



5 x 5G

Five things you need to know about 5G
and what it delivers

The NGMN Alliance Operators' perspective

next generation mobile networks

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Executive Summary:

In February 2015, NGMN published its White Paper on 5G – setting the vision and requirements for the Next Generation of Mobile Networks. It was built around a broad variety of use cases and anticipated the application of mobile networks in multiple industries, building on highly innovative technologies and architectures.

Based on an ambitious Work Programme, the requirements for 5G were defined by the NMGN Partners and subsequently moved into standardisation.

With the completion of the first step of the 5G (NSA) standard by 3GPP in December 2017, an important milestone of this journey has been achieved.

This document, authored by the NMGN Board of global operator executives, presents the view of the NMGN Members with respect to the progress achieved, the expectations on further evolution of the technology and the first steps to market that will happen in 2018. NGMN is positive about the potential of the technology and achievements at this point in time and believes that the objective for commercial rollouts on a global scale by 2020 can be met, despite a number of challenges that have still to be addressed.

- 1. 5G will provide communication capabilities far beyond current networks and support a much wider ecosystem with a broad set of use cases and applications**
- 2. 5G is evolutionary - with the potential for revolutionary applications**
- 3. 5G brings favourable economics by new technologies and appropriate deployment scenarios**
- 4. 5G will come soon - by the end of 2018, first commercial 5G equipment will be available**
- 5. The work is not done yet: NGMN activities are focusing on key challenges for successful 5G delivery**



1 5G will provide communication capabilities far beyond current networks and support a much wider ecosystem with a broad set of use cases and applications

5G will provide a significantly enhanced and consistent user experience. It will ultimately bring a step change in the capability of the networks to deliver new mobile applications and enriched video content.

The new 5G capabilities will not only deliver increased network capacity and support much faster connection speeds to end users. The technology will support new services and applications and will enable further convergence of fixed and mobile networks to deliver the best possible experience to customers wherever they are located.

5G introduces a new technology paradigm: Unlike today, where networks deliver the same capabilities and performance to everyone everywhere, 5G is a multi-service network that will deliver tailored capabilities and performance for a specific need at a given point in time and location. To ensure quality, every service will get its specific slice of the network and network virtualization capabilities will enable the provision of services-on-demand.

5G will enable transformational use cases and business models, bringing new opportunities to work in partnership with “vertical industries” such as Automotive, Transport, Health, Manufacturing, Smart cities etc. to deliver new and innovative solutions. The 5G network capabilities, such as ultra high throughput, low latency and support for large numbers of machine type devices (IoT) will provide new business and revenue opportunities. Service to verticals will be provided in an incremental way, starting from LTE to full 5G capabilities and can be delivered in new ways, e.g. Infrastructure or Platform as a Service (IaaS, PaaS).

To reach its potential, 5G will require all stakeholders, including government and regulatory bodies to work on enabling 5G adoption and the full ecosystem (e.g. spectrum availability, streamlined deployment regulations, innovation friendly regulatory environment etc.) thus stimulating expansion of mobile technologies to new verticals and providing a revenue boost for the overall economy.



2 5G is evolutionary - with the potential for revolutionary applications

5G is not going to be an over-night revolution, but will provide an evolutionary path for the network operators and end users.

5G will build on the foundations of 4G. Many capabilities originally targeted for 5G will already be delivered through evolved 4G technology including lower latency, higher speeds approaching 1 Gbps and the ability to connect machines / IoT devices at low cost with extended range and low power consumption. 5G New Radio access technology will initially provide efficient and complementary connectivity to existing 4G networks where it is deployed and will eventually replace these just as 4G has begun to replace previous technology generations (2G/3G) and re-farm their spectrum bands.

Capabilities will arrive in stages in specific places for specific use cases, augmenting existing technology deployments. The evolution will follow regional dynamics due to the availability of spectrum, capacity needs, business opportunities and macro economical factors, so every network will evolve at its own pace.

- 5G will initially focus on delivering eMBB use cases, complementing the existing 4G deployments and providing a leap in data rates, and capacity.
- Targeted use cases like fixed wireless and industrial IoT (massive machine type communication) will leverage new 5G capabilities locally
- Higher throughput and low-latency capabilities will evolve, enabling new applications and services, e.g. autonomous transportation or automation
- New types of devices will make use of the enhanced 5G capabilities to support e.g. augmented / virtual reality

Service to vertical industries will be provided in a similarly incremental way, starting from LTE to full 5G capabilities. Network slicing and Service-based Architecture will become a key enabler of these services. Enablers like telco cloud and Mobile Edge Computing for supporting latency sensitive use cases etc. will pave the way towards a full 5G ecosystem.



3 5G brings favourable economics by new technologies and appropriate deployment scenarios

5G will transform the network economics, which is of critical importance given traffic growth, and will bring further important societal benefits, both through lowering cost of service and promoting improved sustainability. Investments in 5G network technology and new capabilities will progress over time and will reflect continued evolution of 5G standards and the timely availability of new spectrum bands, both licensed and unlicensed.

Due to the evolutionary character, Operators expect that 5G will provide a smooth migration and cost-effective path from 4G so that return on incremental investment is maximized as much as possible. 4G capabilities will continue to provide area coverage with sufficient speed for many applications for some time. The early deployment of 5G is likely to co-operate with 4G by building on rather than replace it, leveraging network investments including base station sites, backhaul and developments in core network capabilities.

The combination of increased carrier bandwidth and the promise of “Massive MIMO” antenna technology gives 5G significant potential to reduce the cost-per-bit versus 4G. With the combination of macro- and small cell base stations, this allows macro cell based mobile networks to keep pace with increasing traffic demand whilst maintaining good customer experience and network economics. This is a fundamental benefit regardless of use case considerations and provides 5G with a solid commercial rationale and an important role in the digital economy.

On the operational side, the convergence of IT and network technology, driven by virtualisation and cloud technologies, will enable higher automation and operational efficiencies. On-going improvements in energy efficiency will improve sustainability and cost.

Due to the benefits, operators are incentivised to deploy 5G in order to satisfy mobile data demand, which in turn is good for customers because they get a better service as data consumption continues to rise. 5G also offers enhanced support for massive IoT and URLLC use cases, therefore in terms of efficiency, 5G surpasses 4G in cost per bit as well as cost per connection. As a result, 5G provides a positive NPV both for traditional and new business opportunities – assuming of course that the industry is delivering against these needs and growth of traffic and new applications continue.



4 5G will come soon - by the end of 2018, first commercial 5G equipment will be available

The industry is now in a preparation phase. Standardisation is developing well with good quality and progress. Owing to the aggressive commercialization plans in some countries, 3GPP has accelerated its standardisation work. The first version of the 3GPP specification, covering the physical layer and “Non-Standalone” operation of 5G (using 4G as an anchor), was successfully completed in December 2017. The full Release 15 specification is expected on track for publication in June 2018, trials of commercial equipment featuring 5G New Radio conformant to 3GPP R15 standards are expected for late 2018. There is also a clear roadmap to bring enhancements to the standards, including the full 5G core network.

Just like LTE, deployments will be staged. We anticipate the first commercial grade network equipment for certain 5G spectrum based on the 3GPP standard to be available for deployment in operator networks in late 2018, with fixed wireless access CPEs available in late 2018 and first mobile handsets expected to arrive in 2019. Due to regional differences in these timelines, it is important not to jeopardise the goal of one global standard.

The scale of 5G deployment in this time period is likely to remain limited to dense urban areas / major population areas, driven by demands for capability uplift and handset penetration, using 4G to complete coverage.

Time will be needed to deploy equipment and tune networks, all this depending on 5G spectrum availability. It is likely that we will see first 5G deployments and commercial offerings in 2020 in some countries.

Going forward, there will be rapid updates and future releases of the 3GPP standards which will enable operators to fulfil the complete 5G vision.



5. The work is not done yet: NGMN activities are focusing on key challenges for successful 5G delivery

Trial and Testing:

The key building blocks for 5G need to be proven through industry level trials and testing, including the performance of Massive MIMO in realistic network deployment scenarios.

5G needs to deliver value across a range of frequency bands with very different performance characteristics, tailored to different use cases. Three main bands are in focus for initial 5G deployment: sub 1GHz, 3.3-4.2 GHz and 26-28 GHz. Higher frequencies support wider bandwidth and higher throughput than lower frequencies, and allow use of massive MIMO to achieve beamforming gains, but lower frequencies enjoy greater propagation coverage such as outdoor to indoor penetration. Combining the best of these characteristics to maximise performance and customer benefits will be a prime focus in the coming months, and will form part of NGMN's trial and testing initiative.

End to End Architecture

The end to end architecture will enable the 5G platform to dedicate resources and deliver necessary quality and services or features to specific customers, for example emergency services requirements, via "network slicing" without having to build multiple dedicated networks. This is a key element of 5G and consequently, a major item in NGMN's Work Programme that continues through the evolution of standards (3GPP R16 and beyond). This also includes the security challenges - 5G will provide best in class security capabilities indispensable for vertical industries.

One Global Standard

The technical specifications for 5G are based on a single global standard, which is key to fulfil the "global" 5G promise. The earlier risk of regional fragmentation has been successfully mitigated and 5G stands to benefit from significant economies of scale, interoperable technology solutions, undiluted R&D investment and a developing eco-system across multiple industries. Focus must be kept on the completeness of the standard (Stand-Alone and Non-Stand-Alone) to deliver against this goal, including activities beyond 3GPP. Similar to 4G, NGMN will continue to push for a single global standard.

Spectrum

New and globally harmonised spectrum bands are needed in both sub-6GHz and above 24GHz bands in order to deliver the full range of new 5G capabilities. It is important to avoid fragmented and narrow spectrum assignments to efficiently deliver the best customer experience, noting that 3GPP initially cites carrier channel bandwidths for 5G new radio (5G NR) of up to 100MHz wide below 6GHz and 400 MHz wide above 24GHz.

NGMN is providing guidance to the global spectrum allocation on a continuous basis to ensure that 5G will be able to work seamlessly and globally