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Mobile technology evolution – experiences and strategies

DRAFT RSPG Report

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1 Introduction and goals

New mobile technology generations are continuously evolving and brought into use. Newer generations, such as 4G and 5G, provide significant advantages. Phasing out of older technology generations (2G/3G) in order to introduce newer technologies (4G/5G) is intended to increase spectrum and energy efficiency, improve communication security (through better data encryption and authentication techniques), provide higher data speeds and may enable new use cases. At the same time, switching off 2G and 3G will affect legacy systems, equipment and services such as eCall, emergency calls and smart meters. Any impacts should also be identified in advance in order to best address them. This report is the contribution from a strategic spectrum management perspective to this process.

Over the course of the next 5-10 years, many of the licenses in the core mobile bands in some countries are expiring and will be up for re-assignment. In other countries, licences in 900 MHz, 1800 MHz and 2.1GHz have been renewed, granted or auctioned in the recent years.[1] This comes in conjunction with the future phasing out of both 2G and 3G technologies, which were initially launched in 900/1800 MHz for 2G and 2.1 GHz for 3G. 3G is also now operating in 900 MHz in some countries. There are some questions in relation to the implication of the technology neutrality principle, including in the context of the GSM Directive. Sharing experiences, lessons learnt (RSPG Peer Review Forum) and strategies on an RSPG level will be a valuable tool for enabling and preparing for the mobile technology evolution.

Scope of RSPG activity

The June 2021 RSPG Opinion on a Radio Spectrum Policy Programme[2] introduced the following wording:

6.1. Migrating regulatory service obligations to the latest technologies The RSPG recommends

- *the European Commission, when deviating from the principle of technology neutrality, to promote a particular wireless technology supporting services responding to EU public policies (i.e. e-call), to analyse the possible impact and respond to arising challenges. Such an analysis has to take note of the different stages of development of wireless technologies in Member States including the reasoning behind, like their support of national policies (i.e. 4G coverage, 5G coverage).*
- *European Commission and Member States should anticipate any impact of possible future phasing out of some legacy systems (2G, 3G, and 4G) in the next decade.*

[1] See ECO report 03 and EFIS right of use statistics: https://efis.cept.org/views2/rightofusestats.jsp

[2] Available in https://rspg-spectrum.eu/wp-content/uploads/2021/06/RSPG21-033final-RSPG_Opinion_on_RSPP.pdf.

Working method

A questionnaire was issued to RSPG Members and representatives of the EEA countries (hereafter "countries") in relation to the evolution of mobile technologies, experiences, and strategies within their country. Twenty countries responded to the questionnaire. This report incorporates the main findings from the responses.

A workshop with stakeholders was held in September 2022. The purpose of the workshop was to gather input from stakeholders on the impact of 2G/3G switch-off and evolution to 4G/5G technologies and to understand possible obstacles or delays to technology evolution, such as eCall and legacy equipment and applications (e.g. smart meters, home security alarms). The workshop provided information and motivations in addition to that contained in the responses from countries to the questionnaire.

2 Summary of the report

The benefits for MNOs (Mobile Network Operators) of migration to newer technologies include in particular improved spectrum and energy efficiency and communication security. There would also be savings in network and maintenance complexity as well as reduced security risks when reducing the variety of generations deployed on the networks. This can be also a benefit in terms of reduced reserves of spare equipment, but also regarding the required knowledge of maintenance employees. These benefits are of value to operators and customers as well as in the interest of regulatory authorities and administrations.

Based on the feedback from questionnaire and workshop, RSPG recalls the positive impact from Technology neutrality and infrastructure competition towards evolution to newer radio technologies.

- Countries reported that they had no specific migration plans. In general, the licenses for mobile networks are technology neutral and the phase out of technologies is part of the strategy of MNOs on deploying new technologies.
- RSPG noted also that the infrastructure competition between MNOs is triggering evolution to newer radio technologies depending on their own strategy. Some countries benefit from observatories, which revealed this trend.

It is advisable to assess the impacts on current licenses in force, which have been granted on a technology neutral basis and current market evolution towards newer technologies by an update of the eCall framework. However, countries have identified some obstacles to switching off 2G and 3G technologies due to legacy systems, equipment and services such as eCall, emergency calls and smart meters in particular.

Voice calls are also available in 4G networks through Voice over LTE (VoLTE). Nevertheless, not all 4G customers have the possibility to use this feature due to limitations in terminal equipment.

One issue MNOs face is related to the transition from circuit switched telephony over 2G and 3G networks to IP based telephony over 4G (VoLTE) and future generations (5G, 6G). In particular, the development and use of standards for VoLTE require attention by MNOs and other stakeholders like device manufacturers. Existing standards have a high grade of flexibility, leaving scope for tailor made implementations in networks and devices. For device manufacturers this flexibility can result in an unworkable amount of different implementations that they have to test. Thus, they cannot guarantee VoLTE will work on every network, including when roaming within the EU. This could undermine the availability of emergency services at European level.

RSPG identifies a risk that devices that do not support access to emergency services through 4G/5G will keep entering the European market. As long as these devices are in use, they will create a barrier to switch-off of 2G and 3G networks, and this would endanger access to emergency services for both EU citizens (including those roaming within the EU) and travellers from third countries roaming onto European networks.

In addition, RSPG identified some practices, which could assist in removing some obstacles, for example:

- Best MNOs practice is to be transparent with their plans and to inform relevant parties in a timely manner
- The newer technologies will push operators to switch off 2G/3G technologies to fulfil the user needs and gain competitive market advantage. Recent technologies such as 5G and/or 4G are expected to replace the legacy 2G/3G technologies in the 900 MHz, 1800 MHz and 2100 MHz bands.
- The developments of these 4G systems or other systems such as 5G NR support VoLTE and wide area coverage.
- In addition there are national observatories for monitoring developments of mobile technology migration and coverage.
- There is an ongoing standardisation initiative to allow eCall to function in 4G/5G environment as Next Generation eCall. The European Commission is conducting a study on the future of eCall that is still ongoing.
- There is an ongoing exploration within the RED expert group to make the emergency protocol in standards mandatory for VoWiFi (Voice over WiFi) and VoLTE calls. This is expected to remove one of the current obstacles for the 2G/3G switch off, while it ensures future compatibility of new terminals.

Sharing experiences and lessons learnt and strategies on an RSPG level is a valuable tool for enabling and preparing for the mobile technology evolution.

The GSM Directive allows new digital technologies to be deployed in the 900 MHz band while ensuring their compatibility with GSM, but it does not impose any obligation on the Member States to put in place any guarantee that 2G would continue to exist. That means that it does not guarantee that legacy systems requiring a GSM network to operate will be able to do so.

The radio spectrum framework implemented in licenses responds to different national situations and objectives leaving also opportunities for mobile operators to develop according to technology neutral harmonised technical conditions their own strategy towards newer technologies.

3 Some key points from stakeholder workshop

This chapter gives some insight into the presentations made and discussions at the stakeholder workshop arranged by RSPG in September 2022. For a more thorough summary, see Annex 2 of this report.

Mobile technology migration progress:

- 2G/3G switch-off is advancing; Due to the significant size of the markets for 2G based M2M (machine-to-machine) and IoT (internet of Things) applications, many European mobile operators are planning to phase out 3G services before 2G.
- Difficulty to maintain 2G and 3G beyond the decade as the availabilty of spare equipment parts will/might not be adequate by then.

Market drivers for phasing out 2G/3G:

- There is commercial pressure on operators to phase-out 2G/3G networks because 5G or 4G, which are more efficient, will require access to the frequencies.
- From a sustainability and energy efficiency perspective the phasing out of 2G/3G should not be delayed.

Barriers:

- Cost of migrating M2M/IoT connections to newer technologies
- Possible changes in coverage, particularly if the new technology (such as VoLTE) does not provide the same coverage as the replaced legacy technology on the same band.
- Potential brand damage if some customers are left without service and thus are forced to upgrade handsets or a large number of M2M devices are disconnected and forced to do technology upgrades.

Regulatory Aspects:

- The general principle for mobile communication networks in Europe is technology and service neutrality. The principle of technology neutrality is key for future-proof legislation.
- Operators state that they are in the best position to make migration decisions; there is no need for regulatory intervention.
- Recommended MNOs best practices:
  - Transitional period
  - Coverage matching what was previously offered
  - Reasonable formal notice period
  - A well-designed campaign involving direct targeting of affected customers, possibly assisted by the regulator
  - Upgrade incentives for customers

Service specific Concerns:

- Concern about operation of older IoT applications, such as remote sensing and meter reading, and the European eCall system.
- According to car manufacturers, retrofit of cars is not possible due to type approval regulation, while aftermarket solutions may not be reliable and are costly for the consumer.

Mobile Technology Evolution outside Europe:

- Operators in the Asia-Pacific region started rationalising 2G services as early as 2008 to 2012
- Phasing out 2G networks is the preferred option in the Asia-Pacific region and North America.

4 Current EU legislation

GSM Directive

The GSM Directive[3] paved the way for a European single market, when it comes to mobile communications. The directive is still in force, however with the adoption of Directive 2009/114/EC the 900 MHz frequency band is available to other technologies for the provision of additional compatible and advanced pan-European services that would coexist with GSM. It requires that compatibility with GSM is ensured to protect any legacy systems. Up to today, this requirement has not been an obstacle for the introduction of new technologies in the GSM-bands. However, with evolving technology and the progress in the phase-out of GSM the need for compatibility of new technologies with GSM systems is expected to become obsolete in the foreseeable future.

Therefore, the GSM Directive allows new digital technologies to be deployed in the 900 MHz band while ensuring their compatibility with GSM, but it does not impose any obligation to the Member States to put in place any guarantee that 2G would continue to exist. That means that it does not guarantee that legacy systems requiring a GSM network to operate will be able to do so.

Radio Spectrum Decision

Decision No 676/2002/EC establishes a framework for harmonisation of radio spectrum. All mobile bands including 900 MHz/1800 MHz/2.1 GHz benefit from harmonised technical conditions adopted under this Decision and which are technology neutral (see relevant EC Decisions[4] for 700 MHz, 800 MHz, 900 MHz, 1500 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz, 3.5 GHz, 26 GHz). Member States shall allow use of radio spectrum according to these technical conditions (see art 53 EECC) which are implemented in authorisations granted for usage of these mobile bands.

Concerning 900 MHz, 1800 MHz and 2.1 GHz

- Harmonised technical conditions in 900 MHz and 1800 MHz have been updated in order to implement technology neutrality approach and development of the market towards newer technologies (see Decision (EU) 2022/173 under Radio Spectrum Decision[5]). Those harmonised technical conditions are going to be implemented in the licensing conditions in these bands. The co-existence with the GSM services according GSM Directive remains safeguarded. The technology neutral conditions do not address GSM and GSM IoT but would ensure the protection of these technologies.
- Harmonised technical conditions in 2.1 GHz were adopted 10 years ago introducing technology neutrality in a band initially dedicated to 3G and have

[3] Council Directive 87/372/EEC complemented by Council Recommendation of 25 June 1987 on the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community and by Council Resolution of 14 December 1990 on the final stage of the coordinated introduction of pan-European land-based public digital mobile cellular communications in the Community (GSM)

[4] https://digital-strategy.ec.europa.eu/en/library/radio-spectrum-decisions

[5] Decision No 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision).

been recently updated in 2020 in order to foster availability and use of these 2 GHz paired band for 5G deployment while upholding the principles of technology and service neutrality.

This radio spectrum framework implemented in licenses responds to different national situations and objectives leaving also opportunities for mobile operators to develop according to technology neutral harmonised technical conditions their own strategy towards newer technologies.

eCall regulation

The eCall regulation[6] sets out the framework for equipment installed in vehicles with the functionality to initiate a call to the emergency services through the mobile network. In the event of a severe accident that could cause potential road fatality, an emergency call is generated either manually by vehicle occupants or automatically via activation of in-vehicle sensors. eCall is mandatory in all cars and light commercial vehicles (according to Regulation (EU) 2018/858) that have been type approved after 31 March 2018. Current eCall regulation only allows circuit-switched mobile technologies (2G/3G).

European Electronic Communications Code and Framework Directive (2002)

The European Electronic Communications Code (EECC) directive (EU) 2018/1972 adopted at the end of last decade is the current legal basis for licensing mobile usage of the900, 1800 MHz and 2.1 GHz bands. The technology neutrality principle has been reaffirmed in the current directive (see in particular article 3.4.c). Before the EECC entered into force, the licences in 900/1800 MHz/2.1 GHz were granted or auctioned according to the regulatory principles of Framework Directive (2002).

Radio equipment directive

The radio equipment directive or RED (2014/53/EU) establishes a regulatory framework for any radio equipment (like handsets) entering the EU market. It ensures a single market for radio equipment by setting essential requirements for safety, efficient use of the radio spectrum and electromagnetic compatibility. It also provides the basis for further regulation governing some additional aspects. These include technical features for the protection of privacy, personal data and against fraud. Furthermore, additional aspects cover interoperability, access to emergency services, and compliance regarding the combination of radio equipment and software.

Relevant parts of this directive in relation to the availability of emergency services through 4G are the requirements under article 3.3 (b) that covers the interworking of radio equipment in general, and article 3.3 (g) which specifically covers the ability of radio equipment to access emergency services. These requirements can be activated for certain categories of radio equipment by means of a delegated act of the European Commission.

[6] Regulation (EU) 2015/758 of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC

There is an ongoing initiative within the RED expert group to make the emergency protocol in standards mandatory for VoWiFi and VoLTE calls. This is expected to remove one of the current obstacles for the 2G/3G switch off, while it ensures future compatibility of new terminals. Otherwise there is a risk that devices that do not support access to emergency services through 4G and its successors will keep entering the market. As long as circuit switched only devices are in use they will create a barrier to switching off of 2G and 3G networks as this would endanger access to emergency services for both EU citizens (including when roaming within the EU) and inbound roamers from third countries.

5 Obstacles for migration to newer technologies

The main obstacles identified for switching-off 2G/3G networks are related to services still relying only on these networks. These can be divided into voice communication in particular used for emergency calls, and other legacy systems, using mainly data communication.

Voice communication and emergency calls

One issue MNOs face, is related to the transition from circuit switched telephony over 2G and 3G networks to IP based telephony over 4G (VoLTE) and future generations (5G, 6G). A successful transition to IP based telephony such as VoLTE is an essential condition for switching off legacy services.

Emergency calls, as is the case for many voice calls, are still mainly routed through the circuit-switched 2G/3G networks. In the future all voice calls could be routed through the packet switched 4G/5G networks. However, use of VoLTE requires bringing this feature into use on the MNO side, support for VoLTE in the user equipment and user's subscription. Today VoLTE is not so widely in use and closing all 2G and 3G networks in an area would prevent some users from making emergency calls. The handling of emergency calls via 4G networks is constantly improving when users upgrade their mobile phones to ones that support VoLTE calls. Further, some technical challenges still need to be solved relating to positioning of the emergency call.

In particular the development and use of standards for VoLTE require attention by MNOs and other stakeholders like device manufacturers. Existing standards have a high grade of flexibility, leaving scope for tailor made implementations in networks and devices. For device manufacturers this flexibility can result in an unworkable amount of different implementations that they have to test. Thus, they cannot guarantee VoLTE will work on every network, including when roaming within the EU. This could undermine the availability of emergency services at European level.

MNOs have taken initiatives to remedy challenges in relation to the implementation of VoLTE. The GSMA's Network Settings Exchange ('NSX') and its work on creating a limited set of VoLTE implementation profiles should minimise the permutations that can occur. Also, this would make it easier for device manufacturers to ensure their devices will support VoLTE on networks that conform to these standards. However, this does not eliminate all (future) risks for the availability of emergency services within the EU. Given the public interest involved with the availability of emergency services, it may in the end be necessary to mandate relevant stakeholders to ensure that devices that enter the EU market and support 4G (or future generations) are able to call the emergency number, regardless of the network it is operating on. An important legislative instrument for this is the Radio Equipment Directive (2014/53/EU).

eCall

The challenges related to eCall using only circuit-switched technologies have been described previously in this document. The challenge is not a spectrum issue but it is recognised that a switch-off of both 2G and 3G networks will disable the use of eCall under the current regulation. According to car manufacturers, retrofit of cars is not possible due to type approval regulation, while aftermarket solutions may not be

reliable and are costly. The decision to maintain a technology is to be decided at EU level. On the other hand, the continued operation of 2G/3G networks also generates costs. The actual amount of the expected costs has not been determined. In the future, technology neutral approach is preferable to avoid the same debate during future technology migrations.

The European Commission is conducting a study on the future of eCall that is still ongoing. The study includes amongst other topics, the assessment of technological, legal and economic aspects for future eCall legislation considering:

- Relevant technology and market evolutions for the transition from 2G/3G to Next Generation eCall (NG eCall);
- Alternative technologies to provide a service equivalent to eCall;
- Public safety answering points (PSAPs) and 112 services evolution in Member States;
- Regulations and standards affecting eCall deployment.

Any update of eCall framework should assess impacts on current licenses in force, which have been granted on technology neutral basis, and current market evolution towards newer technologies.

Smart meters

Utilities, meaning electricity, gas, water and other energy suppliers, needs vary from one country to another. In some countries M2M/IoT smart meters for measuring electricity, water, gas or district heat have been installed using 2G as the communication link. In some cases 2G is also used for network management by utilities. For smart meters, one of the major challenges for a possible migration is due to the large amount of 2G equipment already installed and their expected long life, which would require specific campaigns in case of replacement. The utility companies need to be informed sufficiently in advance by mobile operators in order to consider their migration to 4G/5G, taking into account alternative solutions and current harmonised spectrum (see also RSPG Opinion on climate change). It is up to utilities to decide on their own strategy depending on national market and situation.

Other legacy systems

Companies and consumers also use legacy 2G equipment for example for security alarms and remote control of different systems. RSPG noted that some MNOs already inform their customers on the life-span of this equipment and encourage them to move to newer technologies. This practice is welcomed.

6 Status of migration to newer technology generations

Responsible Authorities have indicated that they do not have any plans to impose mobile technology migration within their country. Since the licenses issued by the countries fulfil the technology neutrality principle, the MNOs/licensees are able to make decisions based on their market strategy, which can include the migration of subscribers from one technology to another. This is following the Framework Directive (EC) 2002/21, EECC and the harmonised technical conditions under the Radio Spectrum Decision in for example 900 MHz, 1800 MHz and 2.1 GHz. However, few countries have imposed obligations to maintain a certain 2G coverage.

Each operator develops its own strategy in order to respond to obligations from authorisations, market demands, existing customers, etc. When 4G was first launched, mobile phones needed to revert to 2G or 3G for voice services (circuit-switched fall-back (CSFB)) because the 4G network is inherently a data network. Therefore, operators have chosen to retain a 2G or 3G network. Today, voice calls are also available in 4G networks through VoLTE. Nevertheless, not all 4G customers have the possibility to use this feature due to limitations in terminal equipment. It is up to mobile operators to decide on their best strategy according to the national situation/market.

An overview of the plans in different countries is provided in Annex 1.

Plans and differences between migration plans related to different generations

In general, according to experiences and the answers from a number of countries, operators will switch off 3G before 2G, mainly due to lower volume of 3G traffic registered in their networks. However, there are examples of operators that are switching off 2G before 3G in a few European countries. For example, in France one operator has announced that it will switch of 2G by 2025, before 3G. In other countries, there are plans to switch off 3G networks in the coming years. In Germany all 3G/UMTS services were phased out completely by all operators in 2021.

Generally, it is assumed that recent technologies (5G and/or 4G) will at least partly replace the legacy 2G/3G technologies in 900 MHz, 1800 MHz and 2.1 GHz. Currently, operators are implementing 4G and 5G networks using the same frequency bands. Various bands are currently targeted depending on the national context and the MNO strategy: 4G mainly in 700 MHz, 800 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands, and 5G mainly in 700 MHz, 3.5 GHz and 26 GHz bands and also in 2.1 GHz in some countries.

Even if the spectrum used by 2G networks decreases, it might take a few years before operators switch them off. There are several reasons behind this. Some customers use of IoT -type devices and some other customers have no need of services other than voice telephony and basic data and, thus, have no incentives to change to newer devices and technology. Currently the majority of 3G devices also have embedded 2G capability. Customers requiring the use of data or web access will in general have changed to a 4G or 5G device or will be encouraged by the operator to do so.

The benefits for MNOs of migration to newer technologies include improved in particular spectrum efficiency, communication security and energy efficiency. They may also achieve savings in network and maintenance complexity by reducing the variety of equipment deployed on their network. This can be also a benefit in terms of

a reduction in reserves of spare equipment, but also regarding the required knowledge of maintenance employees. Moreover, customers' demand for larger capacities that can be achieved only via newer technologies will push operators to switch off 2G/3G technologies to fulfil the user needs and gain competitive advantage.

Some customers also actively seek the latest technology and will expect their network operator to support the new technology.

Certain countries have established national observatories for monitoring developments of mobile technology migration and coverage (see in particular FR response in Annex).

It can be observed that prior to phasing out of 2G/3G, MNOs tend to repurpose high frequency bands first: 2.1 GHz band from 3G to 4G/5G and 1800 MHz band from 2G to 4G/5G.

Ultimately, MNOs tend to prefer retaining 2G and/or 3G in the 900 MHz band during the coming years, but the situation differs among countries.

Migration plans for the core network

5G SA (Stand Alone) uptake is ongoing. 2G/3G are based on circuit-switched technology, whereas 4G/5G are based on packet-switched technology. If both 2G and 3G are switched-off, circuit-switched parts of the core can be turned off, which brings cost-savings and other advantages (e.g. less complexity).

7 Lessons learnt and ways forward

Not all operators were in the market when 2G/GSM was the only mobile technology in use. Those who entered the market at 3G/UMTS launch might not have a 2G network. Maintaining an older technology in their network does come with some opportunity cost, when a more economically new technology could be deployed. As years go by, maintaining older technologies could become harder if replacement equipment is harder to acquire. This is up to MNO to develop its own CAPEX/OPEX trade off. Moreover, newer technologies generally need spectrum block sizes in multiples of 5 MHz. Recently, the new 900/1800 MHz EU Decision under the Radio Spectrum Decision, took this context into account and provides suitable harmonised technical conditions for long term use narrow band technologies others than GSM and wide band technologies in these bands.

The use of legacy 2G/3G technologies by some applications might cause obstacles to migration to newer technologies. This is an issue that should be part of the MNO's strategy. Use of older devices that do not support 4G is one of the main obstacles for migration. This includes emergency calls, M2M and IoT devices, eCall systems, smart meters and alarm systems as well as the fact that older handsets mostly rely on 2G/3G technology only.

Technology neutrality

The technology neutrality principle was adopted to enable operators to always deploy the most efficient technology according to market demand and to implement state-of-the-art technologies. In general, regulation should support the principle of technology neutrality. Some non-spectrum existing EU regulation that are not technology neutral (e.g. eCall) needs careful consideration. Any deviation from the technology neutral approach needs to be justified by EU legal basis. Regulation may only deviate to the extent that it is necessary in order to achieve important objectives, such as public safety and interoperability of networks in accordance with EU framework.

The RSPG already recommended in its June 2021 RSPG Opinion on a Radio Spectrum Policy Programme that "*European Commission and Member States should anticipate any impact of possible future phasing out of some legacy systems (2G, 3G and 4G) in the next decade.*"

Technical solutions to overcome obstacles caused by applications using legacy technologies

There are a number of possible technical solutions that MNOs consider in order to address legacy technology issues, whilst 4G technology was not designed to carry voice calls as such, operators can enable VoLTE on their network and ensure that user handsets are compatible with VoLTE. Operators have a relationship with subscribers, and thus may be able to incentivise them to change to devices with newer technologies. Equally, stakeholders/suppliers/service providers should be discouraged from introducing devices and solutions, which are based solely on legacy technologies.

Supporting VoLTE will require action from, and cooperation between, M(V)NOs and handset manufacturers. M(V)NOs will have to provide handset manufacturers with information on the configuration of their VoLTE implementation, and manufacturers

will have to configure new and existing handsets so that they can operate on all VoLTE networks. This will also require action from subscribers as they will need to update or change equipment. MNOs may be able to incentivise subscribers to change to devices with newer technologies. Furthermore, (industry) organisations such as the GSMA and ETSI facilitate this transition by providing standards and tools (such as the GSMA Network Settings Exchange) to implement these standards to both M(V)NOs and handset manufacturers.

The described situation does not eliminate all (future) risks for the reliability of emergency calls within the EU. There is an ongoing exploration within the RED expert group to make the emergency protocol in standards mandatory for VoWiFi and VoLTE calls. This is expected to remove one of the current obstacles for the 2G/3G switch off, while it ensures future compatibility of new terminals.

If maintaining 2G/3G services is considered by MNOs, then a small amount of spectrum, preferably in the 900 MHz band, may be reserved for 2G/3G by MNOs. The 900 MHz band is the lowest spectrum for 2G/3G and, thus, can provide for large coverage areas and deep indoor coverage.

Regulatory intervention in order to extend the life span of 2G/3G

From a spectrum regulatory perspective, no need has been identified for regulatory intervention to extend the lifespan of 2G/3G. However, in certain countries, obligations attached to existing rights of use impose continued operation of 2G/3G. Operators in certain countries have agreements for passive sharing of older technology infrastructure. There are, however, some concerns for the operation of emergency services over newer technologies, both in the sense of provision of voice service and in respect of the eCall vehicle emergency call system.

Licensing

Most countries have adapted older licenses to be technology neutral. A few exceptions will be reviewed in the near future. Mostly obligations are associated with certain frequency bands and/or technologies.

Update of some obligations during the lifetime of the licenses remains possible, for example updating harmonised technical conditions.

Annex I: 2G /3G phase out status

Country	2G		3G		
	Start of phase-out	**Finish of phase-out**	**Start of phase-out**	**Finish of phase-out**	**Best practices**
Austria	Currently no plans to substitute these technologies due to e-Call challenge & circuit switched data. However, the amount of spectrum that is used for 2G has been shrinking to a minimum level necessary			Two out of three operators announced to migrate from 3G to 4G & 5G starting after end 2023.	
Belgium	No specific dates are known yet. In any case after the phase out of 3G.		The public mobile operators will gradually phase out 3G in the period 2023-2024.		

Country	2G		3G		
	Start of phase-out	Finish of phase-out	Start of phase-out	Finish of phase-out	Best practices
Croatia		• HT: 2G technology has been migrated from the 1800 MHz band and that band is currently used for 4G technology only. 2G is implemented in part of the 900 MHz spectrum and we do not expect that 2G technology could be completely migrated or shut down during the next 8-10 years. • A1: Technologies within the scope of possible migration are the following: • 2G – B8 only • Telemach: No plans, spectrum auction for all legacy bands (800, 900, 1800, 2100, 2600) expected in 01/2023, after that plans can be made.		• HT: 3G technology has been completely migrated from the 2100 MHz band and is implemented only in the 900MHz band. Our expectation is that 3G technology could be terminated before 2G technology because 3G technology is completely replaceable by 2G (voice service) and/or 4G/5G (data and voice service) technologies. • A1: Technologies within the scope of possible migration are the following: • 3G - B8 There is small amount of UMTS cells on B1 – this are indoor and cells close to the border • Telemach: No plans, spectrum auction for all legacy bands (800, 900, 1800, 2100, 2600) expected in 01/2023, after that plans can be made	
Cyprus		Our operators are in a process of evaluating the possibility to phase out either 2G or 3G		Our operators are in a process of evaluating the possibility to phase out either 2G or 3G	

Country	2G		3G		
	Start of phase-out	Finish of phase-out	Start of phase-out	Finish of phase-out	Best practices
		technologies within the next 4 years		technologies within the next 4 years	
Czechia	With the GSM phased out, MNOs expect a gradual reduction of GSM spectrum usage in favour of 4G/5G. However, no migration plans with the final GSM switch-off have been announced.	Not yet any plans announced by MNOs. One MNO said that in a part of the spectrum (900 MHz), migration to 4G is expected in 2023/2024.		switched off in 2021 and replaced by 4G (2100 MHz).	
Denmark		The MNO's takes the decision on commercial reasons to migrate to newer technologies		The MNO's takes the decision on commercial reasons to migrate to newer technologies	
Estonia				The operator Telia has a plan for phasing out 3G network by the end of 2023 and Tele2 has plan for phasing out 3G network by the end of 2025.	
Finland	Parts of the 900 and 1800 MHz bands previously used for 2G are now being used for 3G and 4G	No current plans in mainland Finland. In the 900 and 1800 MHz network licenses there is a requirement that the GSM network shall cover 99% of the population in mainland Finland. The need for this license condition will be reviewed in 2023.	Current migration plans are mostly related to 3G	Three nationwide operators Telia, Elisa and DNA have announced their plans to close down 3G networks by the end of 2023 and use this spectrum for newer technologies.	Information campaigns to customers on phase-off of 2G/3G.

Country	2G		3G		
	Start of phase-out	**Finish of phase-out**	**Start of phase-out**	**Finish of phase-out**	**Best practices**
France		One operator has publicly announced its decision to switch off its 2G network, by end 2025. See: https://reseaux.orange.fr/actualites/arret-2g-3g-en-france The two other operators who have a 2G network have not yet made any announcement. One operator has no 2G network. Over the last few years, there has been a small increase in 2G radio sites (slightly more than 2% from July 2021 to June 2022), yet only in the 900 MHz band. 2G systems in the 1800 GHz band show a decrease for all operators.		One operator has publicly announced its decision to switch off its 3G network, end 2028. The three other operators who have a 3G network have not made any announcement. Over the last few years, there has been a moderate increase in 3G sites (approximately 6% from July 2021 to June 2022), yet only in the 900 MHz band. 3G systems in the 2100 MHz band are in decline and operators are deploying 5G in 2.1 GHz.	ANFR's observatory tracks these changes: https://www.anfr.fr/fileadmin/mediatheque/documents/Observatoire/0622/20220603-xmshta-Observatoire-reseaux-mobiles-metropole.pdf
Germany	No phase out of 2G services in the 900 MHz band has been announced yet. A number of legacy systems and devices based on 2G technology are deployed, which may be identified as obstacles for a 2G migration.	2G services in 1800 MHz have been migrated to 4G/5G services		3G-Services have been phased out successfully by all network operators in Germany until end of 2021.	

Country	2G		3G		
	Start of phase-out	**Finish of phase-out**	**Start of phase-out**	**Finish of phase-out**	**Best practices**
Greece		The phase out of 3G has a smaller duration compared to that of 2G, which involves more interdependencies due to existing uses and end-user equipment.		The main migration process that has been concluded or is being concluded within the next few months is the replacement of 3G by 4G/5G	
Hungary			Two MNO (Yettel, Vodafone) started to switch off the 3G. Vodafone started the phase-out on 23 May 2022. There is no communication on the final date of the switch off in case of Vodafone. Yettel also started the phase-out of 3G.	One MNO, Magyar Telekom completly phased-out 3G in Hungary until mid of 2022. Yettel anounced the switch off of 3G service in the areas covered by 900 MHz until the end of 2022. The entire 3G network of Yettel is expected to be switched off by the end of 2023.	Since spring 2021, the NMHH has been carrying out intensive educational communication through the "NetreFel!" programme.The primary target group of the communication element of NMHH's "NetreFel!" programme consists of elderly citizens not using mobile internet. (https://netrefel.hu/) There is a Device exchange subsidy programme. (In case of change an 2G/3G phone for at least 4G(VoLTE) phone approximately 100 EURos are available.) https://english.nmhh.hu/article/225118/Details_of_funding_programme_for_mobile_device_replacement_made_available https://mobilcsere.nffku.hu/ The MNOs communication is effective also. The affected settlemens lists are available at MNO's websites.

Country	2G		3G		
	Start of phase-out	Finish of phase-out	Start of phase-out	Finish of phase-out	Best practices
					https://www.vodafone.hu/3glekapcsolas https://www.yettel.hu/3g-lekapcsolas
Ireland (there are 3 MNO's in Ireland)	All three MNOs in Ireland have reduced the number of channels used for 2G carriers to make space for 4G and 5G carriers Vodafone: The 2G network provides core voice coverage, and Vodafone are continuing to invest in and maintain this network		MNOs in Ireland have been actively reducing the number of deployed UMTS 2100 carriers to free up spectrum for 4G / 5G in the band Vodafone: Underway Vodafone will start turning off its 3G network on a phased basis from late 2022, so that they transition the entire 3G service on 4G and 5G networks	Vodafone: to be completed by end of 2023 3: Media coverage suggests by end 2024.	Regulations require licensees to notify ComReg not less than 6 months prior to the proposed cessation of use of any terrestrial system (e.g. 2G, 3G, 4G, etc). Licensees are also required to use all reasonable endeavours to ensure that any adverse effects on users from the cessation of use of a terrestrial system are minimised. Vodafone: published selection of phones that support both Wi-Fi and 4G Calling in Ireland
Italy		No specific plans for phase-out		Partly by end of 2022	
Lithuania		Telia Lithuania 2G network are going to phase out in the end of 2025. Other Operators – 2026-2028. The reason for the delay in 2G closure is the technology's enduring		3G (UMTS) networks are going to be prepared for shutdown: Telia Lithuania – end of 2022, Bite Lithuania and Tele2 – 2024-2025.	

Country	2G		3G		
	Start of phase-out	Finish of phase-out	Start of phase-out	Finish of phase-out	Best practices
		popularity in connecting M2M/telemetry devices requiring only basic low data-rate connectivity.			
Luxembourg		No migration ongoing		Refarming to 4G/5G DSS or 5G-NR ongoing but still need for 3G	
Malta	In Malta, two 2G, three 3G, three 4G and three 5G networks are currently in operation. None of the respective operators announced any plans to totally migrate electronic communications services being provided on old generation mobile technologies.		In Malta, two 2G, three 3G, three 4G and three 5G networks are currently in operation. None of the respective operators announced any plans to totally migrate electronic communications services being provided on old generation mobile technologies.		
Norway	2 out of 3 mobile network operators (MNO) in Norway have 2G in service. They both use part of the 900 MHz band for this. GSM-R is also implemented in the 900 MHz band.			The same 2 out of 3 MNOs had 3G in service until November 2021 when the last base station was shut off. The 900 MHz and the 2100 MHz band was used for 3G and are now being reused as 4G/5G resources.	
Serbia		2G - So far no exact plans for 2G sunset. It will be probably phased only out after 3G is phased out and dependant on VoLTE uptake and share of		3G – It will be phased out first in next few years (switching off the last 3G carrier at the end) and	

Country	2G		3G		
	Start of phase-out	Finish of phase-out	Start of phase-out	Finish of phase-out	Best practices
		M2M devices that use 2G in the future.		spectrum on B1 band will be reused for 4G and/or 5G.	
Slovenia		For 2G and 4G there is no short-term plans for phasing out, one MNO stated that 2G in 900 MHZ band stays for some years		Half of MNOs do not have short-term plans that has been carried out for phasing out 3G, one MNO will switch-off 3G till September 2022 in 2100 MHz band, one has a plan to switch-off 3G in 900 and 2100MHz in 2 years.	
Sweden		Announced for 2025 by all MNOs. No migration has started.	Migration has started and is in progress. Operators Telia, Telenor and Tele2 are switching off as soon as possible but latest 2025.	Announced for 2025 by Telia, Telenor and Tele2. Operator Tre will keep 3G after 2025.	
Switzerland		One MNO already completed the phase out of 2G. One MNOs will phase-out 2G by Q1/2023. One operator did not provide a date, but 2G usage at base stations is in the low single digits.		One MNO communicated to cease 3G operation by end of 2025. The other two MNOs have not yet communicated a date for the phase-out of 3G operations.	
The Netherlands		KPN will keep 2G active until at least 1st of December 2025 T-Mobile: 2G is to be switched off in 2023 VodafoneZiggo: keep 2G active at least until 2024		KPN: ceased 3G T-Mobile: services 3G will be switched off but not before early 2025 VodafoneZiggo: decommissioned 3G in early 2020	

Annex II: RSPG Workshop on Mobile Technology Evolution (20.09.2022) Summary of Presentations' main pooints

MOBILE TECHNOLOGY EVOLUTION

Mobile technology migration progress

- There is commercial pressure on operators to retire 2G/ 3G networks because of 5G and re-farm frequencies
- 2G/3G switch-off is advancing; Due to the significant size of the markets for 2G based M2M and IoT applications, many European mobile operators are planning to retire 3G services before 2G.
- Migrating from 4G to 5G is more flexible compared to migration from previous generations because of dynamic spectrum sharing (DSS); DSS allows supporting both 4G and 5G in same band based on real-time demand.
- While 4G continues to support performant mobile services, all EU countries now have some commercial 5G services in parallel.
- Operators' focus shifting to improve service coverage and introducing new 5G technologies (stand-alone core, RAN virtualization, network slicing).
- 2G and 3G cannot technically be maintained beyond the decade as there will be no more equipment available by then

Market drivers for phasing out 2G/3G:

- Repurpose 2G and/or 3G spectrum for more efficient 4G and 5G technologies
- Reduce operational costs
- Meet increased demand for mobile broadband and data intensive applications from smart devices. The steady increase in data traffic has led to the migration to 4G and subsequently to 5G.
- Potential market and competitive effects for the first mover
- Meet Government expectations of deploying the latest innovative mobile technology
- From a sustainability and Energy efficiency perspective the decommissioning of 2G/3G should not be delayed. 4G and 5G networks are much more efficient in terms of energy, and capacity.

Barriers:

- Customer churn, particularly when operators do not switch off at the same time
- Uncertain demand for new services and capacity
- Cost of migrating M2M connections
- Possible changes in coverage, particularly if the new technology (such as VoLTE) does not provide the same coverage as the replaced legacy technology on the same band, or it operates in a frequency band that does not provide adequate indoor coverage without further network investment
- spectrum availability in rural areas

- security
- hardware provision
- Potential brand damage if some customers are left without coverage, are forced to upgrade handsets or large numbers of M2M connections are disconnected for business customers.

Regulatory Aspects:

- The general principle for mobile communication networks in Europe is technology and service neutrality. Principle of technology neutrality is key for future-proof legislation.
- Operators are in the best position to make migration decisions; there is no need for regulatory intervention.
- Any technology migration is based on market demand and depends on local market conditions e.g. user equipment penetration and dedicated services. Operators should be allowed to migrate to newer technologies when feasible from market perspective, which may vary per country and per operator.
- Recommended best practices:
    - Transitional period
    - Coverage matching what was previously offered
    - Reasonable formal notice period
    - A well-designed campaign involving direct targeting of affected customers, possibly assisted by the regulator
    - Upgrade incentives for customers
    - Maintaining quality of service

Service specific Concerns:

- Concern about operation of older IoT applications, such as remote sensing and meter reading, and various vehicular automatic emergency assistance systems, such as the European eCall system.
- Some applications using low cost end devices such as wireless point-of-sale devices are straightforward to migrate simply by replacing the host equipment. However, where the equipment is of high cost and long life (like the 2G based eCall system in the EU) migration is more problematic.

Mobile Technology Evolution outside Europe:

- Operators in the Asia-Pacific region started rationalizing 2G services as early as 2008 to 2012
- Phasing out 2G networks is the preferred option in the APAC region and North America.

eCall

- eCall: mandated in vehicles via CS eCall by EU Type Approval Regulation since 2019
    - there are several million cars on EU market
    - 2G/3G switch-off will render service impossible
    - Retrofit of cars is not possible (see Type Approval Regulation)
    - Aftermarket solutions not reliable and costly for the customer
- It is urgent that the European Commission amend the EU Type Approval Regulation.
- In the transition period it is up to automotive industry to quickly integrate 4G modules and find adaptive solutions for the existing fleet.
- The volume of distress calls via eCall is marginal.
- We invite the RSPG to publish usage statistics and to list possible workarounds.
- The eCall issue must be separated from 2G/3G usage for specific services (vehicle information, breakdown calls, traffic info etc.).

(Next) eCall

Needs (ACEA):

- Auto OEMs ready to implement as soon as HEN standard is available and Type Approval regulation is updated. But:
    - Need for a clear timeline and lead time – every minute other CS eCall vehicles hit the market and will be switched off?
    - Clarification of the issue of the cost (free of cost like CS-eCall?)
    - Work to be done with eco-system to adapt technicalities, testing and implementation

Standardization progress (ETSI):

- eCall is an important service, originally tightly-linked to GSM & UMTS and needs to be considered as part of planned transition away from 2G/3G networks
- Standards in ETSI (& CEN) have evolved to Next-Generation eCall:
- ETSI has taken action to ensure interoperability of Next-Generation eCall
- The European Commission is an important facilitator to evolve regulations for Vehicles, Networks & PSAPs and ensure continuity of the eCall service

Utilities

Large number installation of smart meters that rely on 2G/3G connectivity to operate
EUTC proposes:

- Standardisation of 4G/5G in 400 MHz bands, including 380 - 400 MHz with 1.4 MHz and 3 MHz channelisation.
- Higher power edge devices (CPEs) for improved coverage and ground penetration.
- Ability for users to see into MNO networks to predict impact of fault scenarios.
- Lack of resilience in public networks.
- Support for standardisation activities.
- Supply chain uncertainties.

What still needs to be addressed with 5G deployment and use cases for 6G:

- Resilience
- Coverage
- Low frequency spectrum for wide-area private networks.
- Pushing the spectrum boundary below 400 MHz.
- Regulatory certainty for interconnections.
- End-to-end latency of less than 10ms with assured symmetry.
- Improved security.
- Supply chain certainty.

Utilities need a combination of radio technologies and frequency bands to complement existing radio and wire-borne technologies of:

- Fibre (utility owned & commercial)
- Copper (PSTN & pilot cables buried with electricity cables and gas pipes)
- PLC and BPL which use the power cables themselves for communications

Spectrum Access is the critical factor
The amount of spectrum required by utilities will have no impact on public broadband networks.

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