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**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE AND THE COMMITTEE OF THE REGIONS**

5G for Europe: An Action Plan

{SWD(2016) 306 final}

1. Timely deployment of 5G: a strategic opportunity for Europe

Twenty-four years after the successful introduction of the 2G (GSM) mobile networks in Europe, another revolution is in sight with a **new generation of network technologies**, known as 5G, opening prospects for new digital economic and business models. 5G is not fully standardised yet but its key specifications and technological building blocks are already being developed and tested. 5G is seen as a game changer, enabling industrial transformations¹ through **wireless broadband services provided at gigabit speeds**², the support of new types of applications **connecting devices and objects** (the Internet of Things), and versatility by way of software virtualisation allowing innovative **business models across multiple sectors** (e.g. transport, health, manufacturing, logistics, energy, media and entertainment). While these transformations have already started on the basis of existing networks, they will need 5G if they are to reach their full potential in the coming years.

The Commission strategy for the Digital Single Market (DSM strategy)³ and the *Communication Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society*⁴ underline the importance of very high capacity networks like 5G as a key asset for Europe to compete in the global market. Worldwide 5G revenues should reach the equivalent of €225 billion in 2025⁵. Another source indicates that the benefits of 5G introduction across four key industrial sectors may reach €14 billion/year⁶.

The Commission launched in 2013 a Public-Private-Partnership (5G-PPP) backed by 700 million euro of public funding with the aim of making sure that 5G technology is available in Europe by 2020. However, research efforts alone will not be sufficient to ensure Europe's leadership in 5G. A wider effort is needed to make 5G and the services that will flow from it a reality, in particular for the emergence of a European "home market" for 5G.

The proposed European Electronic Communications Code⁴ will support the deployment and take-up of 5G networks, notably as regards assignment of radio spectrum, investment incentives and favourable framework conditions, while the recently adopted rules on open Internet⁷ provide legal certainty as regards the deployment of 5G applications. This communication complements and leverages this new regulatory framework through a set of targeted actions. These draw on multiple consultations, events with stakeholders⁸, a targeted survey,⁹ several studies,¹⁰ industry consultations¹¹, and early results from the 5G-PPP¹². It

¹ 5G-PPP, 5G Vision, <https://5g-ppp.eu/roadmaps/>

² 5G should offer data connections well above 10 Gigabit per second, latency below 5 milliseconds and the capability to exploit any available wireless resources (from Wi-Fi to 4G) and to handle millions of connected devices simultaneously. Please see section 3 of the accompanying Staff Working Document.

³ <https://ec.europa.eu/digital-single-market/en/digitising-european-industry>

⁴ <https://ec.europa.eu/digital-single-market/en/connectivity-european-gigabit-society>

⁵ <https://www.abiresearch.com/press/abi-research-projects-5g-worldwide-service-revenue/>

⁶ Studying automotive, health, transport and energy sectors: <https://ec.europa.eu/digital-single-market/en/news/study-identification-and-quantification-key-socio-economic-data-strategic-planning-5g>

⁷ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R2120&from=en>

⁸ See: e.g. <https://5g-ppp.eu/event-calendar/#>.

⁹ <https://ec.europa.eu/digital-single-market/en/news/have-your-say-coordinated-introduction-5g-networks-europe>

¹⁰ See footnotes 5 and 6.

¹¹ *Notably the 5G Manifesto for timely deployment of 5G in Europe*, 7 July 2016:

http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=16579.

¹² 5G-PPP, *5G Empowering Vertical Industries*: <https://5g-ppp.eu/roadmaps/>

presents an action plan for timely and coordinated deployment of 5G networks in Europe through a partnership between the Commission, Member States, and industry¹³.

2. The need for a coordinated approach

Since major research efforts are underway worldwide, it is essential to avoid incompatible 5G standards emerging in different regions. If Europe is to help shape a global consensus as regards the choice of technologies, spectrum bands and leading 5G applications effective, EU coordination and planning on a cross-border basis will be needed. The launch of commercial 5G services will also require substantial investments, the availability of a suitable amount of spectrum, and close collaboration between telecom players and key user industries. Network operators will not invest in new infrastructures if they do not see clear prospects for a solid demand and regulatory conditions that make the investment worthwhile. Equally, industrial sectors interested in 5G for their digitisation process may want to wait until the 5G infrastructure is tested and ready.

In this context, a lack of coordination between national approaches concerning the roll-out of 5G networks would create a significant risk of fragmentation in terms of spectrum availability, service continuity across borders (e.g. connected vehicles) and implementation of standards. As a result, it would delay the creation of a critical mass for 5G-based innovation in the Digital Single Market. This is particularly evidenced by the initial delay in the deployment of 4G in Europe: in 2015, more than 75% of the US population had access to 4G/LTE versus only 28% of the EU population¹⁴. Despite the fact that the gap is steadily narrowing, there are still major differences between Member States. This is why the Commission is proposing this action plan, as a means of fostering the adequate coordination. It aims to build momentum for investment in 5G networks and to create new innovative ecosystems, thus enhancing European competitiveness and delivering concrete benefits to society.

The Commission has identified the following key elements for the plan:

- Align roadmaps and priorities for a coordinated 5G deployment across all EU Member States, targeting early network introduction by 2018, and moving towards commercial large scale introduction by the end of 2020 at the latest.
- Make provisional spectrum bands available for 5G ahead of the 2019 World Radio Communication Conference (WRC-19), to be complemented by additional bands as quickly as possible, and work towards a recommended approach for the authorisation of the specific 5G spectrum bands above 6 GHz.
- Promote early deployment in major urban areas and along major transport paths.
- Promote pan-European multi-stakeholder trials as catalysts to turn technological innovation into full business solutions.
- Facilitate the implementation of an industry-led venture fund in support of 5G-based innovation.
- Unite leading actors in working towards the promotion of global standards.

¹³ The Commission's intention to develop a 5G action plan was previously announced in the Communication *Digitising European industry* and in the Communication on *ICT standardisation priorities*.

¹⁴ IDATE DigiWorld Yearbook 2016 & GSMA Report "The Mobile Economy in Europe 2015". The delayed deployment of 4G networks in Europe has often been attributed to a lack of cross-border coordination in Europe.

3. Keeping Europe ahead in the 5G race: key areas for action¹⁵

3.1. A common EU timetable for the introduction of 5G

An ambitious 5G introduction timeline is essential for Europe to have a leading position and to take early advantage of the new market opportunities enabled by 5G, not only in the telecom sector, but in the whole economy and society. Digitisation of European industry should be initiated today on the basis of available resources (notably 4G/LTE, Wi-Fi or satellite) and will be boosted by the gradual adoption of 5G from 2018 onwards. The Commission will assist Member States in the context of their national broadband plans and the Future Internet Forum (FIF) and in collaboration with industry through the 5G-PPP to establish common objectives and concrete steps for testing and deploying 5G¹⁶.

Action 1 — The Commission will work with Member States and industry stakeholders towards the voluntary establishment of a **common timetable** for the **launch of early 5G networks by the end of 2018, followed by the launch of fully commercial 5G services in Europe by the end of 2020**. The common timetable should be developed as quickly as possible. The EU timetable should be driven by the following key objectives:

- Promoting **preliminary trials**, under the 5G-PPP arrangement, to take place **from 2017 onwards**, and **pre-commercial trials** with a clear EU cross-border dimension **from 2018**.
- Encouraging Member States to develop, **by end 2017, national 5G deployment roadmaps** as part of the **national broadband plans**¹⁷.
- Ensuring that **every Member State will identify at least one major city to be "5G-enabled" by the end of 2020**¹⁸ and that **all urban areas and major terrestrial transport paths have uninterrupted 5G coverage by 2025**¹⁹.

3.2. Unlocking bottlenecks: making 5G radio spectrum available

The deployment of 5G networks requires the timely availability of a sufficient amount of harmonised spectrum. A major new requirement specific for 5G is the need for large contiguous bandwidths of spectrum (up to 100 MHz) in appropriate frequency ranges to provide higher wireless broadband speeds. Such bandwidths are only available in spectrum above 6 GHz.

Therefore, the designation of new frequency bands above 6 GHz is on the agenda of the World Radio Conference 2019 (WRC-19), based on a list of candidate bands identified at WRC-15, subject to ITU studies²⁰, with the aim of targeting the widest possible global harmonisation.

¹⁵ All Commission actions likely to have significant impacts will be prepared in line with its Better Regulation standards (e.g. with evaluations, consultation, and impact assessment where appropriate).

¹⁶ Subject to the timely availability of commercial 5G solutions.

¹⁷ As set out in the Communication *Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society*.

¹⁸ As a means to promote the effective establishment of all necessary pre-conditions in all Member States before 2020.

¹⁹ These is the same 2025 connectivity target as set out in the Communication *Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society*. Please see also Action 4.

²⁰ ITU-R Resolution 238, WRC-15.

Pioneer spectrum bands

Member States and the Commission, working together in the Radio Spectrum Policy Group (RSPG), have recognised the importance of the early identification of common EU-wide pioneer spectrum bands to enable 5G take-up as early as in 2018. This is indispensable to give proper guidance to industry and keep the EU on a par with spectrum availability in other regions of the world.

This first set of such pioneer bands should include a mix of spectrum with different characteristics to address the versatile 5G requirements. The identified bands should also have a potential for global harmonisation and take advantage of the sizeable amount of harmonised spectrum already allocated in the EU for wireless broadband below 6 GHz. The spectrum mix should include:

- Spectrum below 1 GHz, focussing on the 700 MHz band: its availability by 2020, as proposed by the Commission, being critical for 5G success²¹.
- Spectrum between 1 GHz and 6 GHz, where EU-wide harmonised bands are already available and licensed in a technology neutral way across Europe. In particular, the 3.5 GHz band²² seems to offer high potential to become a strategic band for 5G launch in Europe.
- Spectrum above 6 GHz, for new and wider bands to be defined, in line with the WRC-19 milestone.

This approach is supported by industry²³, and considered as an adequate response to the developing spectrum plans in competing economies.

Action 2 — The **Commission** will work with **Member States** to identify **by the end of 2016** a provisional list of **pioneer spectrum bands** for the **initial launch of 5G services**. Taking due account of the RSPG Opinion in preparation²⁴, the list should include frequencies in at least three ranges of the spectrum: below 1 GHz, between 1 GHz and 6 GHz, and above 6 GHz, to account for the diverse application requirements of 5G.

Additional spectrum bands

The set of pioneer spectrum bands should be complemented in a next step to reflect 5G spectrum requirements in the longer term. This step should concentrate on identifying 5G spectrum bands above 6 GHz, focusing on the bands on the agenda for WRC-19, while also assessing further opportunities for economies of scale at international level. The potential for spectrum sharing, including under licence-exempt use, should be maximised as it generally supports innovation and market entry, in line with the objectives of the legislative proposals set out in the proposed European Electronic Communications Code. A particular challenge will be to anticipate the diverse 5G use cases in order to properly satisfy all key spectrum requirements.

²¹ Proposal for a Decision of the European Parliament and of the Council on the use of the 470-790 MHz frequency bands in the Union, COM (2016) 43 final.

²² The 3.5 GHz band designates the frequency range from 3.4 GHz to 3.8 GHz subject to the Commission Implementing Decision 2014/276/EU of 2 May 2014 on amending Decision 2008/411/EC on the harmonisation of the 3400 - 3800 MHz frequency band for terrestrial systems capable of providing communications services in the Community.

²³ See the companion Staff Working Document, section 7.

²⁴ Document RSPG 16-031Final, see <http://rspg-spectrum.eu/public-consultations>.

Action 3 — The **Commission** will work with **Member States** to:

- Agree **by end of 2017** on the **full set of spectrum bands** (below and above 6 GHz) **to be harmonised for the initial deployment of commercial 5G networks in Europe**, based on a planned RSPG opinion on 5G spectrum. The final spectrum harmonisation at EU level will be subject to the usual regulatory process once relevant standards have been developed.
- Work towards a **recommended approach for the authorisation of the specific 5G spectrum bands above 6 GHz**, taking due account of the opinions of BEREC and RSPG. An early indication of technical options and feasibility should be available through CEPT studies by end 2017.

3.3. Leveraging fixed and wireless: a very dense network of 5G access points

Addressing the interplay between fibre and wireless deployment requirements

The planned 5G networks are expected to serve up to one million connected devices per square kilometre, about a one thousand fold increase as compared to today. This dramatic surge in the number of devices will also increase traffic per network access point, which will require increasingly smaller cells²⁵ to deliver the planned connectivity performance²⁶ and an increase in the density of antennae deployed.

The small cells will also have to be connected efficiently to the rest of the network with high capacity backhaul communications since the aggregated volume of data that will transit through these small cells will reach several gigabits per second. In most cases, these will be fibre links, while other high capacity wireless backhauling could also be used.

The path towards 5G and the 2025 connectivity objectives for Europe outlined in the *Communication Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society* will therefore rely on more general deployment of high-capacity networks across the continent. The earlier core broadband networks are rolled out the sooner 5G will be available on a large scale.

The magnitude of the required investments can only be met with a closer cooperation between Member States, the financial community and the European Investment Bank (EIB) to mobilise private and public support, and notably to alleviate risks of a digital divide. This will require public and private actors as well as providers and users of connectivity to develop common implementation roadmaps.

On this basis, the Commission calls for a voluntary coordination of implementation roadmaps between relevant public and private actors, in particular to coordinate investments in cellular base stations and fibre infrastructures.

Reducing the cost of installing access points

A simplification of the deployment conditions for dense cellular networks would reduce costs and support investments. The proposed European Electronic Communications Code aims to

²⁵ A cell is the area which is served by a single network access point.

²⁶ 5G-PPP, *View on 5G Architecture*, highlighting the requirement for 100 Gb/s to the aggregation point: <https://5g-ppp.eu/white-papers/>

remove deployment barriers for the installation of small cells, subject to meeting common technical requirements.

Member States should work to eliminate these barriers in the interests of speedy and cost-effective deployment. In addition, other administrative aspects sometimes create unnecessary burdens for the installation of small cells, such as local planning procedures, high site rental charges, the variety of specific limits on electromagnetic field (EMF) emissions and of the methods required to aggregate them²⁷.

Therefore, the Commission will further encourage best practice by national, regional and local authorities in the deployment conditions for small access points..

Action 4 — As part of the development of the 5G national roadmaps, the Commission will work with the industry, the Member States, and other stakeholders to:

- **Set roll-out and quality objectives** for the monitoring of the progress of **key fibre and cell deployment scenarios**, to meet the target of at least **all urban areas²⁸ and all major terrestrial transport paths²⁹**, having **uninterrupted 5G coverage by 2025**.
- Identify **immediately actionable best practice to increase the consistency of administrative conditions and time frames to facilitate denser cell deployment**, in line with the relevant provisions of the proposed European Electronic Communications Code.

3.4. Preserving 5G Global Interoperability: standardisation challenges

Standards at the heart of innovation

Standards are of paramount importance to ensure the competitiveness and interoperability of global telecommunication networks. The communication *ICT standardisation priorities for the Digital Single Market*³⁰ sets out a clear path to foster the emergence of global industry standards under EU leadership for key 5G technologies (radio access network, core network) and network architectures. It also recognises the particular challenges raised by the need to bring together communities of stakeholders with very different standardisation cultures in order to enable the innovative use cases of key industries,

Lately, the international standardisation agenda for 5G has quickly moved forward. The first phase foresees the early availability of standards for ultra-fast mobile broadband solutions³¹.

²⁷ The regional or local limits are sometimes significantly lower than the limits set by existing EU regulations Directive 2013/35/EU - electromagnetic fields of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC).

²⁸ As per definition: http://ec.europa.eu/eurostat/statistics-explained/index.php/European_cities_%E2%80%93_the_EU-OECD_functional_urban_area_definition

²⁹ Motorways and national roads, and railways, in line with the definition of Trans-European Transport Networks. Where appropriate 5G will operate in seamless co-existence with technologies already being deployed, in particular short-range communication for vehicle-to-vehicle and vehicle-to-infrastructure (ITS-G5), under a complementarity principle.

³⁰ COM(2016) 176 final.

³¹ The 3rd Generation Partnership Project (3GPP) qualifies ultra-fast mobile broadband as mobile systems capable of delivering speeds of 20 gigabits per second, at least uni-directionally, and without specific latency requirements.

A second phase should rapidly deliver the standards for other use cases, such as those for industrial applications, and, crucially, make available standards promoting open innovation and opportunities for start-ups.

From an EU strategy perspective, the main challenges identified are as follows:

- The timely availability of 5G standards which are globally accepted, including possible acceleration of the work in 3GPP.
- The initial focus on ultra-fast broadband services should ensure compatibility with further development of standards for innovative use cases related to massive deployment of connected objects and the Internet of Things. The emergence of parallel, potentially conflicting, specifications developed outside global standardisation bodies must be avoided.
- The development of standards for specific needs should be promoted on the basis of experimental evidence, taking advantage of international cooperation and a multi-stakeholder approach. Standards should not overlook potential disruptive use cases (e.g. meshed connectivity).
- The standards must address the future evolution of the overall network architecture and need for "flexibility", in particular in response to new use cases arising in key industrial sectors. These aspects require due consideration for open innovation and opportunities for start-ups.

Member States and industry should therefore endorse, and promote, a comprehensive and inclusive approach to 5G standardisation.

Action 5 — The Commission calls on Member States and the industry to commit to the following objectives regarding the standardisation approach:

- Ensure the **availability of the initial global 5G standards by the end of 2019 at the latest**, so as to enable a timely commercial launch of 5G, and paving the way **for a wide range of future connectivity scenarios** beyond ultra-fast broadband.
- Promote efforts to support a **holistic standardisation approach** encompassing both **radio access** and **core network challenges**, including due consideration for disruptive use cases and open innovation.
- Establish appropriate cross-industry partnerships, by the end of 2017, to support **the timely definition of standards backed by industrial user experiments**, including through the leveraging of international cooperation partnerships, in particular for the **digitisation of industry**.

3.5. 5G innovation in support of growth

Stimulating new connectivity-based ecosystems through experiments and demonstrations

The acceleration of the digitisation process in several key industrial sectors based on 5G connectivity, as well as the advent of novel business models, will require closer partnerships between the concerned sectors and the telecommunication sector. While a few markets will naturally lead innovation³² and attract most of the initial investments, a number of sectors recognise the need to run pilot trials to increase predictability, reduce investment risks, and

³² See section 5 of the accompanying Staff Working Document.

validate both the technologies and the business models. Experiments are also needed to provide input for the standardisation organisations.

Against this background, the Commission proposes to put greater emphasis on pilots and experiments in the run-up to 5G, notably through the 5G-PPP. In addition, the Commission will work towards the **deployment of selected 5G trials with a clear EU dimension from 2018**. The Commission counts on the trial results to be able to identify and address specific sectorial policy issues and seek the active support of Member States to resolve them whenever they constitute a major obstacle to high value applications relying on 5G³³.

Where possible, 5G experiments should make use of facilities already developed in the context of activities conducted in Member States³⁴. The Commission will also work with a **Focus Group**³⁵ including players in relevant industrial sectors to assess results and carry out gap analysis of 5G trials in Europe. Finally, there is a need to ensure that hardware, terminals³⁶ and devices based on 5G connectivity are available in due time before 2020 to encourage uptake and demand.

Action 6 — To foster the emergence of digital ecosystems based on 5G connectivity, the **Commission calls upon the industry** to:

- **Plan for key technological experiments to take place as early as in 2017**, including the testing of new terminals and applications through the 5G-PPP, demonstrating the benefit of 5G connectivity **for important industrial sectors**.
- **Present detailed roadmaps by March 2017 for the implementation of advanced pre-commercial trials** to be promoted at EU level (trials in key sectors must be launched in 2018 in order to ensure Europe leadership in the context of the accelerated global agenda for the introduction of 5G).

The public sector as an early adopter and promoter of 5G connectivity-based solutions

Public services may be an early adopter and a promoter of 5G connectivity-based solutions, encouraging the emergence of innovative services, contributing to a critical mass of investment, and addressing issues of importance for society. For instance, such a role could involve migrating public safety and security services from existing proprietary communications platforms³⁷ to commercial 5G platforms which will be even more secure, resilient and reliable³⁸.

Action 7 — **The Commission encourages Member States** to consider **using the future 5G infrastructure** to improve the performance of **communications services used for public**

³³ See section 6 of the accompanying Staff Working Document.

³⁴ The Future Internet Forum of Member States (FIF) could also support such EU synergies given the national dimension of many of the potential applications of 5G.

³⁵ Such Focus Group has to be defined in collaboration with the concerned industry sectors, starting from the existing CEO Round Table on 5G.

³⁶ Not only smart phones but also a full range of Internet of Things and connected devices (cars, drones, urban furniture, etc).

³⁷ e.g. TETRA, GSM-R.

³⁸ According to network technology suppliers, the new platforms could be a virtual slice on a shared 5G public network or a separate network using standardised 5G technology and appropriate parameters, or a combination of both.

safety and security, including shared approaches in view of the future procurement of advanced broadband public protection and disaster relief systems.³⁹ Member States are encouraged to include this consideration in their national 5G roadmaps.

A venture financing initiative to stimulate 5G innovation and take-up

5G networks will lower market-entry barriers for customised communications service in multiple sectors, by giving controlled access to real or virtual network resources without the need to own a whole network infrastructure⁴⁰. As a consequence, new innovation models, and new ecosystems, should arise on top of communication services, following a model similar to that of cloud computing platforms, or even the Internet. This also means that service experimentation by "trial and error" will play a bigger role than in the traditional, more linear research and development model that has dominated network innovation so far. This new environment should create opportunities for smaller companies and start-ups.

In order to trigger the new 5G innovation ecosystems, industry suggested setting up a specific **5G venture financing facility**⁴¹, to support **innovative European start-ups**⁴² aiming to develop 5G technologies and related new application **across industrial sectors**. This could foster substantial digital innovation at European scale, beyond connectivity. The modalities for this financing capacity will have to be further specified to determine the appropriate financial instruments and avoid overlaps with venture financing opportunities already available for the digital sector.

Action 8 — The Commission will work with the industry and the EIB Group⁴³ to identify the objectives, possible configuration, and modalities for a **venture financing facility**, possibly linked with other digital start-up actions. The **feasibility should be assessed by the end of March 2017**, taking into account the possibility to enhance **private funding by adding several sources of public funding** in particular from the European Fund for Strategic Investments (EFSI) and other EU financial instruments.

4. Conclusion

The European Union is at the beginning of an important journey to develop the backbone of digital infrastructure that will support future competitiveness. It has already taken bold steps to develop world-class 5G technological know-how. It is now time to move up a gear and reap the benefits of public and private investment for the economy and society. The 5G action plan adopts an ambitious approach and requires united and sustained commitment of all parties: the EU institutions, the Member States, industry and the research and financial communities. The

³⁹ PPDR infrastructure typically supports services for the police and fire brigades.

⁴⁰ Network slicing. This technology also allows to provide various levels of service quality and reliability over the same physical network.

⁴¹ *5G Manifesto for timely deployment of 5G in Europe*.

⁴² The proposed financing facility is different from the broadband fund proposed in the Communication *Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society*, as it focuses on innovation financing and smaller actors.

⁴³ Including the European Investment Fund (EIF), which has special responsibility within the EIB Group regarding the financing of small and medium enterprise (SMEs).

impact of the proposed plan will be further enhanced by the combined effect of the "connectivity" targets set out in the Communication *Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society* and the proposed measures of the European Electronic Communications Code.

The European Parliament and the Council are called upon to endorse this 5G Action Plan.