become the new market standard. In this case its design would have significant impact on consumer choice and competition.

However, the positioning of premium device manufacturers that have launched proprietary solutions in the past is not yet clear. Although the GSMA standard is backed by premium device manufacturers officially, they might still have incentives to stick to proprietary solutions. Some market experts therefore expect that devices with proprietary eSIM solutions will continue to be launched on a significant scale (see Figure 5).¹⁷

Figure 5 eSIMs deployed in consumer electronics
(in million devices, 2015-2020)



Source: Diego (2016)¹⁸

¹⁷ See MacKee, Diego (2016): Navigating the eSIM revolution as an MNO - Embedded SIM - a game changer in mobile telecom, presentation by Arthur D. Little, Oslo, February 4th 2016, slide 8, available for download under <http://telcohub.io/wp-content/uploads/2016/02/Keynote-Diego-MacKee.pdf>.

¹⁸ MacKee, Diego (2016): Navigating the eSIM revolution as an MNO - Embedded SIM - a game changer in mobile telecom, presentation by Arthur D. Little, Oslo, February 4th 2016, slide 8, available for download under <http://telcohub.io/wp-content/uploads/2016/02/Keynote-Diego-MacKee.pdf>.

3 SWOT analysis of relevant players in the mobile communications market

In the previous sections, basic parameters of the eSIM concept have been analysed. This chapter examines the impact of eSIM solutions on the value chain and the main players in the mobile market. We address strategic options by applying a SWOT (strengths, weaknesses, opportunities and threats) analysis according to the concept developed by Michael E. Porter.¹⁹ Our SWOT analysis does not analyse eSIM's impact from a company-specific perspective, but focusses on its potential impact, which can be derived from the different strategies, business models and positionings of the main stakeholders involved (MNOs, MVNOs and Service Providers, Device Manufacturers). The objective of this high-level analysis is to elaborate in a general way how these market players could be affected by the launch of eSIM and how they are most likely to deal with it.

Given the early market phase of eSIM, it is obvious that operator strategies are not yet defined and implementation scenarios are unclear. Nevertheless, this analytic procedure allows to offer important clues with relevance for further developments that need to be taken into account by market participants as well as by political and regulatory authorities.

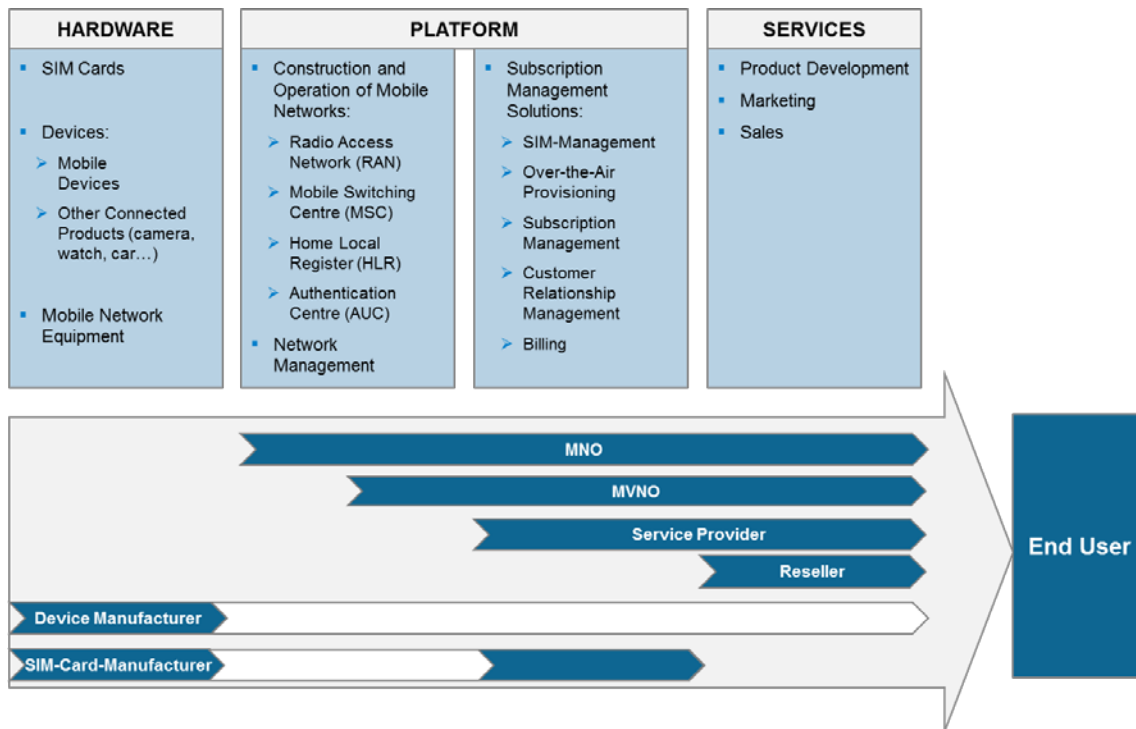
3.1 Mobile communications value chain

Delivering mobile services to the end user involves a variety of market players at different stages of the value chain. In order to reduce complexity it is possible to differentiate between hardware, platform and services. The different steps within the value chain cover global and national players as well as highly specialized services and hardware providers.

In light of eSIM and its implications for the mobile market, we focus on those players with a direct access to the end user (i.e. MNO, MVNO/Service Provider, Device Manufacturers) (see Figure 6).

¹⁹ See Porter, Michael E. (2004): *Competitive Strategy: Techniques for Analyzing Industries and Competitors* and e.g. Grundy, Tony (2006): *Rethinking and reinventing Michael Porter's five forces model*, *Strategic Change*, 15(5), 213-229.

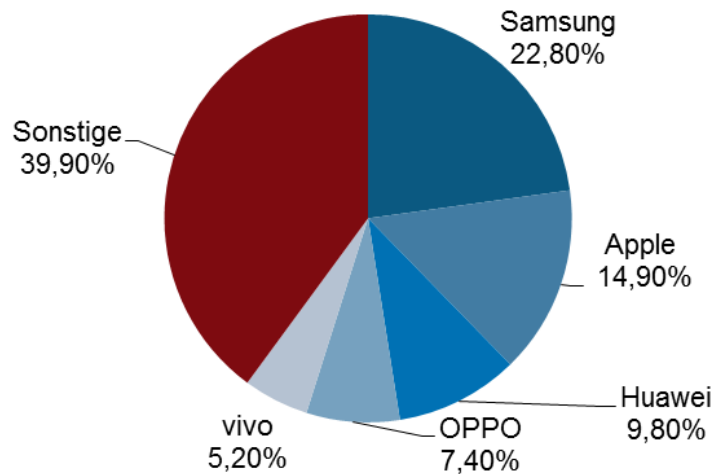
Figure 6 Mobile value chain



Source: WIK.

The device manufacturers segment is highly heterogeneous. Some companies, in particular premium manufacturers such as Apple and Samsung act globally. Others – this holds especially for equipment manufacturers from China such as OPPO and vivo – enjoy a strong position in their home markets and a visible share in the worldwide market, but no (or very limited) business in Europe or the U.S. (see Figure 7).

Figure 7 Market shares of smartphone manufactureres worldwide (Q1 2017)



Source: WIK based on IDC (2017)²⁰

Moreover, premium and standard device manufacturers can be distinguished. The group of premium device manufacturers consists of global players with strong brands including Apple, Samsung and recently also parts of Huawei's portfolio. Apple's focus is exclusively on premium devices. More cost sensitive customers are addressed with the relaunch of older iPhone models. On the contrary, Samsung and Huawei offer a broad product portfolio for all customer segments. Huawei was the latest manufacturer who successfully entered the premium segment with its flagship smartphones. Despite some regional differences with respect to market share and market position, Apple and Samsung develop global strategies without specific national differentiation (besides adapting their smartphone models to the specific needs of national MNOs to guarantee their functioning). Conversely, the group of standard device manufacturers consists of a large number of heterogeneous players including global players (e.g. ZTE) as well as niche players (e.g. feature phones, devices for senior people) and manufacturers with focus on specific regions in the world such as Xiaomi in Asia or Onyx Connect in Africa.

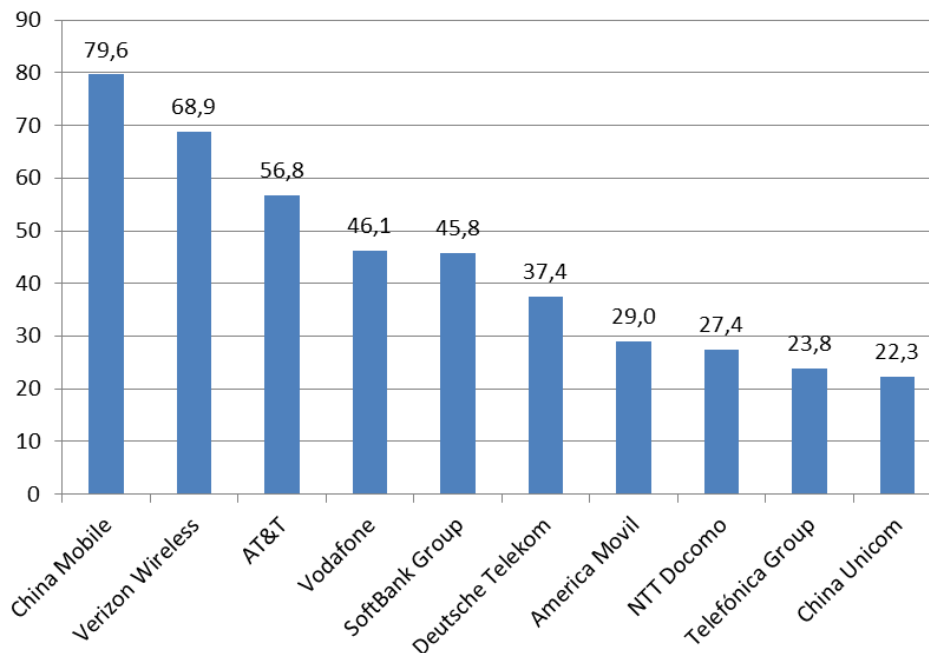
MNOs differ with regard to their product offers, ARPUs²¹, technology, the regulatory and political environment, user behaviour and penetration rates (to name just a few).²² Companies such as Vodafone and Deutsche Telekom have a strong European presence in several member states supplemented by activities in selected non-European countries, whereas the largest Asian and U.S.-based MNOs have been mainly reluctant to enter the European market (see Figure 8).

²⁰ See IDC (2017): Worldwide Smartphone Market Gains Steam in the First Quarter of 2017 with Shipments up 4.3%, According to IDC, Press Release, 27 Apr 2017, available for download under <http://www.idc.com/getdoc.jsp?containerId=prUS42507917>.

²¹ Average Revenue per User.

²² See ICT Fact and Figures 2016, available for download under <http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.

Figure 8 Top 10 MNOs worldwide (revenues in billion Euro, 2015)



Source: WIK based on GSMA (2016)²³, (1 GBP = 1,14766 Euro).

However, worldwide MNO markets are characterized by consolidation processes. In many European countries, we see either 3 (e.g. Germany) or 4 (e.g. in the UK) MNOs with independent national networks.

MVNOs and Service Providers operate no or only limited network-related infrastructure such as mobile switching centres (MSCs) or radio access networks.²⁴ MVNOs do not issue own SIM cards and their service provision depends on the support of their hosting MNOs. A MVNO business model derives either from regulatory intervention (e.g. in Scandinavia or Germany) or from the strategic decision of a MNO to target niche segments using a different brand (MVNO subsidiary). Therefore, this segment is very heterogeneous and characterised by large differences among different markets and countries. In some markets, MVNOs enjoy significant market shares, e.g. in Germany they accounted for 19% of the total mobile revenues in 2016 (18% in 2015).²⁵

²³ See GSMA (2016): Operator Group Ranking 2015, available for download under <https://www.gsmainelligence.com/research/2016/04/operator-group-ranking-2015/556/>

²⁴ In the following we use MVNO as a synonym for both types of business models.

²⁵ See Bundesnetzagentur (2017): Jahresbericht 2016, S. 47, available for download under https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2017/JB2016.pdf?__blob=publicationFile&v=1.

3.2 Relevant market players

3.2.1 Mobile Network Operators (MNOs)

MNOs were relatively reluctant to join the discussion of eSIM at the very beginning since they view eSIM as a potential threat to their existing position. After considering their strategic options in more detail and responding to the launch of proprietary eSIM solutions by leading device manufacturers, MNOs have become advocates for eSIM and have started to push for a standardized eSIM solution within the GSMA.

MNOs are the key players in the mobile markets with strong brands and stable customer relationships. They own and manage mobile network infrastructures that can not be easily rebuilt by new entrants due to limitations such as limited licences for the use of spectrum and financial resources. Therefore, access to their network infrastructure is a precondition to offer mobile connectivity to third parties.

With eSIM, MNOs could enhance their existing product portfolio either by the introduction of new products in the consumer IoT area or by designing new offers and tariffs around “multi-device contracts”. This could help to generate higher ARPUs (also in the field of data driven business models) and to strengthen existing and new customer relationships. In addition to that, most MNOs (e.g. the Chinese MNOs, Vodafone, Telefónica) are already engaged in the M2M communications business and could leverage these experiences to consumer IoT. Moreover, eSIM has the potential to generate cost savings in operational processes (e.g. in the provisioning process) as long as standardised solutions are applied.

MNOs’ bargaining power towards standard equipment manufacturers, SIM card manufacturers and MVNOs is considered as strong. Negotiations with premium device manufacturers such as Apple might be more challenging. Nevertheless, the limited number of MNOs in the market and their respective market shares remain an important bargaining point. In addition to that, big MNOs are characterised by complex internal processes and overlapping responsibilities that could hamper their flexibility to launch new products in the field of consumer IoT.

Overall, the strong competitive position of MNOs does not seem to be threatened for the short or medium term. However, in the long run eSIM could lead to the creation of unpredictable disruptive business models by “Over-the-top”-players (OTTs) such as Google or Amazon that could pose considerable threat to MNOs.

3.2.2 Mobile Virtual Network Operators (MVNOs)

MVNOs depend on access to the MNOs' network infrastructure to implement and maintain their business. Small providers find themselves in a weak position to negotiate for access and favourable conditions. In some countries, access for service providers has therefore been mandated by regulation in order to assure this kind of competition.

MVNOs typically do not have any business relations with SIM manufacturers. They have developed skills in marketing and sales, often with focus on more cost sensitive customer segments or specific customer groups (e.g. ethnic groups). They tend to be more flexible and dynamic than big MNOs due to their lean management and cost structures.

MVNOs could benefit from eSIM as it has the potential to substantially facilitate mass migration processes between different wholesale partners. This might also strengthen their position to negotiate with MNOs. Furthermore, over the air provisioning and switching offer the potential for cost savings. In the long run, new products based on eSIM might be launched and niche markets could be served. Even national roaming solutions could be potentially implemented over eSIM.

Nevertheless, the opportunities of MVNOs in the context of eSIM do heavily depend on the cooperativeness of their MNO wholesale partners (or regulatory intervention in the case of violations of existing rulings and laws). This affects issues such as the introduction of new products in the field of IoT or connected devices as well as access to the entire network capabilities in order to set up own premium offers. Their bargaining power towards premium device manufacturers is limited as well, which could exclude them from newly developed and exclusively marketed devices. Finally, MVNOs would suffer from proprietary eSIM solutions with limited switching options.

Overall, the effect of eSIM for MVNOs depends strongly on the actual implementation. Impairments with regard to operator switching processes imply the risk that eSIM might hamper MVNOs' position in competing with MNOs on a level playing field.

3.2.3 Premium Device Manufacturers

Global premium hardware manufacturers have a strong brand and an innovative image. The mobile connected device plays a significant role for the customer decision which results in a high willingness to pay. Premium device manufacturers, especially Samsung, have been developing a broad product portfolio in the consumer electronics segment. This could be developed further with respect to consumer IoT. Moreover, they will benefit from experiences gained in the course of existing proprietary eSIM solutions.

eSIM solutions offer an increasing number of options for product design. Products can become smaller, less sensitive towards heat or humidity, and production processes can be streamlined. With eSIM, the premium device manufacturers could become even more powerful in negotiations with MNOs. Moreover, they could move up the value chain. Although it is very unlikely that device manufacturers start to build own mobile infrastructure, they could follow the steps of Chinese device manufacturer Xiaomi who became MVNO with its product MiMobile launched in September 2015 on the Chinese market.²⁶ This kind of strategic move, which depends on MNOs' willingness or regulatory obligation to provide access to connectivity, represents a potential key game changer in the context of eSIM. If device manufacturers enter the market and become MVNOs themselves, this may spur competition and weaken MNOs' dominant role in the long run (see also 3.2.5).

Another key question is whether premium device manufacturers will actually apply the GSMA standard or deploy own proprietary eSIM solutions. Officially, they stick to the GSMA specification. However, the possibility still exists that they implement proprietary solutions to monetarise their bargaining power towards MNOs and MVNOs in setting up exclusive contracts and to safeguard their position in developing data business models enabled by connected IoT devices. The result will have major effects not only on MNOs and MVNOs, but also on consumers, competition, and the whole propagation of eSIM in the market.

3.2.4 Commodity Device Manufacturers

Commodity device manufacturers offer products for a highly price sensitive customer segment. They set up cost-efficient processes and are experienced in handling short product life cycles. While some manufacturers produce a wide range of different devices, others focus on specific niches. Overall, competition in this segment is strong and pressure on cost reduction is high. For very cheap devices, eSIM solutions could even be too expensive to be integrated into the device.

Commodity device manufacturers have a weak negotiating power towards MNOs. Different from premium device manufacturers they did not deploy own SIM solutions, but were active in developing the GSMA specifications and will stick to this de facto-standard. Otherwise, they would not be able to find a market for their products.

For commodity device manufacturers, eSIM could be an opportunity to realise first mover advantages, to add value to their devices and to occupy attractive niche markets.

²⁶ See Xiaomi (2015): New Devices, 22.09.2015, available for download under <https://xiaomi-mi.com/news-and-actions/mi4c-mimobile-mispeaker/>, GSMArena (2015): Xiaomi launches its own Mi Mobile virtual carrier in China, 22.09.2015, available for download under http://www.gsmarena.com/xiaomi_launches_its_own_mi_mobile_virtual_carrier_in_china-blog-14116.php.

3.2.5 Disruptive Competitors

eSIM could be a door opener for the deployment of disruptive business models, if OTT-companies manage to add mobile connectivity to their products. Furthermore, they will pay much attention to data driven business enabled by connected devices in the IoT environment, which are currently strongly dominated by OTTs. Some approaches that might be enhanced by the eSIM, such as Google Fi and Amazon Alexa can already be seen on the market.

Google Fi

Google Fi²⁷ is a MVNO project by Google offering national and international roaming to its customers. This project is in an early phase. It was started in 2015 in the US as a test market.

The user is automatically connected to the network offering the highest bandwidth and connectivity – this can be either a WI-Fi or a mobile network. In the course of developing Google Fi, Google has negotiated mobile access on Sprint's, T-Mobile's and US Cellular's network in the U.S..

The price structure of Google Fi is simple: A basic plan is offered for 20 USD per month and includes unlimited national voice minutes, and unlimited national and international text messages (SMS, MMS). A data package is available for 10 USD per GB. No roaming fees are charged, but the bandwidth provided in visiting countries is low (256 kbps).²⁸

So far Google has issued its own Simcard (project Fi SIM card in nano sim-format), which is however limited to three Nexus smartphones. Via eSIM, access to a broad range of devices could be enabled.

Amazon Alexa

Alexa is an artificial intelligence personal assistant in the cloud launched by Amazon in November 2014 along with the connected speakers Amazon Echo and Amazon Echo Dot. Today, a wide range of compatible devices can be connected to Alexa.²⁹

Amazon Alexa is capable of voice interaction, music playback, compiling to-do lists, setting alarms, streaming podcasts, playing audiobooks and providing weather, traffic, news and other real time information. Moreover, it can be used as a home automation system to control several smart devices.

At the end of 2016, Alexa was launched on the German market.

²⁷ <https://fi.google.com/about/>

²⁸ See Google Fi price plans under <https://fi.google.com/about/plan/>.

²⁹ See for a list of these devices https://www.amazon.com/b/ref=cp_aucc_ods?node=15443147011.

Alexa can be accessed via any internet connection, typically WLAN. A mobile connection is possible via a limited number of Alexa-compatible mobile devices, e.g. a Huawei smartphone³⁰. eSIM could enhance the Amazon Alexa offer by providing mobile connectivity.

30 Huawei Mate 9, https://www.amazon.com/Huawei-Amazon-Alexa-Leica-Camera/dp/B01MYRABC3/ref=lp_15443147011_1_2?srs=15443147011&ie=UTF8&qid=1496046038&sr=8-2.

4 Future directions of development

Despite a low market presence of existing eSIM products and a couple of open questions (e.g. regarding operator strategies and the detailed implementation of offers), some general trends for future eSIM development and its implication on the market, competition, and consumers can be already derived at this early stage.

4.1 eSIM penetration

Initially, the penetration of eSIM in the mobile market will develop at a slow path. It is likely that de-facto standardised products (according to GSMA specification) will be launched during 2017. The product range will, however, still be focused on consumer IoT (e.g. wearables) products. Once eSIM solutions are integrated into smartphones by leading manufacturers on a large scale, the penetration will increase.

We expect a co-existence of traditional SIM and eSIM even in the long run. Furthermore, we expect a positive effect of the use of standardised eSIM solutions on the overall eSIM penetration in the market. However, the share of proprietary and standardised eSIM solutions is difficult to predict, as the role of premium device manufacturers is not yet clear. As they officially back the GSMA specification and might face a strong opposition when implementing proprietary solutions, these may play only a minor role in the future.

Overall, the main drivers for eSIM penetration will comprise of:

- The launch of eSIM devices (especially the launch of smartphones with eSIM).
- The emergence of innovative devices and new business models.
- The strategy of MNOs and device manufacturers (especially with regard to proprietary solutions).
- The future relevance of mobile connections compared to other technologies in smart devices.
- The acceptance of new devices and services by end users.

4.2 Effects on competition

From the current perspective it is unlikely that eSIM will become a game changer in the mobile market at least in the short and medium run. It offers, however, some potential to ease existing processes, improve customer satisfaction and generate new sources of revenues through the provision of bundle products and data driven business in the IoT environment.

It can be expected that MNOs will keep their key position in the mobile market. Nevertheless, in the long term eSIM may contribute to the increase of risk of market entrance by disruptive players threatening the MNOs' business. The likelihood of those scenarios will, however, depend on MNOs' willingness to open their networks to third parties as mandated access to the entirety of mobile networks (e.g. in terms of 4G and future 5G technology) is not subject to regulation in most regimes.

If the GSMA specification is to be implemented in a way that enables a level playing field, eSIM should not threaten MVNOs' business models. There remains, however, a risk that proprietary solutions and exclusive agreements may threaten the position of this type of operators.

Device manufacturers are likely to benefit from the emergence of eSIM solutions. Nevertheless, we do not expect disruptive business models from this part of the value chain in the short to medium term.

Finally, some factors with high relevance for the development of competition in the mobile market for the long term need to be taken into account as well:

- Implementation details of eSIM based offers.
- The strategy of MNOs and device manufacturers (especially with regard to proprietary solutions).
- Options for choice and change of providers, especially with regard to de facto-limitations and a surveillance of these by a neutral entity.
- Opportunities of MVNOs/Service Providers to further develop their business models.

4.3 Effects on end-users

eSIM will enable a large variety of new products in the IoT business environment. Unlike the simple IoT products known today with a limited added value or low usability, future eSIM based products will provide real benefits for specific needs, e.g. in the field of health and smart home. The IoT business environment will facilitate bundle products and thus increase customer retention.

Moreover, customers could benefit from easier switching processes, and thus a larger variety of choice between different commercial offers. In a customer friendly scenario, a given end-consumer with an eSIM smartphone could choose his connectivity provider on a drop down menu. However, scenarios with limited consumer choice in an eSIM environment seem possible as well (in particular in connection with proprietary devices). The first eSIM products with proprietary solutions did not explicitly enable the change of the connectivity provider (even after the end of the underlying contract).

Against this backdrop, it is difficult to make detailed predictions on eSIM's impact on end-users' choice – in particular in light of a lack of an existing mass market for eSIM products and thus a lack of knowledge about their ease of use, functionalities and tariffs. However, important aspects that need to be taken into account are related to data driven business models and particularly data security, which gains importance with regard to smart IoT applications.

4.4 Policy implications

The eSIM market development is in a very early stage and its future development is still uncertain. At this stage, we see no need for eSIM specific regulations. Risks regarding potential violations of consumer rights or limitations with regard to competition that could potentially occur in connection with eSIM could be dealt with using the existing competition and regulatory frameworks.

It will be essential to monitor the development of eSIM continuously in order to recognize potential critical changes with respect to switching processes, customer choice and competition to make sure that any attempt for misuse is handled in due course.

The same accounts for aspects related to the storage and commercialization of data, which are generated in the course of connected IoT devices as well as data security in general.

5 Conclusions

eSIM appears to be an important and challenging topic for all stakeholders in the mobile market. It can be expected to offer advantages for consumers as well as for market players. Consumers might benefit from new products and easier switching processes. The industry will have the opportunity to generate new products and gain additional revenues.

In light of the very early market stage, many questions could not be dealt with in this paper. Nevertheless, we were able to derive some preliminary conclusions and make some predictions towards its future development.

With the finalisation of the GSMA specification for consumer devices, the way for standardised eSIM solutions has been paved. If it prevails against proprietary solutions on the market, it can then be considered as an important driver for future market growth. It basically sets the framework for the deployment of eSIM in a competitive way with interoperable standards. However, as its concrete implementation is yet unclear, regulators and competition authorities should monitor the ongoing implementation processes thoroughly and carefully.

The SWOT analysis conducted in this study suggests that MNOs will keep or even improve their position as key players in the mobile market with the emergence of eSIM. MVNOs' position will depend on the implementation of functioning switching processes. Device manufacturers will benefit from eSIM, too - even though we do not expect them move up the value chain in the short run.

Overall, eSIM is very unlikely to become a game changer in the mobile market in the short run. It offers, however, some potential to ease existing processes, improve customer satisfaction, and generate new sources of revenues at different stages of the value chain.

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