



Study on the current and prospective use of the 900 MHz band by GSM as a technology of reference, considering present and future Union policies

SMART 2019/0006

Internal identification

Contract number: LC-01313841

SMART 2019/0006

EUROPEAN COMMISSION

Directorate-General for Communications Networks, Content and Technology

Directorate B — Electronic Communications Networks & Services

Unit B4— Radio Spectrum Policy

*European Commission
B-1049 Brussels*

**Study on the current and
prospective use of the 900 MHz
band by GSM as a technology of
reference, considering present and
future Union policies**

FINAL REPORT

DISCLAIMER

By the European Commission, Directorate-General of Communications Networks, Content & Technology.

The information and views set out in this publication are those of the author(s) and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein. More information on the European Union is available on the Internet (<http://www.europa.eu>).

ISBN 978-92-76-21071-9

doi: 10.2759/002578

KK-01-20-497-EN-N

© European Union, 2020. All rights reserved. Certain parts are licensed under conditions to the EU. Reproduction is authorised provided the source is acknowledged.

The reuse policy of European Commission documents is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under a Creative Commons Attribution 4.0 International (CC-BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated. For any use or reproduction of elements that are not owned by the European Union, permission may need to be sought directly from the respective rightholders.

TABLE OF CONTENTS

TABLE OF CONTENTS	6
TABLES	8
FIGURES	8
ABSTRACT	9
RÉSUMÉ	ERREUR ! SIGNET NON DEFINI.
ÜBERSICHT	ERREUR ! SIGNET NON DEFINI.
EXECUTIVE SUMMARY	ERREUR ! SIGNET NON DEFINI.
RÉSUMÉ	ERREUR ! SIGNET NON DEFINI.
ZUSAMMENFASSUNG	ERREUR ! SIGNET NON DEFINI.
1. Context, objectives, method, description of work carried out	24
1.1 Context	24
1.1.1. Regulatory Situation	24
1.1.2. Licensing situation	26
1.1.3. Legal analysis: The GSM Directive and the 900 MHz band.....	30
1.2 Description of the work carried out.....	31
1.3 Methodology	35
2. Key findings	38
2.1 Task 1 – Mapping the services.....	38
2.1.1. 2G usage forecasts	38
2.1.2. Identified use cases	40
2.1.2.1. eCall	40
2.1.2.2. M2M: Smart meters.....	44
2.1.2.3. M2M: Safety and security	46
2.1.2.4. M2M Telematics (vehicle location tracking and insurance telematics).....	46
2.1.2.5. M2M Healthcare	47
2.1.2.6. M2M Retail vending	48
2.2 Task 2 – Quantifying the market and its expected evolution	48
2.2.1. eCall	50
2.2.2. Smart meters	54
2.3 Task 3 – Identifying the prospective services under 900 MHz.....	57
2.3.1. Alternatives to GSM	58
2.4 Task 4 – Meeting public policy objectives using a successive technology or a different band.....	62
2.5 Task 5 –The future of the GSM directive.....	65
3. Findings and recommendations	70
4. Conclusion	71
ANNEX 1 – STAKEHOLDER CONSULTATION	74
A1.1 Summary of initial consultation	74
A1.1.1 Status quo and its evolution.....	75
A1.1.2 Potential impacts of technological evolution	75

A1.1.3	Policy options	76
A1.1.4	Summary of in-depth discussions.....	76
A1.2	End users' perspective	78
A1.2.1	Value Chain and most impacted actors:	78
A1.2.2	Evolution scenario	78
A1.2.3	Costs and benefits of technology migration:	79
A1.2.4	Impact of the GSM directive:	80
A1.3	Network operators' perspective:	81
A1.3.1	Current use of GSM technology in the 900 MHz and expected continuity of service:.....	81
A1.3.2	Key use cases and impact on decision to switch off 2G:	81
A1.3.3	Benefits of network evolution	82
A1.3.4	Costs of network evolution	82
A1.3.5	Impact of the GSM directive.....	82
A1.3.6	Possibility of mandatory 2G/3G service shared network agreement.....	83
A1.3.7	Summary of survey circulated to Regulators (National Telecommunication Authorities and other national agencies)	83
ANNEX 2	LIST OF SOURCES.....	87
GLOSSARY	90

TABLES

Table 1: Overview of license expiry dates for European MNOs.....	26
Table 2: Overview of activities carried out	31
Table 3: Overview of use cases' prioritisation	49
Table 4: eCall deployments forecast, EU 28	50
Table 5: Cost categories for impacted automotive actors in transition to NG eCall	51
Table 6: Alternative technologies to GSM	59
Table 7: Summary table of baseline ("no action") scenario	66
Table 8: Summary table of assessed policy options	68
Table 9: Overview of the first round of stakeholder consultations	74
Table 10: Overview of the second round of stakeholder consultations.....	77
Table 11: Main sources consulted	87
Table 12: List of acronyms.....	90

FIGURES

Figure 1: Study logic	35
Figure 2: Project tasks and related steps of activity	36
Figure 3: Identifying the Options and performing the impact assessment.....	37
Figure 4: Global mobile subscriber base by technology, 2020	38
Figure 5: Evolution of device connectivity, by technology	39
Figure 6: eCall Timeline	41
Figure 7: eCall value chain.....	43
Figure 8: Smart metering value chain.....	45
Figure 9: Overview of devices enabling in-vehicle connectivity	47
Figure 10: IoT connections by network type, worldwide, 2026	48
Figure 11:NG eCall: Potential evolution.....	53
Figure 12: Target year for 80% rate of electricity smart meters installation, EU28.....	54
Figure 13: Smart meters: Potential evolution.....	56
Figure 14: LTE-M and NB-IoT deployments in Europe	61
Figure 15: Technology roadmap: MNOs vs industry.....	63

ABSTRACT

As part of the 'Study on the current and prospective use of the 900 MHz band by GSM as a technology of reference, considering present and future Union policies', VVA and LS analysed the market and technology developments as well as potential issues related to meeting public policy objectives for services currently provided by GSM in order to evaluate the usefulness of maintaining the 2G protection status guaranteed today by the GSM directive in **the 900 MHz band**. The team studied:

- The context in terms of users and services relying on GSM technology in the band, including the way demand for 2G-based services is expected to evolve in the future;
- For key public interest services based on 2G, different scenarios have been explored to understand the evolution (independently of the GSM directive), which includes a definition of the implications which migration to alternative connectivity would entail for all actors involved;
- Finally, taking into account the differential impact as a result of potential amendments to the directive, the usefulness of maintaining GSM protection in the 900 MHz has not been rejected.

The future repeal of the protected status of GSM (GSM Directive) will follow the sunset of legacy networks in Europe.

RÉSUMÉ

Dans le cadre de l' "Étude sur l'utilisation actuelle et future de la bande 900 MHz par le GSM en tant que norme de référence, considérant les politiques actuelles et futures de l'Union", VVA et LS ont analysé l'évolution du marché, les développements technologiques ainsi que les problématiques liées à la réalisation des objectifs de politique publique pour les services actuellement fournis par GSM, afin d'évaluer l'utilité de maintenir le statut de protection garanti aujourd'hui au GSM par la directive dans la **bande de fréquences 900 MHz**. L'équipe a étudié:

- Le contexte, en termes d'utilisateurs et de services reposant sur la technologie GSM dans la bande, y compris la manière dont la demande de services basés sur la 2G devrait évoluer à l'avenir ;
- Pour les principaux services d'intérêt public basés sur la 2G, différents scénarios ont été explorés pour comprendre l'évolution (indépendamment de la directive GSM), et notamment une analyse des implications qu'une migration vers une connectivité alternative entraînerait pour tous les acteurs concernés ;
- Enfin, compte tenu de l'impact qui résulterait d'éventuelles modifications de la directive, l'utilité de maintenir la protection du GSM dans les 900 MHz n'a pas été exclue.

L'abrogation du statut protégé du GSM (directive GSM) suivra l'extinction des réseaux existants en Europe.

ÜBERSICHT

Im Rahmen der "Studie über die derzeitige und künftige Nutzung des 900-MHz-Bandes durch GSM als Referenztechnologie unter Berücksichtigung der derzeitigen und künftigen Politik der Union" analysierten VVA und LS telcom die Markt- und Technologieentwicklungen sowie potenzielle Fragen im Zusammenhang mit der Erfüllung von Zielen im öffentlichen Interesse für die derzeit von GSM erbrachten Dienste. Ziel war den Nutzen der Beibehaltung des heute durch die GSM-Richtlinie garantierten 2G-Schutzstatus **im 900 MHz Band** zu untersuchen. Das Team analysierte:

- Den Kontext in Bezug auf Benutzer und Dienste, die auf die GSM-Technologie im Band angewiesen sind, einschließlich der Art und Weise, wie sich die Nachfrage nach 2G-basierten Diensten in der Zukunft voraussichtlich entwickeln wird;
- Für wichtige Dienste von öffentlichem Interesse, die auf 2G basieren, wurden verschiedene Szenarien untersucht, um die Entwicklung (unabhängig von der GSM-Richtlinie) zu verstehen. Hierzu zählte auch eine Ermittlung der Auswirkungen, die eine Migration zu alternativer Konnektivität für alle beteiligten Akteure mit sich bringen würde;
- Als Ergebnis wurde, unter Berücksichtigung der unterschiedlichen Auswirkungen infolge möglicher Änderungen der Richtlinie, der Nutzen der Beibehaltung des GSM-Schutzes im 900-MHz-Bereich nicht in Frage gestellt.

Die künftige Aufhebung des Schutzstatus für GSM (GSM-Richtlinie) wird dem Wegfall der noch bestehenden GSM Netze in Europa folgen.

EXECUTIVE SUMMARY

After 10 years of application of the latest amendment to the GSM Directive, the relevance of GSM as the technology of priority reference in the 900 MHz band is an essential element to consider, taking into account technological evolution in wireless broadband systems (in particular the advent of 5G), the technical characteristics of the 900 MHz band and the need to ensure the most efficient use of spectrum. This protection does not guarantee that GSM systems will continue to operate, but ensures that, where they do, they remain protected from interference by other technologies using the same band and that GSM is the reference technology for technical coexistence in the 900 MHz band. Whilst this amounts to a form of technical priority for GSM services, it does not imply that there must be a continued GSM service. Hence, rather than studying the need to remove GSM, the objective is to evaluate arguments for maintaining its priority status in the 900 MHz band as opposed to treating it on an equal basis in comparison with other technologies.

GSM and other public mobile communications networks, in particular under Regulation (EU) 2015/758 of the EP and of the Council regarding eCall are used for the provision of certain general interest applications or to achieve Union policy objectives. This includes the interoperable, EU-wide eCall service, a system of general interest improving transport safety in the Union. This system which is built in vehicles¹ requires the use of public mobile communications networks in the Union, although this does not specify the type of network nor impose GSM. As defined by Article 3 of the Commission Delegated Regulation (EU) 305/2013, the eCall system relies on standards EN 16072 and 16062.²

When evaluating arguments to determine the usefulness of maintaining technical protection of GSM in the 900 MHz band, account has been taken of the advantages and specific characteristics of GSM compared to other wireless communications systems, in particular with a view to achieving Union policies through the use of public interest services such as the eCall system and other relevant services relying on 2G thereby taking into account the socio-economic dimension behind commercial decisions to evolve networks.

¹ Directive 2010/40/EU of the EP and Council of 7 July 2010; Commission Delegated Regulation 305/2013 of 26 November 2012; Decision No 585/2014/EU of the European Parliament and of the Council of 15 May 2014 on the deployment of the interoperable EU-wide eCall service, OJL 164 of 3 June 2014, p.6; Regulation (EU) 2015/758 of the European Parliament and 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.

² The CEN standard issued in 2015 ([EN 16062:2015](#)) is designed on GSM/UMTS circuit switched networks. Standard [EN 16072](#) refers to Public Land Mobile Networks and also does not specify whether eCall is provided using embedded equipment or other means (for example in the case of aftermarket equipment).

The study has been structured to respond to the following essential questions:

1) What services are currently provided with GSM technology in the 900 MHz band?

Remote data and measurements collection i.e. telemetry and M2M services have been historically based on legacy (2G/3G) communication technologies. Given that much of the 1800 MHz band has been re-farmed for 4G services, the 900 MHz band is the only one that can be used to continue to carry GSM traffic. Hence, the remaining end users of these legacy networks are assumed to be using 2G in the 900MHz band. These are:

- eCall
- M2M services such as:
 - smart meters - intelligent devices for electricity and gas metering deployed at consumer premises and industrial sites³;
 - safety and security i.e. alarm systems;
 - telematics - aftermarket devices for vehicle location tracking and providing insurance telematics services, excluding In-Vehicle Systems);
 - healthcare - remote patient monitoring;
 - and retail vending - vending machines and Wireless Point of Sales (PoS) Terminals.

2) How is the use referred to in task 1 likely to evolve, taking into account market demand?

For most of the commercial M2M services, the choice of GSM is cost driven and vendors will continue supplying GSM-only modules in response to demand but expect transition/migration to happen in line with announced sunsets by mobile network operators. Market projections (CISCO, Ericsson) show that ~5% of subscriptions will be GSM-only by 2025 across EU Member States.

For the two public interest services, clear barriers (including legal provisions) to influence the migration timeline have been identified. In the case of the eCall service, technology choice is embedded in legislation (as defined by Article 3 of the Commission Delegated Regulation (EU) 305/2013, the eCall system relies on standards EN 16072 and 16062) and triggering the evolution (updating the production which is a complex process in the automotive sector) would require an update of the type approval legislation in the first place⁴. In the case of smart meters, there is a relatively large installed base of devices on field today and Distribution System Operators (DSOs) expect GSM services to be available to continue supporting these throughout their lifetime (15 years) given the regulated environment (time consuming procurement process to replace existing devices relying on GSM). Nevertheless, it should be

³ Also, devices relying on wireless connectivity e.g. to provide remote control services in European energy grids.

⁴ From the point of view of end users; in addition, a similar provision for the infrastructure i.e. PSAPs would be necessary for Member States to upgrade and enable transition of the emergency service to alternative connectivity.

noted that migration to alternative connectivity in the Energy sector has started, as from 2020 onwards all rollouts are based on next generation technologies.

3) Are there any prospective services that operators envisage to provide with GSM technology in the 900 MHz band?

No future GSM based services are envisaged to be introduced into the band. The scope for new services in the 900 MHz band is limited to 3G, 4G and in the future 5G technologies as spectrum efficiency is the main driver behind operators' plans to re-farm the band.

4) To what extent could general interest services such as eCall be provided, and realistically attain their public policy objectives, as well as other relevant services identified in point 1 and 3 (or enhanced versions of such services), in the 900 MHz band using a successive technology such as 3G, 4G or 5G technology or using frequency bands other than the 900 MHz band?

As such there are no challenges from a technical point of view to provide both public interest services i.e. eCall and smart meters using next generation technologies, including the use of alternative spectrum bands to do so: this has been confirmed both through a technical assessment and expert interviews. From a standardisation point of view, 3GPP standards are in place for the provision of eCall on any 3GPP platform (IMS based eCall) and from a technology point of view, backwards compatible chipsets are available for the automotive industry. In the case of smart meters, rollouts from 2020 onwards are taking place based on next generation mobile standards. The technical specification (embedded standards EN 16072 and 16062 in Regulation (EU) 2015/758) therefore remains the only **legal** barrier for triggering an evolution of the eCall service to be provided on next best connectivity (4G).

Next, the migration period would need to take into account not only the process of updating production in the automotive sector but also the remaining devices that are dependant on legacy networks. For both the automotive industry and utilities sectors providing public interest services based on 2G, the only differentiator is expected to be the availability of GSM and/or 3G service within their expected timeline (based on feedback from end users, GSM service would be expected to continue up to 2040 by OEMs in the automotive sector and up to 2030 by utilities). Given that stakeholders (end users, suppliers and MNOs) confirm that the GSM directive is not the instrument which guarantees or mandates continued availability of 2G networks (which is a decision taken by individual carriers based on business/competitive/market assessments), no amendment to the directive will influence the extent to which public policy objectives are met.

5) Taking into account the technology developments and market demand trends identified in points 1 to 4, to what extent is it necessary or useful to maintain GSM as the priority reference system in the 900 MHz band?

While it is true that, with the introduction of 5G, mobile operators are progressively likely to want to use their spectrum holdings for the latest available technologies, which use spectrum more efficiently, there are no technical or legal obstacles (including the GSM directive) today that could pose an issue to do so in the 900 MHz band. Regardless of the protection guaranteed by the GSM directive, for remaining 2G services currently provided in the respective band, this evolution will never be allowed (by the mobile operators) to occur to the detriment, understood as harmful interference, of GSM⁵.

⁵ Regarding the benefit of protection from harmful interference: neither the Commission nor CEPT can adopt harmonised technical conditions which would create harmful interference to or which would not protect GSM

One outcome of the market assessment conducted in this study is that GSM is already going through a phasing out process that will lead to a complete global sunset of the technology by 2030 at the latest. However, combined with the expectations of end users (especially those involved in providing public interest services) and their migration timelines, **there may be a need to preserve the continuity of GSM technology.**

Referring to the GSM directive, as identified throughout the study, in its current formulation, the GSM directive does not pose any issue to making the most efficient use of spectrum and should therefore remain in force. It also grants protection against harmful interference to the existing GSM networks, which benefits those services that have no alternative connectivity method. Hence at this stage, **our recommendation is to maintain the GSM directive for unlimited duration.**

systems in the 900 MHz band. Moreover, where GSM services persist in the band, however, it would be highly unlikely that operators would introduce a technology which causes harmful interference to existing GSM services, regardless of the protection provided by the directive. This reasoning is also confirmed by discussions with end users and operators who do not report harmful interference as a potential issue to affect their services (also in the absence of the GSM directive) but rather focus on the presence of 2G in the 900MHz band.

RÉSUMÉ

Après 10 ans d'application du dernier amendement de la Directive GSM, la pertinence du GSM comme technologie prioritaire de référence dans la bande 900 MHz est un élément essentiel à considérer, compte tenu de l'évolution technologique des systèmes d'accès sans fil à large bande (notamment la 5G), les caractéristiques techniques de la bande 900 MHz et la nécessité d'assurer l'utilisation la plus efficace du spectre. Cette protection ne garantit pas que les systèmes GSM continueront à fonctionner, mais assure que, là où ils le font, ces systèmes restent protégés contre les interférences d'autres technologies utilisant la même bande et que le GSM est la technologie de référence pour la coexistence technique dans la bande 900 MHz. Si cela constitue une forme de priorité technique pour les services GSM, cela n'implique pas l'assurance d'un service GSM continu et permanent. Par conséquent, plutôt que d'examiner la nécessité de supprimer le GSM, l'objectif de l'étude est d'évaluer les arguments en faveur du maintien de son statut prioritaire dans la bande 900 MHz plutôt que de le traiter sur un pied d'égalité par rapport aux autres technologies.

Le GSM et d'autres réseaux publics de communications mobiles, en particulier au titre du règlement (UE) 2015/758 du Parlement Européen et du Conseil concernant le 'eCall', sont utilisés pour la fourniture de certaines applications d'intérêt général ou la réalisation de certains objectifs politiques de l'Union. Ceci comprend le service eCall interopérable à l'échelle de l'UE, un système d'intérêt général visant à améliorer la sécurité des transports dans l'Union. Ce système intégré dans les véhicules⁶ nécessite l'utilisation de réseaux publics de communications mobiles, sans toutefois que soit précisé le type de réseau ni imposé le GSM. Comme défini par l'article 3 du règlement délégué (UE) 305/2013 de la Commission, le système eCall repose sur les normes EN 16072 et 16062⁷.

Lors de l'évaluation des arguments visant à déterminer l'utilité du maintien de la protection technique du GSM dans la bande 900 MHz, il a été tenu compte des avantages et des caractéristiques spécifiques du GSM par rapport à d'autres systèmes de communication sans fil, notamment en vue de la réalisation de politiques de l'Union par l'utilisation des services d'intérêt public tels que le système eCall et d'autres services pertinents reposant sur la 2G, tenant ainsi compte de la dimension socio-économique des décisions commerciales de faire évoluer les réseaux.

⁶ Directive 2010/40/UE du Parlement européen et du Conseil du 7 juillet 2010 ; Règlement délégué (UE) de la Commission 305/2013 du 26 novembre 2012; Décision 585/2014/UE du Parlement européen et du Conseil du 15 mai 2014 concernant le déploiement du service eCall interopérable dans toute l'Union européenne, OJ L 164 du 3 juin 2014, p.6 ; Règlement (UE) 2015/758 du Parlement européen et du Conseil du 29 avril 2015 concernant les exigences en matière de réception par type pour le déploiement du système eCall embarqué fondé sur le service 112 et modifiant la directive 2007/46/CE.

⁷ Le CEN standard issu en 2015 ([EN 16062:2015](#)) est conçu sur les réseaux commutés de circuit GSM/UMTS. La norme EN 16072 fait référence aux réseaux mobiles fonciers publics et ne précise pas non plus si eCall est fourni à l'aide d'équipements embarqués ou d'autres moyens (par exemple dans le cas de l'équipement d'après-vente).

L'étude a été structurée pour répondre aux questions essentielles suivantes:

1. Quels sont les services actuellement fournis par la technologie GSM sur la bande 900 MHz?

La collecte des données et des mesures à distance à savoir la télémétrie et les services M2M ont été historiquement basés sur des technologies de communication existant (2G / 3G). Étant donné qu'une grande partie de la bande 1 800 MHz a été réaménagée pour les services 4G, la bande de 900 MHz est la seule qui puisse encore être utilisée pour continuer à acheminer le trafic GSM. Par conséquent, les utilisateurs finaux de ces réseaux sont supposés utiliser la 2G dans la bande 900 MHz pour les services suivants:

- eCall
- M2M services tels que:
 - compteurs intelligents - dispositifs intelligents de comptage d'électricité et de gaz déployés dans les locaux des consommateurs et les sites industriels⁸;
 - protection et sécurité- dont les systèmes d'alarme;
 - télématique - dispositifs de localisation des véhicules et la fourniture de services télématiques d'assurance (à l'exclusion des systèmes embarqués);
 - soins de santé – surveillance à distance des patients ;
 - vente au détail - les distributeurs automatiques et les terminaux de points de vente sans fil.

2. Comment les utilisations mentionnées dans la tâche 1 sont-ils susceptibles d'évoluer, compte tenu de la demande du marché?

Pour la plupart des services commerciaux M2M, le choix du GSM est déterminé par les coûts et les fournisseurs continueront de fournir des modules liés uniquement au GSM en répondant à la demande, mais s'attendent à ce que la transition / migration se produise au rythme des réaménagements des réseaux par les opérateurs de réseaux mobiles. Les projections du marché (CISCO, Ericsson) montrent qu'environ 5% des abonnements seront encore basés uniquement sur le GSM d'ici 2025 dans les États membres de l'UE.

Pour les deux services d'intérêt public, des contraintes précises (y compris des dispositions légales) influenceront le calendrier de migration . Dans le cas du service eCall, le choix de la technologie est ancré dans la législation (au sens de l'article 3 du règlement délégué (UE) 305/2013 de la Commission, le système eCall repose sur les normes EN 16072 et 16062) et toute évolution (la mise à jour du produit est un processus complexe dans le secteur automobile) nécessitera avant tout une modification de la législation relative à la réception par type⁹.

⁸ Y compris les dispositifs basés sur une connectivité sans fil, par exemple pour fournir des services de contrôle à distance pour les réseaux d'énergie européens.

⁹ Du point de vue des utilisateurs finaux, une disposition similaire pour l'infrastructure, serait nécessaire pour que les États membres améliorent et permettent la transition du service d'urgence vers une connectivité alternative.

Dans le cas des compteurs intelligents, il existe aujourd'hui une base relativement importante d'appareils installés sur le terrain et les opérateurs de réseau de distribution s'attendent à ce que les services GSM restent disponibles pour garantir l'utilisation de ces appareils pour leur durée de vie (15 ans) complète compte tenu du contexte réglementaire (longues procédures d'approvisionnement et de remplacement des appareils qui s'appuient sur le GSM). Néanmoins, il convient de noter que la migration vers une connectivité alternative dans le secteur de l'énergie a déjà commencé puisque depuis 2020, tous les nouveaux déploiements sont basés sur des technologies de nouvelle génération.

3. Existe-t-il des services que les opérateurs envisagent potentiellement de fournir avec la technologie GSM dans la bande 900 MHz?

Aucun service futur basé sur le GSM n'est envisagé d'être introduit dans la bande. Les nouveaux services envisagés pour la bande 900 MHz concernent la 3G, la 4G et à l'avenir les technologies 5G, car l'usage efficace du spectre est le principal moteur des projets de restructuration de la bande pour les opérateurs.

4. Dans quelle mesure des services d'intérêt général tels que le eCall pourraient-ils être fournis et atteindre de manière réaliste leurs objectifs de politique publique, ainsi que d'autres services pertinents identifiés aux points 1 et 3 (ou des versions améliorées de ces services), dans la bande 900 MHz en utilisant une nouvelle technologie telle que la 3G, 4G ou 5G ou utilisant des bandes de fréquences autres que la bande 900 MHz?

En tant que tel, il n'y a pas d'obstacle d'un point de vue technique pour fournir tant des services d'intérêt public, c'est-à-dire le eCall que des connexions de compteurs intelligents par le biais des technologies de nouvelle génération y compris en utilisant des bandes de fréquences alternatives: cela a été confirmé à la fois par une évaluation technique et des entretiens avec des experts. Du point de vue de la normalisation, les normes 3GPP sont en place pour la fourniture d'eCall sur n'importe quelle plate-forme 3GPP (eCall basé sur IMS) et d'un point de vue technologique, des composants rétrocompatibles sont disponibles pour l'industrie automobile. Dans le cas des compteurs intelligents, à partir de 2020 les déploiements se font sur la base des normes mobiles de nouvelle génération. **La spécification technique (normes embarquées EN 16072 et 16062 dans le règlement (UE) 2015/758) reste donc la seule barrière juridique pour déclencher une évolution du service eCall vers une meilleure connectivité (4G).**

Ensuite, la période de migration devrait prendre en compte non seulement le processus de mise à jour de la production dans le secteur automobile, mais également le reste des appareils qui dépendent des réseaux existants. Pour les secteurs de l'industrie automobile et des services publics fournissant des services d'intérêt public basés sur la 2G, le seul facteur de différenciation devrait être la disponibilité du service GSM et / ou 3G dans les délais prévus (sur la base des commentaires des utilisateurs finaux, le service GSM devrait subsister jusqu'en 2040 pour les équipementiers du secteur automobile et jusqu'en 2030 pour les services publics). Étant donné que les parties prenantes (utilisateurs finaux, fournisseurs et opérateurs de réseaux mobiles) confirment que la directive GSM n'est pas l'instrument qui garantit ou impose la disponibilité permanente des réseaux 2G (disponibilité qui est une décision prise par les opérateurs à titre individuel sur la base de leurs évaluations commerciales / de concurrence / de marché), aucun amendement à la directive influera la réalisation des objectifs de politique publique.

5. Compte tenu des développements technologiques et des tendances de la demande du marché identifiés aux points 1 à 4, dans quelle mesure est-il nécessaire ou utile de maintenir le GSM comme système de référence prioritaire dans la bande 900 MHz?

S'il est vrai qu'avec l'introduction de la 5G, les opérateurs de communications mobile sont de plus en plus susceptibles de vouloir utiliser les fréquences qu'ils détiennent pour les dernières technologies disponibles, qui utilisent le spectre plus efficacement, il n'y a pas d'obstacles techniques ou juridiques (y compris la directive GSM) aujourd'hui qui pourraient poser un problème pour ce faire dans la bande 900 MHz. Indépendamment de la protection garantie par la directive GSM, pour les services 2G restants actuellement fournis dans la bande respective, cette évolution ne sera jamais autorisée (par les opérateurs mobiles) à se produire au détriment, compris comme interférences nuisibles, du GSM¹⁰.

L'un des résultats de l'évaluation du marché menée dans cette étude est que le GSM fait déjà l'objet d'un processus de retrait progressif qui devrait conduire à une extinction complète de la technologie à l'échelle mondiale d'ici 2030 au plus tard. Toutefois, combiné avec les attentes des utilisateurs finaux (en particulier ceux impliqués dans la fourniture de services d'intérêt public) et leurs délais de migration, **il peut être nécessaire de préserver la continuité de la technologie GSM.**

Se référant à la directive GSM, comme identifié lors de cette étude, dans sa formulation actuelle, celle-ci ne pose aucun problème pour utiliser le spectre de la manière la plus efficace et devrait donc rester en vigueur. Elle assure également une protection contre les interférences nuisibles aux réseaux GSM existants, ce qui profite aux services qui n'ont pas de méthode de connectivité alternative. Par conséquent, à ce stade, notre recommandation est de **maintenir la directive GSM pour une durée illimitée.**

¹⁰ En ce qui concerne l'avantage de la protection contre les interférences nuisibles: vu la Directive GSM, ni la Commission ni la CEPT ne peuvent adopter des conditions techniques harmonisées qui créeraient des interférences nuisibles ou qui ne protégeraient pas les systèmes GSM dans la bande 900 MHz. De plus, lorsque des services GSM subsistent dans la bande, il est très peu probable que des opérateurs introduisent une technologie qui cause des interférences nuisibles aux services GSM existants, quelle que soit la protection fournie par la directive. Ce raisonnement a été également confirmé par des discussions avec les utilisateurs finaux et les opérateurs, qui ne considèrent pas les interférences nuisibles comme un problème potentiel pour leurs services (même en l'absence de directive GSM) mais se soucient plutôt de la présence de 2G dans la bande 900 MHz.

ZUSAMMENFASSUNG

Seit der Umsetzung der letzten Änderung der GSM-Richtlinie vor 10 Jahren ist die Relevanz von GSM als vorrangige Referenztechnologie im 900-MHz-Band immer noch ein wesentliches Element, das unter Berücksichtigung der technologischen Entwicklung bei drahtlosen Breitbandsystemen (insbesondere der Einführung von 5G), der technischen Merkmale des 900-MHz-Bandes und der Notwendigkeit, die effizienteste Nutzung des Frequenzspektrums zu gewährleisten, zu beachten ist. Die GSM-Richtlinie garantiert dabei nicht, dass die GSM-Systeme grundsätzlich weiterhin funktionieren, stellt aber sicher, dass sie dort, wo sie es tun, vor Störungen durch andere Technologien, die dasselbe Band nutzen, geschützt bleiben und dass GSM hierfür die Referenztechnologie für die technische Koexistenz im 900-MHz-Band ist. Dies stellt zwar eine Art technische Priorität für GSM-Dienste dar, bedeutet aber nicht, dass es einen kontinuierlichen GSM-Dienst geben muss. Es geht also nicht darum, die Notwendigkeit der Abschaffung von GSM zu untersuchen, sondern die Argumente für die Beibehaltung seines Prioritätsstatus im 900-MHz-Band im Gegensatz zu einer einheitlichen Behandlung mit anderen Technologien zu bewerten.

GSM und andere öffentliche Mobilfunknetze, insbesondere im Rahmen der Verordnung (EU) 2015/758 des Europäischen Parlaments und des Rates, werden für die Bereitstellung bestimmter Anwendungen von allgemeinem Interesse oder zur Erreichung übergeordneter Ziele der Union genutzt. Dazu gehört der interoperable EU-weite eCall-Dienst, ein System von allgemeinem Interesse, das die Verkehrssicherheit in der Union verbessert. Dieses in Fahrzeuge eingebaute System¹¹ erfordert die Nutzung öffentlicher Mobilfunknetze in der Union, wobei allerdings weder die Art des Netzes spezifiziert noch GSM vorgeschrieben ist. Wie in Artikel 3 der Delegierten Verordnung der Kommission (EU) 305/2013 definiert, stützt sich das eCall-System auf die Normen EN 16072 und 16062¹².

Bei der Bewertung von Argumenten zur Aufrechterhaltung des technischen Schutzes von GSM im 900-MHz-Band wurden die Vorteile und spezifischen Merkmale von GSM im Vergleich zu anderen drahtlosen Kommunikationssystemen berücksichtigt. Im Hinblick auf die Erfüllung von EU-Vorgaben zum Einsatz von Diensten im öffentlichen Interesse wie dem eCall-System und anderen relevanten Diensten, die auf 2G basieren, wurden hierbei insbesondere die sozioökonomische Dimension hinter kommerziellen Entscheidungen zur Entwicklung von Netzwerken berücksichtigen.

¹¹ Richtlinie 2010/40/EU des Europäischen Parlaments und des Rates vom 7. Juli 2010; Delegierte Verordnung (EU) Nr. 305/2013 der Kommission vom 26. November 2012; Beschluss Nr. 585/2014/EU des Europäischen Parlaments und des Rates vom 15. Mai 2014 über die Einführung des interoperablen EU-weiten eCall-Dienstes OJL 164 vom 3. Juni 2014, Seite 6; Verordnung (EU) 2015/758 des Europäischen Parlaments und des Rates vom 29. April 2015 über Anforderungen für die Typgenehmigung zur Einführung des auf dem 112-Notruf basierenden bordeigenen eCall-Systems in Fahrzeugen und zur Änderung der Richtlinie 2007/46/EG

¹² Die 2015 herausgegebene CEN-Norm (EN 16062: 2015) ist für leitungsvermittelte GSM / UMTS-Netze ausgelegt. Die Norm EN 16072 bezieht sich auf öffentlichen Landmobilfunk und legt nicht fest, ob eCall mit eingebetteten Geräten oder auf andere Weise (z. B. Geräte von Drittherstellern) bereitgestellt wird.

Die Studie wurde so strukturiert, dass die folgenden wesentlichen Fragen beantwortet werden:

1) Welche Dienste werden derzeit mit der GSM-Technologie im 900-MHz-Band angeboten?

Historisch gesehen waren Ferndaten- und Messdatenerfassung, z.B.. Telemetrie- und M2M-Dienste, auf 2G/3G Kommunikationstechnologien ausgelegt. Angesichts der Tatsache, dass ein Großteil des 1800-MHz-Bandes für 4G-Dienste umgewidmet wurde, ist das 900-MHz-Band das einzige, das weiterhin für die Übertragung von GSM-Kommunikation genutzt werden kann. Daher wird davon ausgegangen, dass die verbleibenden Nutzer der folgenden Dienste weiterhin 2G Netze im 900-MHz-Band nutzen werden:

- eCall
- M2M-Dienste wie zum Beispiel:
 - Intelligente Zähler - intelligente Geräte für die Verbrauchsmessung von Elektrizität und Gas, die an Verbraucherstandorten und Industrieanlagen eingesetzt werden¹³,
 - Sicherheit und Überwachung - .z.B. Alarmsysteme
 - Telematik - Nachrüst-Geräte zur Fahrzeugortung und Bereitstellung von Telematikdiensten für Versicherungen, ausgenommen fahrzeuginterne Systeme,
 - Gesundheitswesen – Patientenfernüberwachung,
 - und Einzelhandelsverkauf - Verkaufsautomaten und drahtlose Point-of-Sales (PoS)-Terminals.

2) Wie wird sich die in Frage 1 genannte Nutzung unter Berücksichtigung der Marktnachfrage voraussichtlich entwickeln?

Bei den meisten kommerziellen M2M-Diensten ist die Wahl von GSM kostengetrieben; aufgrund der Nachfrage am Markt werden die Anbieter auch weiterhin reine GSM-Module liefern. Die Anbieter erwarten jedoch, dass der Übergang bzw. die Migration parallel zu dem durch die Mobilfunknetzbetreiber angekündigten Auslaufen von GSM erfolgen wird. Marktprognosen (CISCO, Ericsson) zeigen, dass bis 2025 in allen EU-Mitgliedstaaten ~5% der Nutzung ausschließlich auf GSM basieren wird.

Für die beiden Dienste von öffentlichem Interesse wurden offensichtliche Hindernisse (einschließlich rechtlicher Bestimmungen) identifiziert, die den Zeitplan für die Migration beeinflussen könnten. Im Falle des eCall-Dienstes ist die Wahl der Technologie in die Gesetzgebung eingebettet (wie in Artikel 3 der Delegierten Verordnung der Kommission (EU) 305/2013 definiert, stützt sich das eCall-System auf die Normen EN 16072 und 16062). Eine Veranlassung zur Weiterentwicklung (Aktualisierung der Produktion, die im Automobilsektor ein komplexer Prozess ist) würde in erster Linie eine Aktualisierung der

¹³ Auch Geräte, die auf drahtlosen Verbindungen beruhen, z.B. Fernsteuerungsdienste in europäischen Energienetzen bereitzustellen.

Typgenehmigungsvorschriften erfordern¹⁴. Im Falle der intelligenten Zähler gibt es heute eine relativ große Anzahl installierter Geräte. Angesichts des regulierten Umfelds für den Zählereinsatz, (mit entsprechend zeitaufwändigem Beschaffungsprozess um die vorhandenen GSM-basierten Geräte zu ersetzen), erwarten Betreiber der Anlagen, dass GSM-Dienste während der gesamten Lebensdauer der Zähler (15 Jahre) zur Verfügung stehen. Dennoch ist anzumerken, dass die Migration zu alternativen Verbindingstechnologien im Energiesektor begonnen hat, da von 2020 an sämtliche Neuinstallationen auf Mobilfunkstandards der nächsten Generation basieren.

3) Gibt es zukünftige Dienste, die die Betreiber mit der GSM-Technologie im 900-MHz-Band anbieten wollen?

Es ist nicht geplant, in Zukunft GSM-basierte Dienste in dieses Band einzuführen. Die Nutzung durch neue Dienste im 900-MHz-Band ist auf 3G-, 4G- und in Zukunft 5G-Technologien beschränkt, da die Frequenzeffizienz die Haupttriebskraft der Betreiber ist, die Nutzung im Band zu ändern.

4) Inwieweit könnten Dienste von allgemeinem Interesse, wie eCall, oder andere relevante Dienste, die unter Punkt 1 und 3 genannt werden (oder weiter entwickelter Versionen solcher Dienste), unter Verwendung einer Folgetechnologie wie der 3G-, 4G- oder 5G-Technologie oder unter Verwendung anderer Frequenzbänder als dem 900-MHz-Band bereitgestellt werden und realistischer Weise ihre wichtigen ordnungspolitischen Ziele, erreichen?

An sich gibt es aus technischer Sicht keine Herausforderungen, sowohl Dienste von öffentlichem Interesse, wie z.B. eCall als auch intelligente Zähler, auf der Grundlage von Technologien der nächsten Generation und unter Verwendung alternativer Frequenzbänder bereitzustellen. Dies wurde sowohl durch eine technische Bewertung als auch durch Expertenbefragungen bestätigt. Aus Sicht der Standardisierung gibt es 3GPP-Normen für die Bereitstellung von eCall auf jeder 3GPP-Plattform (IMS-basiertes eCall) und aus technologischer Sicht sind für die Automobilindustrie rückwärts kompatible Chipsätze verfügbar. Bei den intelligenten Zählern erfolgt der Ausbau ab 2020 auf der Grundlage von Mobilfunkstandards der nächsten Generation. Die technische Spezifikation (eingebettete Normen EN 16072 und 16062 in der Verordnung (EU) 2015/758) bleibt daher das einzige **rechtliche** Hindernis, um eine Weiterentwicklung des eCall-Dienstes zur Nutzung moderneren Funksysteme (wie z.B. 4G) einzuleiten.

Im nächsten Schritt müsste der Migrationszeitraum nicht nur den Prozess der Anpassung der Produktion im Automobilsektor berücksichtigen, sondern auch die verbleibenden, bereits verbauten Geräte, die von älteren Netzen abhängig sind. Sowohl für die Automobilindustrie als auch für Versorgungsunternehmen, die Dienste von öffentlichem Interesse auf der Basis von 2G anbieten, wird das einzige Unterscheidungsmerkmal voraussichtlich die Verfügbarkeit von GSM- und/oder 3G-Diensten innerhalb ihrer erwarteten Lebensdauer sein (auf der Grundlage der Rückmeldung der Nutzer wird erwartet, dass der GSM-Dienst von den OEMs im Automobilsektor bis 2040 und von den Versorgungsunternehmen bis 2030 weitergeführt wird). Angesichts der Tatsache, dass die Interessengruppen (Nutzer, Zulieferer und Mobilfunknetzbetreiber) bestätigen, dass die GSM-Richtlinie nicht das Instrument ist, das die kontinuierliche Verfügbarkeit von 2G-Netzen garantiert oder vorschreibt (dies ist eine Entscheidung, die von einzelnen Betreibern auf der Grundlage von Geschäfts-/Wettbewerbs-

¹⁴ Aus Sicht der Endnutzer wäre darüber hinaus eine ähnliche Bestimmung für die Infrastruktur, z.B. Notrufzentralen für die Mitgliedstaaten erforderlich, um sie in die Lage zu versetzen Upgrades durchführen und den Übergang des Rettungsdienstes zu alternativen Technologien zu ermöglichen.

/Marktbewertungen getroffen wird), werden Änderungen der Richtlinie keinen Einfluss darauf haben, inwieweit die ordnungspolitischen Ziele erreicht werden.

5) Inwieweit ist es unter Berücksichtigung der in den Punkten 1 bis 4 identifizierten technologischen Entwicklungen und Marktentwicklungen notwendig oder sinnvoll, GSM als vorrangiges Referenzsystem im 900-MHz-Band beizubehalten?

Mit der Einführung von 5G wird es zunehmend wahrscheinlicher, dass die Mobilfunkbetreiber ihr Spektrum mehr und mehr mit aktuellen Technologien nutzen wollen, weil diese spektrumeffizienter sind. Es gibt aktuell, einschliesslich der GSM-Richtlinie, keine technischen oder rechtliche Hürden, die dies im 900 MHz Band verhindern könnten. Unabhängig des durch die GSM-Richtlinie garantierten Schutzes für die verbleibenden 2G-Dienste, die derzeit in dem jeweiligen Band angeboten werden, wird diese Entwicklung von den Mobilfunkbetreibern niemals zum Nachteil von GSM (im Sinne einer störenden Beeinflussung / harmful interference) zugelassen werden.¹⁵

Ein Ergebnis der in dieser Studie durchgeführten Marktbewertung ist, dass GSM bereits einen Abbauprozess durchschreitet, der bis spätestens 2030 zu einem vollständigen globalen Verschwinden der Technologie führen wird. Aufgrund der Erwartungen der Nutzer (insbesondere derjenigen, die an der Bereitstellung von Diensten von öffentlichem Interesse beteiligt sind) und ihren Migrationszeitplänen **könnte es jedoch notwendig sein, die Kontinuität der GSM-Technologie zu wahren.**

Im Hinblick auf die GSM-Richtlinie wurde in der Studie festgestellt, dass diese in ihrer aktuellen Formulierung kein Hemmnis für eine effiziente Nutzung des Spektrums darstellt. Sie sollte daher in Kraft bleiben. Darüber hinaus bietet sie den existierenden GSM-Netzen einen Schutz gegen störende Beeinträchtigungen, was den Diensten zugute kommt, für die es keine alternative Verbindungsmethode gibt. **Daher lautet unsere Empfehlung zum jetzigen Zeitpunkt, die GSM-Richtlinie für unbegrenzte Zeit beizubehalten.**

¹⁵In Bezug auf die Vorteile zum Schutz vor störender Beeinträchtigung: Weder die Kommission noch die CEPT können harmonisierte technische Bedingungen übernehmen, die störende Beeinträchtigung verursachen oder GSM-Systeme im 900-MHz-Band nicht schützen würden. Wenn GSM-Dienste im Band bestehen bleiben, ist es jedoch höchst unwahrscheinlich, dass die Betreiber eine Technologie einführen, die bestehende GSM-Dienste, ungeachtet des durch die Richtlinie gebotenen Schutzes, schädigen. Diese Argumentation wird auch durch Gespräche mit Endbenutzern und Betreibern bestätigt, die störende Beeinträchtigung (auch ohne die GSM-Richtlinie) nicht als potenzielles Problem für ihre Dienste ansehen, sondern sich auf das Vorhandensein von 2G im 900-MHz-Band konzentrieren.

1. Context, objectives, method, description of work carried out

1.1 Context

1.1.1. Regulatory Situation

The first true mobile phone technology, termed 1G (first generation) was introduced in Europe in the early 1980s. It was based on analogue technology and as well as operating in different frequency bands (typically either 450 or 900 MHz), there were three competing technologies:

- C450 which was primarily used in Germany under the brand name C-Netz.
- NMT (Nordic Mobile Telephony) which was originally launched in Denmark, Finland, Norway and Sweden, and was later used in a number of other countries including the Baltic countries and much of Eastern Europe.
- TACS (Total Access Communication System) which was a modified version of the American AMPS (Advanced Mobile Phone System) and was used in Ireland, Italy and the UK.

The fact that different frequencies and different technologies were used meant that it was generally not possible for users to roam between countries. In addition, analogue technology was not an efficient user of the radio spectrum meaning that as the systems' popularity grew, it became difficult to satisfy demand.

It was against this backdrop that the 2G GSM (Global System for Mobile Communications) standard was developed. The standard was first agreed in 1987 and was for circuit-switched voice and short messages (SMS) only. It was later upgraded to include GPRS (general packet radio service) which provides limited data connectivity, and then improved data speeds using EDGE (Enhanced Data rates for GSM Evolution). In 1986 the European Commission proposed reserving the 900 MHz band (initially 905-914 paired with 950-959 MHz from 1 January 1991 and later 890-915 paired with 935-960 MHz) for GSM and this became a directive (known as the 'GSM directive') in June 1987¹⁶. The first commercial GSM services went live in Finland in 1991. It is generally recognised that this move by the European Commission led to the global success of GSM providing harmonised spectrum and a harmonised standard and thus, for the first time, significant economies of scale for manufacturers.

In the early 1990s, the GSM standard was extended to include the 1800 MHz band and in 2009, the European Commission modified the GSM directive through a new directive¹⁷ to include systems which can coexist with GSM (of which only UMTS was, at that time, identified) and to extend the 900 MHz band to include an additional 10 MHz (880-890 paired with 925-

¹⁶ Council Directive on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community (87/372/EEC).

¹⁷ Directive 2009/114/EC of the European Parliament and of the Council amending Council Directive 87/372/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community.

935 MHz). A European Commission Decision¹⁸ also identified the new 1800 MHz band (1710-1785 paired with 1805-1880 MHz) for GSM and UMTS.

In 2011, a further decision¹⁹ was published which permitted LTE and WiMAX to also operate in the 900 and 1800 MHz bands. It is worth noting that, whilst other 3GPP mobile standards (such as LTE and 5G) have been developed to allow multiple, different technologies to operate in the 900 MHz and 1800 MHz bands, the GSM standard itself can only operate in the 900 or 1800 MHz bands (in Europe, with other bands being available in other regions). As such, whilst operators have the flexibility to introduce 3G and 4G services into a range of bands, the same is not true of GSM.

In the case of the 2009 and 2011 modifications, GSM services are protected from interference by any other technology as it is stated that:

*“Member States may designate and make available the ... bands for other terrestrial systems not listed in the Annex, provided that they ensure that (a) such systems can coexist with GSM systems”*²⁰

This provides ongoing protection of GSM services from interference from any new technology which may be introduced into the band. In addition, specific technical characteristics are provided in the Annex to the directive which are intended to ensure protection of GSM systems from those listed (currently UMTS, LTE and WiMAX).

This protection does not guarantee that GSM systems will continue to operate, but ensures that, where they do, they remain protected from interference by other technologies using the same band and that GSM is the reference technology for technical coexistence in the 900 MHz band. Whilst this amounts to a form of technical priority for GSM services, it does not imply that there must be a continued GSM service.

The GSM directive therefore guarantees that if GSM communications services are provided in the 900 MHz band, this cannot be interfered with. Moreover, neither the Commission nor CEPT can adopt harmonised technical conditions which would create harmful interference to or which would not protect GSM systems in the 900 MHz band. Where GSM services persist in the band, however, it would be highly unlikely that operators would introduce a technology which causes harmful interference to existing GSM services, **regardless of the protection provided by the directive.**

¹⁸ Commission Decision on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications Services in the Community (2009/766/EC).

¹⁹ Commission Implementing Decision amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communication services in the Community.

²⁰ Article 5 of Decision 2009/766/EC

1.1.2. Licensing situation

Most licences for the 900 and 1800 MHz bands were awarded in the early 1990s. Some countries have since re-farmed the bands to permit easier implementation of broadband technologies (i.e. by giving operators multiples of 5 MHz blocks) and re-licensed the bands. Article 6(2) of the Radio Spectrum Policy Programme (RSPP) Decision²¹ states:

“In order to promote wider availability of wireless broadband services for the benefit of citizens and consumers in the Union, Member States shall make the bands covered by ... 2009/766/EC (900-1 800 MHz) available under terms and conditions described in those decisions. Subject to market demand, Member States shall carry out the authorisation process by 31 December 2012 without prejudice to the existing deployment of services, and under conditions that allow consumers easy access to wireless broadband services.”

The following table shows the mobile operators in each EU Member State together with the expiry date of their existing 900 MHz licence. Note that some operators do not have a 900 MHz licence, and that in some countries, the expiry dates for different operators are not the same. Where data on expiry dates is available, these dates have been shown.

Table 1: Overview of license expiry dates for European MNOs

Country	Operators	900 MHz Licence Expiry Date
Austria	A1, 3, T-Mobile	2034
Belgium	Base, Orange, Proximus	2021
Bulgaria	A1	2024
	Bulsatcom	[no 900 MHz spectrum]
	Max	[no 900 MHz spectrum]
	Telenor	2021
	Vivacom	2024
Croatia	Hrvatski Telekom, Tele2, Vip	2024
Cyprus	Cyta	2024
	MTN	2023

²¹ Decision number 243/2012/EU of the European Parliament and of the Council establishing a multiannual radio spectrum policy programme.

	Primetel	2029
Czech Republic	O2	2024
	T-Mobile	2024
	Vodafone	2021
Denmark	3	2034/2040
	TDC	2020/2040
	Telia	2020
	Telenor	2020
Estonia	Elisa, Tele2, Telia	2030
Finland	DNA, Elisa, Telia	2033
France	Bouygues	2024
	Free	2034
	Orange	2031
	SFR	2031
Germany	Telefonica O2, T-Mobile, Vodafone	2033
Greece	Cosmote, Vodafone, Wind	2027
Hungary	Digi	[no 900 MHz spectrum]
	Telekom, Telenor, Vodafone	2029
Ireland	3, Eir, Vodafone	2030
Italy	Iliad, TIM, Vodafone, Wind	2029
Latvia	Bite	2025
	LMT	2026
	Tele2	2026/2028
Lithuania	Telecentras	[no 900 MHz spectrum]

	Bite, Tele 2, Telia	2032
Luxembourg	MTX Connect Orange, Post, Tango	[no 900 MHz spectrum] 2027
Malta	Go, Melita, Vodafone	2026
Netherlands	KPN, T-Mobile, Vodafone	2030
Poland	Orange Play Plus T-Mobile	2029 ²² 2023 2023/2026 2026
Portugal	MEO NOS Vodafone	2022 2027 2021/2027
Romania	Digi, Orange, T-Mobile, Vodafone	2029
Slovakia	4ka O2 Orange T-Mobile	[no 900 MHz spectrum] 2026 2025 2025
Slovenia	T2 A1, Telekom Slovenije, Telemach	[no 900 MHz spectrum] 2031
Spain	Orange Movistar Vodafone Yoigo	2030 2030 2028 [no 900 MHz spectrum]

Sweden	3, Tele2, Telia, Telenor	2025
United Kingdom	3, EE O2 Vodafone	[no 900 MHz spectrum] [no 900 MHz spectrum] Indefinite Indefinite

Sources: ECO Report 03, European Commission data, PolicyTracker Global Spectrum Database

Very few operators have actually stipulated a date at which they will switch-off GSM services, with the exception of T-Mobile in the Netherlands, who plans to switch off GSM in November 2020²³.

Licences for the 900 MHz band are technology neutral, and in many cases, operators have already re-farmed their 2G services to use the 900 MHz band for 3G (and more recently 4G), so just because a licence is not due to expire in a certain year, does not mean that there will continue to be GSM services in the band until the expiry date is reached. It is likely however that, until current licences expire, many operators may continue to offer GSM services in the 900 MHz band for some considerable time because:

- Much of the 1800 MHz band has been re-farmed for 4G services, meaning that the 900 MHz band is the only one that is in use to continue to carry GSM traffic.
- Many of the assignments in the 900 MHz band are not multiples of 5 MHz. This means that they cannot be fully re-farmed for 3G or 4G. The remaining spectrum could either be left unused, or, as long as there is no substantive cost from continuing to do so (i.e. because of high maintenance costs of legacy equipment), could provide ongoing GSM services.
- Being the oldest network, thus, the one that has had the longest time for rollout to grow, GSM tends to have the widest coverage (this is enhanced by the good propagation characteristics of the 900 MHz band) and as such, it may be the only connection available to many people in remote areas. It may not be economically viable to replace this service with a newer technology for some years.

Several mobile operators suggested that at the point when their current 900 MHz licences expire, they expected the regulator to re-award the band. This poses certain potential changes in the use of the band:

- It will not be guaranteed that operators will be re-awarded their current spectrum assignments in the 900 MHz band. In the case of a re-competition of the band, it is possible that they may even lose their current assignments. In this instance, they would no longer be able to offer GSM (or indeed any) services in the band.
- It is likely that the band will be re-awarded based on 5 MHz blocks, making it easier to use for newer technologies such as 4G and 5G. Therefore, there would not be fractions of the band where GSM services could continue to operate.

²³ <https://www.t-mobile.nl/2g-uitzetten>

There has been slightly more movement towards the closure of 2G outside of the European Union. Swisscom (Switzerland and Liechtenstein) is proposing turning off its GSM service in 2020/2021, and Telenor in Norway is proposing to end its GSM service in 2025.

Outside of Europe, East Asia is leading the way with regard to switching-off 2G networks: In Japan, Macau, Singapore and South Korea, there is no 2G available at all. In Taiwan and Thailand, the major network operators have already phased out 2G with some operators in those countries still offering 2G services for a limited time. In Australia, Vodafone switched the last remaining 2G network in 2018 and as of 2020, there will be no 2G network available in North America.

1.1.3. Legal analysis: The GSM Directive and the 900 MHz band

Council Directive 87/372/EEC of 25 June 1987 defined the reserved frequency bands 900 MHz (and 1800 MHz) for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community. This Directive has been amended in 2009 by the Directive 2009/114/EC. Since then, the 900 MHz band is no longer reserved for GSM services:

- Commission Decision 2009/766/EC of 16 October 2009 defined harmonized technical measures to enable the use of the 900 and 1800 MHz bands for UMTS and other more advanced technologies that can coexist with GSM;
- Commission Decision 2010/166/EU of 19 March 2010 harmonized conditions of use of radio spectrum for mobile communication services on board vessels (MCV services). The Commission also mandated Member States to make available starting March 2011 at least 2 MHz of spectrum for uplink and 2 MHz for downlink in the 900 MHz and/or 1800 MHz bands. Since 1 February 2017, also LTE and UMTS are allowed for MCV;
- Commission Decision 2011/251/EC of 18 April 2011 obliged Member States to allow the use of LTE and WiMAX, both 4G mobile technologies, in the 900 and 1800 MHz bands by 31 Dec. 2011;
- in April 2018 Commission Decision 2018/637/EC provided the basis to use the bands also for the Internet of Things (IoT);
- CEPT is now working on least restrictive technical conditions to use the bands for 5G, aiming to adopt CEPT Report 72 B in November 2020.

Accordingly, GSM still maintains technical priority in the 900 MHz band across Europe, however several technologies have coexisted within the 900 and 1800 MHz bands for several years now, following the amendment to the GSM directive.

Likewise, most of the current 900 and 1800 MHz licenses delivered to service providers allow the use of GSM, UMTS and LTE, except for Italy, where some licenses allow this use on request only.

1.2 Description of the work carried out

This study combines a market assessment and technical analysis guided by expert interviews and complemented by desk research. Following initial consultations and desk research, outcomes were validated in a second round of discussions with experts, and further investigations undertaken including data collection to quantify benefits and costs of technology migration identified by stakeholders. Next, the main activities involved a survey circulated with Member States and national telecommunication authorities, in-depth discussions with representatives across the value chain of the prioritised use cases as well as additional data collection. Outcomes from the three streams of information are presented in the table below:

Table 2: Overview of activities carried out

Outcome	Member States Survey	Expert interview findings	Data collection/desk search research results	Status
Definition of the status quo: context, the problem and their likely evolution in the absence of EU action	(eCall legislation) National regulators believe that network evolution will trigger an update in the relevant regulatory framework to facilitate transition	Bottlenecks for mandated and public interest services (e.g. eCall) have been discussed in more detail and preliminary feedback is integrated into the report's content.	Feedback from stakeholders has been structured (e.g. timeline) and complemented by available quantitative data and reports	Validated findings focusing on defined use cases
Prioritisation of critical use cases/applications	RSC meeting: use cases have been validated by present representatives of national authorities	eCall and smart meters defined as key use cases providing public interest services and based on complexity of migration to alternative technology	Qualitative definition of use cases and identification of relevant standards and legislation; initial quantitative data where applicable	Validated prioritisation with in-depth analysis of relevant factors and migration scenarios
Comparison of policy options within the GSM directive's scope	N/A	The final set of options considered in the assessment and discussed with stakeholders is	N/A	Validated feedback on difference between policy options from end users and

		presented in section 2.5. ²⁴		networks operators.
Identification and definition of cost and benefit categories to be considered for impact assessment	N/A	Main cost for end users consists in the need to replace hardware and associated costs (e.g. labour, certification and procurement process related costs) as opposed to the cost (mainly related to the opportunity cost of deploying LTE and/or 5G) of maintaining GSM networks for MNOs.	Additional dimension assessed (social cost of switching off 2G) in terms of the number of Voice/SMS subscribers (global figures and European share from GSMA data)	Validated cost and benefit categories through in-depth expert interviews. High-level quantification
Assessment of alternative technologies to meet public policy objectives	Member States converge on the idea that eCall services will be supported by next generation networks either in existing bands (e.g. 900 MHz) or alternative ones with similar or better propagation characteristics.	eCall: LTE/4G is identified as the follow up technology. Smart meters: NB-IoT, Cat-1, LTE-M are potential replacements for GSM.	In terms of coverage, technical analysis confirms UMTS as the direct substitute of 2G for legacy devices supporting both technologies.	Final: reflecting the views of the industry and technical analysis performed

²⁴ In addition, beyond the scope of the GSM directive, feedback was collected from stakeholders (end users and carriers) on a potential scenario whereby an agreement between ACEA/CLEPA and GSMA is reached to effectively maintain GSM coverage for a certain period through a gradual phase out of 2G/3G with an obligation for operators to maintain at least one 2G/3G network per country for a certain period of time for eCall (and possibly other) purposes.

Any repeal of the technical protection currently provided by the GSM directive is expected to create a less restrictive framework for migration to new technologies (e.g. facilitate planned technology migration to LTE/5G using available spectrum in the 900 MHz) rather than incentivise operators to take specific actions (namely, changing technology or bandwidth for providing services). In this sense, the goal of the study is to investigate the coherence and relevance of the GSM directive as formulated today (i.e. technical protection granted for GSM technology where it is provided in the 900 MHz band). Operators have clearly expressed an intention to migrate to next generation technologies, and thereby optimise their current use of resources (including spectrum) by discontinuing spectrally inefficient and/or commercially unviable services within a relatively defined timeframe. National regulator's strategies as well as the way to meet public policy objectives using successive technologies or bands have been additionally investigated in the context of the study. We highlight the drivers and considerations per stakeholder category which impact the current and future use of the 900 MHz band²⁵:

- MNOs: Current protection status of GSM in the 900 MHz mandated by the GSM directive is not seen as an impediment for MNO re-farming plans. Aside from this, an obligation to continue providing 2G service beyond commercial viability is seen as a potentially major issue. IoT/M2M specific needs are expected to be met by other technical solutions (e.g. NB-IoT) which rely on LTE spectrum bands and technology but are not backwards compatible with existing GSM or LTE solutions.
- Automotive industry (with focus on the eCall public interest service): In addition to an envisaged update of the eCall legislation, stakeholders argue that GSM service will need to be maintained to support transport safety through the use of the eCall system for vehicles produced and put on the market before this update. There is a mismatch in terms of expected continuity of 2G service of the automotive industry (i.e. 15 years after the entry into force of the update of eCall legislation to reflect the automotive lifecycle) and plans of network operators to maintain these legacy networks. Coverage provided by successive technologies is a key issue for migration to NG eCall (e.g. LTE geographical coverage should match that of GSM today to provide a similar level of service, in particular in non- or low-populated areas of the road network).
- Public interest M2M services (focus on smart meters): Utilities have an expectation that GSM services will be available to continue supporting the relatively high installed base of metering devices deployed in Europe throughout their lifetime (15 years); rollouts of smart meters from 2020 onwards already incorporate alternative connectivity.
- Standardisation bodies: Technological migration across use cases is not an issue from a standardisation point of view (3GPP standards are in place for defined use cases and future 5G applications) including the provision of eCall on any 3GPP platform (e.g. 2G, 3G, 4G or 5G).
- Regulators (National Regulatory Authorities (NRAs) and/or other competent authorities): According to the Regulators, continuity of GSM/legacy networks service is subject to the decision of individual MNOs and there are generally no contracts nor enacted legislation that mandate a specific technology to continue. When it comes to the GSM directive, in its current formulation, Member States do not expect it to be an issue as for instance the technical conditions are set out by Decision (2011/251/EU)

²⁵ An extended version of the consultation's summary including the complete list of consulted stakeholders can be found in ANNEX 1

rather than the directive itself. ECC Report 297²⁶ has already provided compatibility criteria for 5G operating in the 900 MHz band and there is therefore no obstacle to using the band for this. Some Regulators²⁷ indicate that eCall services can be provided by other spectrum bands (confirming **technical feasibility**) and that technological advancements in mobile communications will trigger updates in the eCall type-approval regulation which contains specifications (standards) for 2G/3G networks only (i.e. accelerate transition to NG eCall **to ensure feasibility from a legal point of view**)²⁸. Although coverage is an important characteristic of legacy networks (2G/3G), alternative bands may be equally used to provide eCall/public interest services (i.e. it is **technically feasible** for the service to be provided using other spectrum bands). Finally, binding coverage obligations attached to licenses are one of the strategies used by national regulators to ensure matching coverage of GSM for public communication networks in transition to next generation standards.

²⁶ “Analysis of the suitability and update of the regulatory technical conditions for 5G MFCN and AAS operation in the 900 MHz and 1800 MHz bands.”

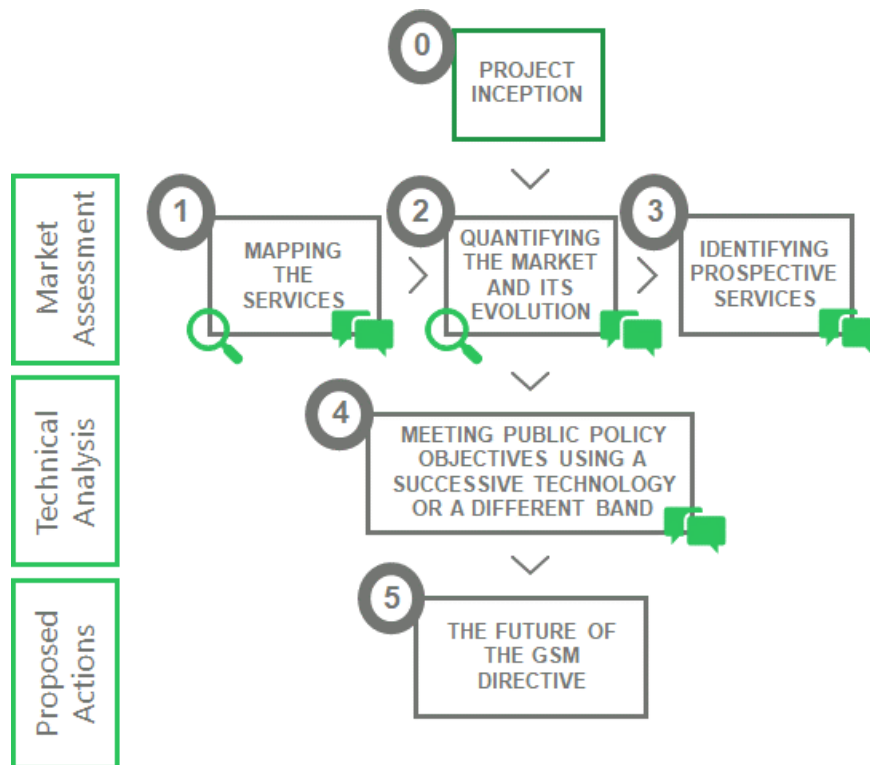
²⁷ The survey circulated was addressed towards the members of the Radio Spectrum Committee; nevertheless, answering specific questions (e.g. regarding eCall directive) involved other ministries such as Economic/Transport etc.

²⁸ While of the 25 Member States responding to the survey, not all responses explicitly refer to the legal framework in the question, at least 14 talk about “the obligation” [issued from the legal text] which does not refer to any frequency band or technology or the fact that the eCall service should be capable of using alternative technologies such as 4G /5G.

1.3 Methodology

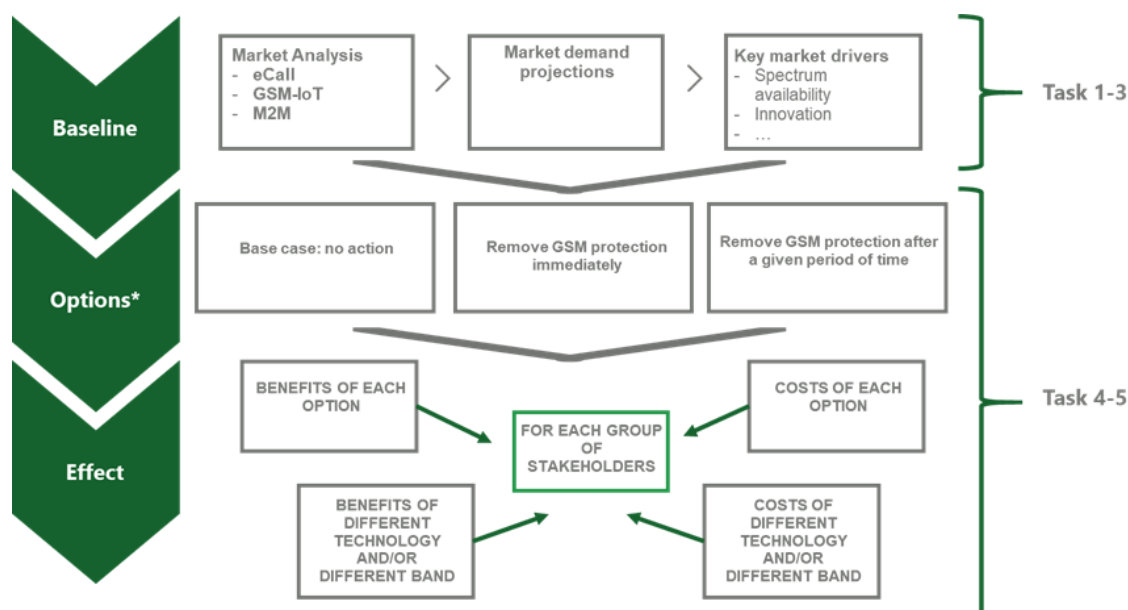
The impact assessment logic starts with the identification of the context, the problem and their likely evolution in the absence of EU action. The general structure of our study logic is summarized in the figure below:

Figure 1: Study logic



As the sequence of activities to be performed under each task should lead to the identification of policy recommendations based on the assessment of net gains from re-farming the 900 MHz band for the use of other technologies which would not be able to co-exist with GSM, we have summarised in the figure below the various steps and how they relate to the project tasks. The possibilities that need to be explored within the Impact Assessment have been a result of inception activities (e.g. the study's kick-off meeting) as well as feedback from expert interviews leading to a finalised version of the figure below:

Figure 2: Project tasks and related steps of activity

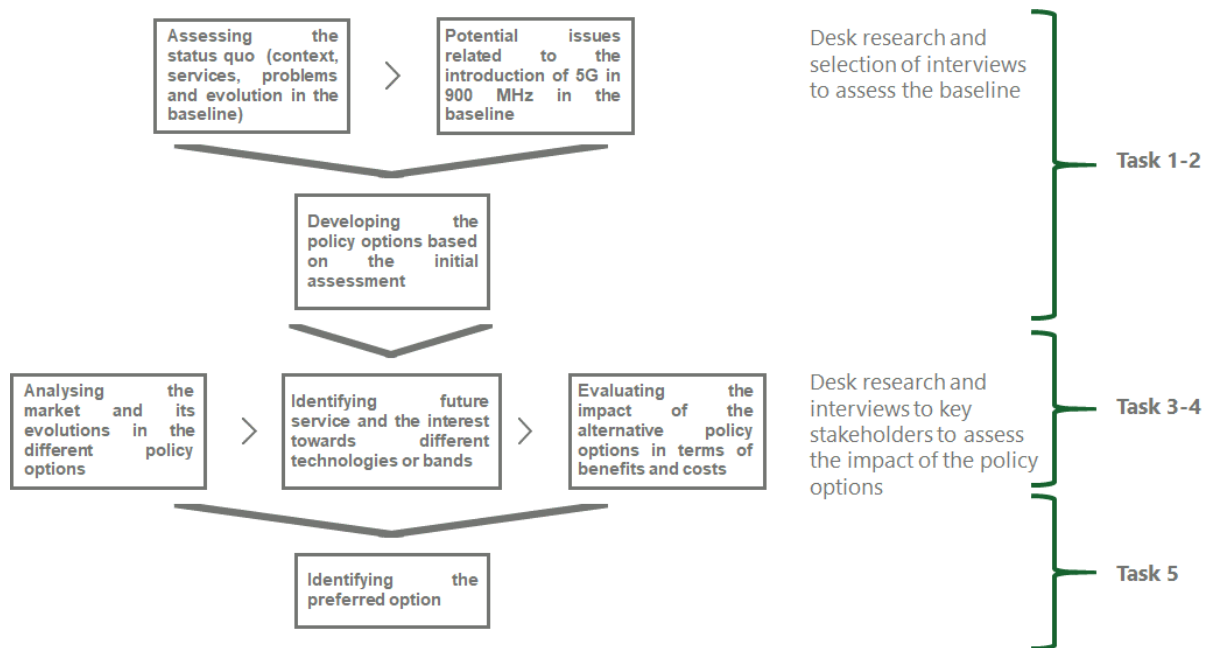


The final decision regarding the Options to be analysed as part of the Impact Assessment (IA) has been taken following the analysis of the context, problem and their likely evolution in the absence of EU action which has been an outcome of on the one hand desk research activities (key sources provided in ANNEX 2) and on the other hand, supported by stakeholder consultations and discussions with the Commission. The following policy options have been considered as part of the analysis:

- Baseline scenario: No action (i.e. protection guaranteed by the GSM directive is maintained forever)
- Option 1: Remove protection immediately
- Option 2: Maintain protection for a defined period of time (e.g. determined by when coverage of next best technology equals that of 2G).
- In addition, beyond the scope of the GSM directive, during discussions with stakeholders we have been investigating a potential scenario whereby an agreement between ACEA/CLEPA and GSMA is reached to effectively maintain GSM coverage for a certain period through a gradual phase out of 2G/3G with an obligation for operators to maintain at least one 2G/3G network per country for a certain period of time for eCall (and possibly other) purposes.

To further clarify the steps to be undertaken in the project activities, we have described below the approach, from the identification of the context and the baseline, to the selection of the preferred option based on IA methodology.

Figure 3: Identifying the Options and performing the impact assessment



2. Key findings

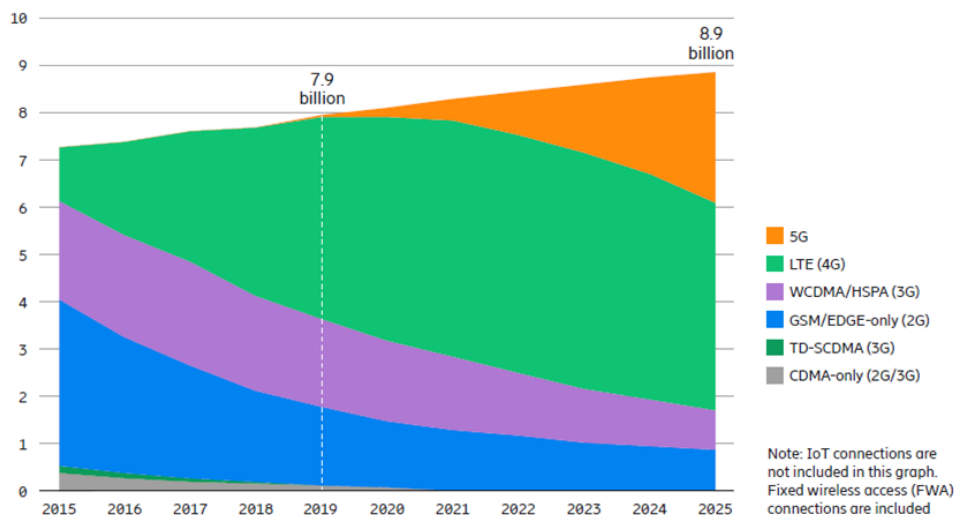
2.1 Task 1 – Mapping the services

2.1.1. 2G usage forecasts

Mobile vendor Ericsson produces an annual mobility report, in which it predicts the future subscriber base for the different mobile technologies. The figure below is taken from their report dated June 2020, and indicates that (globally) the number of 2G-only subscriptions is currently around 2 billion, but this will fall to around 700 million by 2025. Note that this excludes IoT and M2M subscriptions, and is thus just the value for individuals.

Figure 4: Global mobile subscriber base by technology, 2020

Figure 7: Mobile subscriptions by technology (billion)



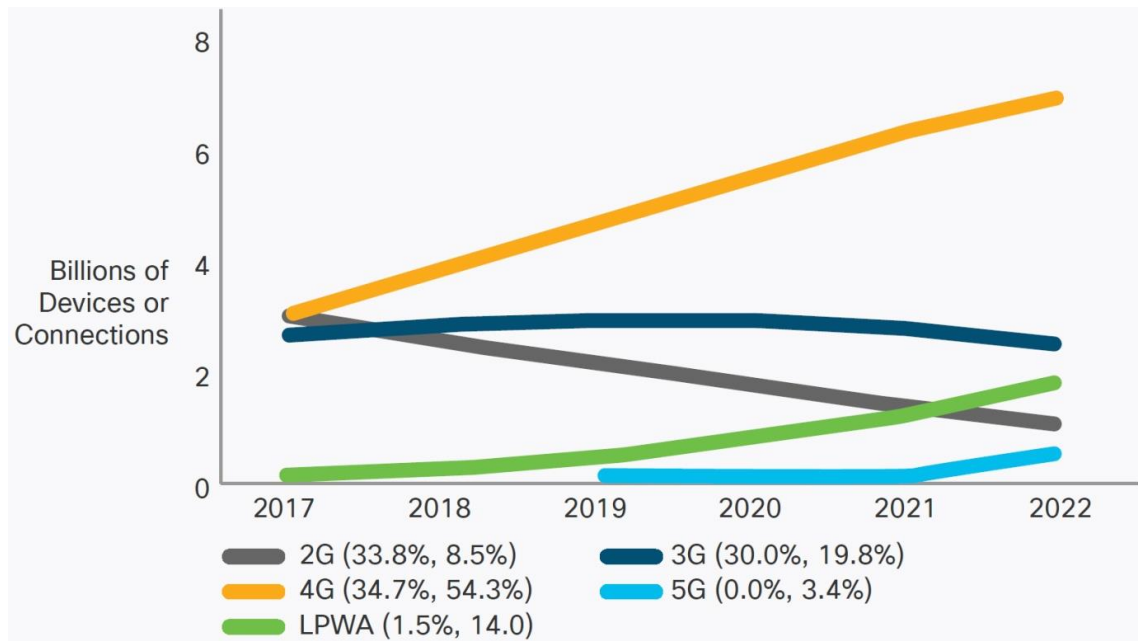
Source: Ericsson Mobility Report, June 2020

Ericsson also provides the figures for 2019 and 2025 on a regional basis:

- In 2019, the number of 2G only subscriptions in Western Europe is around 25%, falling to under 5% in 2025;
- In 2019, the number of 2G only subscriptions in Central and Eastern Europe is around 40%, falling to under 5% in 2025.

A similar graph is published by Cisco. This shows that the number of 2G connections in 2019 was nearer to 3 billion but falls to 1 billion by 2022. Note that this does include IoT and M2M subscriptions.

Figure 5: Evolution of device connectivity, by technology



Source: CISCO VNI, February 2019

Both charts show a continued need for 2G over a 2 to 5 year timetable; however, it is difficult to infer the extent to which this is for IoT type applications or for individual subscribers.

In terms of voice subscribers, the GSMA anticipates that by 2024, only 1% of mobile connections will be via 2G in Europe (compared to 13% currently).²⁹ This forecast is significantly below that of Ericsson (see above).

²⁹ Source: Interview with the GSMA

2.1.2. Identified use cases

Remote data and measurements collection i.e. telemetry and M2M services have been historically based on legacy (2G/3G) communication technologies. M2M applications use 2G networks for information transmission (comprising small amounts of data) via GSM/GPRS/EDGE or SMS. Basic M2M applications use Short Message Service (SMS) for remote control or status queries.³⁰

2.1.2.1. eCall

eCall is an automatic emergency call system designed to bring rapid assistance to drivers involved in serious road incidents by sending a minimum set of data (MSD) including GNSS coordinates to emergency services, and by opening a voice connection between the occupants of the vehicle and the operator of the emergency call centre.

The pan-European eCall initiative is an undertaking by the European Commission with the aim of reducing the number of fatalities and the severity of injuries on European roads. The European initiative is compatible with the ERA-GLONASS system in Russia. Initially subject to voluntary implementation across EU territory (through a Memorandum of Understanding in 2009³¹ signed by 15 MS and representatives of the industry, including MNOs), insufficient progress in terms of rollouts set the background for legislative action to ensure an EU-wide deployment of the system. From 2015, Regulation (EU) 2015/758 which defines type-approval requirements for M1 and N1 vehicle categories (i.e. passenger cars and light commercial vehicles) for the deployment of the eCall in-vehicle system based on 112 emergency call services came into force, with the mandate for motor vehicles type approval to support eCall from 31 March 2018. Decision No 585/2014/EU provides for the deployment of the eCall infrastructure (Public Safety Answering Points) required for the handling of all eCalls on the EU territory, with a final deadline for the deployment set at October 1, 2017.

In the event of a road accident, the emergency call devices will automatically alert emergency services and establish a voice connection with the most appropriate emergency call centre or Public Safety Answering Point (PSAP). The standardised set of data received by the PSAP is defined by CEN; it has a maximum size of 140 bytes and includes, for example, the vehicle identification number, location information and timestamp.³²

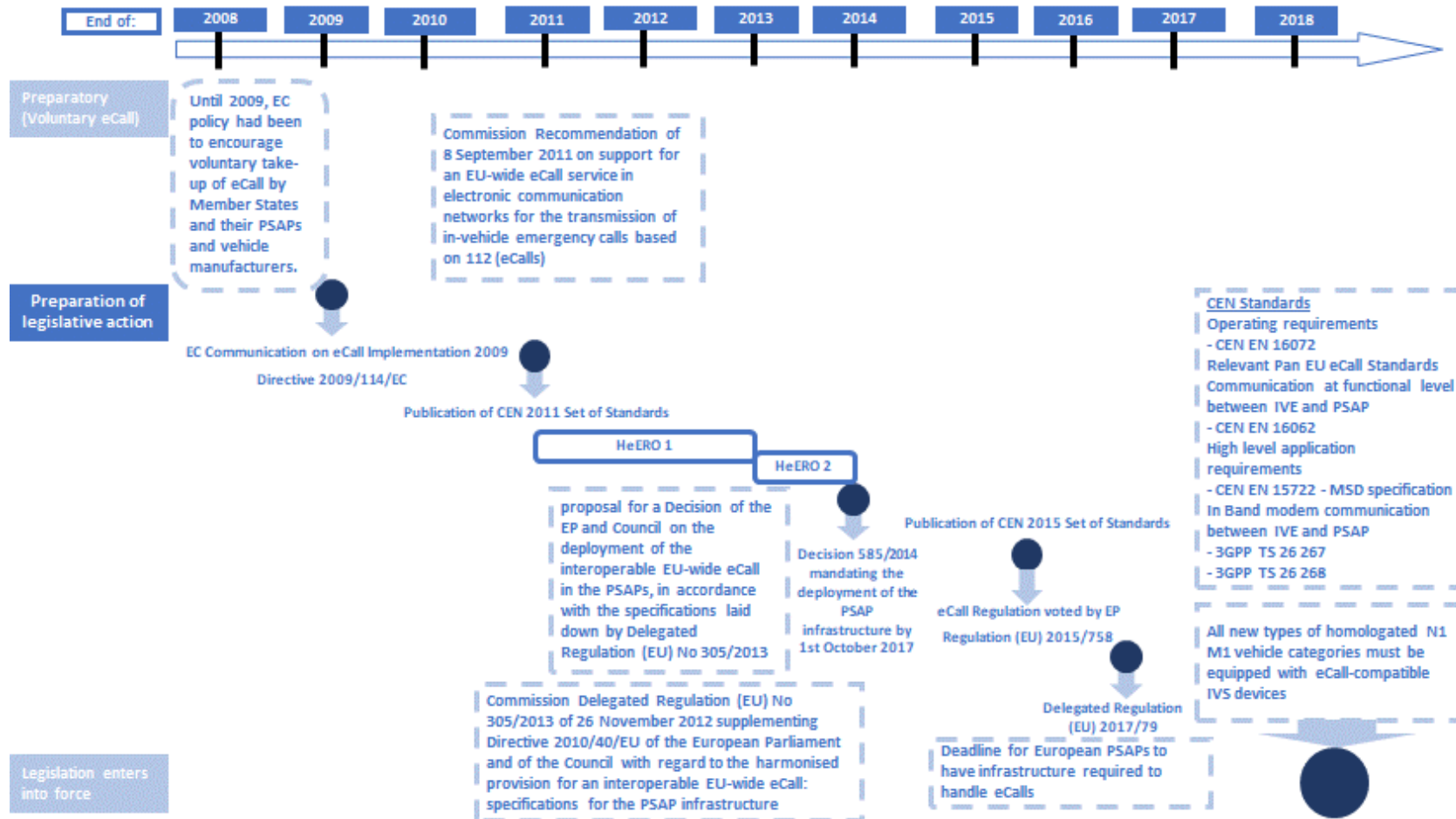
With a timespan of around 10 years to set-up and implement the initiative, CEN standards have also played a crucial role in terms of defining the technology choice. The figure below presents a schematic roadmap towards eCall, reconstructed based on inputs from key interviewees and complemented by additional desk-research activities.

³⁰ <https://www.swisscom.ch/dam/swisscom/en/about/company/portrait/network/2g-phase-out/documents/factsheet-m2m.pdf>

³¹ https://ec.europa.eu/commission/presscorner/detail/en/IP_09_1245

³² https://portal.etsi.org/cti/downloads/TestSpecifications/eCall_TestDescriptions%20v1_0.pdf

Figure 6: eCall Timeline



Source: Consortium based on desk research and stakeholders' feedback

Drivers can also opt for a private eCall service contract supported by Third Party Service Providers (eCall TSP) such as car manufacturers or insurance providers. Compared to the Pan-European eCall, the technological choice for each service provider is open (i.e. the EN 16102 standard does not prescribe the choice of technology to be adopted for data or voice transmission between the vehicle and TSP); however, the current implementations rely on circuit switched connections that can only be provided by 2G (GSM) or 3G (UMTS) technologies.

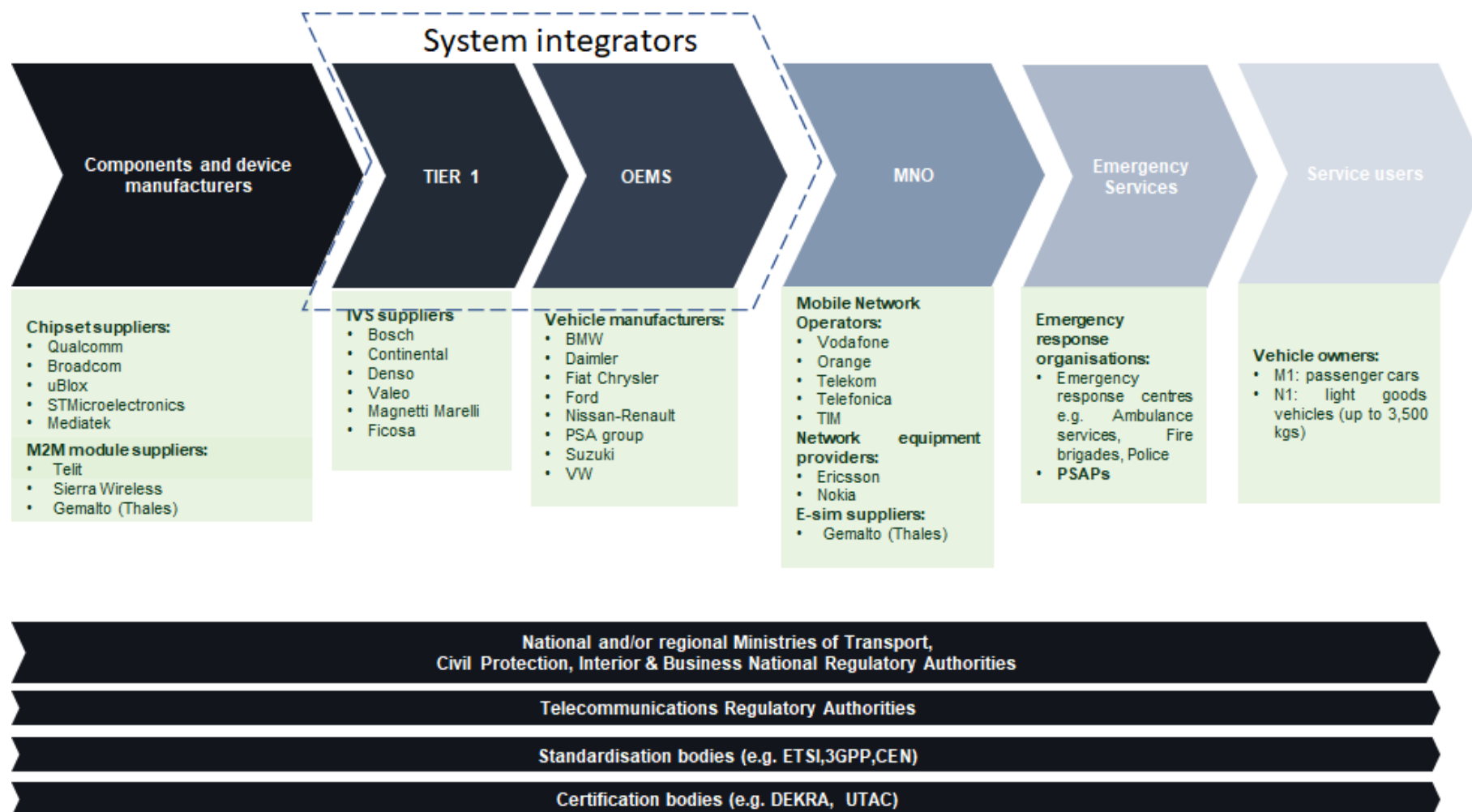
Key stakeholders involved in the eCall service value chain include:

- Automotive suppliers (Tier 1 or In-Vehicle Systems (IVS) and components suppliers): supply the eCall system with integrated chipsets to OEMs;
- Vehicle manufacturers or Original Equipment Manufacturers (OEMs): are responsible to comply with the type-approval requirements defined by regulation;
- Mobile Network operators (MNOs): have the legal obligation to process incoming eCalls as normal 112 emergency service calls (through implementing eCall discriminators or flags) and enable transmission of eCall from the car to the appropriate PSAP. A number of MNOs signed the Memorandum of 2009 expressing their commitment to support eCall services. While the European Electronic Communications Code (EECC) implies an obligation to support emergency services such as 112 and eCall, interviewees consider that this will be done on a technologically neutral basis and in line with the technological development of communications³³;
- National authorities: have the obligation to deploy the necessary PSAPs infrastructure to receive and handle eCalls;
- Service users: direct users of the eCall service are vehicle occupants of passenger and light goods cars; other road users including vulnerable road users e.g. cyclists and pedestrians benefit from the eCall service through the reduction of road fatalities and severe injuries.

The next figure is an illustrative rather than exhaustive list of companies involved in the eCall service provision:

³³ Source: expert interviews and survey with Regulators (cf. ANNEX 1 for summary)

Figure 7: eCall value chain



Source: Consortium elaboration based on desk research and expert interviews

2.1.2.2. M2M: Smart meters

M2M communication modules in intelligent metering devices deployed by utility companies transmit information used to bill the metered resource. Devices are pre-configured to send meter readings at requested intervals (e.g. end of billing cycles); also, reports of meter readings from specific devices can be requested by power companies for instance when service is terminated.³⁴ Smart metering enables pre-paid delivery of utilities (e.g. gas and electricity) as communication with the M2M module allows supply to be stopped once a specified (i.e. purchased) volume of the resource has been consumed.

The Third Energy Package of 2009 that consists of the Electricity (2009/72/EC15) and Gas (2009/73/EC) directives, promotes the use of smart metering technology to improve the efficiency of the energy sector both in terms of retail market competition and demand-side consumption. Member States were expected to perform a benchmarking exercise: a wide scale target roll-out of smart meters (i.e. for at least 80% of final consumers) by 2020³⁵ was mandated upon positive assessments of cost benefit analyses (CBA) conducted by individual MS. By 2012, two-thirds of the MS confirmed a positive outcome and the updated electricity directive turned the CBA into a periodic process in such a way that the 80% target set Third Energy Package became a moving one (7 years from the positive CBA or by 2024 and in case of a negative outcome, at least 4 years for a revised CBA in response to significant changes to technological and market developments).³⁶ The Gas directive is also subject to a cost-effectiveness analysis, but has no timeline associated with deployments.

Key stakeholders involved in the smart-meter rollout programmes and services include:

- Distribution System Operators (DSOs): DSOs collect meter data and provide information to producers about how much energy is used by each consumer; they are also responsible for metering installation, readings and operation of the grid; including choice of communication standards; storing and processing data in line with the transposed directives. Data on usage can in addition be sent to national authorities/governments and transmission system operators (TSOs). Depending on the chosen business model, DSOs may either chose to outsource all aforementioned steps to a third-party (e.g. smart meter supplier) to only receive billing data (illustrated in the figure below as the alternative Smart Metering Managed Service) or manage the deployment and metering service themselves.
- National authorities: have an obligation to perform periodic CBAs for wide scale smart meter rollouts and define the minimum requirements on function, technology and interoperability of smart metering devices.

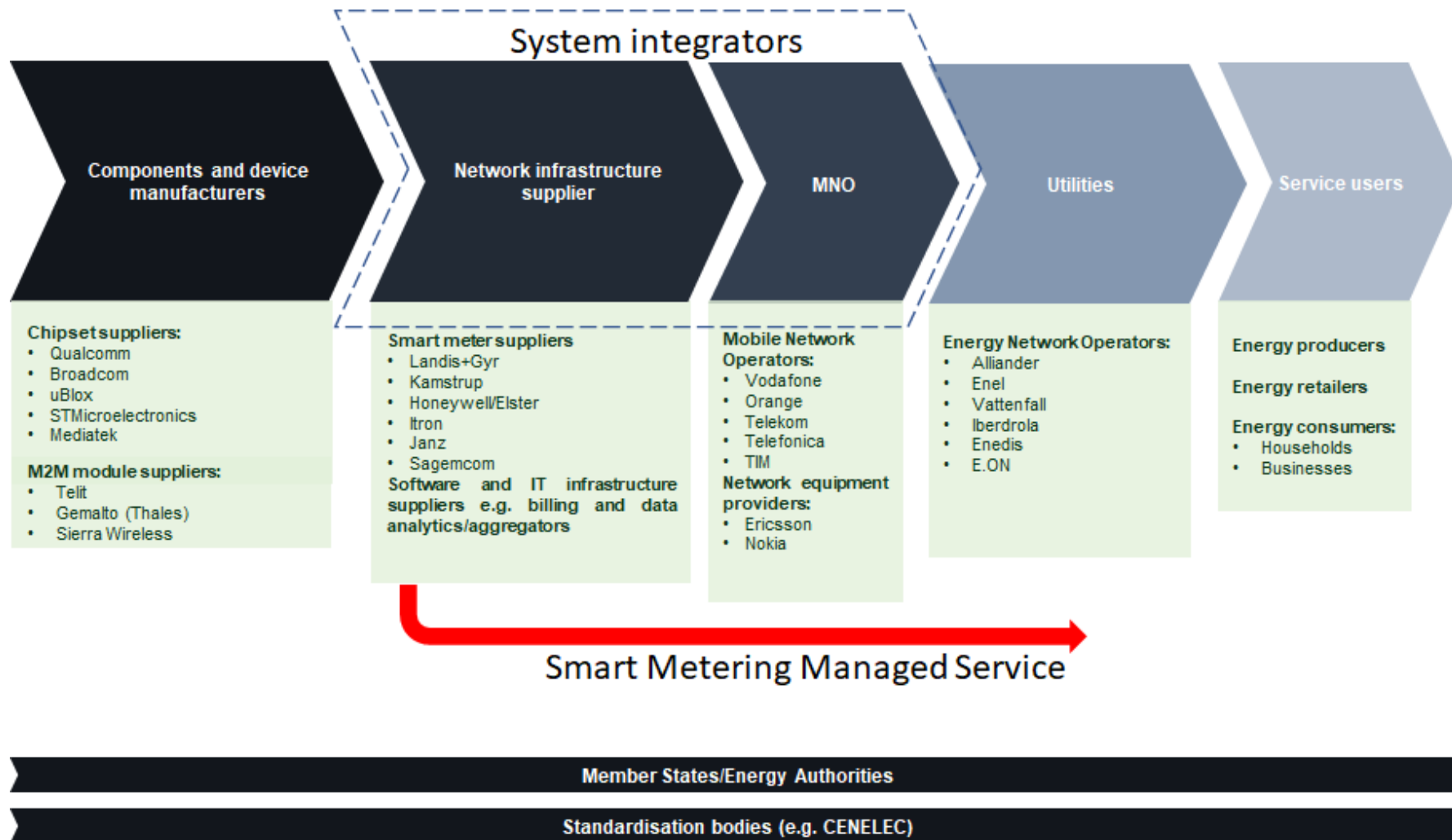
There are a number of possible business models for smart metering service provision with approaches diverging between larger and smaller DSOs as well as regional/country level differences. The next figure is an illustrative rather than exhaustive list of companies as well as business models validated by majority of stakeholders involved the smart metering service provision:

³⁴ https://www.etsi.org/deliver/etsi_tr/122900_122999/122988/12.02.00_60/tr_122988v120200p.pdf

³⁵ According to E.DSO, at least 80% of final customers will be equipped with smart meters within seven years of a positive cost-benefit analysis by 2024.

³⁶ European smart metering benchmark report EU 28, 2019 DG ENER

Figure 8: Smart metering value chain



Source: Consortium elaboration based on desk research and expert interviews

At the end of 2018, based on most recent data made available by the EU Agency for the Cooperation of Energy regulators (ACER) Market Monitoring report, the roll-out of smart meters has reached 50% of household consumers in 12 MS, whereas 6 MS completed their roll-out targets. This translates into around 100 million devices installed among households, small and medium-size enterprises across the EU.³⁷

In terms of gas meter deployments, given the predominantly negative outcomes for the CBA's, only 5 MS have commenced systematic deployment of such devices. Most recent estimation amounts to 12 million installed devices.

EU level estimation for the number of devices relying on cellular networks (in particular 2G): Based on feedback from technology suppliers, a maximum share of 10 to 15% of devices rely on cellular connectivity.

Country level data collection for the number of devices relying on cellular networks (in particular 2G): more granular data has been collected to estimate the specific figure of devices (modems/data concentrators/routers and devices installed in households) requiring 2G connectivity. Based on inputs received from individual operators (European DSOs) in the Netherlands, Spain, Greece, Ireland, Lithuania, France, Austria, Italy and Portugal, there are around 4.6 million devices relying on GSM connectivity for smart metering and remote control services in European energy grids. This corresponds to around 5% of the total installed base of electricity metering devices in EU 27 and 4 percent of gas and metering devices (cf. figures from ACER above).

2.1.2.3. M2M: Safety and security

Security and safety alarms which send low amounts of data (e.g. compared to video surveillance which implies significant data traffic) rely on 2G/GPRS networks for wireless communications between the central monitoring station and on-site control panel.

While ETNO estimates 15.9 million connections in the smart buildings vertical in 2019 in its perimeter³⁸, it can be argued that access control systems requiring lower data volumes (e.g. not transmitting video for surveillance) only represent a small share of the “smart buildings” vertical which is expected to rely on “more future-proof” connectivity³⁹.

2.1.2.4. M2M Telematics (vehicle location tracking and insurance telematics)

While there are a number of devices used by insurance providers to collect information on drivers' behaviour to offer tailored products, ranging from smartphones to connected cars, a number of the solutions illustrated below (including OBD II port with cellular connectivity and black box solutions) require mobile connectivity.

³⁷ ACER Market Monitoring Report 2018

³⁸ 2019 The State of Digital Communications, ETNO

³⁹ <https://www.gemalto.com/m2m/markets/smart-buildings>

<https://iot-analytics.com/new-report-shows-11-4-billion-global-smart-home-market-currently-growing-95-driven-voice-enabled-home-gateways-new-smart-appliances/>

Figure 9: Overview of devices enabling in-vehicle connectivity



Source: Intellimec

For instance, information stored in black boxes with integrated mobile connectivity modules including driving time or location data from the GNSS receiver would be forwarded to insurance companies.⁴⁰

Given privacy concerns associated with sharing in-vehicle data, the adoption rates in the European telematics market are limited⁴¹. Berg insight estimates 30 million usage-based insurance policies in Europe by 2021⁴². Among the most developed markets, the penetration of UBI policies in Italy corresponds to 20.5% or 7.1 million telematics-based policies.⁴³

As reported during stakeholder consultations, consumer electronics and commercial applications will be expected to migrate in line with announced switch-offs during device replacement cycles, hence the relevance of exploring market size of (aftermarket/non-embedded) 2G only devices is limited.

2.1.2.5. M2M Healthcare

In remote patient monitoring (i.e. medical telemetry collecting data on temperature, blood pressure, glucose) use cases, alarms (e.g. SMS) can be triggered in case abnormal readings are registered by wearable sensors.

2.8 million active connections in the health vertical are estimated in 2019 by ETNO in its perimeter. Besides the limited market size, additional bandwidth is expected to significantly improve existing and enable new eHealth services in such a way that devices are expected to be upgraded to next generation technologies at the end of useful life.⁴⁴

⁴⁰ <https://www.octotelematics.com/news/clear-box-and-video-event-data-recorder/>

⁴¹ <http://us.milliman.com/uploadedFiles/insight/2018/raw-telematics-data-driving-behaviour.pdf>

⁴² <https://www.researchandmarkets.com/reports/4767183/insurance-telematics-in-europe-and-north-america>

⁴³ https://www.swissre.com/dam/jcr:931665fd-cd40-4f4e-9e0b-69e484971f82/swiss_re_automotive_solutions.pdf

⁴⁴ <https://www.telit.com/blog/4-revolutionary-use-cases-5g-healthcare/>

2.1.2.6. M2M Retail vending

Connection to mobile telecommunication networks allows vending machines to transmit information on current fill levels, sales and trouble reports according to a specified schedule.

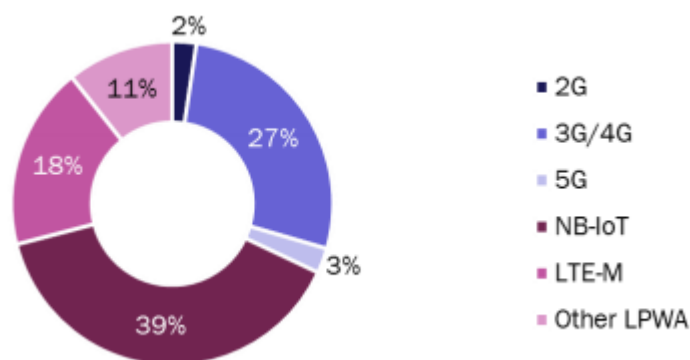
In the case of Wireless Point of Sale (PoS) Terminals, M2M communication modules are used to pass security requirements for financial transactions (e.g. credit or debit card on-line transactions).

ETNO research counts 2.3 million connections in retail in 2019 in its perimeter. This application is also expected to rely on additional layers of connectivity and the relevance of GSM is foreseen to be limited and evolve in line with device replacement lifecycles.

2.2 Task 2 – Quantifying the market and its expected evolution

Emerging cellular LPWA solutions (5G, LTE-M and NB-IoT) technologies are expected to dominate the share of global IoT connections in 2026 (compared to legacy cellular 2G, 3G and 4G connections). According to ABI, this is also expected to be the case in Europe, while in terms of M2M use cases, regulation and EU-wide initiatives play a significant role. Consequently, transport applications (related to the eCall directive) and smart grids (intelligent meters deployments related to the Third Energy Package) are expected to account for the largest drivers of the increasing demand for connectivity in these sectors. Road/telematics device deployments requiring cellular connections are estimated to account for a 67.4% share or 86 million cellular M2M devices at the end of 2017 while intelligent infrastructure-related deployments (e.g. smart city and energy/utilities applications) are linked to 22% of total connections.⁴⁵

Figure 10: IoT connections by network type, worldwide, 2026



Source: Analysis Mason, 2019

The study aims to identify the most relevant use cases which were defined using a Multi-Criteria Analysis (MCA), using the following criteria based on feedback from stakeholders and desk sources:

⁴⁵ <https://www.abiresearch.com/market-research/product/1027320-european-network-operator-m2m-market-analy/>

- Significant market size based on available information (2019 figures from ETNO and GSA);⁴⁶
- Exclusive reliance on GSM (e.g. relevant legislation with embedded technical specifications);
- Significant lifetime of devices (over 10 years);
- Value of device/complexity of replacement.

Table 3: Overview of use cases' prioritisation

Use case	Relevant Market potential	Exclusive reliance on GSM	Device lifetime	Value of device/complexity of replacement
eCall	NO ⁴⁷	YES	YES	YES
Smart meters	YES	NO ⁴⁸	YES	YES
Safety and Telematics	NO	NO	NO	NO
Healthcare	YES	NO	NO	NO
Retail vending	NO	NO	NO	NO

⁴⁶ The decision of MNOs to decommission 2G networks is based on commercial viability measured as a proportion of installed base (for M2M) and subscribers compared to network capacity/resources used. In Norway, Telenor Group which announced 3G and 2G networks decommissioning, estimates 1.3 million devices connected to 2G and 3G networks; Swisscom's decision to discontinue GSM service was based on a report that only 0.1% of its data traffic was handled by 2G based technology (i.e. GSM, GPRS, EDGE).

Sources:

<https://www.telenor.com/media/announcement/the-mobile-internet-of-things-gets-even-better>

<https://www.swisscom.ch/en/about/company/portrait/network/2g-phase-out.html#show=1>

⁴⁷ In 2019, the reported installed base by ACEA is limited to 1 million vehicles equipped with the mandatory eCall service, compared to the market size of smart meters (100 million). This volume is expected to increase i.e. 9 million cars in 2020 so that market potential criterion will be subject to change.

⁴⁸ National implementations to transpose the Energy Package directives may vary; for instance, the Italian National Gas Standardization Body UNI CIG lead standardization activities for smart metering technologies, and defines the architecture, protocols and infrastructure functionalities for smart gas metering (UNI TS 11291) mandating technology choice between P2P based on GSM/GPRS vs. PMP - Point Multi Point at 169 MHz for DSOs. KPN, in the Netherlands explains its decision to guarantee 2G service until 2025 due to the high volume of smart meters deployments dependent on this technology.

Sources:

https://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/6717-anigas-presentation-at-the-berec-workshop_0.pdf

<https://www.kpn.com/zakelijk/blog/-de-toekomst-van-iot-vraagt-om-meer-dan-2g.htm>

Following this initial prioritisation, the future evolution of 2 selected use cases, namely eCall⁴⁹ and smart meters are explored in the following sections.

2.2.1. eCall

ACEA indicates that in November 2019, 80 models and 1 million vehicles were equipped with the 112 eCall.⁵⁰ While the initial uptake was slowed down by the type-approval process, future uptake is expected to accelerate. Combining historical figures reported by Eurostat on new passenger car registrations (15.1 million passenger cars in 2017) in line with the methodology applied in the “Study on the inclusion of eCall in the periodic roadworthiness testing of motor vehicles” of 2019, an average growth rate of 4.63% was derived. Next, based on the validated uptake rate of eCall by vehicle manufacturers⁵¹, the growth rate estimated by the GSA (European GNSS Agency Market Report) was applied. Cumulating the numbers, we obtain the forecasted installed base of vehicles featuring eCall in the table below. To contextualise, ACEA reports 308 million motor vehicles in use at the end of 2018 in EU 28.⁵²

Table 4: eCall deployments forecast, EU 28

	2019	2020	2021	2022	2023	2024	2025	2026
New eCall vehicles	2.38	4.84	7.44	10.22	13.37	16.51	17.55	17.72
Installed base eCall vehicles	2.38	7.22	14.67	24.90	38.27	54.78	72.33	90.06
% of new registrations	17.2%	33.4%	49.1%	64.4%	80.5%	95%	100%	100%

Source: Consortium elaboration based on Eurostat, ACEA and GSA data

Stakeholders explain that on-field units may rely on circuit switched (2/3G networks) not only to comply with the mandatory eCall type-approval but also to provide TSP eCall.⁵³ However, the continued dependence of new vehicles introduced to the market exclusively relying on legacy networks is related to the implementation of the Delegated Regulation (EU) 2017/79 which defines operational requirements based on CEN standards issued in 2015 (EN 16062:2015) designed on GSM/UMTS circuit switched networks. This specification is translated as an obligation for OEMs to integrate 2/3G technologies to provide the eCall service, whereas no such regulation to specify communication technology applies to mobile carriers. The same obligation applies to public authorities i.e. Member States to equip PSAPs. In turn, this leads to an expectation from the industry and from the users (occupants of the vehicles) that GSM (or UMTS) service will be maintained throughout vehicle lifetime after an update in the regulation (mandating NG eCall to incorporate alternative connectivity).

For the evolution, a large TIER 1 supplier of IVS explained that technical feasibility is not an issue for them already at this stage as their devices support 4G and would only require 1-2

⁴⁹ Given that the same Telematics Control Unit is used to provide commercial services, this application has been implicitly part of the analysis performed on the eCall service

⁵⁰ ACEA, EeIP 25/11/2019, 2G/3G switch off presentation

⁵¹ who agree that in 2024, 95% of newly registered cars will be equipped with eCall

⁵² <https://www.acea.be/statistics/tag/category/report-vehicles-in-use>

⁵³ The EN 16102 standard does not prescribe the choice of technology to be adopted for data or voice transmission between the vehicle and TSP.

years for new vehicles to be compliant with NG eCall once regulation is in place (provided that standards are finalised 2-3 years advance).

In terms of costs, to upgrade production, OEMs would undergo a new type-approval process and development costs. IVS suppliers would also need to certify and homologate new TCUs. The PSAP infrastructure would also need to be upgraded to be able to receive and handle NG eCalls⁵⁴. For units on field, voluntary recalls to exchange TCUs throughout the vehicle's lifetime is considered as unfeasible from an economic point of view by all actors in the automotive industry (suppliers and OEMs). Additional information is available in (ANNEX 1) and summarised cost categories reported by impacted automotive actors are shown below:

Table 5: Cost categories for impacted automotive actors in transition to NG eCall

Cost	New production of vehicles (NGeCall)	Installed base of vehicles
IVS suppliers	Certification and homologation of new TCUs	Voluntary recalls to upgrade hardware (replacement of TCUs) is not feasible from an economic and sometimes technical point-of views ⁵⁵
OEMs	Type-approval and development	

Source: Stakeholder consultations

As explained above, one key issue pointed out by stakeholders during consultations is the fact that technology choice is embedded in the type approval regulation referring to CEN standards designed on GSM/UMTS circuit switched networks. While a migration path to the new generation eCall will have to take into account the average lifecycle of cars⁵⁶ (implying the need for PSAPs and in-vehicle systems to support Standard and NG112 eCall in parallel), stakeholders (carriers and automotive industry) suggest that a first step to ensure the lifecycle of systems exclusively relying on these legacy communication networks is not initiated. This would require the update of the type-approval directive to include the latest CEN standards for eCall over IMS (which allows the service to function over LTE networks).

In terms of technology readiness for NGeCall, interoperable chipsets (for 2G/3GeCall and NG eCall connections) are expected to become available as from the second quarter of 2020. PSAPs would also have to update their infrastructures to support both types of calls: legacy eCall and NGeCall. The earliest date to mandate the introduction of NGeCall cars based on supporting technical standards is foreseen by stakeholders as 2024.

Another prerequisite for updating the type approval legislation to end the lifecycle of 2/3G only vehicles shipped to the market in 2024, is that at the end of 2021, NG eCall standards to be incorporated in the updated type-approval are known to the automotive industry (especially

⁵⁴ The upgrade of PSAPs is already expected to take place due to the Next Generation (NG112) development (<https://eena.org/next-generation-112-now/>) While eCall PSAPs may be different from 112 PSAPs in some Member States, e.g. the cost in France to update a single PSAP receiving eCall will be incremental to the cost of updating the whole network of PSAPs for next generation 112 services (in case this requires an upgrade of hardware).

⁵⁵ Moreover, stakeholders explain that retrofitting units is not possible based on the current type approval regulation.

⁵⁶ Average age of vehicles is [11 years](#), 10 to 15 years based on the ACEA/CLEPA transition period and interviews with OEMs who are required to maintain spare parts of vehicles for 10 years.

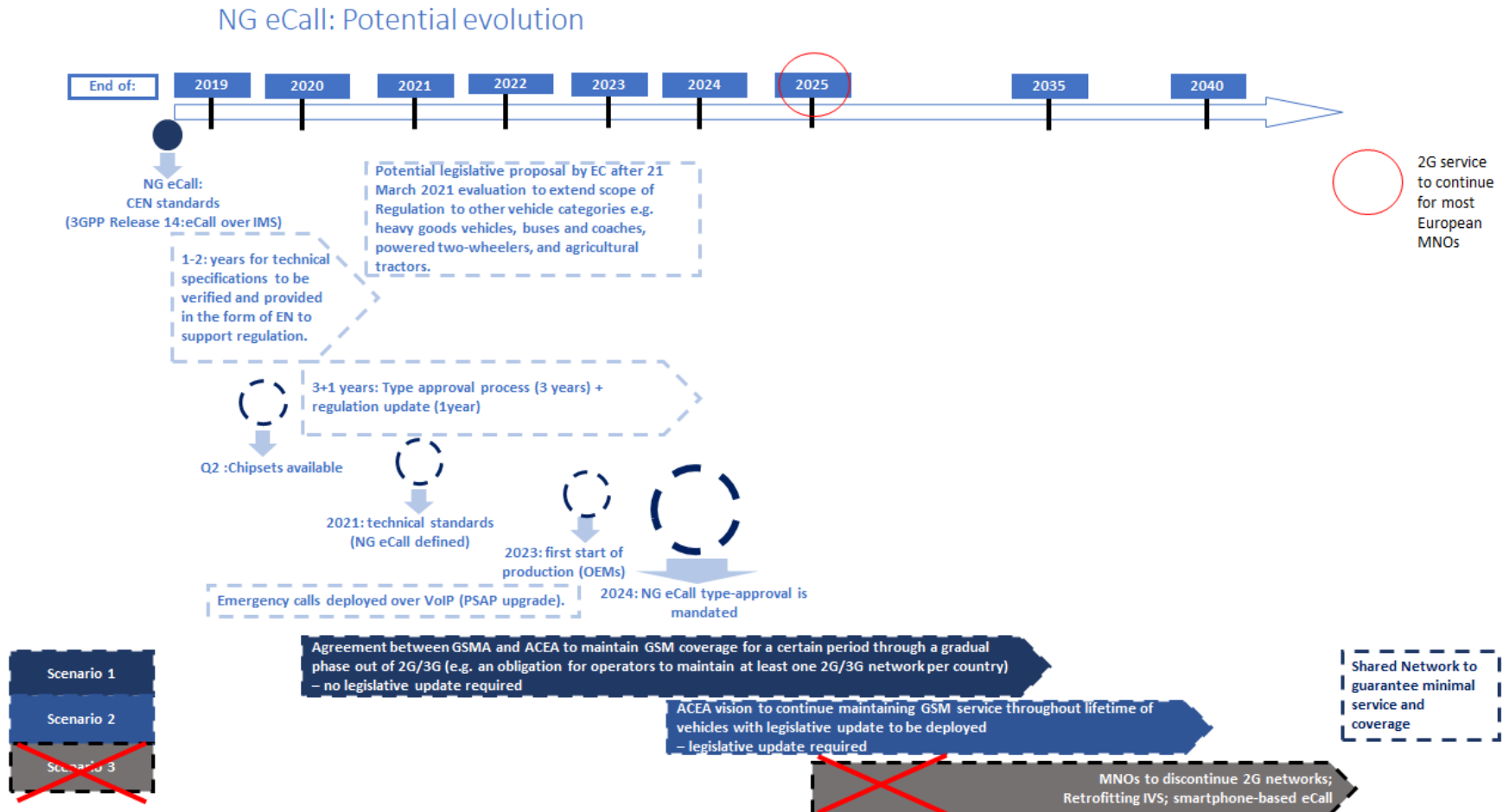
suppliers). Standards for MNOs to operate eCall over LTE have been finalised in February 2020 (ETSI TS103 683). Next 3 scenarios are forecasted, based on iterations of interviewees:

- Scenario 1: The automotive industry starts preparing for migration at least by including 4G in TCUs before any legislative update but will expect 2G services to continue throughout the lifetime of 2/3G enabled vehicles only. This scenario is partially confirmed by automotive suppliers who highlight that the majority of IVS and chipsets have been shipping with at least 4G technologies (and which also provide backwards compatibility with 2/3G) for some time. For these 4G-enabled vehicles (which are expected to represent a large majority of IVS on the market to be integrated in new production), migration would imply a software upgrade. Nevertheless, OEMs maintain that there is no guarantee the transition to NG eCall will be secured through a software upgrade of 4G-enabled vehicles and prefer to dismiss this scenario.
- Scenario 2: The automotive industry requires an update in the type approval legislation to start directly migrating to NGeCall, and will expect 2G service to continue throughout the lifetime of 2/3G enabled vehicles from the last year when such devices are put on the market. The transition period i.e. continuity of GSM service would be expected up to 2040 if new legislation becomes applicable by 2024-25.
- Scenario 3: No agreement is reached and 2G service is phased-out in line with announced switch-offs by operators; based on feedback from the automotive industry this scenario whereby 2G networks are discontinued and existing fleet is retrofitted is not possible under the current type-approval regulation (including the smartphone-based solution⁵⁷). The scenario is therefore disregarded.

Perspective of MNOs: carriers categorically dismiss the possibility/feasibility of maintaining service up to 2040 and are equally against a shared network or any obligation to maintain 2G service beyond the targeted switch-off dates which will vary on a country-by country basis. Although some operators intend to maintain (sometimes publicly commit to guaranteeing) GSM service up to 2025, given the short period of notification switch-offs can start happening even before 2025.

⁵⁷ Although such a solution does not exist (but rather remains a concept put forward by an OEM during early stages of the in-vehicle emergency system's development) the reason why such a scenario is mentioned is based on scoping consultations with stakeholders who highlight during scoping interviews that alternative possibilities should be considered, including the relevance of maintaining the eCall service based on developments such as ADAS, front vehicle collision avoidance systems which reduce the occurrence of incidents in the first place.

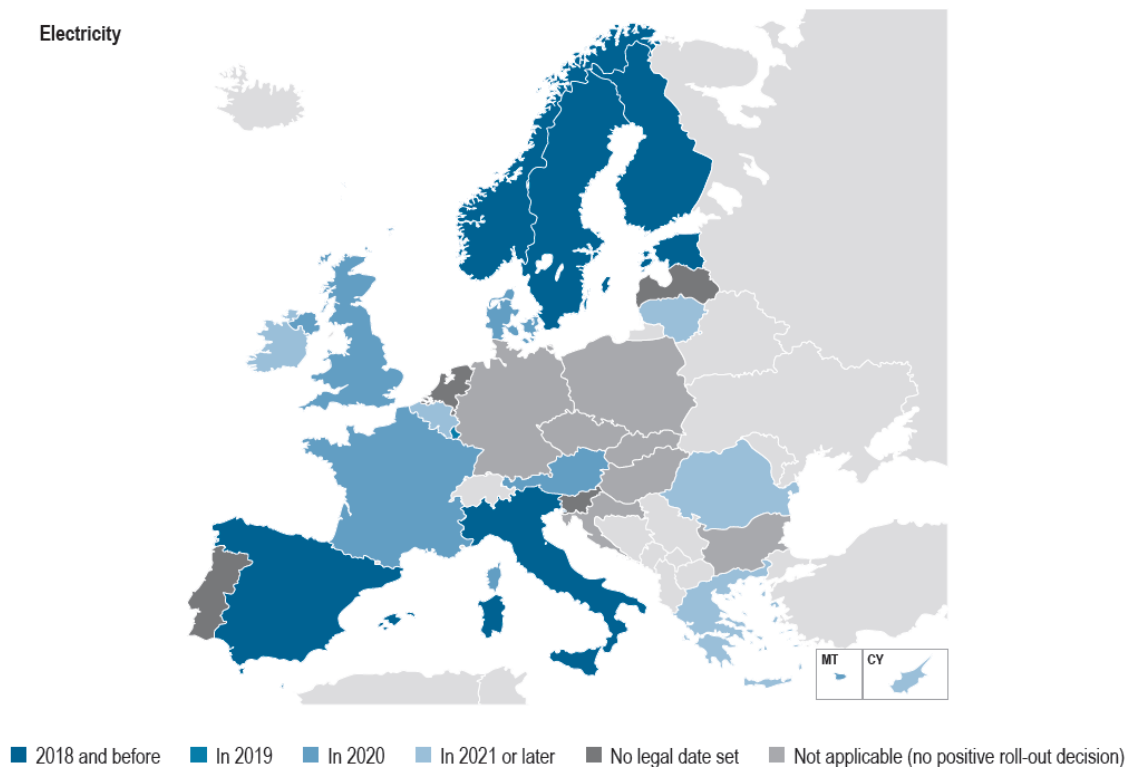
Figure 11:NG eCall: Potential evolution



Source: Consortium based on stakeholder feedback

2.2.2. Smart meters

Figure 12: Target year for 80% rate of electricity smart meters installation, EU28



By 2020, based on the originally announced rollout plans, 127.6 million additional smart meters were to be installed within the EU-28 (setting the total number of smart meters to nearly 226 million). That would correspond to a penetration ratio of electricity smart meters of approximately 78%. However, given the speed of deployment observed in 2017, the latest EC benchmark report estimates that only 24 million additional smart meters will be installed by 2020, setting the total number of electricity smart meters to 123 million with a respective 42.5% penetration rate.⁵⁸

With less prescriptive EU rules compared to electricity metering, gas smart metering system deployment is much more limited. On January first 2018, according to the available data only 10.57% of all gas metering points were equipped with smart meters, which represents approximately 12.1 million gas smart meters.

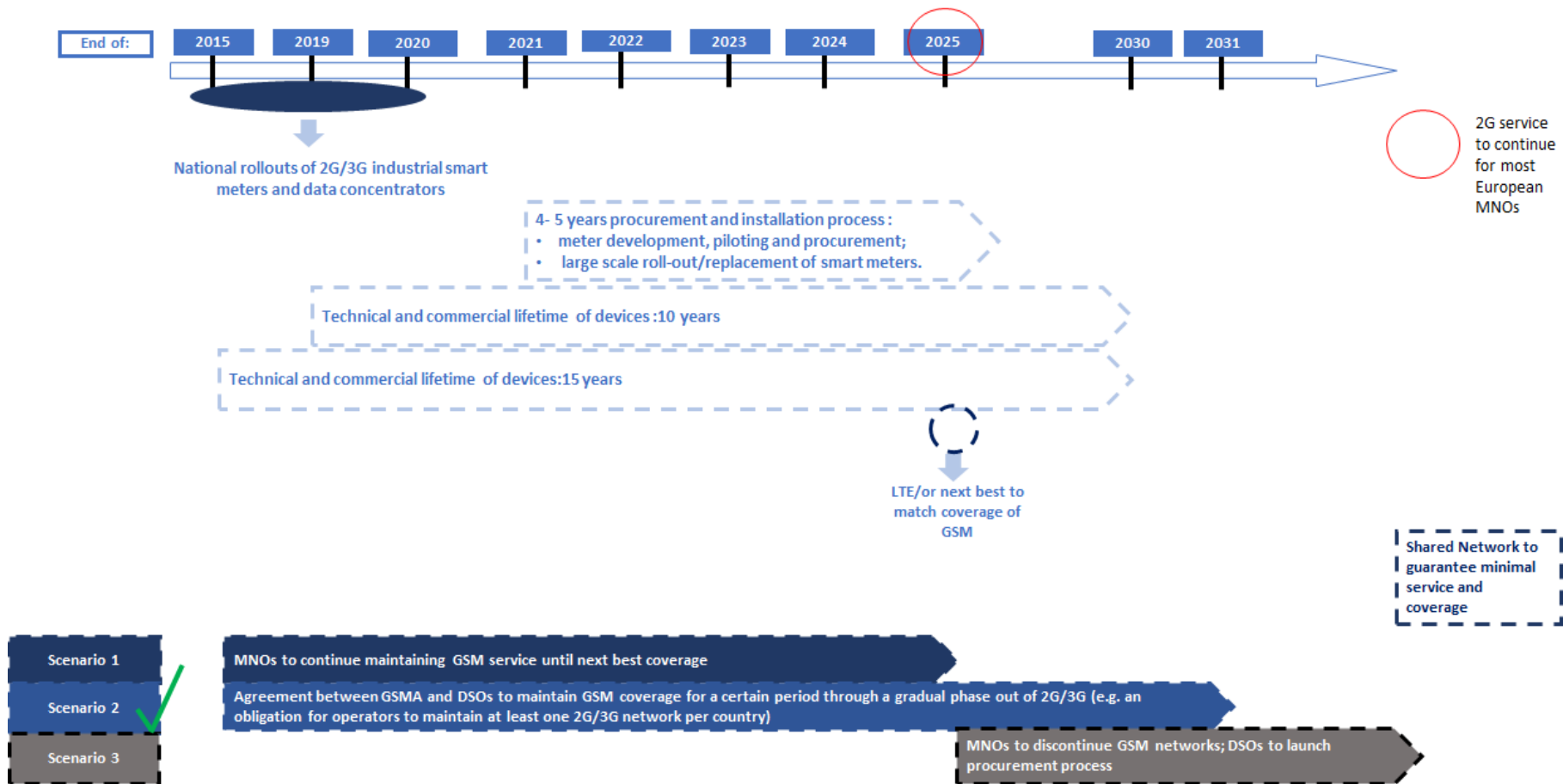
As mentioned above, based on inputs received from European DSOs, there are around 4.6-5.6 million devices relying on GSM connectivity for smart metering and remote control services in European energy grids. Given that rollouts based on GSM have been taking place until recently (except for Ireland where rollout is still ongoing), DSOs expect 2G networks to continue throughout the lifetime of such devices (10 to 15 years) i.e. 2030 (2035 for Ireland). An earlier end of service would result in stranded costs due to replacement of devices before

⁵⁸ European smart metering benchmark report EU 28, 2019 DG ENER

commercial and technical lifetime that could range from 930 million to 1,375 million EUR.⁵⁹ After this date, costs of replacement (referring to remaining cost of amortisation given that smart meter deployments under regulated framework are subject to amortisation periods of 10 to 15 years) are expected to be negligible. In this sense the only differentiator for DSOs is expected to be the availability of GSM and/or 3G service within their expected timeline. Next, we illustrate 3 scenarios including milestones and timelines expected (e.g. procurement and installation process) according to European utilities:

⁵⁹ Figure represents an estimation based on inputs from stakeholders in terms of price of replacing a metering device and installed base of devices to be replaced. Cf. ANNEX 1 for the stakeholder consultation summary.

Figure 13: Smart meters: Potential evolution



Source: Consortium based on stakeholder feedback

2.3 Task 3 – Identifying the prospective services under 900 MHz

A study for Ofcom⁶⁰ found that the increase in spectrum efficiency from moving from one generation of mobile technology (e.g. 3G) to the next (e.g. 4G) was typically a factor of around 2.5 times. It is therefore clear that replacing an older technology with a newer one offers large increases in capacity, and thus a higher perceived connection speed for end users.

The 900 MHz band is known in 3GPP by its designation as 'Band 8' and is included in the specifications for GSM, UMTS and LTE. It is also included in the 3GPP 5G bands, as 'Band n8'. As such, the band is available to be used by mobile operators for any current 3GPP technology from 2G to 5G.

The ability of mobile operators to re-farm the 900 MHz band for new technology depends upon:

- The revenues being made from the technology already being used in the band. Note that most operators interviewed stated that the cost of maintaining their GSM networks already exceeded the amount of revenue they made from the services it provided.
- The amount of spectrum available to them in the band. Although, in theory, LTE can operate in 1.4 and 3 MHz channel bandwidths, UMTS and 5G require channel bandwidths in multiples of 5 MHz (GSM requires multiples of 0.2 MHz). As such, operators require large contiguous blocks of spectrum in order to re-farm it for use by other technologies, and it is preferred that these are in multiples of 5 MHz. As such, an operator with just (2x) 5.6 MHz of spectrum in the 900 MHz band has sufficient spectrum to implement a single 3G, 4G or 5G carrier in 5 MHz of the spectrum, but is left with a remaining 0.6 MHz in which there is no opportunity to deploy a new technology, and which may be insufficient to continue to provide even a basic GSM service, and certainly not one that would be commercially viable to continue operating.⁶¹
- The ecosystem of network infrastructure and user equipment in the band. UMTS has been deployed in the 900 MHz band for over a decade⁶². According to a 2019 report by the GSA⁶³, 51 mobile operators have launched LTE services (including, for example, Deutsche Telekom⁶⁴) in the 900 MHz band with a further 46 in the process of consolidating their licences or undertaking trials, and 60% of new mobile user devices (e.g. handsets) are capable of using LTE in the 900 MHz band. There is thus plenty of equipment available for newer technologies and thus this is no impediment. Though the band is designated for 5G use, there is no evidence yet that there is any equipment (either infrastructure or user) which is available for the band.

The key blockage at current to fully switching-off 2G (other than pressure from the likes of the eCall and smart meter communities to continue to provide a service) is therefore primarily in

⁶⁰ https://www.ofcom.org.uk/data/assets/pdf_file/0025/72790/4gcapacitygainsfinalreport.pdf

⁶¹ 0.6 MHz is insufficient to roll-out a GSM network. The minimum is around 1.4MHz (this gives just one carrier per cell). Taking into account eCall, the amount of traffic the network could carry would be insufficient to make any return on the provision of the service.

⁶² ECC Report 96 "Compatibility between UMTS 900/1800 and systems operating in adjacent bands" dates back to 2007.

⁶³ <https://gsacom.com/paper/sub-1-ghz-spectrum-for-lte-and-5g/>

⁶⁴ <https://www.commsupdate.com/articles/2017/03/23/telekom-deutschland-embarks-on-lte-900-rollout/>

cases where GSM is still making positive revenues (which operators told us is rarely the case) and where spectrum was assigned for GSM based on a 200 kHz channel spacing, but which now does not allow the full re-farming of the spectrum for a more up-to-date technology. This latter issue is likely to be remedied when current licences expire.

Thus the scope for new services in the 900 MHz band is limited to 3G, 4G and in the future 5G technologies. No future GSM based services are envisaged to be introduced into the band.

2.3.1. Alternatives to GSM

GSM provides three specific services:

- Circuit-switched voice calls. The uniqueness of circuit-switched calls (over packet-switched) is that a dedicated connection is established for the duration of the call, as opposed to the capacity being shared amongst multiple users.
- Short messaging service (SMS). SMS provides the facility to send a 160-character text message from one mobile device to another (or from certain web-portals to mobile devices).
- Low-bandwidth packet-switched data, using the General Packet Radio Service (GPRS). GSM can provide a packet-switched data capability of around 56 kbps at best. If the network is upgraded to Enhanced Data for GSM Evolution (EDGE) this can increase to around 256 kbps. Historically, GSM also provided circuit-switched data (CSD), but this capability has been phased out in preference for GPRS.

GSM is a wide area technology meaning that a single base station can provide a coverage area of up to 35 km (under ideal conditions)⁶⁵.

There are a range of alternative technologies which can provide these services and these are set out in the table below.

⁶⁵ Note that this can be increased to 120km using Extended Range GSM.

Table 6: Alternative technologies to GSM

Technology	Can operate at 900 MHz	Circuit-Switched Voice	SMS	Packet Data	Maximum Range	Maximum Data Speeds
3GPP Mobile Technologies						
GSM/EDGE	✓	✓	✓	✓	35/120 km	256 kbps
UMTS (3G)	✓	✓	✓	✓	9.2 km	337 Mbps ⁶⁶
LTE (4G)	✓	✓ [1]	✓	✓	100 km	> 1 Gbps
NR (5G)	✓	✓ [1]	✓	✓	100 km	20 Gbps
3GPP Low Power Wireless Area Network (LPWAN) Technologies						
LTE-M	✓		✓ [3]	✓	10 km	375 kbps
LTE-NB-IoT	✓		✓ [3]	✓	10 km	62 kbps
EC-GSM-IoT	✓		✓ [3]	✓	15 km	98 kbps
Other LPWAN Technologies						
SigFox			✓ [2]		40 km	100 bps
LoRaWAN			✓ [3]	✓	20 km	50 kbps
WiFi			✓ [3]	✓	1.6 km	10 Gbps ⁶⁷
Zigbee			✓ [3]	✓	~100 metres	

[1] There are methods available to allow packet-switched voice calls of an equivalent quality to circuit-switched calls.

⁶⁶ Evolved HSPA+ (based on 3GPP UMTS Release 11)

⁶⁷ IEEE 802.11ax

[2] Each SigFox message is 12 bytes and up to 140 messages can be sent from a device each day, so in principle this is sufficient data to support the sending of around 10 SMS type messages per day.

[3] A short text message can easily be sent as a small packet data transmission.

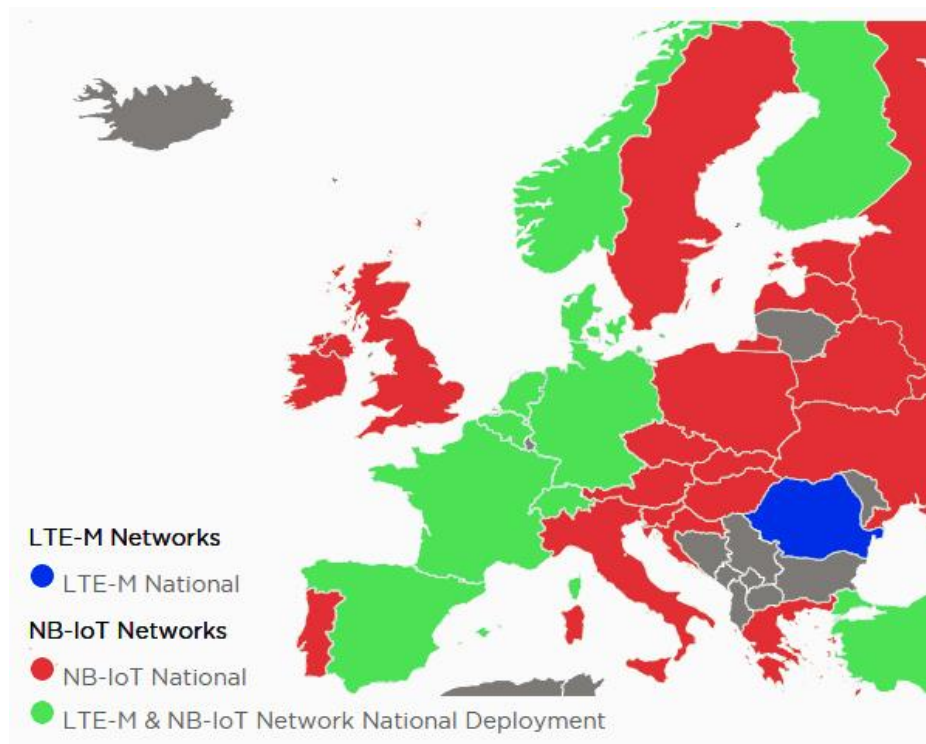
3GPP (the body which creates the standards for mobile technologies), has defined three specific variants of existing technologies which are dedicated to providing IoT connectivity. They are as follows:

- LTE-M⁶⁸: From the perspective of a network provider, LTE-M is a simple software update and is otherwise compatible with their existing networks and within their existing spectrum (though it would require that some spectrum is dedicated to it). It uses a 1.4 MHz LTE carrier meaning that it supports slower data speeds than standard LTE, but also uses less battery power in the user equipment.
- LTE-NB-IoT (officially LTE Cat-M2): This is a narrowband (NB) technology which uses 200 kHz channels and is designed specifically for IoT applications. In addition to slower data rates, it also has high latency (> 1 second). It is not a software upgrade to existing networks and requires new infrastructure to be rolled-out, as well as dedicated spectrum (though there is an option to place the carrier in the guard-band of existing LTE carriers, re-using an available channel).
- GSM-EC-IoT: This is a variant of GSM that has extended coverage and is designed specifically for IoT applications. It is a software upgrade to existing GSM networks and replaces a normal GSM carrier, meaning it can fit alongside existing networks comfortably. As with its LTE counterpart, it has high latency.

It is worth noting that none of these are backwards compatible with existing GSM/GPRS solutions or user equipment, meaning they would require both changes to the network and to the user devices in order to be implemented.

⁶⁸ Massive Machine Type Communications

Figure 14: LTE-M and NB-IoT deployments in Europe



Source: GSMA

The only direct replacement for GSM is therefore UMTS, as it is the only technology which provides the exact same set of services. Even this, however, is not a direct replacement for GSM unless the modules in existing IoT/M2M devices have both 2G and 3G capabilities (such as those currently in use for eCall).

Because an alternative solution provides the correct characteristics to replace GSM, does not mean that this is a straightforward option for the replacement of GSM in the various use cases. In most cases, it is almost certain that the equipment into which the GSM device is embedded will need to be modified or replaced. In practice, whether or not one of the alternative technologies can be used as a replacement for GSM boils down to a number of different factors, such as:

- Which services are required (e.g. voice, SMS, data) and whether the alternative provides these with sufficient data speeds to replace the GSM service;
- Whether the alternative technology provides coverage in the areas where the service is required;
- Whether a module of similar form factor, and with the correct interfaces, can be used to replace the GSM module (including any antennas necessary);
- In battery-powered applications, the replacement technology needs to draw no more power than the existing GSM solution.

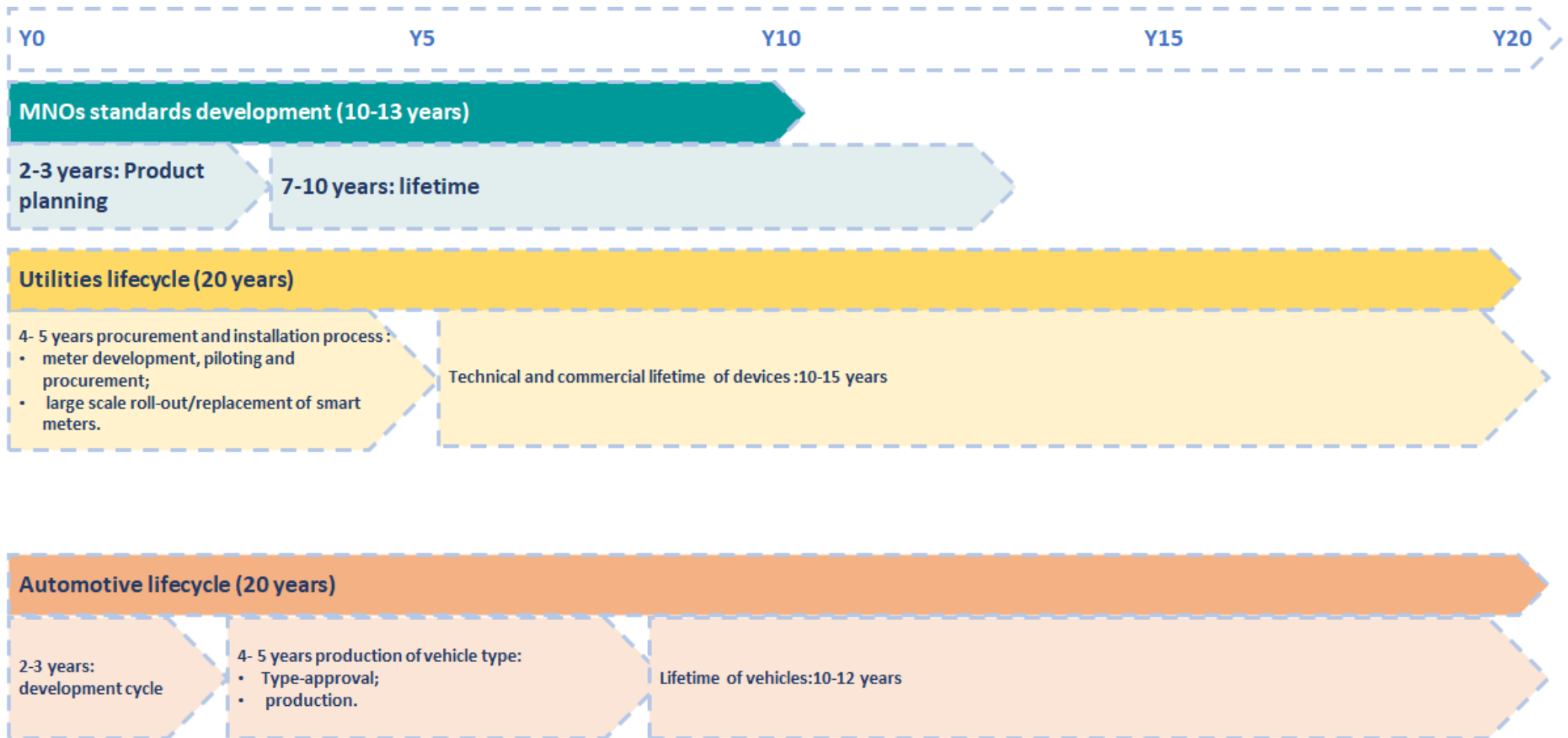
As such, whilst there may be options that would offer similar services, and in the 900 MHz band, these are not direct replacements for GSM and would require user equipment (and, potentially, operational scenarios) to be modified in order to adopt them.

2.4 Task 4 – Meeting public policy objectives using a successive technology or a different band

Based on the findings above the objective of this task was to understand to what extent could general interest services such as eCall and smart metering services be provided, and realistically attain their public policy objectives, in the 900 MHz band using a successive technology such as 3G, 4G or 5G technology or using frequency bands other than the 900 MHz band.

According to information collected at the time of publication, there are technologies providing a similar set of characteristics to replace GSM (cf. Table 6: Alternative technologies to GSM). End users are aware of these alternatives which may or not be already provided using the same band. Rather than technology readiness, the main issue of migrating services consists in the need to replace equipment which is complicated by a mis-match of expectations and timelines between operators on the one hand and end users providing GSM-based public interest services (in the automotive and energy sectors) on the other hand:

Figure 15: Technology roadmap: MNOs vs industry



Source: Consortium elaboration based on GSMA study and expert interviews

For both the automotive industry and utilities, the only differentiator is expected to be the availability of GSM and/or 3G service within their expected timeline (cf. feedback on scenarios and expectations of end users above: GSM service would be expected to continue up to 2040 by OEMs and up to 2030 by utilities). Given that stakeholders (end users, suppliers and MNOs) confirm that the GSM directive is not the instrument which guarantees or mandates continued availability of 2G networks (which is a decision taken by individual carriers based on business/competitive/market assessments), and therefore will not influence the extent to which public policy objectives are met, the impact of the GSM directive and differences between the available policy options with respect to the baseline scenario⁶⁹ will be presented separately in the next section.

Feedback was also collected on a potential scenario to guarantee availability of 2G service (beyond the scope of the GSM directive to ensure technical co-existence) whereby an agreement between ACEA/CLEPA and GSMA is reached to effectively maintain GSM coverage for a certain period through a gradual phase out of 2G/3G with an obligation for operators to maintain at least one 2G/3G network per country for a certain period of time for eCall (and possibly other) purposes. Overall, MNOs are against any obligation to maintain GSM service which is expected to hinder 5G deployment. On the cost of maintaining 2G networks to support M2M use cases (including the key examples explored in the study based on the timeline expected by end users), operators explain that the operating expenses to support 2G networks are negligible compared to the opportunity cost of not being able to use spectrum more efficiently by deploying 4G/5G technologies in the band. The focus of the ongoing dialogue with the automotive industry is to identify a joint position with regard to the legacy installed base and migration path to NG eCall (rather than discuss continued coverage of 2G). Technological possibilities (e.g. thin layer; 2G wholesale network) and implementation would require an additional agreement between operators, regulators and concerned industries that should be negotiated at the national level and happen on a voluntary basis. With regard to the type-approval, both sides (carriers and stakeholders across the service's value chain) agree that standards embedded in legislation⁷⁰, designed on CS networks, determine technology choice which OEMs have to comply with, is an issue and contrasts to the technology neutral commitment of MNOs to support public interest services, including emergency services such as 112 and eCall.⁷¹

⁶⁹ The baseline scenario for the GSM directive should be understood as the scenario whereby no action is taken to modify the directive (i.e. protection is maintained forever). As summarised in Task 2, based on the market trends and stakeholder consultations, for most of the commercial IoT/M2M applications, choice for GSM is cost-driven and vendors will continue supplying 2G only modules in-line to market demand (which is decreasing) but expect migration to alternative connectivity to happen in line with announcement of switch-offs by European MNOs. For the public interest services examined more closely in the context of this study, network evolution is similarly expected to happen, albeit transition to alternative connectivity will face several barriers including the embedded standards in the type-approval legislation for eCall as well as the expected migration timeframe (20 years) based on the lifecycle of cars; in the case of smart meters, the migration timeline will need to take into account the remaining high installed base of devices relying exclusively on 2G (and/or 3G) as well as the regulated environment of DSOs (timeframe for procurement process and device replacement).

⁷⁰ Delegated Regulation (EU) 2017/79 which defines operational requirements based on CEN standards issued in 2015 (EN 16062:2015) designed on GSM/UMTS circuit switched networks.

⁷¹ In such a way end users are expected to align (and not be prevented to do so) to the technological development of mobile communications. ; Source: expert interviews (cf. ANNEX A1.1 for complete overview).

2.5 Task 5 –The future of the GSM directive

At this stage all the data, information and points of view collected and analysed along the study are compared and integrated in order to draw the study conclusions, identifying the most relevant highlights and supporting the definition of a set of recommendations about the future of the GSM Directive.

Taking into account the technology developments and market demand trends identified in previous tasks, in this section we look into the extent to which it is necessary or useful to maintain GSM as the priority reference system in the 900 MHz band.

Based on outcomes of preceding tasks the summary table below presents the qualitative outcomes of the impact assessment of costs and benefits first for the baseline scenario and then compares these elements for each of the investigated policy options and use cases, for each cluster of stakeholders in the value chain to support the definition of a set of recommendations about the future of the GSM Directive. The baseline scenario is that networks will evolve which will trigger benefits and costs both, for actors involved in the eCall and smart metering services, as shown in the table below:⁷²

⁷² Next, we explore the GSM directive policy options where priority is removed immediately vs. when it is maintained for a certain period of time, vis-a-vis the baseline scenario.

Table 7: Summary table of baseline (“no action”) scenario

Baseline Scenario/Value chain actor	Benefits ⁷³	Costs	Alternative technologies
<i>eCall</i>			
<i>OEM</i>	⁷⁴	<p><u>For existing vehicles</u>: retrofit of 2/3G only vehicles on the market is not possible based on current type-approval regulation.</p> <p><u>For future production</u>: undergoing new type approval process and integrating next generation technology into production.</p>	LTE(4G);5G
<i>Module supplier</i>	Business opportunity	None	LTE(4G);5G
<i>IVS supplier</i>	None	<u>For future production</u> : certification and homologation costs.	LTE(4G);5G
<i>Member States (emergency services, PSAPs)</i>	Potentially improved service performance	Costs of upgrading existing infrastructure to receive IP (VoLTE) calls.	LTE(4G);5G
<i>M2M (smart meters)</i>			
<i>DSOs</i>	Improved performance: higher bandwidth, deeper indoor penetration, higher security/resilience level.	Replacement of meters and modules/data concentrators before end of lifetime	NB-IoT; Cat-M
<i>Suppliers (including module supplier and smart meter suppliers)</i>	Business opportunity	None	NB-IoT; Cat-M
<i>Both applications</i>			
<i>MNOs</i>	Better use of spectrum and associated benefits (cost-savings)	<p>Deployment of VoLTE NGeCalls (part of 4G strategy rollouts);</p> <p>Improving coverage.</p>	LTE(4G);5G

⁷³ On the general benefit of having technical protection of GSM in the 900MHz to guarantee absence of harmful interference for all actors in the value chain: neither the Commission nor CEPT can adopt harmonised technical conditions which would create harmful interference to or which would not protect GSM systems in the 900 MHz band. Where GSM services persist in the band, however, it would be highly unlikely that operators would introduce a technology which causes harmful interference to existing GSM services, in contradiction with the protection provided by the directive. In addition, none of the stakeholders reported interference as a concern and/or benefit as a result of the GSM directive.

⁷⁴ Although Infotainment services are expected to benefit from higher bandwidth and are often provided using the same Telematics Control Unit as the eCall public service, this stakeholder group maintains that this benefit is irrelevant in the context in which the safety/emergency service will no longer be provided in the absence of 2G (and 3G).

Next, compared to the baseline scenario, 2 policy options have been compared in view of amending the GSM directive, namely:

- Option 1: Remove protection immediately
- Option 2: Maintain protection for a defined period so that future technology can meet the same coverage (optimum timing) delta.

ECC Report 297⁷⁵ has already provided compatibility criteria for 5G operating in the 900 MHz band and there is therefore no obstacle to using the band for this. Given the technology neutral nature of the directive, whereby current systems (GSM, UMTS, LTE, WiMAX and IoT cellular technologies and 5G), are required not to interfere with GSM service, and confirmed not to do so (including 5G), any changes to the directive will not have an impact on services provided in the 900 MHz band.

In addition, since removing protection immediately is not expected to represent an incentive for MNOs to switch off 2G earlier than already planned, we do not foresee any substantial change in the timeline that characterizes the baseline described above. For this reason, the policy option of removing protection is not expected to generate any specific differential benefit or cost vis-à-vis the baseline scenario. The same logic applies to the policy option maintaining protection for a certain period of time: which is a combination of the baseline scenario and aforementioned option to remove protection. **The GSM Directive has an impact in terms of guaranteeing protection to GSM in case MNOs decide they are willing to continue offering the service, while it does not mandate the continuation of the service. Similarly, CEPT and the Commission could not work towards the introduction in the 900 MHz band of systems which could cause harmful interference to GSM.** As explained above, end users in the automotive and utilities sectors will only be affected by the extent to which the timeline of GSM service availability is aligned with their own timelines (for devices operating on 2G).

Given the inability of the GSM directive to guarantee/mandate continuity of 2G networks (which is a decision taken by individual carriers based on business/competitive/market assessments), no differential impact in terms of benefits and costs is expected between the abovementioned policy options, as summarised in the table below:

⁷⁵ “Analysis of the suitability and update of the regulatory technical conditions for 5G MFCN and AAS operation in the 900 MHz and 1800 MHz bands.”

Table 8: Summary table of assessed policy options

Scenario	Benefits	Costs	Alternative technologies
Option 1 – Remove protection immediately			
eCall			
OEM	No difference expected	No difference expected	No difference expected
Module supplier			
IVS supplier			
Member States (emergency services, PSAPs)			
M2M (smart meters)			
DSO	No difference expected	No difference expected	No difference expected
Suppliers (including module supplier and smart meter suppliers)			
Both applications			
MNOs	No difference expected	No difference expected	No difference expected
Option 2 – Maintain protection for a defined period of time			
eCall			
OEM	No difference expected	No difference expected	No difference expected
Module supplier			
IVS supplier			
Member States (emergency services, PSPAs)			
M2M (smart meters)			
DSO	No difference expected	No difference expected	No difference expected
Suppliers (including module supplier and smart meter suppliers)			
Both applications			
MNOs	No difference expected	No difference expected	No difference expected

Regarding the benefit of protection from harmful interference, neither the Commission nor CEPT can adopt harmonised technical conditions which would create harmful interference to or which would not protect GSM systems in the 900 MHz band. Where GSM services persist in the band, however, it would be highly unlikely that operators would introduce a technology which causes harmful interference to existing GSM services, regardless of the protection provided by the directive. In addition, none of the stakeholders reported interference as a concern and/or benefit as a result of the GSM directive (for instance, operators do not report any issues with GSM interference). The summary table exploring the differential impact of changes to the GSM directive therefore takes the point of view of end users, where the benefits and costs will be triggered by continuity of GSM service (which cannot be guaranteed by the GSM directive); in this sense protection of a service which can be phased out by MNOs who are free to do so already in the baseline scenario i.e. today) makes no difference for end users relying on GSM.

To conclude, based on the outcomes of our assessment, a trade-off between social-cost of availability of networks⁷⁶ to support devices providing general interest services and deployment of next generation services, will have to be sought by policy actions beyond the suggested modifications to the GSM directive which as summarised above, are expected to make no difference.

⁷⁶ As presented in section 2.1.1, in terms of the use of 2G for voice (e.g. elderly people simple communications systems), the expected share of 2G subscriptions only based on market projections will fall under 5% in 2025 in Europe according to Ericsson and expected to reach 2% according to the GSMA.

3. Findings and recommendations

The final goal of the study was to provide a set of recommendations on whether the future of the GSM Directive should still grant protection to GSM as a priority reference system in 900 MHz band or not - with regard in particular to its availability in the Union and in the world - for the internal market and for the continuation of services of general interest across the Member States for the implementation of EU policies, including pan-European services – i.e. services covering the entire territory of the Union such as the eCall system or emergency services. There are several trends to influence this decision namely:

- GSM is already going through a phasing out process that, based on market projections, will lead to a complete global switch off of the technology by 2030 at the latest;
- ECC Report 297⁷⁷ has already provided compatibility criteria for 5G operating in the 900 MHz band and there is therefore no obstacle to using the band for 5G while ensuring protection of GSM thereby making a priority reference even in the transition phase unnecessary.

As documented throughout the study, **there may be a need to preserve GSM technology** in the 900 MHz band taking into account various factors such as:

- The fact that there is a mis-match between the timelines of end users and operators, including the (non)capability of the former to migrate to a new technology (e.g. based on the eCall type approval implementation). From this point of view, to define the migration period, what needs to be taken into account is not only the amount of equipment (for example, vehicles still in service which exclusively rely on GSM in the 900 MHz band) but also the replacement cycle of such vehicles, and in addition to the above, the timeline when regulation (i.e. NG eCall) will be updated;
- The extent to which the lifecycle of devices will converge with the end of GSM service availability will influence the costs for end users to deliver existing GSM public interest services with successive technologies (4G/5G). For instance, a replacement cycle for metering devices will need to be initiated 4 years before the announced end of 2G service;

Nevertheless, already today, the GSM directive includes the technology and service neutrality principles whereby operators have the right to evolve and use advanced communication systems in the 900 MHz band, and it will therefore not be capable to address the concerns of users affected by technology migration.

Given that amending the Directive (i.e. removing GSM protection today or at a later stage) will not impact the evolution of the baseline (no action) scenario outlined throughout the study for end-users and carriers, at this stage the effort to introduce any modifications (i.e. repeal the directive by removing protection immediately or specifying a phase-out period) will outweigh the benefit of this intervention if the Commission implementing decision is modified without considering any more coexistence with GSM. Hence at this stage, **our recommendation is to maintain the GSM directive**. We expect that at some point in the future, e.g. when GSM service is not available, the necessary process will be put in place to update or repeal the

⁷⁷ “Analysis of the suitability and update of the regulatory technical conditions for 5G MFCN and AAS operation in the 900 MHz and 1800 MHz bands.”

directive thus taking out the specific protection, which already today has a marginal effect in terms of influencing network evolution.

4. Conclusion

After 10 years of application of the latest amendment to the GSM Directive, the relevance of GSM as the technology of priority reference in the 900 MHz band is an essential element to consider. When evaluating arguments to determine the usefulness of maintaining technical protection of GSM in the 900 MHz band, which does not guarantee that GSM systems will continue to operate, account has been taken of the advantages and specific characteristics of GSM compared to other wireless communications systems, in particular with a view to achieving Union policies through the use of public interest services such as the eCall system and other relevant services relying on 2G thereby considering the socio-economic dimension behind commercial decisions to evolve networks.

The study has been structured to respond to the following essential questions:

1. What services are currently provided with GSM technology in the 900 MHz band?

Remote data and measurements collection i.e. telemetry and M2M services have been historically based on legacy (2G/3G) communication technologies. Given that much of the 1800 MHz band has been re-farmed for 4G services, the 900 MHz band is the only one that can be used to continue to carry GSM traffic. Hence, the remaining end users of these legacy networks are assumed to be using 2G in the 900MHz band. These are:

- eCall
- M2M services such as:
 - smart meters - intelligent devices for electricity and gas metering deployed at consumer premises and industrial sites⁷⁸;
 - safety and security i.e. alarm systems;
 - telematics - aftermarket devices for vehicle location tracking and providing insurance telematics services, excluding In-Vehicle Systems);
 - healthcare - remote patient monitoring;
 - and retail vending - vending machines and Wireless Point of Sales (PoS) Terminals.

2. How is the use referred to in task 1 likely to evolve, taking into account market demand?

For most of the commercial M2M services, the choice of GSM is cost driven and vendors will continue supplying GSM only modules in response to demand but expect transition/migration to happen in line with announced sunsets by mobile network operators. Market projections (CISCO, Ericsson) show that ~5% of subscriptions will be GSM only by 2025 across EU Member States.

⁷⁸ Also, devices relying on wireless connectivity e.g. to provide remote control services in European energy grids.

For the two public interest services clear barriers (including legal provisions) which influence the technology migration timeline have been identified. In the case of the eCall service, technology choice is embedded in the standards mentioned by legislation.⁷⁹ Upgrading future production to ensure it incorporates next generation connectivity will first require an update in the type approval legislation.⁸⁰ Next, the migration period would need to take into account not only the process of updating production in the automotive sector but also the remaining on field devices dependant on legacy networks. In the case of smart meters, DSOs expect GSM services to be available to continue supporting a relatively large installed base of devices on field today throughout their lifetime (15 years) although, from 2020 onwards all rollouts are based on next generation technologies.

3. Are there any prospective services that operators envisage to provide with GSM technology in the 900 MHz band?

No future GSM based services are envisaged to be introduced into the band. The scope for new services in the 900 MHz band is limited to 3G, 4G and in the future 5G technologies as spectrum efficiency is the main driver behind operators' plans to re-farm the band.

4. To what extent could general interest services such as eCall be provided, and realistically attain their public policy objectives, as well as other relevant services identified in point 1 and 3 (or enhanced versions of such services), in the 900 MHz band using a successive technology such as 3G, 4G or 5G technology or using frequency bands other than the 900 MHz band?

As such there are no challenges from a technical point of view to provide both public interest services i.e. eCall and smart meters based on next generation technologies, including the use of alternative spectrum bands to do so: this has been confirmed both through a technical assessment and expert interviews.⁸¹ The technical specification in the eCall legal framework⁸² therefore remains the only **legal** barrier for eCall to operate on 4G (or other next generation connectivity). An additional element to be taken into account when defining a migration period for connectivity will be the amount of remaining vehicles on field dependant on legacy networks.

For both the automotive industry and utilities in the Energy sector providing public interest services based on 2G, the only differentiator is expected to be availability of GSM and/or 3G

⁷⁹ As defined by Article 3 of the Commission Delegated Regulation (EU) 305/2013, the eCall system relies on standards EN 16072 and 16062.

⁸⁰ From the point of view of end users; In addition, a similar provision for the infrastructure i.e. PSAPs would be necessary for Member States to upgrade and enable transition of the emergency service to alternative connectivity.

⁸¹ From a standardisation point of view, 3GPP standards are in place for the provision of eCall on any 3GPP platform (IMS based eCall) and from a technology point of view backwards compatible chipsets are available for the automotive industry. In the case of smart meters, rollouts from 2020 onwards are taking place based on next generation mobile standards.

⁸² Embedded standards EN 16072 and 16062 in Regulation (EU) 2015/758.

service within their expected timelines.⁸³ In this sense, the GSM directive is not seen by any of the interviewed stakeholders (end users, suppliers and MNOs) as an instrument to guarantee or mandate the continued availability of 2G networks.⁸⁴ The directive will not be able to address the concerns of end users and thereby influence the extent to which public policy objectives are met.

5. Taking into account the technology developments and market demand trends identified in points 1 to 4, to what extent is it necessary or useful to maintain GSM as the priority reference system in the 900 MHz band?

The 900 MHz band is today capable of supporting various mobile technologies (i.e. GSM, UMTS, WiMAX and LTE) and the characteristics of the spectrum, particularly its utility and propagation, continue to deliver cost effective benefits to operators. While it is true that with the introduction of 5G, mobile operators are progressively likely to want to use their spectrum holdings for the latest available technologies, which use spectrum more efficiently, there are no technical (or legal obstacles, including the GSM directive) today that could pose an issue to do so in the 900 MHz band. With or without the protection guaranteed by the GSM directive in place, for remaining 2G services currently provided in the respective band, this evolution will not occur to the detriment, understood as harmful interference, of GSM⁸⁵.

One outcome of the market assessment conducted in this study is that GSM is already going through a phasing out process that will lead to a complete global sunset of the technology by 2030 at the latest. However, combined with the expectations of end users (especially those involved in providing public interest services) and their migration timelines, **there may be a need to preserve the continuity of GSM technology.**

Referring to the GSM directive, as identified throughout the study, in its current formulation, the GSM directive does not pose any issue to making the most efficient use of spectrum and should therefore remain in force. It also grants protection against harmful interference to the existing GSM networks, which benefits those services that have no alternative connectivity method. Hence at this stage, **our recommendation is to maintain the GSM directive for unlimited duration.**

⁸³ Based on feedback from end users GSM service would be expected to continue up to 2040 by OEMs in the automotive sector and up to 2030 by utilities

⁸⁴ Which is a decision taken by individual carriers based on business/competitive/market assessments.

⁸⁵ Regarding the benefit of protection from harmful interference: neither the Commission nor CEPT can adopt harmonised technical conditions which would create harmful interference to, or which would not protect GSM systems in the 900 MHz band. Where GSM services persist in the band, however, it would be highly unlikely that operators would introduce a technology which caused harmful interference to existing GSM services, regardless of the protection provided by the directive. This reasoning is also confirmed by discussions with end users and operators who do not report harmful interference as a potential issue to affect their services (also in the absence of the GSM directive) but rather focus on the presence of 2G in the 900MHz band.

ANNEX 1 – Stakeholder consultation

The table below presents an overview of the status of the initial stage of the consultation:

Table 9: Overview of the first round of stakeholder consultations⁸⁶

#	Organization name	Service
1	VW	eCall
2	ERTICO	eCall, M2M services
3	European Emergency Number Association – EENA 112	eCall
5	3GPP (& ETSI)	eCall, M2M services, IoT
6	Continental	eCall, M2M services
7	Vodafone	eCall, M2M services, IoT
8	Orange	eCall, M2M services, IoT
9	GSMA	eCall, M2M services, IoT
10	PTS	All applications
11	ACEA	eCall
12	Telit	eCall, M2M services, IoT
13	EUTC (+2 DSOs)	Smart meters
14	Qualcomm	eCall, M2M services, IoT

The initial/scoping interviews were conducted to understand the context, issues and potential evolution for mapped applications potentially relying on GSM in the 900 MHz and has been followed by more in-depth discussions with end-users of the validated/relevant applications dependant on 2G. Current discussions focused on 3 main aspects, namely:

- Status quo and its evolution:
- Potential impacts of technological evolution
- Policy options

A1.1 Summary of initial consultation

In what follows we summarise the feedback received in the initial phase of consultations, distinguishing between on the one hand the mandated public eCall service and commercial IoT/applications on the other.

⁸⁶ The table shows only organisations which agreed to be linked with the published report.

A1.1.1 Status quo and its evolution

eCall: Stakeholders point out that technology choice (circuit-switched 2/3G connectivity) is embedded in the type-approval regulation which refers to the 2015 CEN standard. Although specifications for the IMS platform (NG eCall) are in place (ETSI/3GPP), deployment requires an update of the type-approval [Regulation (EU) 2015/758]⁸⁷ which is in itself a time-consuming process (followed by production cycles of 3-4 years for new vehicles); automotive industry representatives expect GSM service to continue throughout the lifetime of vehicles to support devices on the market although some interviewees acknowledge there will be a need to re-evaluate costs of maintaining networks (compared to re-farming band in favour of LTE/5G) to guarantee minimal service and consider subsidizing an accelerated transition to LTE/5G capable devices. An additional aspect to be considered is coverage: LTE coverage is suggested to be different to that of GSM – LTE having a generally lower coverage except in at least two Member States.

All other IoT/M2M use cases: technological evolution is expected in line with device lifecycles.

In terms of the use of spectrum, MNOs do not expect to migrate GSM service to a different frequency band (as the only other band 1800 MHz has already been largely re-farmed for LTE and expected to be used for 5G). Overall, there is a clear indication to discontinue 2G service which is spectrally inefficient but at the moment the number of devices continuing to rely on service (IoT and handsets) does not make transition cost-effective and despite an anticipated reduction in the number of devices within 5 years, evolution will vary on a country basis.

A1.1.2 Potential impacts of technological evolution

eCall: updating the legislation to enable IMS eCall will ensure that no new devices relying exclusively on 2G/3G networks are launched in the market;

Technological evolution to ensure continuity of eCall service could involve:

- upgrading devices during vehicle service (costly and complex according to OEMs);
- aftermarket retrofitting (not an ideal scenario given that it will not meet the type-approval requirements);
- re-certification of cars and homologation of existing TCUs (TIER 1)
- an upgrade of PSAPs is expected to already take place due to the Next Generation 112 (NG112); hence cost of software upgrade to support NG eCall over VoLTE (voice over LTE) will be shared.
- MNOs will need to match 4G and NB-IoT coverage to 2G, deploy eCalls over VoLTE and also deploy VoLTE roaming in the markets.

⁸⁷ In addition to the mentioned changes to Regulation (EU) 2015/758 mentioned by representatives of the automotive sector and MNOs, the same changes will apply to regulation referring to PSAPs when upgrading infrastructure in transition to NG eCall.

Alternatively maintaining GSM service will ensure continuity of the public eCall service. In this sense MNOs emphasize that the obligation to support emergency services is technology neutral and that users are expected to update hardware in line with technological evolution to be able to connect.

All other IoT/M2M use cases: devices are expected to be replaced at the end of lifecycles and driven by connectivity performance requirements which cannot be met by legacy networks; on the other hand, cost-driven, commercial applications will also migrate to alternative connectivity within replacement cycles, once switch-off dates have been defined by MNOs. Stakeholders refer to forecasts by Ericsson which project IoT cellular connectivity in 2025 to be dominated 80% by 4G/5G devices compared to 20% of devices relying on GSM.

A1.1.3 Policy options

Ecall: representatives of the automotive industry emphasize the need to maintain GSM service to support CS eCall-based in-vehicle systems which will be complemented by Option III i.e. grace period for maintaining protection of existing GSM service. Acknowledge that requirement is beyond the scope of the GSM directive.

While MNOs do not object to maintaining GSM protection in the next 5 years (preliminary timeline foreseen for 2G networks service continuation), an obligation to continue service beyond a point when this is commercially viable and an interference with LTE and 5G deployments is seen as extremely problematic. Therefore, in case the GSM directive were to interfere with MNO plans, operators would suggest discontinuing the directive itself (remove GSM protection i.e. Option II), but this is not the case at the moment.

Across M2M/IoT services: Feedback on policy options was coherent with the eCall use case. An additional suggestion regarding Option IV i.e. maintaining service and priority for a limited set of frequencies to support minimal service for IoT and eCall use cases could be problematic from a technical point of view as this would imply obliging a specific operator holding spectrum to continue running 2G networks. Also, some stakeholders point out that there is no distinction between the baseline scenario and Option V.

A1.1.4 Summary of in-depth discussions

The second round of expert interviews explored more in depth the initial findings and discussed evolution scenarios, including the impact of the policy options available in relation to the GSM directive. Discussions have been held with 24 stakeholders (including suppliers, end users, MNOs as well as associations of the aforementioned actors) involved in the service provision of key use cases:

Table 10: Overview of the second round of stakeholder consultations⁸⁸

#	Organization name	Service
1	VW	eCall
2	Volvo Cars Corporation	eCall
3	European Emergency Number Association – EENA 112	eCall
4	Valeo	eCall
5	Continental	eCall
6	Gemalto	eCall, M2M services
7	Landis+Gyr	Smart meters
8	Nokia	eCall, M2M services
9	Vodafone	eCall, M2M services
10	Orange	eCall, M2M services
11	Telia	eCall, M2M services
12	Telecom Italia	eCall, M2M services
13	GSMA	eCall, M2M services
14	ACEA (+ 10 OEMs) CLEPA (+1 TIER 1); SMMT (Society of Motor Manufacturers and Traders, UK)	eCall
15	Telit	eCall, M2M services
16	EUTC (+3 DSOs)	Smart meters
17	Iberdrola	Smart meters
18	Enedis	Smart meters
19	Qualcomm	eCall, M2M services
20	BMVI & BNetzA	eCall, M2M services
21	TRAFICOM	eCall, M2M services
22	AGCOM	eCall, M2M services
23	E.DSO (+10 DSOs)	Smart meters

⁸⁸ The table shows only organisations which agreed to be linked with the published report.

In what follows we provide a summary distinguishing between the perspective of end-users (including intermediary actors in the applications' value chain e.g. suppliers) and communication network providers for each of the key use cases (i.e. eCall and smart meters):

A1.2 End users' perspective

A1.2.1 Value Chain and most impacted actors:

- eCall: Overall interviewed stakeholders agree with the value chain which covers the main actors⁸⁹ involved in the eCall service ecosystem. There are some variations in terms of the business model e.g. in the way connectivity is managed and interaction between MNOs and OEMs: in some cases these are linked via e-sim providers acting as subcontractors of MNOs; another option is that MNOs and OEMs are not directly linked via any contractual relationships. In terms of actors most impacted by technology evolution, depending on the evolution scenario, system integrators (i.e. TIER1 and OEMs) are seen to be most impacted. These actors highlight the type-approval standards referring to CS technology and dependence on MNOs (to provide connectivity) for which regulation is technology neutral. Nevertheless, migration to alternative connectivity (eCall over IMS or NGeCall) would require a collaboration and upgrade across the entire value chain (including infrastructure i.e. PSAPs).
- Smart meters: the majority of stakeholders found the value chain complete. In general it is difficult to accurately capture smart metering service provision as there are various business models e.g. Nordic countries have a service oriented smart metering operation: utilities typically outsource everything from the deployment, installation to operation of smart metering solution to a third-party (e.g. meter supplier); whereas other utilities could produce their own residential meters and run the metering system themselves. Larger utilities have more bargaining power and could contract with each of the actors separately. One convergence is that most impacted by technology change are utilities and finally cost will be transmitted to end users.

A1.2.2 Evolution scenario

- eCall:

Stakeholders find the depicted timeline reasonable in terms of technology availability. A milestone was added for EN specifications to be known at least to 2 years prior to the start of production. All stakeholders agree that it is reasonable to assume that in 2024 all new vehicle model types supplied to the market can be NG eCall enabled (with upgraded start of production possible already in 2023), provided all aforementioned milestones take place.

Type approval process is usually included in production timeline which lasts 4 to 5 years per vehicle type. Lifetime of cars and commercial vehicles 10-12 years needs to consider development 2-3 years. This adds up to a required migration timeframe of 15 to 20 years. On the various scenarios:

- Scenario 1: OEMs can already start to integrate latest available (4G/5G capable) devices, which would require a software upgrade to be upgraded to NG eCall as soon as MNOs and PSAPs support the next generation service. According to some suppliers, given that it is expensive to have 2 separate TCUs (one for telematics services requiring bandwidth and another TCU to provide a

⁸⁹ The table shows only organisations which agreed to be linked with the published report.

public eCall service) this upgrade 4G connectivity is already partially taking place among OEMs.

- Scenario 2: Agreement (with or without) regulatory intervention to ensure technology availability and implementation/migration timelines between network operators and the automotive industry. More likely/probable and favourable according to representatives of the automotive sector.
 - Scenario 3: Upgrading devices during vehicle service is not feasible from an economic point of view but partially possible (replacement of hardware based on voluntary recalls). Nevertheless, retrofitting would not satisfy type-approval requirements and the same applies for smartphone-based emergency calls (since strictly speaking eCall is by definition an inbuilt system in the car), the latter being a concept explored before the IVS system design and implementation.⁹⁰ Cars will be left on the market without a functioning emergency service (if 3G networks are switched off before 2G) and option is dismissed by the representatives of the automotive industry.
- Smart meters:
 - Scenario 1: Timeline of GSM service does not match that envisaged by utilities based on latest deployments based on 2G (national roll-outs of 2/3G smart meters and data concentrators have been ongoing up to 2020). DSOs would prefer to avoid this scenario which would lead to stranded costs and the need to start replacing devices already in 2022 (if GSM were to be switched off in 2025).
 - Scenario 2: DSOs preferred scenario whereby meters are supported by 2G networks until the end of their useful life (2030).
 - Scenario 3: has the preference of network equipment suppliers which implies switch off of 2G network to prepare for evolution to next generation standards. Despite the caveat in terms of standards being updated every 10 years by MNOs and that utilities will face the same issue in 10 years, these actors emphasize that new technologies currently deployed (i.e. LTE Cat-1; LTE-NB-Cat-1) already contain 5G standards meaning that already today service continuity can be expected/guaranteed in next 20 years.

A1.2.3 Costs and benefits of technology migration:

- (NG) eCall: There is a need to consider development and production compared to units already in the field.
 - OEMs: Costs of upgrading production include undergoing a new type-approval process including costs of development. For units on field, voluntary recalls to exchange TCUs throughout the vehicle's lifetime is considered as unfeasible from an economic point of view by all actors in the automotive industry (suppliers and OEMs): according to car manufacturers the cost excluding

⁹⁰ Although such a solution does not exist (but rather remains a concept put forward by an OEM during early stages of the in-vehicle emergency system's development) the reason why such a scenario is mentioned is based on scoping consultations with stakeholders who highlight during scoping interviews that alternative possibilities should be considered, including the relevance of maintaining the eCall service based on developments such as ADAS, front vehicle collision avoidance systems which reduce the occurrence of incidents in the first place.

development could amount to 2,500 to 3,000 EUR per vehicle. Fixed cost estimated at 500,000 EUR (according to an OEM).

- IVS suppliers: For new production certification and homologation of TCU implies a fixed cost of 200-300,000 EUR). Cost of software upgrade (according to module supplier) could be of around 50 EUR.
 - Module suppliers: upgrading connectivity modules in existing TCUs is a business opportunity for suppliers.
 - PSAP infrastructure: expected to be ready by 2025 for NGeCall although current technology readiness will differ across countries based on the implementation of the Next Generation 112 service (ongoing activities in 3 member states) but also on the initial implementation of the eCall service (i.e. as a centralised single PSAP processing eCalls vs. all PSAP networks receiving eCalls) and the way upgrade will be handled (national prerogative). Nevertheless, it has not been confirmed that today any PSAP (of the approximately 300 involved in eCall service across EU28⁹¹) is able to process VoIP calls.
- Smart meters:
 - DSOs: utilities distinguish between modular design of data concentrators which would have a lower cost compared to replacing hardware (smart meters) at consumer premises. The latter is estimated at 200 to 300 EUR per meter. Applied to around 4.6 million devices that would require replacement after legacy networks are switched off stranded costs could amount to replacement of devices before commercial and technical lifetime (2030) could range from 930 million to 1,375 million EUR.
 - Suppliers (modules and meters): the switch-off of 2G is a business opportunity. Suppliers confirm to have meters with 2/3/4G: so if utility is forced to replace devices, the smart meter industry is ready to provide replacement required to make this move from 2G. In addition, technology suppliers highlight the benefits of using NB-IoT Cat-M1 which have been specifically designed for M2M services including smart meters (including improved performance such as better penetration e.g. buildings, basements).

A1.2.4 Impact of the GSM directive:

- eCall: OEMs and automotive suppliers converge that any changes to the GSM directive are no relevant: on the one hand no difference expected from the GSM directive as long as standards mentioned in the type-approval regulation create a life cycle of devices relying on obsolete technology and foreclose the possibility to provide a functioning eCall service, on the other hand , with additional services (telematics) that require bandwidth, network evolution in mobile networks is expected to take place in any case.
- Smart meters: Amendments to the GSM directive are not expected to influence the switch-off trend of legacy networks.

⁹¹ The current section summarises the feedback received during consultations with key stakeholders involved in eCall and smart metering service. Source of all statements are interviews and we report figures mentioned by stakeholders which may not be exact.

A1.3 Network operators' perspective:

A1.3.1 Current use of GSM technology in the 900 MHz and expected continuity of service:

All of the interviewed MNOs explained that decisions with regards to service continuity are expected to vary on a country per country basis⁹²; hence none of the operators interviewed (including the association) was able to provide a specific date or statement as to when GSM service is expected to be switched off.⁹³ Some operators (and Regulators) suggested that at the point when mobile carriers' current 900 MHz licences expire, there is no guarantee that current assignments will be re-awarded in the same way, and they may no longer be able to offer GSM services in the band (which prompts operators to migrate customers relying on 2G/legacy networks before expiry date of licenses in the specific band, or in the case of Italy before the date defined as the end of 2G service by national decree i.e. 2029).

- Factors affecting continuity of GSM service include:
- Level of congestion in existing bands
- Number of M2M devices and their lifespan
- Contractual relationships and obligations
- Status of VoLTE deployment

A1.3.2 Key use cases and impact on decision to switch off 2G:

All interviewed operators agree with identified use cases as the most relevant to take into account when planning 2G networks shutdown considering the number, lifetime and complexity of migrating devices. Once again MNOs pointed out the technology neutral nature of emergency call systems legislation for telecommunications operators (eCall/E112 and EECC) which would not affect their decision to maintain or decommission GSM networks.

With regards to eCall MNOs point out the unbalanced decision of the type-approval regulation which refers to CS technology and results in car manufacturers obligation to integrate 2/3G only devices. Collaboration between ecosystem (e.g. MNOs, OEMs, chipset manufacturers, PSAPs) will be key to accelerate transition to IMS eCall (technology neutral and future proof).

On smart meters, operators are aware of the legacy installed base but also transition to alternative connectivity (e.g. NB-IoT, LTE-M and CAT-1) in newer devices. MNOs consider that regulatory intervention may be required to accelerate this transition as well as address the issue of legacy devices on the market.

⁹² e.g. a national decree in Italy has defined the end date of GSM service in 2029, by which MNOs will be expected to migrate all their customers to next generation connectivity.

⁹³ One of the interviewed MNOs publicly committed to guaranteeing GSM service up to 2025 while another operator suggested switch-off is currently not foreseen before 2025. Overall information on the timeline/continuity of 2G networks is deemed as sensitive and commercial information for individual operators.

A1.3.3 Benefits of network evolution

Main rationale behind the switch-off of 2G and re-purposing spectrum holdings for LTE/5G consists in more efficient use of spectrum. This in turn is expected to result in significant energy cost savings (estimated benefit by GSMA a 90% reduction on energy use (from the current 2-3% of global energy consumption based on the 3GPP 5G specifications))⁹⁴. In addition, the magnitude of the opportunity cost of deploying LTE/5G services has been illustrated by cost savings related to purchasing new spectrum for LTE/5G service coverage (based on spectrum auctions and valuation based on prices of respective licenses). Customers are expected to benefit from improved quality of services and applications.

A1.3.4 Costs of network evolution

- Of the listed costs for network evolution namely:
- matching 4G and NB-IoT coverage to 2G,
- deploying eCalls over VoLTE (NG eCall)
- deploying VoLTE
- using national roaming for GSM.
- using dual LTE/GSM base stations

Operators expect 4G coverage to be increasing independently of the GSM switch-off date and have an interest to improve LTE coverage (which is at different levels in Eastern and Western European countries compared to GSM) but add that repurposing the band (e.g. from 2G/3G to 4G) will also reduce the cost to achieve coverage; operators are already deploying VoLTE and regarding eCall over LTE, have been recently finalised in February 2020 (TS103 683⁹⁵). All of the aforementioned items are part of the 4G deployment strategies of MNOs (who were not able to share cost indicators separately). Operators do not foresee using national roaming agreements to ensure continuity of GSM service as according to them it leads to inefficient use of spectrum.

Regarding a potential obligation to introduce geographical obligations, as opposed to population coverage (which is typically attached to spectrum licenses but is not specific of technology), this is seen as an additional cost factor. At present MNOs report 4 member states with such policies in place: France which has binding geographical coverage across main transport corridors and 3 other member states (Finland, Germany and Italy).

A1.3.5 Impact of the GSM directive

Operators converge on the absence of impact when it comes to suggested policy options related to the GSM directive (i.e. removing or maintaining the protection status) as long as regulation maintains the technology neutral status of spectrum usage rights and does not imply an obligation to continue GSM service. MNOs highlight that the CEPT report confirms

⁹⁴ In addition, some member states apply fiscal incentives for improvements in Energy Consumption Index of individual MNOs which can be achieved through technology evolution.

Alternative figure :20-40% of operational expenses (source GSMA study).

⁹⁵ https://www.etsi.org/deliver/etsi_ts/103600_103699/103683/01.01.01_60/ts_103683v010101p.pdf

compatibility between GSM and 5G, meaning that there are no barriers to deploy next generation services in the band.

A1.3.6 Possibility of mandatory 2G/3G service shared network agreement

Overall MNOs are against any obligations to maintain GSM service which are expected to hinder 5G deployment. On the cost of maintaining 2G networks to support M2M use cases (including the key examples explored in the study based on the timeline expected by end users) operators explain that the operating expenses to support the 2G network are negligible compared to the opportunity cost of not being able to use spectrum more efficiently by deploying 4G/5G technologies in the band.⁹⁶ The focus of the ongoing dialogue with the automotive industry is to identify a joint position with regards to the legacy installed base and migration path to NG eCall migration (rather than discuss continued coverage of 2G). Technological possibilities (e.g.. thin layer; 2G wholesale network) and implementation would require an additional agreement between operators, regulators and industry that should be negotiated to a national level and happen on a voluntary basis.

A1.3.7 Summary of survey circulated to Regulators (National Telecommunication Authorities and other national agencies)

A survey was circulated to national representatives of the Radio Spectrum Committee⁹⁷ with feedback collected from 25⁹⁸ of the 29⁹⁹ Regulators (National Regulatory Authorities (NRAs) and/or other competent authorities).

Below we present the summarised feedback per question:

1. Do the licenses of the 900 MHz spectrum holders give operators technology flexibility, or do they require them to use GSM? When are these licenses due to expire? (26* of 25 responses)

All surveyed Member States confirm technological flexibility applies to licenses issued in the 900 MHz band. Expiry dates range from 2021 to 2030, with some MS subject to annual license renewal (e.g. Estonia), or infinite duration (e.g. UK).

2. Is there national legislation, policies or relevant contracts that could imply an obligation for MNOs to continue providing GSM service? (25 of 25 responses)

Member States converge that continuity of GSM/legacy networks service is subject to the decision of individual MNOs and there are generally no contracts nor enacted legislation that mandate a specific technology to continue. On the contrary there is a free-market movement

⁹⁶ Cf. feedback above on benefits of technology migration including energy efficiency and cost-savings related to re-using existing spectrum for 4/5G rollouts.

⁹⁷ National Regulatory Authorities (NRAs) and/or other competent authorities.

⁹⁸ Feedback from PTS (Sweden) was partially collected during the scoping interviews.

⁹⁹ EU 27 MS + UK and Norway.

towards more spectrally efficient technologies. One exception in Italy – on the basis of a public consultation – AGCOM introduced a GSM service obligation until 30 June 2022 (term that can be revised pursuant to further analysis to be carried out by 2020), to safeguard 2G-only users and also the growing 2G M2M applications.

3. Demand for mobile broadband is an important consideration for migrating to new technologies. Is the 900 MHz band relevant for the future 5G spectrum deployment strategies formulated by MNOs and/or from your point of view as a national regulator?

(26 of 25 responses)

- a. If this is the case, do you foresee any issues with 5G deployment in the 900 MHz in the context of the GSM directive?¹⁰⁰

Given the property of mobile bands below 1 GHz to contribute to wide area coverage, most Regulators agree that the 900 MHz band could be relevant for future 5G NR deployments. In terms of potential issues, although these are expected to be addressed by individual MNOs (who are at very different stages when it comes to 5G deployments and/or decommissioning of legacy networks in the favour of newer technologies), Regulators aim to create the necessary conditions to facilitate these plans e.g. through the rearrangement of specific bands including the 900 MHz band. When it comes to issues posed by the GSM directive itself, member states do not expect it to be one of the issues as for instance the technical conditions are set out by Decision (2011/251/EU) rather than the directive itself and from a radio perspective LTE and 5G have minor variations (i.e. 5G is not expected to be incompatible with GSM). Also, there is a view that since GSM will be at some point replaced altogether by newer technologies the GSM directive itself might have to be withdrawn.

4. 2G networks are known for their significant (almost ubiquitous) coverage. How would you as a national regulator foresee maintaining this level of coverage for public communications in the event of GSM decommissioning? (25 of 25 responses)

One of the strategies to ensure matching coverage of GSM for public communications mentioned by Regulators are defined and binding coverage obligations attached to licenses (e.g. in specific bands and not necessarily 900 MHz and not related to a specific technology). In this sense only a couple of member states (3 of 25 responding) are concerned with a future decrease of mobile coverage in the transition to next generation standards (moreover a few member states highlight that LTE coverage is already identical to GSM coverage today).

5. How do you see the future of the use of the 900 MHz band in relation to the application of the EU legal framework regarding the provision of eCall in-vehicle system, such as Article 4 of Decision 585/2014/EU pursuant to which “Member States shall ensure that eCalls can originate from anywhere in their territory, provided there is at least one

¹⁰⁰ The majority of NRAs and competent authorities responding to the question focus on 1) the technology neutral nature of their licenses and 2) potential issues associated with the use of the 900 MHz band beyond the GSM directive (e.g. band fragmentation and necessary rearrangements to accommodate wideband technologies and thereby facilitate deployment of next generation standards). In this sense only 8 respondents explicitly refer to the GSM directive.

public mobile wireless communications network available” as well as Articles 108 and 109 of the European Electronic Communications Code under Directive 2018/1972? (25 of 25 responses)

Some member states indicate that **eCall services can be provided by other spectrum bands** and that technological advancements in mobile communications will trigger updates in the eCall regulation [Regulation (EU) 2015/758] which contains **specifications for 2G/3G networks only** (i.e. transition to NG eCall). Although coverage is important, stakeholders mention that alternative bands with similar and/or better propagation characteristics may be equally used to provide eCall (i.e. it is **technically feasible** to provide eCall through other spectrum bands).

6. Are you aware of spectrum holders in the 900 MHz plans to re-farm/re-purpose their shares in the specified frequency band (e.g. phasing out GSM in favour of LTE)? (25 of 25 responses)

a. If this is the case: do you have a defined set of actions to handle the phase-out of the 2G network and ensure seamless technological migration for the affected applications/end-users (including a clear view of which users will be most affected)?

i. Do you foresee cross-border coordination issues?

b. If this is the case: do you know if the MNOs have planned to use / are using a Multi RAN (Single RAN) to provide the 2G service? Which amount of the spectrum will be used for the 2G/3G/4G in 900 MHz range?

Although MS confirm that LTE is already deployed in the 900 MHz band, due to the high number of M2M connections, Regulators consider switch-off of GSM unlikely within the next few years. Of the MS providing feedback to the survey (25¹⁰¹) only 1 reports concrete plans of an MNO planning to decommission its 2G network in 2020 (of 3 operating ones) and another tentative GSM switch-off of a network for the general public (of 3 existing networks) is planned in 2025. One member state confirms that although re-farming of the band is already ongoing in favour of LTE/5G, MNOs intend to keep 200 kHz GSM carriers depending on market demand from M2M/eCall applications until 2025. Only 3 member states were able to confirm (at least plans) of MNOs to use Multi RAN technologies (not only for providing 2G); the phasing-out process of GSM networks is expected to be handled by individual operators and cross-border coordination issues (largely not foreseen, but if any) will be solved through updating existing agreements with neighbouring countries.

7. Related to the previous question, are you aware of reports published by operators to estimate the potential effects such a transition could have (e.g. indications on the number of users and applications affected, estimations on the type of cost savings for

¹⁰¹ Feedback from PTS (Sweden) was partially collected during the scoping interviews.

MNOs as a result of re-farming spectrum as opposed to purchasing additional bandwidth etc.)(25 of 25 responses)

None of the MS were able to point us to a relevant report/study commissioned by MNOs to estimate the effect such a transition could have in terms of opportunity costs and/or users affected.

8. Could infrastructure sharing be relevant in the context of 2G phasing out plans by selected MNOs? (25 of 25 responses)

Network sharing (including spectrum) is seen as a relevant solution by many member states to ensure seamless transition e.g. a common network with roaming agreements between MNOs to support 2G service in a cost-efficient way.

ANNEX 2 List of sources

Table 11: Main sources consulted

Source	Year
Legacy mobile network rationalisation – lessons from 2G and 3G migrations	2020
The state of Digital Communications by ETNO	2019
EEC Report 297	2019
The Mobile Economy 2019 by GSMA	2019
The potential of switching off 2G in the UK	2019
Ericsson Mobility Report	2019
European smart metering benchmarking report EU28	2019
ACER Monitoring Report 2018 (published 2019)	2019
CEPT report 72 of 5.7.2019	2019
Implementing Technology that Benefits Consumers in the Clean Energy for All Europeans Package	2019
Emerging-Technologies-and-Impact-on-Non-Federal-Spectrum-Demand	2019
Cisco's Mobile Visual Networking Index (VNI) Forecast	2019
Shutdown of 2G/3G (Article by Analysis Mason)	2019
The Benefits of Technology Neutral Spectrum Licences	2019
GSMA Position Paper on eCall Support and Mobile Network Evolution	2019
ACEA/CLEPA Position Paper on eCall	2019
CEPT Report 66	2018
Commission amending Decision 2009/766/EC	2018
Next Generation 112 eCall, HEERO112 Harmonised eCall Deployment	2018
Directive (EU) 2018/1972 of the EP and Council of 11 December 2018 establishing the European Electronic Communications Code	2018
eCall and open issues	2018
Transmission with 2G (GPRS/EDGE) or SMS	2018
Communication (Telenor Group)	2018
Communication (Swisscom)	2018
EEC Report 266	2017

Spectrum Policy: Analysis of technology trends and future needs and demand for spectrum in line with Art.9 of the RSPP	2017
Identification and quantification of key-socio economic data to support strategic planning for the introduction of 5G in Europe	2016
Costing the new potential connectivity needs	2016
Spectrum for the IoT: GSMA Public Policy Position	2016
Cellular networks for massive IoT	2016
Connectivity technologies for IoT	2016
Regulation (EU) 2015/758 of the EP and 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	2015
Spectrum Refarming Benefits, challenges, and solutions	2015
Study on cost benefit analysis of Smart Metering Systems in EU Member States	2015
Communication Technologies and Networks for Smart Grid and Smart Metering (450 Alliance.org)	2014
Benchmarking smart metering deployment in the EU-27 with a focus on electricity	2014
Decision 585/2014/EU of the EP and Council of 15 May 2014 on the deployment of the interoperable EU-wide eCall service	2014
Universal Mobile Telecommunications System (UMTS); LTE; Study on alternatives to E.164 for Machine-Type Communications (MTC) (3GPP TR 22.988 version 12.2.0 Release 12)	2014
Inventory and review of spectrum use: Assessment of the EU potential for improving spectrum efficiency	2012
Decision No243/2012/EU of the EP and Council of 14 March 2012 establishing a multiannual radio spectrum policy programme	2012
CEPT Report 40 (Report from CEPT to the EC in response to Task 2 Mandate to CEPT on the 900/1800 MHz bands)	2010
CEPT Report 41	2010
ETSI TS 102 689 Machine-to-Machine communications (M2M); M2M service requirements	2010
Commission Decision on the harmonisation of the 900 MHz and 1800 MHz frequency bands	2009
Directive 2009/114/EC of the EP and Council of 16 September 2009 amending Council Directive 87/372/EEC on the frequency bands to be reserved for the	2009

coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community	
--------------------------------------------------------------------------------------------------------------------	--

GLOSSARY

Table 12: List of acronyms

Acronym	Definition
1G	First generation mobile telecommunications
2G/GSM	Global System for Mobile Communications
3GPP	3rd Generation Partnership Project (standards organisation)
ACEA	European Automobile Manufacturers' Association
ACER	EU Agency for the Cooperation of Energy regulators
AGCOM	regulator and competition authority for the communication industries in Italy
AMPS	Advanced Mobile Phone System
BMVI	Federal Ministry of Transport and Digital Infrastructure (Germany)
BNetzA	Federal Network Agency (Germany)
CBA	Cost benefit analyses
CEER	Council of European Energy Regulators
CEN	European Committee for Standardization
CEPT	The European Conference of Postal and Telecommunications Administrations
CLEPA	European Association of Automotive Suppliers
CSD	circuit-switched data
DSOs	Distribution System Operators
EC	European Commission
eCall TSP	eCall Third Party Service Providers
ECO	European Communications Office
EDGE	Enhanced Data rates for GSM Evolution
EECC	European Electronic Communications Code
EENA	European Emergency Number Association
EN	European Standards
ERA-GLONASS	Russian automated emergency response system
ERTICO	ITS Europe

ETNO	European Telecommunications Network Operators' Association
ETSI	European Telecommunications Standards Institute
EU	European Union
EUTC	European Utilities Telecom Council
GNSS	Global Navigation Satellite System
GPRS	General packet radio service
GSMA	GSM Association
IA	Impact Assessment
I-HeERO	Infrastructure Harmonised eCall European Pilot
IMS	IP Multimedia Subsystem
IVS	In-Vehicle Systems
LPWA	Low-Power Wide-Area
LTE	Long Term Evolution
MCA	Multicriteria analysis
MNO	Mobile Network Operator
MS	Member State
MTC	Machine-Type Communications
NG eCall	Next Generation eCall service
NMT	Nordic Mobile Telephony
NRA	National Regulatory Authorities
OBD	On-board diagnostics
PSAPs	Public Safety Answering Points
PTS	Swedish Post and Telecom Authority
RSC	The Radio Spectrum Committee
RSPP	Radio Spectrum Policy Programme
SMMT	Society of Motor Manufacturers & Traders (UK)
SMS	Short Message Service
TACS	Total Access Communication System
TRAFICOM	Finnish Transport and Communications Agency
TS	Technical Specification

TSOs	Transmission system operators
UBI	Usage-based insurance
UMTS	Universal Mobile Telecommunications Service
VNI	Visual Networking Index
WiMAX	Worldwide Interoperability for Microwave Access

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696
- by email via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications at: <https://publications.europa.eu/en/publications>. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: <http://eur-lex.europa.eu>

Open data from the EU

The EU Open Data Portal (<http://data.europa.eu/euodp/en>) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.

