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This document has been written by experts from members of the 5G Infrastructure Association. It represents the best of their expert knowledge to date and aims to provide a perspective on the development of 5G in Europe. This document is released in February 2015.

Updates will be made regularly and are available for download at www.5g-ppp.eu/roadmaps .

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5G Vision

The 5G Infrastructure Public Private Partnership:
the next generation of
communication networks and services.

5G infrastructure

Smart network convergence

An open ecosystem for innovation

Better sustainability and scalability

Business models based on shared resources

New network and service capabilities

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EXECUTIVE SUMMARY

Future European society and economy will strongly rely on 5G infrastructure. The impact will go far beyond existing wireless access networks with the aim for communication services, reachable everywhere, all the time, and faster. 5G is an opportunity for the European ICT sector which is already well positioned in the global R&D race. 5G technologies will be adopted and deployed globally in alignment with developed and emerging markets' needs.

Key drivers

5G will not only be an evolution of mobile broadband networks. It will bring new unique network and service capabilities. Firstly, it will ensure user experience continuity in challenging situations such as high mobility (e.g. in trains), very dense or sparsely populated areas, and journeys covered by heterogeneous technologies. In addition, 5G will be a key enabler for the Internet of Things by providing a platform to connect a massive number of sensors, rendering devices and actuators with stringent energy and transmission constraints. Furthermore, mission critical services requiring very high reliability, global coverage and/or very low latency, which are up to now handled by specific networks, typically public safety, will become natively supported by the 5G infrastructure.

5G will integrate networking, computing and storage resources into one programmable and unified infrastructure. This unification will allow for an optimized and more dynamic usage of all distributed resources, and the convergence of fixed, mobile and broadcast services. In addition, 5G will support multi tenancy models, enabling operators and other players to collaborate in new ways.

Leveraging on the characteristic of current cloud computing, 5G will push the single digital market further, paving the way for virtual pan European operators relying on nationwide infrastructures.

5G will be designed to be a sustainable and scalable technology. Firstly, the telecom industry will compensate tremendous usage growth by drastic energy consumption reduction and energy harvesting. In addition, cost reduction through human task automation and hardware optimization will enable sustainable business models for all ICT stakeholders.

Last but not least, 5G will create an ecosystem for technical and business innovation. Since network services will rely more and more on software, the creation and growth of startups in the sector will be encouraged. In addition, the 5G infrastructures will provide network solutions and involve vertical markets such as automotive, energy, food and agriculture, city management, government, healthcare, manufacturing, public transportation, and so forth.

5G disruptive capabilities

5G will provide an order of magnitude Improvement in performance in the areas of more capacity, lower latency, more mobility, more accuracy of terminal location, increased reliability and availability. 5G will allow the connection of many more devices simultaneously and to improve the terminal battery capacity life. Lastly, 5G will help European citizens to manage their personal data, tune their exposure over the Internet and protect their privacy.

5G infrastructures will be also much more efficient. The enhanced spectrial efficiency will enable 5G systems to consume a fraction of the energy that a 4G mobile networks consumes today for delivering the same amount of transmitted data. 5G will reduce service creation time and facilitate the integration of various players delivering parts of a service. Lastly, 5G systems will be built on more efficient hardware. The ultra-efficient 5G hardware will be energy aware, very flexible and interworking in very heterogeneous environments. The increased efficiency of the 5G infrastructure will allow costs to be dramatically reduced.

Design principles

5G design will ensure high flexibility and be driven by a service approach. The network shall flexibly and rapidly adapt to a broad range of usage requirements and deliver converged services preserving security and privacy across a versatile architecture with unified control of any type of ICT resources.

Since 5G will enable new business models in a programmable manner, Application Programming Interfaces (APIs) should be available at different levels (resources, connectivity and service enablers) to support a variety of network and service application developers.

Key technological components

5G wireless will support a heterogeneous set of integrated air interfaces: from evolutions of current access schemes to brand new technologies. 5G networks will encompass optical, cellular and satellite solutions. Seamless handover between heterogeneous wireless access technologies will be a native feature of 5G, as well as use of simultaneous radio access technologies to increase reliability and availability. The deployment of ultra-dense networks with numerous small cells will require new interference mitigation, backhauling and installation techniques.

5G will be driven by software. Network functions are expected to run over a unified operating system in a number of points of presence, especially at the edge of the network for meeting performance targets. As a result, it will heavily rely on emerging technologies such as Software Defined Networking (SDN), Network Functions Virtualization (NFV), Mobile Edge Computing (MEC) and Fog Computing (FC) to achieve the required performance, scalability and agility.

5G will ease and optimize network management operations. The development of cognitive features as well as the advanced automation of operation through proper algorithms will allow optimizing complex business objectives, such as end-to-end energy consumption. In addition, the exploitation of Data Analytics and Big Data techniques will pave the way to monitor the users Quality of Experience through new metrics combining network and behavioral data while guaranteeing privacy.

Spectrum considerations

It is expected that 5G access networks for some services will require very wide contiguous carrier bandwidths (e.g. hundreds of MHz up to several GHz) to be provided at a very high overall system capacity. To support the requirements for wide contiguous bandwidths, higher carrier frequencies above 6 GHz need to be considered. The consideration of any new bands for such services will require careful assessment and recognition of other services using, or planning to use, these bands. Maintaining a stable and predictable regulatory and spectrum management environment is critical for the long term investments. Research on this spectrum has to take into account long-term investments so that they can be preserved. The exclusive mobile licensed spectrum assignment methods will remain important even if new techniques may be envisaged to improve spectrum utilization under some circumstances.

Timeline

The start of commercial deployment of 5G systems is expected in years 2020+. The exploratory phase to understand detailed requirements on future 5G systems and to identify the most promising technical options has already started. Although several standardization bodies will potentially be involved in the 5G definition, 3GPP will be most probably the focal point for technical specifications, with 5G study items starting from 2015.