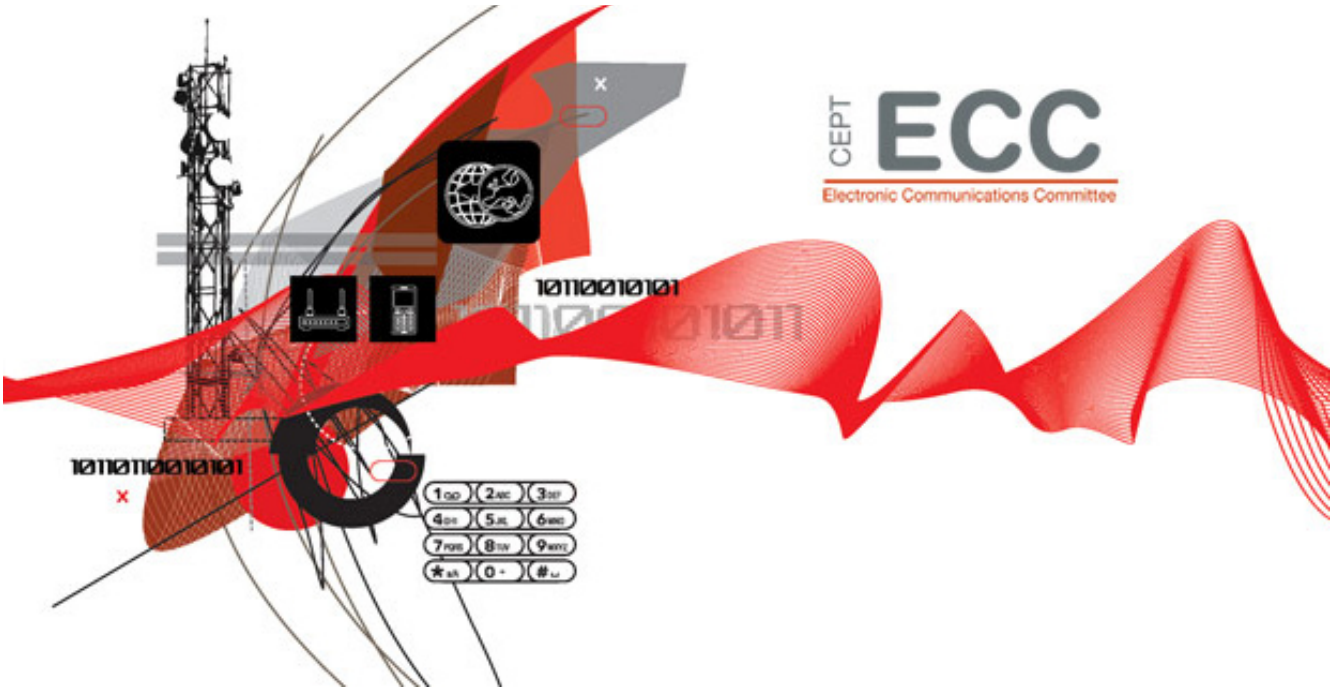

ECC Newsletter December 2018

Europe prepares to shape the radiocommunications of the future at WRC-19

The World Radiocommunications Conference is now less than a year away. Several thousand delegates from all over the world are expected to meet at the event, which takes place in Sharm el-Sheikh (Egypt) from 28 October to 18 November, 2019. They will review and revise, as appropriate, the ITU Radio Regulations (RR).

CEPT, through the work of the ECC Conference Preparatory Group (CPG), is preparing its proposals for the Conference, and will provide its own view on shaping radiocommunications of the future. In the last three years, CPG has worked on the Agenda agreed for WRC-19 at the previous Conference, carrying out studies, participating actively to the preparation in ITU-R, and developing CEPT positions and views for the various Agenda items.

Although WRC-19 is almost one year away, CEPT has already unanimously adopted five European Common Proposals (ECPs). These proposals support no change to the RR for Agenda items on railway communications, intelligent transport systems and radio local area networks (RLAN) in the bands 5250-5350 MHz, 5350-5470 MHz and 5850-5925 MHz. They take utmost account of the results of the study activities, and, in the case of railway communications and intelligent transport systems, spectrum harmonisation opportunities outside the WRC process. Several ECPs are also expected to be approved next May, including proposals for initial bands suitable for 5G, as well as those that are currently deemed not suitable for 5G (i.e. 31.8-33.4 GHz, 71-76 GHz and 81-86 GHz). The last set of ECPs will be ready in August next year.

CEPT is further looking forward to the upcoming second session of ITU´s Conference Preparatory Meeting (CPM19-2) in February. This will be the first opportunity for CEPT to defend its own views when the methods to resolve the various Agenda items are consolidated. After CPM, CEPT will finalise its proposals for the Conference and will seek to achieve broad support for them.

Figure 1 - Development of the European Common Proposals

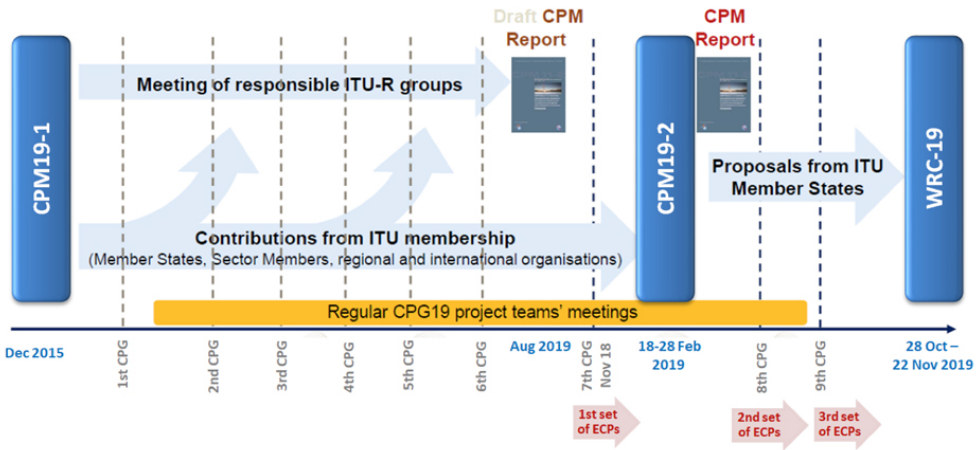

Figure 2 - Timeline of the work in CEPT until the next WRC-19

Broadband communications

The global harmonisation of suitable spectrum for 5G (IMT-2020) is certainly among the most debated Agenda items. Due to the fact that 5G envisages very high data rates, much larger bandwidths than ever before will be required−up to several GHz−which can only be

found in higher frequency bands. WRC-15 agreed to consider a number of bands above 24 GHz for the use of 5G. Compatibility with existing users in the same and adjacent bands needs to be taken into account. CEPT has focussed its work on a set of priority bands based on the CEPT 5G roadmap: 24.25-27.5 GHz, 40.5-43.5 GHz, 66-71 GHz.

The first of these, 24.25-27.5 GHz, referred to as the 26-GHz-band, has been identified in Europe as a pioneer band for 5G. CEPT has already harmonised it under ECC Decision (18)06 and plans to promote the band for IMT at WRC-19, with the conditions outlined in this ECC Decision.

The 40.5-43.5 GHz band is also proposed for 5G. This band is considered in light of a possible tuning range concept, which involves the adjacent band 37.5-40.5 GHz allowing a global identification for IMT. Although, CEPT administrations have no intention to use this lower range for 5G.

The 66-71 GHz band is also proposed for IMT identification while noting that wireless access systems (e.g. WiGig) should have equal access in this band.

For the bands not deemed suitable for 5G, no change to the RR is proposed, while some remaining bands (45.5-50.2 GHz and 50.4-52.6 GHz) are still under discussion.

Besides its work on 5G, WRC-19 will consider other systems and applications to provide wireless broadband connectivity. For instance, studies are still ongoing in CEPT to assess if proper conditions and mitigation techniques would allow additional RLAN uses in the 5725-5850 MHz and 5150-5250 MHz bands. Connectivity solutions through high altitude platforms (HAPs) are also gaining momentum, with the recent advent of new technologies. In this respect, the bands at 6 GHz, 28 GHz, 31 GHz, 38 GHz, and 47 GHz for HAPs use are of interest in Europe, and studies will be finalised in the upcoming months.

Satellite communications

WRC-19 will discuss how to meet the demand for spectrum for different types of satellite uses. On one hand, the quick uptake of new systems such as non-geostationary satellite (non-GSO) systems requires a proper regulatory response. On the other hand, provisions need to ensure that undue legacy limitations are avoided and the deployment of already admitted uses is effectively viable.

In view of the increasing interest in non-GSO systems, CEPT is proposing appropriate measures to allow these systems in new bands at 40/50 GHz while ensuring they can also operate in the bands which, from a regulatory perspective, are already available to non GSO systems, such as the 3700-7025 MHz range. CEPT is also working on the proper definition of a milestone-based approach, which will bring into use frequency assignments to non-

GSO systems. This will provide a degree of regulatory certainty while recognising that non-GSO constellations may generally take time to be fully deployed. Simplified procedures for non-GSO short duration satellite systems are also being discussed.

Furthermore, there is a strong interest in the usage of the 17.7-19.7 GHz and 27.5 29.5 GHz bands for satellite earth stations in motion (ESIM) operating with geostationary space stations. This matter is considered in continuity with the work of WRC-15, which opened the 19.7-20.2 GHz and 29.5-30.0 GHz bands to ESIM. With the ECC Decision (13)01, the harmonised use of ESIM in these bands has already been achieved in Europe. However, the discussion is still ongoing about the proper operational conditions, coordination methodologies and responsibilities for operation and interference management which CEPT will propose at WRC-19 for maritime, aeronautical and land ESIM.

Each WRC considers possible changes to the satellite regulatory procedures. In preparation of WRC-19, 13 different issues have been identified on a variety of satellite procedures. These include measures to facilitate newcomers who want to access satellite orbits, and procedures to convert and record administrations' assignments in the ITU Master Register. Proposals have already been developed for some of these issues while others are still under discussion. This highlights that CEPT favours the review or development of any RR provision which can bring accurate solutions to specific inconsistencies, and focusses on the most urgent issues.

Aeronautical and Maritime communications

In the preparation of WRC-19, a significant effort is dedicated to the Global Maritime Distress and Safety System (GMDSS), which is needed to improve communications and enhance maritime capabilities. The recent recognition of the Iridium satellite system as part of the GMDSS requires regulatory actions. According to the CEPT view, this would include the allocation of primary spectrum to the maritime mobile-satellite service (MMSS) in the band 1621.35-1626.5 MHz while ensuring protection to radio astronomy and existing MMSS operations in the adjacent frequency band.

WRC-19 will also consider possible new spectrum allocations for MMSS to enable the satellite component of VHF data exchange systems (VDES-SAT). VDES-SAT offers potential enhancements to maritime safety and CEPT is in favour of the allocation of proper spectrum on a primary basis at 160.9625-161.4875 MHz. Provisions on channelisation and coordination mechanisms for these systems need to be defined, too.

After two serious aeroplane accidents, the last WRC-15 also agreed on the necessity to identify either additional spectrum or regulatory provisions to facilitate the Global Aeronautical Distress and Safety System (GADSS). CEPT is now discussing the most appropriate solution to recognise GADSS in the relevant parts of the RR dealing with distress and safety communications.

Scientific use of spectrum

Short duration non-GSO satellites, with a life span of typically less than three years, offer great potential for a variety of scientific and experimental missions. These satellites require telemetry, tracking and command (TT&C). This has led to the challenging task of assessing the suitability for TT&C of spectrum already allocated to the space operation service (SOS) below 1 GHz, alongside considerations on a possible upgrade of the existing allocations, or even a new allocation to SOS. When it comes to short duration non-GSO satellites in the space-to-Earth orbit, CEPT is still discussing alternative options. These have a common element in the identification of the existing allocation to the space-operation-service in the frequency band 137-138 MHz. There is a need to strike the right balance in the regulatory environment for such satellite missions.

A specific Agenda item for WRC-19 deals with the growing use for TT&C in the 401-403 MHz and 399.9-400.05 MHz bands under the Earth exploration-satellite service (EESS), meteorological satellite service (MetSat) or mobile satellite service. Power limits would reduce the impact of the TT&C usage on the existing, lower power data collection system stations. Such stations communicate to sensitive receivers and typically work at lower power levels. To provide confidence and long-term continuity to space and meteorological data collection system programmes of great public interest, CEPT is also considering the allocation of primary spectrum for MetSat and EESS (downlink) at 460-470 MHz. However, the conditions to ensure protection of services in the same and adjacent frequency bands still need to be defined.

Future agenda

Each Conference has a standing Agenda item which regards the definition of the provisional Agenda of future Conferences. In 2015 a provisional Agenda for WRC-23 was already defined, which includes for instance the continuation of the GMDSS modernisation and the review of the spectrum use in the 470-960 MHz band in Region 1. There´s a general support for this provisional Agenda, however, further consideration is required on the needs and possible new allocations to the fixed satellite service at 37.5-39.5 GHz. CEPT has also received a number of new proposals, which will be further discussed and developed in the next year.

Doriana Guiducci Spectrum Expert, European Communications Office
Peter Faris, Spectrum Expert, European Communications Office

Broadband – and IoT opportunities for land mobile systems in 400 MHz: the regulatory framework for their introduction

The arrival of information and communication technology in almost all sectors of the economy - such as smart grid, smart metering and industry 4.0 - increases the demand for mission-critical machine-to-machine communication. More and more, companies and organisations require communication that provides the excellent reliability and resilience found in Private (Professional) or Public Access Mobile Radio Networks.

The Private (Professional) or Public Access Mobile Radio Networks (PMR/PAMR) market can be characterised by two different trends. On the one hand, 6.25/12.5/25 kHz services and technologies are still demanded and used extensively, on the other there is a trend towards PMR/PAMR systems using 200 kHz, 1.25 MHz, 1.4 MHz, 3 MHz and 5 MHz channels. This development has gained substantial momentum in recent years with expected deployment of millions of devices. It is linked to the introduction of information and communication technologies to several market sectors which request data oriented PMR/PAMR services.

The developments of technologies−to support more data, varying frequency bandwidths, and in business and mission-critical machine-to-machine (M2M) communications − is important for users across industries. The evolution of market demands, the availability of cellular mobile technologies in 400 MHz bands, as well as evolving requirements for mission-critical M2M applications, should be carefully reflected in spectrum management activities and in national frequency policies.

In consideration of the above, a number of studies have been recently completed within the Electronic Communications Committee (ECC). Their aim is to build a general framework and additional guidelines, which will assist CEPT national administrations in accommodating the growing needs within the 400 MHz spectrum for land mobile systems.

Studies were performed in the ECC Working Group for Spectrum Engineering Project Team SE7, which led to the publication of the following two ECC Reports:

1. ECC Report 276, identifying thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band;
2. ECC Report 283, containing compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz.;

Based on these studies, one new draft ECC Decision (19)02, two revised ECC Decisions (16)02 and (08)05, and one new ECC Report 292 concerning 400 MHz spectrum, prepared by the Working Group Frequency Management Project Team FM 54, have been in the public consultation process. They should be finalised in early 2019.

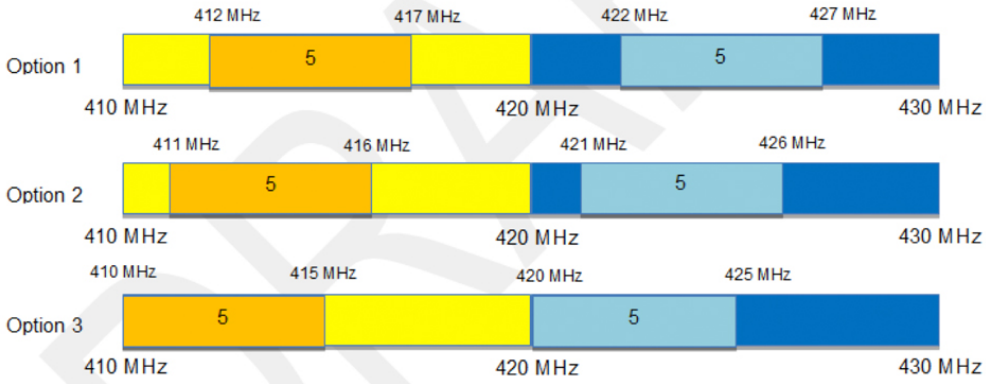

Figure 1 - New non-exhaustive options for broadband systems in 410-430 MHz

Public Protection and Disaster Relief (PPDR)

ECC has been investigating a flexible harmonised approach for broadband-PPDR for several years.

The current edition of ECC Decision (16)02 already has harmonised technical conditions with least restrictive technical conditions for PPDR broadband services at 450 MHz and 700 MHz. In the proposed revision of ECC Decision (16)02, the 410 – 430 MHz band is added as another possibility for broadband for PPDR services.

CEPT administrations can introduce additional spectrum for BB-PPDR in parts of the 400 MHz range with least restrictive technical conditions channelling arrangements for 1.4, 3 or 5 MHz within the following paired frequency ranges: 450.5 – 456/460.5 – 466 MHz; 452 – 457.5/462 – 467.5 MHz; 410 – 415/420 – 425 MHz; 411 – 416/421 – 426 MHz; and 412 – 417/422 – 427 MHz.

Under the developments, ECC proposed that the Third Generation Partnership Project (3GPP) should consider standardisation activities for Long Term Evolution (LTE)-based systems for 410 – 430 MHz spectrum.

ECC Decision (08)05 identifies the frequency bands for digital PPDR narrowband and wideband radio applications in the 380 – 470 MHz band, using tuning ranges where necessary. Sufficient spectrum shall be made available for narrowband digital PPDR radio applications. This could be done by using channel bandwidths up to 25 kHz within the duplex bands 380 – 385/390 – 395 MHz and/or for wideband digital PPDR radio applications that use channel bandwidths up to 150 kHz within available parts of 380 – 470 MHz, preferably in 380 – 430 MHz. This Decision has been revised to include the aspect of

free circulation and use of compliant PPDR-user equipment which operates under the control of a network. A similar provision is also included in the new draft ECC Decision (16)02.

Land mobile systems in the 400 MHz range

The new draft ECC Decision (19)02 covers land mobile systems in the following frequencies: 68 – 87.5, 146 – 174, 406.1 – 410, 410 – 430, 440 – 450 and 450-470 MHz. The Decision recognises land mobile systems use with different channel bandwidths, which vary from 6.25 kHz up to 5 MHz. It defines technical requirements, depending upon the frequency band and the channel bandwidth and provides further guidance, in particular for the coexistence between different systems. The technical requirements are described in a technology neutral way, while accommodating the introduction of a range of relevant technologies. These include: dPMR; DMR; TETRA; CDMA PAMR or LTE-based land mobile systems; M2M/internet of things (IoT) based on narrowband IoT (NB-IoT), and low-power WAN (LPWAN) technologies. This approach offers CEPT administrations the opportunity to decide which of the land mobile systems can be introduced in their national frequency allocation and use plan.

The draft new Decision also exempts from individual licensing and allows the free circulation and use of terminals of land mobile systems operating under the control of a network.

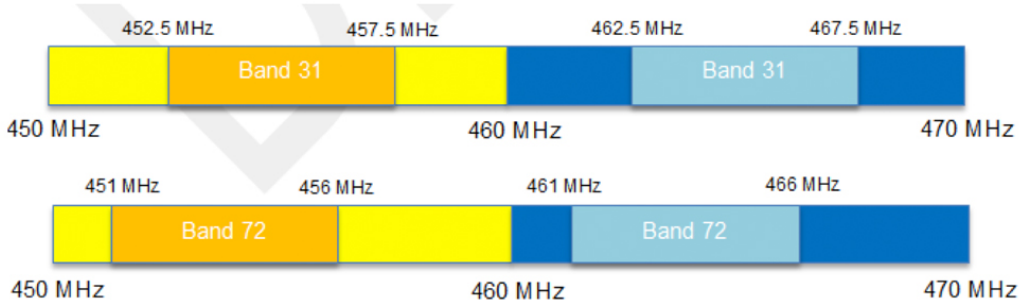

Figure 2 - New non-exhaustive options for broadband systems in 450-470 MHz

Broadband networks in Europe are already deployed in Austria, Czech Republic, Denmark, Finland, Germany, Hungary, Latvia, The Netherlands, Norway, Sweden and Russia. They provide connectivity for millions of devices using CDMA450 or LTE450 technology. These networks have been assigned nationwide licences, and it is assumed that existing CDMA networks are likely to migrate towards LTE including eMTC and NB-IoT.

The new draft ECC Report 292 provides a good overview of the situation in Europe for the 400 MHz frequency ranges to be used by land mobile systems. The new Report includes guidance, fostering the increased shared-use of PMR channels, how administrations can amend their PMR/PAMR regulatory framework, and how they could achieve more

contiguous band segments for wideband and broadband systems. The Report also recommends more flexible approaches for licensing and the adoption of a concept defining area licences, as already used in the United Kingdom.

The draft ECC Report 292 also sets out the results of the PMR/PAMR survey which highlight that the use of the frequency bands between 400 MHz and 470 MHz varies significantly throughout the European countries. The total estimate in the CEPT is that about 120,000 PMR/PAMR licences are awarded with a channel bandwidth of up to 25 kHz, excluding most likely some governmental use or PPDR use that was not counted. Due to congestion situations - for example, in European capital cities or at border areas - the increased shared use of PMR frequencies and related methodologies such as 'sharing number' seem to represent a significant opportunity for serving more users in the existing spectrum for PMR.

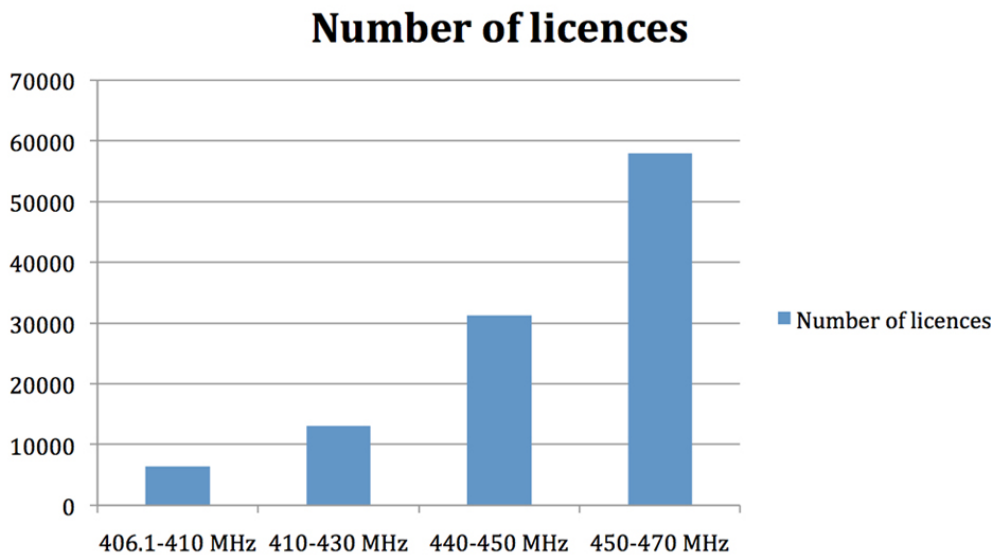

Figure 3 - Number of PMR/PAMR licences in Europe in the 400 MHz range

In this situation, it is important for spectrum regulators to apply a technology-neutral regulatory approach which maintains a balance among the different technologies without favouring one technology approach. The technical conditions set out in the new ECC Decision (19)02 are considered to provide the necessary guidance on this aspect.

The ECC Working Group Frequency Management also updated the Recommendation T/R 25-08 on planning criteria and coordination of frequencies in the land mobile service in the range 29.7-470 MHz. A revision was published in September 2018. The revision includes new recommendations for the cross-border coordination of land mobile systems having different channel bandwidths on both sides of the border for the 400 MHz ranges.

It should be noted that some aspects require further consideration and investigations are still ongoing within the ECC, for example on the intermodulation effect from broadband interferers into narrowband victims for which no conclusion could be reached during the drafting of ECC Report 283.

Conclusions

ECC is finalising the new regulatory framework for land mobile systems in the 400 MHz frequency ranges. This will provide harmonised technical conditions for various technologies, and will support possible technology moves and new network types - such as from CDMA to LTE or towards wide area data networks for M2M/IoT mission critical applications - while keeping the balance with the requirements for other PMR/PAMR radio applications.

Thomas Weber, Spectrum Expert, European Communications Office

Keeping it eSIMple – The future of mobile

It was a German company called Giesecke & Devrient[1] that unveiled the world's first commercial SIM card in 1991. This product quickly gained acceptance as the global standard for the SIM card format. Over the years the SIM card has been downsized as devices have become smaller — from a credit card-sized piece of plastic with a chip (1FF), to the "Nano" SIM which fits in most smartphones today. Apart from the smaller size, the basic functionality has remained largely unchanged over the years.

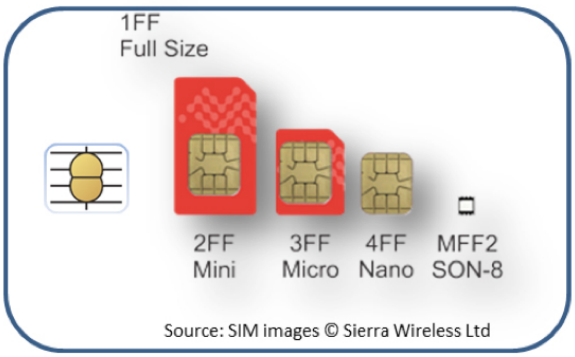

Figure 1 - SIM card form factors over the years

MFF2, the smallest form factor depicted in Figure 1 above, was designed to be embedded or soldered onto the circuit board of a device. This type of SIM is designed for devices which may be exposed to extreme conditions (cold, heat, dust, moisture, vibration etc.) and where space on circuit boards is regarded as high value real estate. Embedded SIMs are commonly found in mobile-based machine-to-machine (M2M) devices.

Mobile-based M2M – the switching challenge

Competition across Europe in the consumer market for mobile electronic communications (referred to as Person-To-Person (P2P) communications in this article) has been vibrant for many years and this has been largely enabled by number portability. If a subscriber wishes to switch operator it is a simple matter of approaching a new operator and purchasing a new SIM card, which can then be inserted into the subscriber's device. The subscriber's number can be ported to the new service provider in a very short period of time. The whole process is quite seamless.

While number portability may not have significant relevance for M2M communications, a different and unique challenge for mobile operators and service providers has emerged. An M2M customer may have hundreds, thousands or millions of devices installed over a wide

geographical area (possibly across borders). Physically replacing SIM cards to switch service provider is neither economically nor logistically feasible in most cases. If embedded SIMs are used to overcome environmental challenges (i.e. extreme temperature, moisture, vibration etc.), then the switching challenge becomes even greater and the concept of "operator lock-in" is introduced.

ECC Report 212[2] identified “operator lock-in” as a potential competition risk for the emerging M2M market and explored administrative and technical solutions to resolve the issue. One administrative solution that was identified was to assign E.212 numbering resources directly to M2M customers which essentially allows them to generate their own International Mobile Subscriber Identity (IMSI) numbers independent of their host mobile operator. There are examples of this type of solution deployed in the market today but these solutions often result in introducing operational and contractual complexities into the relationship between the service provider and the customer, and the responsibility for regulatory obligations regarding the use of the numbers can become ambiguous.

The alternative to an administrative solution is a technical one where the subscription can be initially provisioned remotely over the air or re-provisioned to facilitating switching of service providers.

In 2013, the GSMA released a first version of its specification[3] for an embedded Universal Integrated Circuit Card (eUICC – referred to as eSIM in this article) which provides the capability of managing subscriptions remotely in the M2M communications sphere thereby allowing eSIMs to be managed over the air. This was followed up in 2017 by another specification[4] for the P2P market. In certain cases consumer devices may have eSIMs (e.g. tablets, smartphones, wearables, etc.), so the challenge of switching operator without a physical SIM card replacement is also relevant.

A physical SIM replaced by a logical SIM

ECC Report 274, published in November 2018, describes how the traditional SIM card and the eSIM are configured. There are two key identifiers involved:

1. The Integrated Circuit Card Identifier (ICCID), defined in ITU-T Recommendation E.118[5], identifies the physical SIM card and the SIM card issuer.
2. The International Mobile Subscription Identity (IMSI), defined in ITU-T Recommendation E.212[6], identifies a unique mobile subscription.

With traditional SIM cards, the ICCID identifies the physical hardware, and it is possible to have multiple profiles in one SIM card which have different IMSIs. With the eSIM, the GSMA specification introduces a new identifier called the embedded Universal Integrated Circuit Card Identifier (EID). The EID identifies the physical hardware. The ICCID is no longer used for this purpose and is now associated with a SIM profile that is stored

logically on the eSIM. This is illustrated on the right hand side of Figure 2 below. Each logical SIM profile is identified by a unique ICCID and IMSI which can be initialised or re-provisioned over the air.

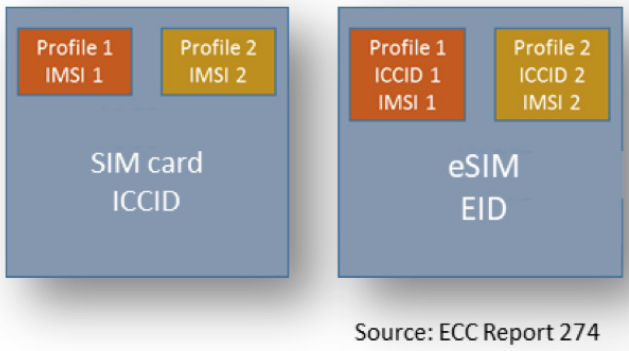

Figure 2 - Identifiers in the traditional SIM and the eSIM (source: ECC Report 274)

Traditional SIM cards are manufactured, pre-programmed and distributed to wholesale partners, retail shops or directly to enterprise customers. The integrity and security of the supply chain is inviolable. A recent whitepaper[7] from the GSMA noted that as "well as being secure, the distribution channels for SIM cards also contain 'business logic' which is required by various service models. In some channels that logic may even dictate who has control of device connections. It is not practical to combine this logic into a single technical solution for eSIM". This explains the rationale for having two separate specifications for the M2M and P2P markets. Figure 3 below illustrates the common features of the M2M and P2P specifications.

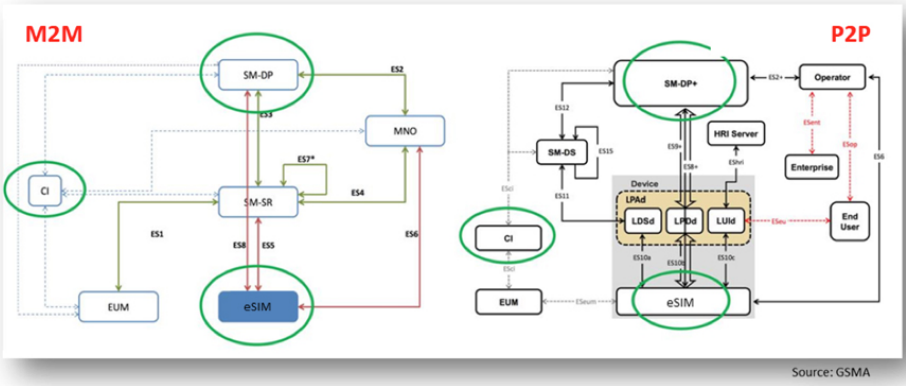

Figure 3 - Common features of M2M and P2P specifications

Both architectures feature a network-domain remote SIM provisioning system called the Subscription Manager - Data Preparation (SM-DP or SM-DP+). In the P2P solution, SM-DP+ has extra capabilities to support functions specific to the P2P solution. Both architectures rely on a secure element within the mobile device for the storage,

management and operation of profiles (i.e. the eSIM). Both architectures use Pre-Shared Key (PSK) and Public Key Infrastructure (PKI) based cryptography. However, for the M2M solution authentication with the Subscription Manager - Secure Routing (SM-SR), PSK is used and only allows a single SM-SR to communicate with the eSIM. For the P2P solution, the PKI-based authentication is used and therefore any SIM and SM-DP+ can connect so long as they share the same root PKI certificate.

Both architectures require a GSMA Certificate Issuer (CI) that issues digital certificates. The certificates then enable entities to securely communicate with each other, and in the P2P solution, mutually authenticate each other. It should be noted that although there are architectural similarities between the P2P and M2M solutions, they are inherently technically different and cannot be overlapped in an implementation that serves both the P2P and M2M markets. ECC Report 274 provides a more detailed description of the over-the-air provisioning ecosystem.

The impact of eSIM

There is no doubt that eSIM will have an impact on the mobile value chain as enabling new business models will ultimately lead to new entrants and alternative ways of delivering new and innovative services. eSIM has the potential to streamline initial provisioning processes and reduce time to market and subscription activation. Furthermore, the updated regulatory framework for electronic communications services in the European Union, due to come into force in December 2018, explicitly promotes the use of over-the-air provisioning technology. This is likely to have a positive effect on market uptake.

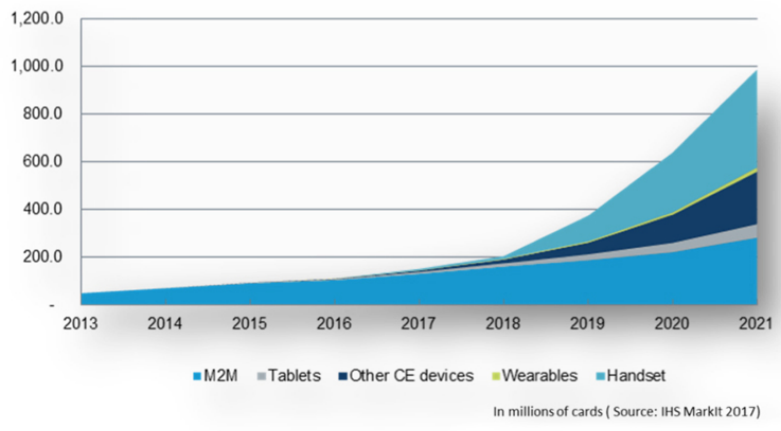

Figure 4 - World eSIM shipments split by device year-to-year

IHS Markit[8] predicts that eSIM shipments will increase to 986 million units by 2021. Figure 4 above illustrates that, at least initially, most eSIMs will be deployed in M2M devices but that from 2018 onwards there will be significant growth in eSIMs deployed in P2P devices also. This development will change the dynamics of the relationships that exist between the different stakeholders in the industry value chain. If eSIMs are installed in devices at point of manufacture, chipset manufacturers will negotiate with the main device

manufacturers directly (i.e. Apple, Samsung etc.) and the physical distribution of SIM cards to points of sale could become redundant in the future. This development will change the mobile operator's future role and influence in the value chain and their relationship with the end customer — a relationship which was effectively owned by the mobile industry until now. A McKinsey article from 2016[9] refers to this as "disintermediation of network operators from the end-to-end relationship". This raises some questions about how P2P customers will interface with mobile service providers in the future and what impact this might have on number portability processes and procedures.

Number portability

As well as examining the architectures defined in the GSMA specifications, ECC Report 274 considers the relevance of Number Portability (NP) in the M2M and P2P markets. For M2M, the relevance of NP is limited as the value of a number assigned to a machine has little relevance when compared to the value of a number assigned to a person. However, if the same numbering ranges are used for both M2M and P2P services it will be difficult for national regulatory authorities to distinguish between and apply separate regulatory treatment — unless, M2M services are confined to specific dedicated numbering ranges. Such ranges already exist in some countries in Europe.

NP will remain a critically important competition enabler for mobile P2P services. With traditional SIM cards, the NP request is usually made by the customer at point of sale. Information is then exchanged between the donor and recipient operators to execute the NP request and, provided everything is in order, the NP request is executed within a short period of time. With eSIM, that interaction between the customer and the service provider at point of sale may decrease or be removed entirely over time. In the future, the customer could buy a mobile device online and request service activation online by choosing from a number of service providers. The customer could also, at a later date, switch service providers through a similar online process. As there is no need to physically change a SIM card, it is essential that NP is properly accounted for in these processes. Regulators will therefore need to review their NP processes to ensure that the data exchange between service providers and customers is synchronised and takes proper account of NP processes and procedures. Safeguards may also need to be put in place to ensure that end-users are not switched to other service providers against their will.

There is no doubt that eSIM is game-changing technology. There are potential benefits for all stakeholders in the mobile value chain, including end users. Regulators will have an important role to play to ensure that these benefits are realised without any adverse effects on competition and consumer protection.

Freddie McBride, ECO Expert, Numbering and Networks

[1] https://www.gi-de.com/en/ie/g-d-group/about-us/history/

[2] ECC Report 212 - Evolution in the Use of E.212 Mobile Network Codes – April 2014

[3] GSMA SGP.01 - "Embedded SIM Remote Provisioning Architecture", - version 1.1 of 30 January 2014

[4] GSMA SGP.02 - "Remote Provisioning Architecture for Embedded UICC Technical Specification" - version 3.2 of 27 June 2017

[5] ITU-T Recommendation E.118 - "The international telecommunication charge card" - 11 May 2006

[6] ITU-T Recommendation E.212 - "The international identification plan for public networks and subscriptions" - September 2016

[7] GSMA eSIM Whitepaper - "The what and how of Remote SIM Provisioning", March 2018

[8] IHS Markit - eSIM Market Projected to Increase Nearly Nine-Fold, to Almost One Billion Shipments – May 2017

[9] McKinsey & Company – E-SIM for consumers—a game changer in mobile telecommunications? – January 2016