# The Evolution to 6G

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With the evolution of 5G well underway, the world's eyes are already looking forward to the potential of 6G. Demands resulting from innovative use cases, for instance specific requirements from different industries and other user groups, as well as overarching goals like sustainability, are driving the standardization and development of mobile technologies.

With the first wave of successful 5G rollouts having taken place already, focus is still required on reaching the full potential of 5G. Only then will it be feasible to fully consider the needs and possibilities of a sixth generation of mobile network that is currently on the horizon.
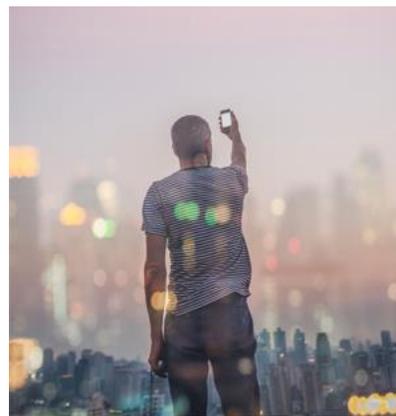
The standards for 5G

In March 2015, the first set of end-to-end requirements for 5G was agreed upon with the publication of the first NGMN 5G White Paper. The groundwork was laid for a global, open, and free-of-fragmentation ecosystem, resulting in the first commercial solutions being available today.

Jump forward to July 2020, when the status of 5G was reviewed for another leading message to the mobile industry, published as the second NGMN 5G White Paper. The conclusion of the review was that a number of areas require an increased focus of standardization by organizations and industry players.

Over the last few years, virtualization, cloud, and edge computing became highly important for mobile network operators, promising a new level of agility and scalability. To best meet user demand, operators in the NGMN Alliance strive for global standards with open and interoperable

interfaces and APIs, requesting a common operator platform architecture to allow edge computing to be used on a global scale. Also, mobile network operators see that partnerships with vertical industries will be mutually beneficial for both parties, especially when realizing the full potential that 5G can deliver to the verticals.

The NGMN Alliance urges the worldwide research community to focus on the societal and environmental challenges currently seen or expected in the near future, expecting that future wireless systems can help to address these. Research on new technologies to support these efforts is being encouraged, with future network architectures looking beyond 5G and toward 6G.

Looking at the timeframe of 2030 and later, an increased focus needs to be given to further improving energy efficiency, sustainability, social well-being, trust, and digital inclusion.

Creating a greener telecommunications future

Now is the time to rethink how to build, operate and manage networks and devices in a more holistic, smarter, and sustainable way. Sustainability and energy efficiency are becoming top priorities for our industry.

Although watts per bit is much lower for 5G than 4G, with 5G specifications already introducing new means like advanced sleep modes, overall power consumption is a concern that is prevalent within the industry now. However, the scope of this NGMN activity is much broader.

End-to-end services footprint

Lifecycle assessment is the method to assess environmental footprint. It is a promising methodology that allows for the consideration of environmental indicators directly linked to the entire product lifecycle. With this methodology, the project is considering not only the energy consumed during service but also the production and disposal of equipment used to provide the service. This is a more comprehensive view of overall energy spent for providing the service needs to be taken. This is being achieved not only by looking at equipment and hardware in detail but also through considering virtualization, software and functions, network design and artificial intelligence, impacts of terminals, and many other aspects.

Eco-design requirements

A very precise list of requirements—drilling into even the component or material level—needs to be produced. While this is currently being done for gateways, set-top boxes, or Wi-Fi repeaters, a similar effort for network equipment is still missing and would provide comprehensive knowledge on how to reduce the overall environmental footprint.

Network energy efficiency

The evolution to 5G has seen different mobile generations introduce different energy-efficiency features that have allowed control of the network energy consumption. As an example, 5G has introduced the advanced sleep modes, an efficient energy-saving technique. The sleep modes allow a network to dynamically adapt to the traffic demand and therefore to consume electricity only when needed. This interesting path should be continually explored as we move forward to 6G—but it is not sufficient. The industry is now considering additional advanced green features for the network to save energy. Another methodology to save energy might be real-time network dimensioning by using forward-looking new technologies like artificial intelligence.

On-board metering

While the focus in the above sections was on reduction of energy consumption, the telecommunications industry should also be looking at operations, and in this regard specifically at measurement of energy consumption in every part of the network. This is fundamental in order to control and reduce the energy consumption overall. It helps with identification of energy-intensive areas of the network to optimize them. Network operators require data metering in the broadest sense, for example in all the technical elements they operate. This data could thus be fed back, allowing operators more complete optimization possibilities for temperatures, fuel consumption, air-conditioning power consumption, photovoltaic power generation, and more.

The adoption of green techniques, including a common methodology for end-to-end life cycle analysis and eco-design of products, will take time. Therefore, the goal should not be specifically looking at 5G for realization of all the above-mentioned features and recommendations but be generation-agnostic in the sense of being forward-looking enough to be applicable as we move towards 6G, too.

6G vision and drivers

Experience shows that a mobile network generation typically needs eight to ten years from design, standardization, and development, to commercial availability and deployments, although we are getting faster and faster. Hence, it is not too early to start work on 6G. However, the telecommunication industry needs to improve inclusion of users and their needs when establishing requirements for a new generation. In short, we need to consider societal needs *and* operational requirements. The industry will require early and timely direction for global 6G activities, which will develop the mobile network technology representing a future evolution of networks and services. In addition, operators are in a unique position to engage with end users, including in vertical industries as well as in user groups representing societal needs.

Operators' views should be emphasized and represented by identifying a set of high-level business drivers, including social responsibility aspects *and* operational aspects required by mobile network operators and developing requirements by taking a customer-centric view.

The focus needs to be first on understanding drivers and developing a vision for 6G. For this it is very important to initiate a dialogue with different organizations representing societal and user groups.

It will be important to identify how digitalization can benefit them in every aspect, including environmental considerations. Further, social challenges that the United Nations' Sustainable Development Goals (UN SDGs) have identified will be considered as drivers for 6G. Starting with vision and drivers, use cases and end-to-end system requirements for 6G will follow. Actively engaging with different stakeholders, monitoring external 6G activities and facilitating bilateral exchange with the wider ecosystem at the right time will drive the successful implementation of 6G.

Industry-wide collaboration

The NGMN Alliance has provided industry-wide guidance on 4G and 5G, supporting global alignment as well as ensuring that next-generation mobile networks meet the ecosystem requirements and, ultimately, satisfy customer demand and expectations. NGMN is dedicated to once again providing impactful guidance to the industry for the development of the next generation, 6G. NGMN's 6G Vision and Drivers project, launched in October 2020, intends to provide such guidance beyond 5G and into the realm of 6G.

As it continues to support implementations and further development of 5G to maximize the benefit of its potential, NGMN's goal is to remain at the forefront of mobile network technology requirements. It is therefore essential to start anticipating the future societal needs and define the drivers for mobile communications. As a result, the NGMN Alliance's Green Future Networks project is not specifically looking at 5G to meet sustainability goals but is already considering the potential of 6G to help achieve a greener future for telecommunications.

Alongside network operators, vendors, and research associations, NGMN has set the requirements of 4G and 5G and will continue to provide guidance for the next generation of mobile networks with 6G on the horizon. In this context, NGMN will also facilitate an information exchange within its internal partnerships and relevant external stakeholders.