The Future of SIM

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The SIM card is a tamperproof silicon hardware chip inserted inside a mobile handset and its main purpose is to securely authenticate the subscriber to the MNOs network linking the user subscription, handset and network together. It protects MNO administration information data and subscriber traffic (text, voice and data) via strong cryptography algorithms and also allows the MNOs to personalise the SIMs contents to deliver these services to a specific subscriber. SIM authentication is transparent to the subscriber and within a few seconds the subscriber device is connected to a MNOs network almost anywhere in the world.

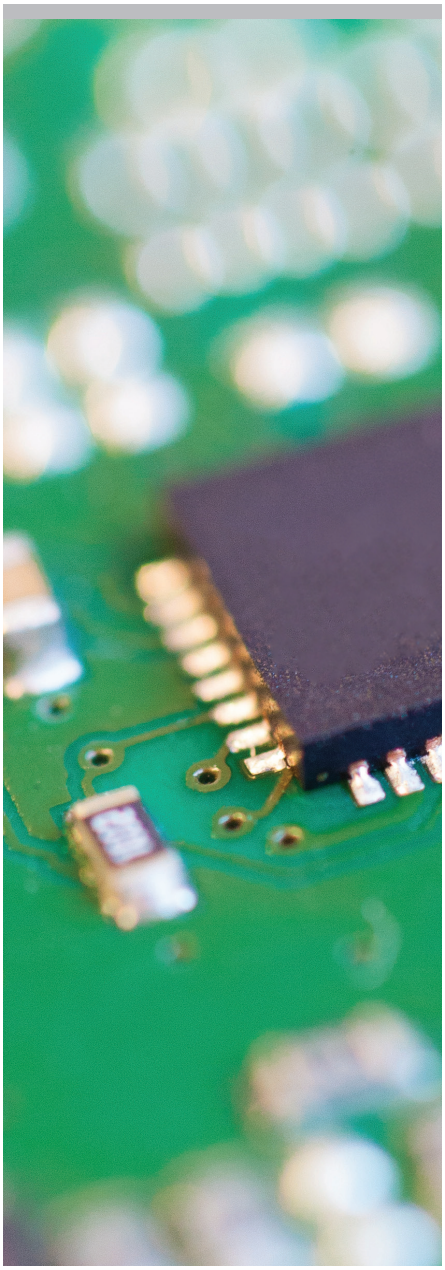
This paper will investigate the business and technical aspects behind the arrival of new technologies such as removable reprogrammable SIMs, embedded SIMs and other initiatives to determine what they mean for the consumer, the telecoms industry as a whole and indeed the future of the SIM.

They could impact the future of the SIM card to the point that it completely disappears and all handsets remove SIM slots in favour of these new emerging technologies, to deliver the concept of 'service portability'. Service portability is the ability to move the subscribers account and services seamlessly from one MNO to another offering the best level of service at the most competitive cost.

Reconfiguring the traditional SIM

Service portability is not something new to the telecoms industry. A diluted version of the service portability concept by reconfiguring the SIM with multiple International Mobile Subscriber Identities (IMSI) in SIM cards, has been offered by various different providers for some time.

The Mobile Virtual Network Operator (MVNO) Truphone as part of their Local Anywhere initiative has used relationships with other VMNOs to add Mobile Station International Subscriber Directory Number (MSISDN), which are local mobile phone numbers on the SIM, to reduce roaming fees. Recent regulation changes regarding international and local roaming has also led to the appearance of other roaming-only MVNOs such as Telna providing voice, SMS and data roaming to subscribers via the concept of the roaming hub that can flexibly offer single and dual IMSI roaming allowing MVNOs, and MNOs alike, to gain access to hundreds of international roaming agreements. SIM cards would initially need to be replaced, but they can keep their existing MSISDN,



and all services (voice, SMS, data) are available to them when roaming just as they are at home controlled by their Home Location Register (HLR) in the usual fashion.

Additionally many Over-The-Top (OTT) service providers have emerged offering competitive roaming applications that work on top of the traditional removable SIM such as Bluefish's Smart Roaming application which automatically attempts to log on to the preferred roaming partners network. They also as many others do (WorldSIM), offer a Dual/ Multi IMSI service which allows the subscriber to associate multiple MSISDNs with one handset. It is controlled by a SIM Toolkit menu where the SIM issues a special Refresh command to force the handset to read the new IMSI.

Procescom also offer Roaming Buddy which allows subscribers to make and receive calls with Voice over IP (VoIP), using their own MSISDN avoiding churn to alternative technologies and MNOs. They also offer Virtual SIM where users are required to purchase a virtual MSISDN number which acts as a domestic prepaid number. All voice calls and SMS' from/to this virtual phone number are transferred to the Virtual SIM network. Several MSIDNs can be associated with one mobile device. CellBuddy offers similar functionality with their virtual on-line ID-SIM and Link Buddy application which allows subscriber's to choose a preferred roaming option in advance. When the device is booted all phone calls are routed to a local access number obtained once the SIM authenticates to the local network.

In most of these solutions the best choice selection is automated for the customer as they are acting as Managed Service Provider (MSP) forming multiple MVNO relationships in different countries enabling SIMs that contains multiple IMSIs. When the customer travels abroad, the SIM automatically detects that it is in a new country and changes to the best IMSI. The customer can then receive calls on both numbers and receive all their charges on a single bill. These are only a few examples of the many different applications and services available and there has long been a niche in the market for them.

MNOs are now starting to offer free roaming services in countries where they have a network. In late 2014, the UK MNO Three recently started to offer free roaming throughout the USA and Europe. It is clear that the consumer and market demand exists for flexible roaming services. So let us now look at how the market has evolved to offer more products aimed at simplifying and standardizing these many options.

The Removable Reprogrammable SIM

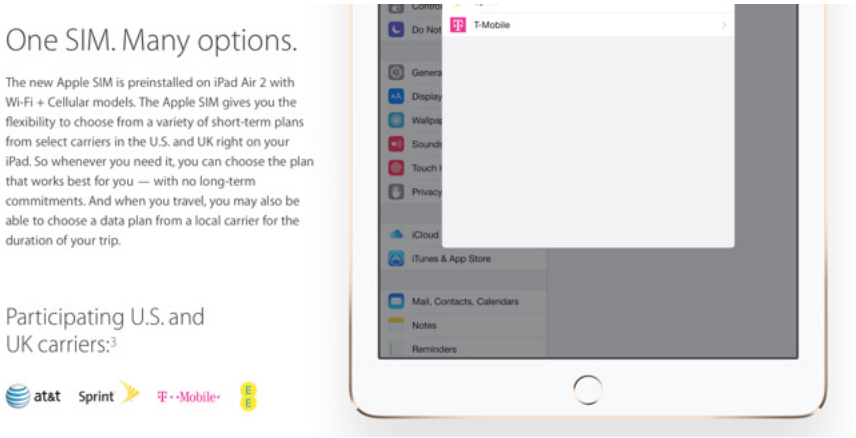
To a degree reconfiguring the SIM as detailed in the previous section is still actually reprogramming the SIM, but the term here is more concerned with changing the whole SIM profile as versus changing the contents of the IMSI file on the SIM file system. Moving to a removable reprogrammable SIM is the next logical step in the evolution of the SIM form factor.

Apple SIM

Apple SIM was introduced on October 16th 2014 where it was barely mentioned at the iPad Air 2 launch event. Apple's marketing states:

"The Apple SIM gives you the flexibility to choose from a variety of short-term plans from select carriers in the U.S. and UK right on your iPad. So whenever you need it, you can choose the plan that works best for you — with no long-term commitments. And when you travel, you may also be able to choose a data plan from a local carrier for the duration of your trip."

Apple now ship iPads with a nano-SIM card already installed in the SIM card slot. It's not an embedded non-removable SIM, nor is it a virtual or soft SIM, it's just a regular 'white label' UICC. Its Apple branded with the necessary telecoms applets loaded and an additional proprietary Apple mechanism that allows the customer to choose their preferred MNO without having to physically switch SIM cards. The consumer is presented with the choice of short term data plans from a variety of MNOs. These are bundled data plans with an Apple 'markup' presumably applied.



Consumers can quickly and easily switch between different MNOs to take advantage of the best short-term deals available, without having to swap the SIM card. Signing up for fixed term contracts will block the ability to switch deals, but for pay-as-you-go customers it is a good fit.

Currently one cannot buy the SIM separately and it is only available in the cellular-enabled iPad Air 2 and iPad mini 3 and can only be used to enable data services and cannot enable voice calls, text, nor new technologies such as VoIP

Interestingly the iPhone 5s, iPhone 5c have been available SIM free since mid-2013 and now the iPhone 6 and iPhone 6 Plus are both available SIM-free on Apple's Website and in Apple Stores. But Apple SIM is not being offered with these devices, hence Apple note that in this case customers do not qualify for the subsidized price associated with a MNO contract.

In the US, T-Mobile, AT&T and Sprint have signed up, but in the UK, only Everything Everywhere (EE) was on board at launch. Currently this is the biggest problem for Apple as they were hoping that more MNOs would sign up. But potentially this could still happen as subscriber awareness of the benefits of Apple SIM increases.

In the US, by selecting AT&T you are locked into their network and the switching option is disabled. Afterwards if one wants to move, you will have to physically remove the Apple SIM card and replace it with another MNOs SIM as these iDevices are sold unlocked. If any other MNO is activated, the AT&T option is removed.

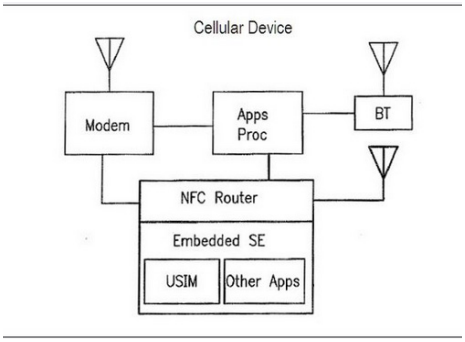
T-Mobile fully support Apple SIM from launch as the contract free 'pay as you go' nature of T-Mobile's business is a good fit for Apple Pay.

SPRINT requires that the International Mobile Equipment Identity (IMEI) number associated with an iDevice activated with an Apple SIM be in their network registry to activate i.e. bought from a Sprint store. That means an iDevice originally sold in any other MNO store will not activate on SPRINT, even if a non-configured Apple SIM is used. Unless of course the customer makes the effort to get the MNO that they are switching to, to add their IMEI in the SPRINT registry.

Verizon Wireless do not support Apple SIM.
In the UK as only EE signed up for launch there will be no switching domestically in the UK until the other MNOs sign up. In the meantime, EE should experience a rise in its share of connected tablets also boosted by travellers who own these iDevices visiting from the US.

It is expected that the MNO list will expand over time when MNOs realise that some revenue is better than no revenue.

Apple may not be the only manufacturer that could have delivered such a system but they are the first and the other handset manufactures must be considering the value of duplicating this model.

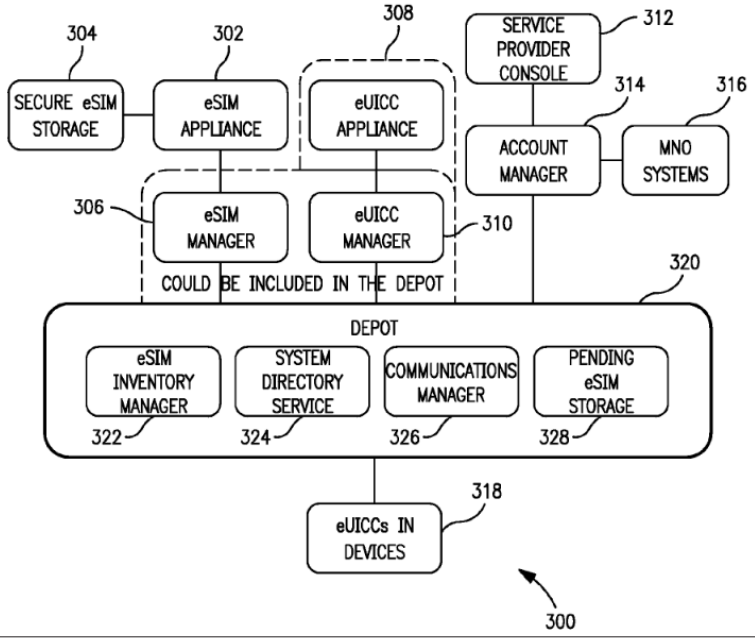


Technical Overview

It is presumed that the Apple SIM concept is actually derived from a patent Apple filed with the US Patent and Trademark Office (USPTO) in 2010 for an embedded SIM which is a non-removable SIM physically soldered to the handset baseband. Apple SIM is the first step in the journey to the realization of this patent.

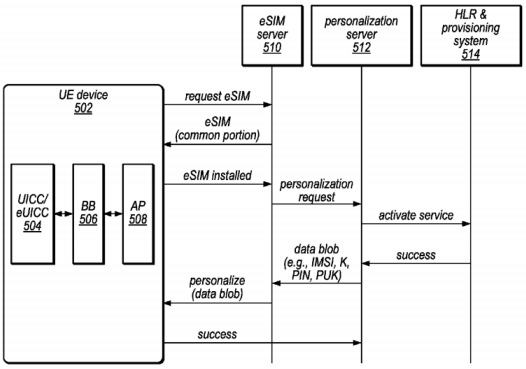
It is well known that Apple has wanted to remove the SIM form factor entirely since they launched their first iPhone and they have explored the use of embedded and soft SIM (Soft SIM is a virtualised SIM residing in handset memory) in the past with a series of patents filed that go back as far as 2007. Moving to a virtual SIM saves on space, enables selecting the preferred MNO from a list or even providing their own MVNO service

Apple SIM is actually a removable UICC that fully supports GlobalPlatform and JavaCard standards. It is authenticated and activated using Wi-Fi in the apple store or OTA to an Apple server providing a portal where the customer can choose their preferred MNO. It is unclear which wireless technology is actually used during an in store activation. To enable this functionality Apple defined the following supporting iNetwork architecture.



The highlighted sections above are within the Apple domain and each component in the architecture can deliver different levels of security. The iNetwork is used for distributing and storing the different profiles and each MNOs profile is referred to as an electronic Subscriber Identity Module (eSIM).

Apple defined a patent for the process of initial activation and subsequent switching of the Apple SIM.
The request to provision the eSIM is

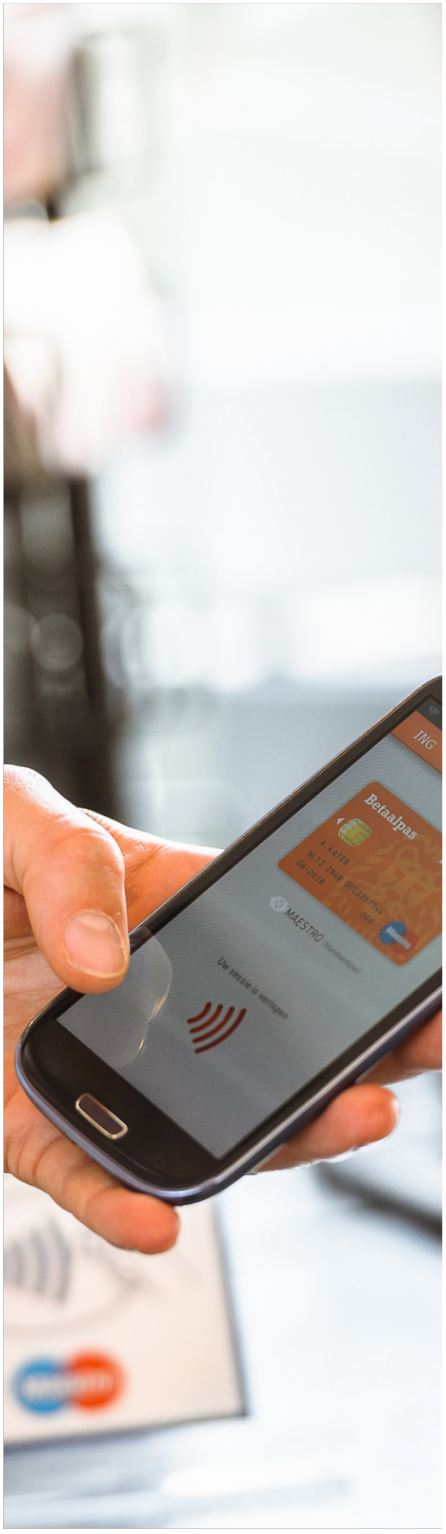


resolved by Apple's eSIM Server and ultimately by the MNO's HLR. In order to implement this architecture Apple need to interface with the MNOs backend APIs HLR and Authentication Centre (AuC) to be able to register and authenticate the subscriber on the network. After this provisioning has occurred, the eSIM provisioning is complete, and the handset should be able to attach to the MNOs network.

Features and Benefits
The range of features and benefits offered by removable reprogrammable SIMs initiatives such as Apple SIM is an extremely tempting proposition for subscribers, especially for those who travel frequently with impact in the short and longer term.

• International roaming is one of the big selling points of removable reprogrammable SIMs as if you are travelling from the UK to the US (or vice versa) you can avoid roaming fees by powering on your iDevice and selecting the local MNO offering the best data only deal.
• Regional roaming is aimed at travelling in the region where you live. If you go somewhere and discover your existing network has poor coverage, you can switch MNOs making it ideal for business trips or short breaks. It could also be viewed as an alternative to paid-for Wi-Fi.
• The number of cellular-enabled tablets in general connected to MNO networks is surprisingly low, so reprogrammable SIMs would hopefully to address this problem by offering uninterrupted end-to-end journey network coverage.

Business Drivers
The removable reprogrammable SIM introduces the cost of issuing the SIMs and the associated administrative production and pre-perso costs. So for any business moving towards the removable reprogrammable SIM would need to implement a strategy to recover or offset these additional costs.



Players in this technology arena could consider becoming a MVNO, but there are low profit margins, higher customer support issues and complicated billing system overheads.

Most governments now regulate the MNO industry which introduces unwanted complications, and the MNOs market has peaked, which is why the GSMA is working on new revenue generating initiatives. Plus, the MNOs subsidise many of the devices they offer to ease their path into the market so any player in this space would need to compete with these MNO subsidies.

The MNOs also may not want to offer one of their device suppliers the chance to compete directly in their market and may ignore any advances made towards them becoming a MVNO on the back of the MNOs network. But even if that did happen the handset manufacturer brand is then at the mercy of the network(s) of the MNO(s) that they are 'piggybacking' on top off! So the business drivers behind becoming a MVNO may not be as appealing as they may initially appear.

Any handset manufacturer introducing the removable reprogrammable SIM certainly expands and enhances their position in the mobile ecosystem potentially eliminating the need to tie the customer into the MNO. They could position themselves as a central access point to the world's MNOs, becoming a gateway to the SIM card charging the MNOs for the privilege of being one of the menu choices in the approved list of MNO deals offered to the user.

In Apple's case their strategy usually involves selling more iDevices and accessories, but other handset manufacturers entering this arena may not have the 'high-end' value proposition that Apple offers with regards to their devices and therefore still may consider the move to becoming a MVNO.

So the next logical step would be to move to an embedded SIM, 'Soft SIM' or 'Virtual SIM' solution, as driven by consumer demand for the benefits of the removable reprogrammable SIM.

However, any player in this market still needs to interface and build business deals with the MNOs.

Industry View

In general the industry response was that any initiative offering a removable reprogrammable SIM and associated benefits, such as Apple SIM, is great for the industry in general as it forces the MNOs to deliver better services.

Any new player offering a removable reprogrammable SIM may try to cut into MNOs profit margins but this lost MNO revenue could eventually impact the MNO's quality of service (QoS) and future planning for new services. Having said that, in any competitive market there will always be challenges to overcome and competition between MNOs will ensure that they maintain the QoS that we have come to expect. Therefore, one could argue that removable reprogrammable SIM should only have a minor impact on their long term planning allowing the MNOs to maintain the expected QoS. In fact it could itself boost the upsell of tablet devices that historically do not make up any significant numbers for the MNOs boosting profit and churn where it previously never existed.

In the UK, the British Culture Secretary, is considering new legislation requires MNOs to introduce regional roaming throughout the country allowing customers to switch MNOs when they have no signal from their preferred MNO. Also the European Commission and Body of European Regulators of Electronic Communications (BEREC) for data roaming services unbundling in Europe is imposing compliancy with the Local Break-Out (LBO) initiative for all European MNOs. Neither of these initiatives are specifically a glance towards Apple SIM, but is more a change in government view of the type of service that they would expect to be offered to the public. Apple SIM doesn't offer voice or SMS services but initiatives like this may eventually force MNOs to collaborate with players in the removable reprogrammable SIM market to offer full service portability for SMS, voice and data.

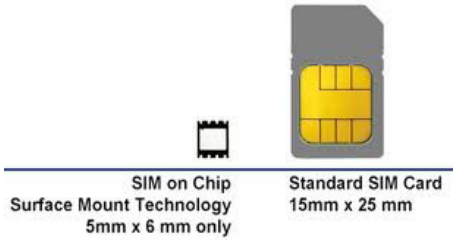
One can only assume that the GSMA view Apple SIM as a competitor, although it would be a strategic move to work alongside Apple. Irrespective of the GSMA's motives here Apple SIM is in fact a variant of the ETSI and GSMA Embedded SIM standard, intended to promote cellular use in machine-to-machine (M2M) devices.

Previously GSMA had opposed the embedded SIM idea defined in Apple's early patents on the grounds that over-the-air (OTA) activation represented a potential security weakness if a soft SIM or virtual SIM was used as it resides in the handset OS application layer. This prompted a number of European MNOs to threaten to withdraw iPhone subsidies and volume purchases if Apple proceeded with their plans for a fully embedded chip solution with SIM vendor Gemalto back in 2010. Reports at that time suggested that Apple backed down, but back in those days the iOS ecosystem was still in its infancy and it still needed the support of the MNOs. Since then, new industry focus on issuing applications OTA enabling Mobile Payment has played a major role in changing the GSMA's attitude and Apple SIM has not induced the same 'knee-jerk' reaction.

Offering customers the choice of short-term data plans without commitments could weaken the MNOs main business model, diluting their brand turning them into simple 'bit pipes'. The ownership of the access to the SIM becomes key at this point as where the secret keys are stored might threaten future MNO business plans. So it is understandable why the uptake of Apple SIM has been significantly less amongst MNOs. Although it is still uncertain whether Apple SIM will move to iPhones without the tie in of long term contracts, government initiatives and consumer demand will play a key role in that potential migration.

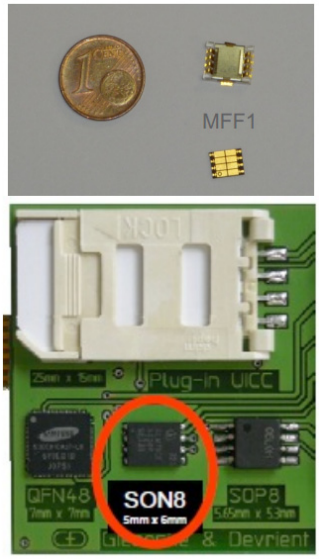
The Non-removable Reprogrammable Embedded SIM

The next logical step for the removable reprogrammable SIM is to evolve to become a fully embedded SIM chip soldered onto the handset baseband that cannot be removed or easily accessed. The origins of the embedded SIM can be found in ever decreasing form factor size of the UICC. Driven mainly by the need for slimmer devices, the Embedded SIM concept is a reduction of the smallest nano-SIM form factor to that of a chip soldered directly on to the handset baseband performing most of the same functions as the traditional SIM card with the additional ability to be reprogrammed on demand. So it's not a removable reprogrammable SIM, it's not a soft or virtual SIM, it's an embedded SIM (eUICC).



GSMA's Embedded SIM

ETSI and GSMA standardized the eUICC defining two types of eUICC form factors; MFF1 solderable and socketable or MFF2 soldered only which is cheaper but both still have the same PCB footprint.



ETSI initially started to work on the concept back in 2010 but the GSMA wanted to drive forward the initiative to deliver new business opportunities. As a result eUICC is a GSMA initiative aimed at business to business (B2B) relationships between the GSMA's MNO members and their future business partners mainly in the M2M market. GSMA continues to be very supportive of ETSIs activities in this area and fully believe that ETSI is best placed to agree a long term standard. However, in the future eUICC may evolve to address business to customer (B2C) relationships that the MNO has with their current mainstream customer base, as it is a hardware agnostic technology that is surface mounted on the telecoms device baseband.

These B2B relationships are a key GSMA vertical that they are addressing as part of an initiative called the Internet of Things (IoT), where the concept is that almost any device in the environment around us is able to interconnect and communicate with any other device (millions of sensors, embedded computers, and other miscellaneous devices) via cellular connectivity. The M2M industry has evolved as part of the IoT concept allowing devices to interconnect via the eUICC where it is impractical to swap out when a change of subscription is required.

As such M2M vendors will procure eUICCs from their chosen vendors that may be provisioned with initial connectivity of their chosen MNO, or the eUICC can be provisioned OTA via the "initial provisioning profile" which allows limited connectivity to the chosen MNOs network

The GSMA represents the global mobile industry with a membership comprised of approximately 800 MNOs with more than 250 companies in the mobile industry spanning 220 countries worldwide. So the potential active resource base for eUICC is massive. The following companies and MNOs have launched or are committed to launch GSMA Embedded SIM Specification compliant solutions are as follows.

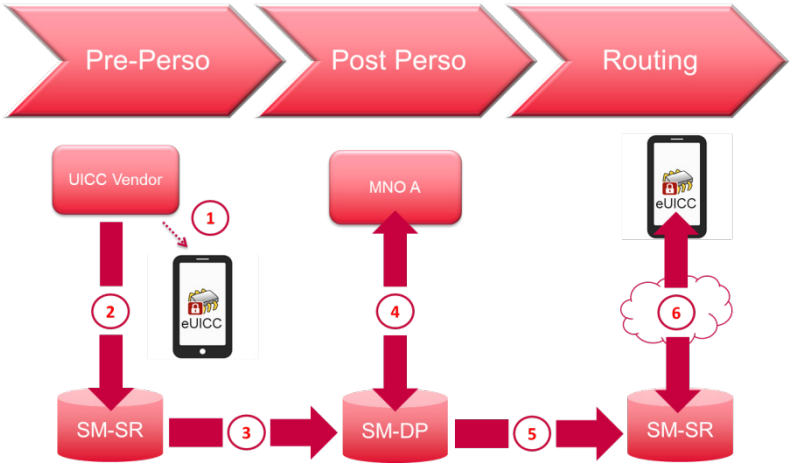
NTT DoCoMo launched its Embedded SIM services in June in Japan 2014. Amazon's Kindle Fire HDX also ships with pre-installed SIMs, provided by Vodafone in Europe and during initial boot up the SIM is configured to support Vodafone in whichever country the subscriber is located. Many other member MNOs are all working on their own implementations throughout the world.

How does Embedded SIM work?

In the words of the ETSI:
"Work on Machine-to-Machine (M2M) applications has given rise to the possibility of having a UICC that is embedded in a communication device in such a way that the UICC is not easily accessible or replaceable. The ability to change network subscriptions on such devices becomes problematic, thus necessitating new methods for securely and remotely provisioning access credentials on these Embedded UICCs (eUICC) and managing subscription changes from one MNO to another."

At boot up, or if driven by the M2M vendor the device authenticates on a central server called the Subscription Manager (SM) which has two roles Secure Routing (SM-SR) and Data Preparation (SM-DP):
• The SM-DP securely packages the profiles to be provisioned on the eUICC and manages the installation of them onto the eUICC.
•The SM-SR ensures the secure transport of both eUICC platform and eUICC profile management commands in order to load, enable, disable and delete profiles on the eUICC.

The activation process for the chosen MNO is currently only for a M2M perspective, and the resulting provisioning ecosystem is as follows.
1. The eUICC Manufacturer (EUM) builds the eUICC and ships them to the handset manufacturer.
2. The management and secure delivery of eUICC profiles is performed using GlobalPlatform Secure Channel Protocol (SCP) technology. SCP80 uses either SMS or Card Application Toolkit- Transfer Protocol (CAT-TP) over UDP/IP for its transport mechanism, whereas SCP81 uses HTTPS over TCP/IP. During pre-perso of the eUICC, the EUM loads the SCP03, SCP80 or SCP81 keys of the eUICC into the SM-SR database.
3. When a new profile is requested, the eUICC identifies itself and the associated SM-SR retrieves the eUICC Information Set (EIS) from a network of SM-DPs for the selected MNO.
4. The SM-DPs prepares the selected eUICC profile including the IMSI, PIN, K Key etc for secure download by generating commands secured using the GlobalPlatform SCP03 keys.



5. The SM-DP forwards the eUICC profile to the associated SM-SR.
6. The SCP80 or SCP81 keys allow the SM-SR to access the eUICC OTA in the handset and securely download new MNO profile to the eUICC.

When M2M vendor requests a new MNO profile as part of the eUICC activation, secure communications between the SM-SR associated with the eUICC occur via the “initial provisioning profile” pre-installed on the eUICC under the Issuer Security Domain Profile (ISD-P), which is effectively a bootstrap profile that allows the initial MNO profile to be provisioned onto the eUICC. Currently it is understood that this initial profile has been tested and proven to be interoperable across all the major eUICC vendors in Europe, however, some MNOs have slightly different UICC operating systems and profile requirements which may result in some features and functions being lost when switching from one MNO to another.

The SP can then move to another MNO by deleting the old MNO profile while still authenticated to the old MNO, then load and provision the new MNO profile securely over this connection without either MNO being able to see the other MNOs data.

The scheme depends on each of the involved entities trusting each of the involved Certificate Issuers (CI). This also provides the degree of assurance required for the interfaces that are not covered by the GSMA architecture.

Whoever controls or plays the role of the SM is key as they deliver the data preparation and manage and provide access to the eUICC.

As per the similar issues with removable programmable SIM ecosystem, again if the SM does not link to all MNOs in a country or region, then M2M vendors may be unable to switch to an MNO of their choice. This may then lead to the need for interlinking between the potentially different SM-SRs serving a region or country which will require a degree of industry cooperation and standardisation previously seen in the TSM mobile payments industry.

Features & Benefits

The GSMA’s eUICC is addressing the IoT by targeting the M2M industry. They foresee many new potential business opportunities for their members thanks to the range of new features and benefits that it introduces:

• Many M2M vendors will move their products internationally and therefore need the eUICCs reprogrammable functionality to activate and provision it locally for the final destination, avoiding the issue of international roaming.

• After the initial activation of the SIM in the M2M device in the field the eUICC provides the M2M vendor with the ability to change MNO subscriptions for all their devices wherever they are.

Other benefits exist for the other players in the eUICC ecosystem:

• The technologies involved are provided and supported by the UICC vendors and they will probably be required to play the role of the Subscription Manager (SM) in the eUICC ecosystem which is similar to the Trusted Service Manager (TSM) product that many of them already provide or at least support in their products i.e. Softcard in the USA or VALYOU in Norway. The concept is the same, but instead of a transported payment, transit or loyalty applet payloads, the payload is now the SIM profile for the chosen MNO.

• Handset manufacturers would be able to produce slimmer and cheaper devices as there is no need for SIM card acceptance devices (CADs) if eUICC was supported, but by the same means similar impact

can also be realised by M2M vendors in their devices as the same modem chip will be used. As a result battery life for any non-powered devices will improve.
• The Billing systems across MNOs can also be optimized to not only reduce operating costs to the MNOs but also to the end customer.

Business Drivers
Currently GSMA's eUICC is aimed only at the M2M industry where there are many new opportunities for the MNO's allowing them to faster realise their investments. In addition to that additional business drivers can be identified:
• Logistically, sending out SIM cards to customers is a massive management overhead and expense especially when the M2M volumes are considered.
• In addition to that there are also the hidden costs of dealing with lost and faulty SIMs.
• Reduces the costs of OTA subscription handling.

This focus on minimizing costs may eventually mean the disappearance altogether of the removable SIM and its associated CADs resulting in all handsets using eUICC because they keep manufacturing costs down and handsets become more reliable as issues surrounding the CAD also disappear - no SIM-doors, SIM trays or connection issues with SIM card to worry about. This is a return to the Advanced Mobile Phone System (AMPS) and Code Division Multiple Access One (cdmaOne) business model, but this time with the added benefit of having the flexibility to change MNOs.

Normally the MNOs view the SIM as the gateway to their services and have historically fought to maintain control over it, but they have relinquished their control of the SIM for these benefits and especially the lure of the new M2M business. Even within the GSMA membership achieving such a degree of interworking is extremely difficult and acts as testament to the openness of this agreement.

However, not all MNOs have signed up to the GSMA's eUICC initiative and many may view the potential loss of ownership of these new customers as something they would like to avoid. But they will soon realise that the service portability that eUICC offers is its main selling point.

The GSMAs intention with eUICC had been not to support commercial handsets, but the influence of the consumer reaction to the benefits associated with removable reprogrammable SIMs might drive the use of eUICC to support the MNOs main contract and handset bundled business use cases.

Industry View
To the whole industry it seems like an excellent business choice by the MNOs that opens up new lucrative markets.

The M2M industry has so many new potential players it is potentially huge business for the MNOs. Transatel is a leading European MVNO Enabler (MVNE) and M2M solution provider, delivering managed services mainly for MNOs are currently supporting more than 80 MVNOs in Europe and the M2M service of EE. It provides several business models according to customer needs:
• MVNE for managed services
• MVNO Aggregator (MVNA) for voice, SMS and data
• MVNO direct operation towards potential subscribers.

As such they are a member of the GSMA and are compatible with eUICC standards branding their eUICCs are SIM901, but their MVNO business does not support eUICC enabled commercial handset as per the GSMA's directive and supporting specifications. An extension of the eUICC concept is offered by Sonopt, who combines service portability with comprehensive mobile security and integration to the corporate IT infrastructure. It is expected that other handset manufacturers and also OTT Service Providers will push the GSMA to open eUICC to commercial handsets. This may however provide the handset OEMs with as much more influential role in the MNOs ecosystem than the MNOs may be comfortable with i.e. if the eUICC is truly 'blank' apart from the initial provisioning profile, handset manufacturers could modify the list of offered MNOs in favour of any relationships they may or may not have with the MNOs in that region or country. So pre-provisioning the eUICC with an assigned MNO might be an option for the MNOs to consider.

Comparison of Removable Reprogrammable SIM Vs Embedded SIM (eUICC)

Having identified the evolution of the SIM so far, comparing the Removable Reprogrammable SIM to the eUICC will enable a better understanding of where they are headed.

Technical/Buiness Driver	Removable Reprogrammable SIM	Embedded SIM (eUICC)
Impact on MNOs network	Potential impact on quality of service (QoS) in the long term due to loss of revenue caused by frequent subscriber switching.	MNOs entering the eUICC market have made infrastructure updates to ensure continued QoS even if the network volumes increase dramatically so no impact should be expected. However, no network investments have been made to cater for commercial handsets which in theory would experience much more frequent switching.
	Potential impact on ability to plan for budgeting & maintenance due to lack of visibility on predicted traffic volumes.	Most MNOs have been performing these tasks in expectation of eUICC and other GSMA initiatives so no impact should be expected.
Device Subsidies	Forces the MNOs to compete on a service quality basis so a drop in free or subsidised handsets is to be expected in exchange for longer term contract commitments.	Aimed at M2M vendors, but if it did evolve to incorporate handsets the same drop in free or subsidised handsets would be expected. In many markets this is a major USP for the MNOs so the loss here will be felt by the subscriber.
	High end Smartphones offer the least subsidies, so only a small impact and tablets are not subsidized so no impact is predicted.	Tablets are not subsidized, so if eUICC did evolve to incorporate handsets/tablets the MNOs would have to take the hit here as they could not increase the price of currently available devices.
Customer Perception/ Reception	General customer excitement regarding the ability to switch MNOs to save on costs.	Not applicable at the moment as eUICC is aimed at the M2M market. So in that sense the MNOs should experience general SP excitement. The main issue here though, is that pressure from consumers may force GSMA to incorporate handsets in the eUICC initiative.
	In some markets where dual IMSI devices are prevalent (Asia; Indonesia, Malaysia, Japan etc) this will appeal. But dual IMSI handsets tend to be feature phones or lower end smartphones.	Aimed at M2M vendors, but if it did evolve to incorporate commercial handsets the MNOs would feel the pain of constant swapping. In the case of existing dual IMSI/SIM swapping behaviour is too low to have any impact.
	In South America and Southern Europe most subscribers are prepaid & it's common for prepaid subscribers to have one UICC per MNO in order to use the different benefits. So in these markets would be a welcome option.	As above.

Technical/Buiness Driver	Removable Reprogrammable SIM	Embedded SIM (eUICC)
Device Portability	Currently it is only aimed at tablets but it is expected that it will move to handsets. But the main question here is whether it will work in all types of devices such as Apple, Android or Windows Phones. Handset manufacturers could intentionally make it difficult to switch to another manufacturers device. Technically it should work, but there is no real business reason for each handset manufacturer to support this as they are not going to profit from becoming SIM vendors.	There is no device portability as the device is tied to the eUICC. But it should work on all devices in the sense that the eUICC is designed to be device agnostic therefore it can be inserted in any device supporting the eUICC standards and if it did evolve to incorporate commercial handsets the same would be expected.
Subscription Portability	The subscriber can only use approved MNO partners. Plus not all MNOs may join up to these schemes which would limit the portability concept.	Embedded SIM should avoid potential lock-in pitfall, although the eUICC SM could hit the same problems if not all MNOs sign up or there are different SMs in regions or countries. But sign up should be high as this is an MNO initiative designed to increase churn. Moving to commercial handsets could be a move back to the 'bad old days' of AMPS and cdmaOne where you could only select MNOs in the SIM list. But the open architecture and design of eUICC should prevent this.
Mobile Number Portability (MNP)	The current initiatives in this area are only for data but this issue would need to be resolved with the help of the MNOs which might prove to problematic.	This is not an issue for M2M as MNP is not required as it is only for data, but should commercial handsets be supported, then a more streamlined MNP scheme would need to be implemented between the MNOs. Any solution should avoid customer exposure to "slamming" practices (unauthorised switches) or loss of phone number for unacceptable lengths of time.

Technical/Buiness Driver	Removable Reprogrammable SIM	Embedded SIM (eUICC)
Subscription Offerings	Changes in contract style to offer short term subscriptions may start a price war between all MNOs including those who don't support it. In Sweden subscriptions have evolved to have no tie in period instead having a standard notice period of three months for subscription termination, so resistance from these MNOs on contract styles should be less. This contract style may be a future template that all MNOs should copy. Mapping the services provided from one MNO to another in the case regional service switching will be problematic for the MNOs so high resistance is to be expected.	This should cause minimal friction as new subscription offerings will be created for the M2M market. If it did evolve to incorporate handsets the MNOs would again need to create effective subscription strategies. As such the ripple effect from the impact on the network and loss of revenue from roaming would also see a rise in base line subscription fees. The same argument stands here if it evolved to include commercial handsets.
Flexibility	Great flexibility for different subscriptions and swapping MNOs to save on costs but currently it's only available on tablets.	One of the major selling points for the M2M market is the flexibility that it offers. If it did evolve to incorporate commercial handsets it does not mean an end for MNO's to tie their customers to their networks. They can still program the eUICC with a secure ID in a way that the device has primary connectivity to MNO's network (SIM-LOCK), so they can continue subsidising handsets to try to keep their customers. The same could be said for the M2M market but these tie-in mechanisms oppose the very core of the eUICC concept so it is not expected that they have any longevity.
Customer Retention	Existing customers will definitely benefit from the pros of a removable reprogrammable SIM product and it will increase new customer uptake, especially for frequent travellers. But with regards to keeping them it is doubtful that these customers are staying only for the benefits.	The very nature of eUICC encourages the relinquishment of customers to deals of competing MNOs. But taking this potential loss into consideration it is offset by the fact that potential M2M vendors are encouraged to enter the market due to the lure of the service portability.

Technical/Buiness Driver	Removable Reprogrammable SIM	Embedded SIM (eUICC)
Security	Apple have defined different layers of security and the Level of Assurance (LoA) that they deliver, but it is still unclear regarding the exact security mechanisms and protocols that they have utilised.	Complies with GlobalPlatform SCP03 to secure the perso data and also the CAT_TP SCP80 or RAM Over HTTP SCP81 to transport the C-APDUs delivering end point security from the SM to the UICC: • CAT_TP SCP80 [SCP03(APDUs)] • RAM SCP81 [SCP03(APDUs)] Both these options equate to a strong and secure ecosystem.
Flexibility	Great flexibility for different subscriptions and swapping MNOs to save on costs but currently it's only available on tablets.	One of the major selling points for the M2M market is the flexibility that it offers. If it did evolve to incorporate commercial handsets it does not mean an end for MNO's to tie their customers to their networks. They can still program the eUICC with a secure ID in a way that the device has primary connectivity to MNO's network (SIM-LOCK), so they can continue subsidising handsets to try to keep their customers. The same could be said for the M2M market but these tie-in mechanisms oppose the very core of the eUICC concept so it is not expected that they have any longevity.
Cost	There are no figures available	Again there are no figures available, but the expected costs may be similar to the TSM world given the close comparisons between the two.
Architecture	Apple SIM defines a Depot which is the gateway to the Apple SIM device in the field. It is expected that other handset manufacturers would employ a similar concept as the obvious starting point would again be the ETSI and GSMA specifications.	It defines a SM which is the gateway to the eUICC device in the field.
Preloaded Profiles	Apple Sim is pre -provisioned with a "bootstrap eSIM" which delivers limited access to an MNOs network providing the ability to then provision the eSIM. It is unclear as to how many profiles can be stored on the Apple SIM.	eUICC has an "initial provisioning profile" pre-installed under the ISD-P, which is effectively a bootstraping profile that allows the initial MNO profile to be provisioned onto the eUICC.

The result of this comparison is that clearly any removable reprogrammable SIM initiative and eUICC are both derived from the same ETSI concept, except that they are driven by different business reasons and enablers.

Initially the concept of the removable reprogrammable SIM was seen as a massive headache for the MNOs but the reality is that each is targeting different markets. So although MNOs may not be the biggest fan of the removable reprogrammable SIM it is currently only targeting the high end consumer B2C relationship with promises of data savings and eUICC targets the M2M business opportunities in a different market segment.

The real issue here then, is that the cost savings will become visible to consumers across all handset platforms. To deliver those savings eUICC would need to evolve to incorporate the commercial handset. Traditionally Smartphone users usually subscribe to post-paid plans so they can use unlimited data, but in this case the MNOs keep subscribers loyal by means of a contract or with excellent services. Switching MNOs may damage MNO profit in this area and MNOs are expected to resist removable reprogrammable SIM and support by eUICC the most.

But if eUICC did migrate to commercial handsets, the great uncertainty is whether the previously loyal customer who changes to a local MNO for roaming returns to their original MNO after they are back in their home location. The MNOs will be looking closely at the Apple consumers and their usage of Apple SIM to determine the next steps for removable reprogrammable SIM product and eUICC.

Any removable reprogrammable SIM product such as Apple SIM definitely has more advantages for the end-user and in fact, as far as disadvantages are concerned, there are none from a consumer perspective. Handset manufacturers following the removable reprogrammable SIM model would definitely experience a shift in the balance of power away from the MNOs. But again the limiting factor here is that they need to form business agreements and interface with the MNO backend systems.

Ultimately though, for the MNOs it means that handset manufacturers, on their networks, with their customers, can now divert the MNOs revenue stream to another MNO. The MNOs do not want the handset manufactures to have that amount of influence and power in their market. So the integration of the removable reprogrammable SIM may face road blocks at every junction and the evolution of eUICC to support commercial handsets even more so.

Conclusion

There is a definite drive for service portability in telecoms markets around the world as evidenced by the reconfiguration of the traditional SIM model for dual IMSI and reduced roaming fees to the appearance of the removable reprogrammable SIM architecture targeting the same market segments with its improved solution. But ultimately any removable reprogrammable SIM architecture has to interface with the MNOs backend systems and at launch it is notable that Apple SIM only had T-Mobile US and EE in the UK fully on board with limited support from AT&T and SPRINT. Any other handset manufacturer making the same play in this space would experience the same limited uptake as Apple has experienced.

Market trends are then indicating that in the future at some point all device will move to support only an embedded SIM. But how much of a threat is that for the MNOs and is there potential for other handset manufacturers to enter this space?

The eUICC is also a natural evolution as a service portability platform to target the M2M market. Both systems essentially deliver similar types of functionality albeit targeting different markets and looking to the future, there are different evolution paths regarding each technology.

Removable Reprogrammable SIM Evolutionary Path

To try to predict the evolutionary path for the removable reprogrammable SIM, one must initially try to determine what any player would stand to gain from this move into service portability. They could look to gain a stronger footing in the MNOs ecosystem by becoming VMNOs but as identified earlier profit margins are slim and management and support overheads are high.

It would be in the interests of any removable reprogrammable SIM initiative to be compliant with the GSMA's eUICC. But proprietary solutions aimed only at one type of handset platform will limit the scope of their integration. Therefore handset manufacturers trying to enter this market would be wise to consider eUICC compliance to ensure ease of integration with the MNO backend systems.

Initially introducing removable reprogrammable SIMs in commercial handsets would have caused a massive backlash from the MNOs, but considering the low uptake of the cellular version of tablets, it was more subdued way of introducing the concept. So the next logical step for removable reprogrammable SIMs would be to issue them with commercial handsets but the reality of this might be problematic:

• Cellular "attach rates" for tablets is low, less than 20%, so the MNOs have an incentive to increase this and any removable reprogrammable SIM initiative, but handsets have attach rates of 100% and therefore the MNOs leverage no value here.

• Removable reprogrammable SIM initiatives work well for data, but there is no current method for fast MNP making it impossible to switch your number from your current MNO to a new MNO when you move from cell to cell optimising signal strength & coverage. So MNP is required to make a well-rounded service offering and MNO support would be required.

• The GSMA have not defined eUICC standards for handsets and it is not expected in the foreseeable future

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But irrespective of the drive behind removable reprogrammable SIMs, at the end of the day offering consumers the flexibility to choose MNOs is a tantamount, and it may prove to be an effective USP while the GSMA deliberate on the pros and cons of evolving the scope of eUICC.

So considering the removable reprogrammable SIMs specific evolutionary options, it could continue as proprietary mechanisms (continuing to experience the current MNO on-boarding issues) or it can integrate with the eUICC system but only if GSMA opens up their system to support the proprietary systems or vice versa. Ultimately though if the next step for any removable reprogrammable SIMs is aimed at migrating towards eUICC or indeed the 'Soft' or 'Virtual SIM' that can be connected to any MNO in the world, the technical and commercial complexity of voice, text and data subscription is far more difficult a problem to solve than data-only services .

GSMA's eUICC Evolutionary Path

The GSMA's plan was to use eUICC as a starting point for enabling M2M business opportunities, but consumer demand alone for the benefits of a removable reprogrammable SIM may force the eUICC standards to support commercial handsets. The concern for the GSMA will be whether the profits realised from new M2M opportunities cover the eventual losses they may suffer from having to offer service portability to commercial handsets.

The MNOs could rebuff any removable reprogrammable SIM initiatives or indeed any other eUICC commercial handsets hitting the market as they have done so in the past as evidenced by the Softcard mobile payments scheme where AT&T, T-Mobile & Verizon stood resolutely side by side to bar the entry of eUICC enabled handsets into their ecosystem. The MNOs could also choose to not support a SM who enabled eUICC in their market, or even choose not to collaborate in the GSMA's eUICC initiative at all. Ironically MNOs could offer subsidised handsets for only those who opt to not use service portability and increase the use of SIM locking. So the reality is that it may not mean that it will be any easier to change MNO now or in the future.

But the trick for the GSMA and the MNOs is how to best adopt removable reprogrammable SIM initiatives and the eventual market forces that drive eUICC to support commercial handsets:
• Subscriber plans could evolve to deal with eUICC commercial handsets, so we might still continue to see tie in plans
• Plans that allow the user to use the service portability under certain conditions, but force the customer back onto the MNOs network when that conditions has disappeared or improved i.e. roaming, bad reception etc.
• In general the MNOs should not try to prevent subscribers from leaving, rather make them want to stay. The disruption will then be for the MNOs to invest in network services that provide incentives for consumers to actively switch.

But all of this hinges again on development of new techniques to handle the MNP issue and performance enhancements required to deliver the overhead of frequent and mass switch that will follow.

The handset manufacturers wield huge power within the smartphone and tablet markets and the low volumes of cellular-enabled tablets are the only reason that the MNOs have agreed to hand over some of the power to them. Therefore both MNOs and device manufacturers (UICCs & handsets) know that to drive this adoption rate higher, they need to change how the system works.

Therefore handset manufacturers trying to enter this market would be wise to consider eUICC compliance to ensure ease of integration with the MNO backend systems. Initially introducing removable reprogrammable SIMs in commercial handsets would have caused a massive backlash from the MNOs, but considering the low uptake of the cellular version of tablets, it was more subdued way of introducing the concept. So the next logical step for removable reprogrammable SIMs would be to issue them with commercial handsets but the reality of this might be problematic:
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All of this indicates that the MNOs on one hand need to change their commercial B2C models, whilst on the other hand, they have to deal with being forced to become 'bit-pipe' networks. The best way to combat this is by focusing on the M2M market. The eUICC is a step in the right direction and hopefully the MNOs will evolve to adopt removable reprogrammable SIM initiatives and if needed refocus eUICC to deliver service portability without any impact to the quality of the service for commercial handsets, but the timeline for this or indeed likely hood of this happening is uncertain.

Erosion of MNOs Profit Margins
We may start to see handset manufacturers adopting the removable reprogrammable SIM business model or jumping direct to eUICC effectively forcing GSMA's eUICC to adopt commercial handsets, which in the eUICC case may be a concern for the MNOs.

Throughout the years the MNOs have seen the profit margins from their various services eroded:

• Number portability was not possible until their customers and industry watchdogs pushed for it
• Voice, text and Mobile Data were never unlimited until their customers and industry watchdogs pushed for it
• SIM locking and Roaming are the next targets cutting into the MNOs profits

So eventually it is expected that full service portability will follow suit, but at least the MNOs will have reduced costs by not having to manage the SIM and benefit from new M2M business.

The telecoms market is full of competition, and MNOs that offer superior services will always have the best market share. These changes and disruptive drivers are a reflection of the transition that the mobile industry is undergoing. Handset manufacturers have been disrupting the MNOs business plans for many years as they want to fully control the customer experience. The challenge for the MNOs is how to position themselves to deliver true perceived value to their customers.

Who controls the gateway to the eUICC?
Strategically the control point for the MNOs has always been the UICC as a gateway to secure storage where services requiring and using sensitive data are located. Ultimately they are relinquishing their control over this 'golden' gateway for the bounty of future treasures delivered by the promise of new M2M business opportunities.
The removable reprogrammable SIM may maintain and strengthen the handset

manufacturer's role as the ultimate "owner" of the end user relationship. By achieving this goal they will have effectively positioned themselves as the gatekeeper to this gateway. The only limitation to this plan may be that ultimately each handset manufacturers reach is limited as it will only be for their devices consumers and the GSMA's eUICC solution will serve the remainder of this market should eUICC eventually include commercial handsets. To ensure that the regulation of the removable reprogrammable SIM and ultimately eUICCs arrival is treated fairly by all involved parties, new processes may be needed to accommodate the role of the gatekeeper as it controls access to the eUICC and it services. In its basic form there is potential for fragmentation caused by removable reprogrammable SIM and eUICC, but unfortunately the main negative driver against global the service portability is delivered by the key players in the ecosystem themselves. The MNOs may not want to connect to the handset manufacturer gateways or certain eUICC Service Managers and vice versa they may feel the same about the MNOs. So regulating bodies will need to continuously evaluate eUICC handset ecosystem to prevent fragmentation, interoperability issues, and the impact that this would have on consumer choice.

Final Thoughts

Many MNOs are turning to Wi-Fi calling to reduce network congestion and initiatives like Wi-Fi First , where mobile devices and services use Wi-Fi as the primary network and MNO networks only to fill the Wi-Fi service gaps. It has the potential to change the industry, putting Wi-Fi at the forefront of mobile communications minimizing the need to control the gateway to the eUICC, but it even this does not completely eliminate the need for some sort of SIM function. Intel is working on an Identity-Capable Platform (ICP) which is a secure hardware area in a processor which supports future converged mobile wireless security and high-value, trusted services including secure access to any device, network or service. But this is still in its infancy and is not viewed as short to mid-term threat to the SIM. GSMA may be reluctant to introduce eUICC support in commercial handsets because the main impetus for the eUICC standard comes not from GSMA, device manufacturers, or even consumer products at all, but from the M2M industry. But even so, ETSI still doesn't discard the possibility that commercial handsets will use the eUICC in the future. There are entire sections of the requirements documents devoted to consumer use.

So the concept and prospect of an eUICC, whether it be GSMA's view with a consumer slant or the consumer focused evolution by handset manufacturers, both are likely to bring a vast change in the traditional mobile and networking systems as a whole.

Other industry sectors such as Qualcomm's 'Virtual SIM' patent with its reliance on the Trusted Execution Environment (TEE) are also worth considering. But it is unclear as to how secure the current implementations of the TEE based on ARM's TrustZone will actually prove to be. But a recognised and reliable stable TEE platform may prove the biggest threat of all to the future of the removable reprogrammable SIM and eUICC replacing it with a Virtual SIM.

But until that happens, it is expected that the removable SIM will disappear to be replaced by the eUICC in all future devices. Of the many inputting factors discussed driving this transition, smaller slimmer devices, at lower prices, minus the overhead of managing the physical side of the SIM (akin to the old AMPS and cdmaOne devices issued by MNOs like Verizon Wireless and SPRINT in the past), combined with the new compelling consumer experience of service portability, may well be the final death blow to the SIM as a removable form factor. But long term future still clearly has a need and use for the SIMs core functionality albeit hidden away as an integral part of the handset.

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