6G

6G (sixth-generation wireless) is the successor to 5G cellular technology. 6G networks will be able to use higher frequencies than 5G networks and provide substantially higher capacity and much lower latency. One of the goals of 6G internet will be to support one microsecond-latency communication. This is 1,000 times faster -- or 1/1000th the latency -- than one millisecond throughput.

The 6G technology market is expected to facilitate large improvements in imaging, presence technology and location awareness. Working in conjunction with artificial intelligence (AI), the computational infrastructure of 6G will autonomously determine the best location for computing to occur; this includes decisions about data storage, processing and sharing.

What are the advantages of 6G over 5G?

6G is expected to support data rates of 1 terabyte per second. Access points will be able to serve multiple clients simultaneously via orthogonal frequency-division multiple access. This level of capacity and latency will extend the performance of 5G applications and expand the scope of capabilities to support innovative applications in wireless connectivity, cognition, sensing and imaging.

6G's higher frequencies will enable much faster sampling rates, in addition to providing significantly better throughput and higher data rates. The combination of sub-mm waves (e.g., wavelengths smaller than one millimeter) and frequency selectivity to determine relative electromagnetic absorption rates could potentially lead to significant advances in wireless sensing technology.

Mobile edge computing (MEC) will be built into all 6G networks, whereas it must be added to existing 5G networks. Edge and core computing will be more seamlessly integrated as part of a combined communications/computation infrastructure framework by the time 6G networks are deployed. This approach will provide many potential advantages as 6G technology becomes operational, including improved access to AI capabilities.

When will 6G internet be available?

6G internet is expected to launch commercially in 2030. The technology makes greater use of the distributed radio access network (RAN) and the terahertz (THz) spectrum to increase capacity, lower latency and improve spectrum sharing. While some early discussions have taken place to define 6G, research and development (R&D) activities started in earnest in 2020.

China, for instance, launched a 6G test satellite equipped with a THz system, while technology giants Huawei Technologies and China Global reportedly plan similar 6G satellite launches in 2021. Many of the problems associated with deploying millimeter wave radio for 5G must be resolved in time for network designers to address the challenges of 6G.

How will 6G work?

It's expected that 6G wireless sensing solutions will selectively use different frequencies to measure absorption and adjust frequencies accordingly. This method is possible because atoms and molecules emit and absorb electromagnetic radiation at characteristic frequencies, and the emission and absorption frequencies are the same for any given substance.

6G will have big implications for many government and industry approaches to public safety and critical asset protection such as:

- threat detection;
- health monitoring;
- feature and facial recognition;
- decision-making in areas like law enforcement and social credit systems;
- air quality measurements; and
- gas and toxicity sensing.

Improvements in these fields would also benefit mobile technology, as well as emerging technologies such as smart cities, autonomous vehicles, virtual reality and augmented reality.

Who is working on 6G technology?

The race to 6G will draw the attention of many industry constituents, including test and measurement vendor Keysight Technologies, which has committed to its development. This may well make the race to reach 5G look minor compared to the wait to see which countries dominate the 6G technology market and its related applications and services.

The major projects underway, include the following:

The University of Oulu in Finland has launched the 6Genesis research project to develop a 6G vision for 2030. The university has also signed a collaboration agreement with Japan's beyond 5G Promotion Consortium to coordinate the work of the Finnish 6G Flagship research on 6G technologies.

- South Korea's Electronics and Telecommunications Research Institute is conducting research on the terahertz frequency band for 6G and envisions data speeds 100 times faster than 4G LTE networks and five times faster than 5G networks.
- China's Ministry of Industry and Information Technology is investing in and monitoring 6G research and development in the country.
- The U.S. Federal Communications Commission (FCC) in 2020 opened up 6G frequency for spectrum testing for frequencies over 95 gigahertz (GHz) to 3 THz.
- Communications companies Ericsson (Sweden) and Nokia (Finland) are spearheading Hexa-X, a newly formed consortium in Europe of academic and industry leaders working to advance 6G standards research.

Vendor commitments to 6G include major infrastructure companies such as Huawei, Nokia and Samsung, which have all signaled that they have R&D in the works.

Future scope of 6G networks

About 10 years ago, the phrase "Beyond 4G (B4G)" was coined to refer to the need to advance the evolution of 4G beyond the LTE standard. It was not clear what 5G might entail, and only pre-standards R&D level prototypes were in the works at the time. The term *B4G* lasted for a while, referring to what could be possible and potentially useful beyond 4G. Ironically, the LTE standard is still evolving and some aspects will be used in 5G.

Similar to B4G, beyond 5G (B5G) is seen as a path to 6G technologies that will replace fifth-generation capabilities and 5G applications. 5G's many private wireless implementations involving LTE, 5G and edge computing for enterprise and industrial customers have helped lay the groundwork for 6G.

Next-generation 6G wireless networks will take this one step further. They will create a web of communications providers -- many of them self-providers -- much in the way that photovoltaic solar power has brought about co-generation within the smart grid.

Data centres are already faced with big changes due to 5G, such as virtualization, programmable networks, edge computing and issues surrounding simultaneous support of public and private networks. For example, some business customers may want a combination of on-premises RAN with hybrid on-premises and hosted computing -- for edge and core computing, respectively -- and data center-hosted core network elements for private business networks or alternative service providers.

6G radio networks will provide the communication and data gathering necessary to accumulate information. However, a systems approach is required for the 6G technology market. It will include data analytics, AI and next- generation computation capabilities using HPC and quantum computing.

In addition to profound changes within the RAN, the core communications network fabric will also transform as many new technologies converge with 6G. Notably, AI will take center stage with 6G. Also, there is potential for a so-called nano-core to emerge as a common computing core that encompasses elements of HPC and AI. Assuming this vision is realized, the nano-core does not need to be a physical network element, but rather a logical collection of a web of computational resources, shared by many networks and systems.

6G networks will create substantially more data than 5G networks, and computing will evolve to include coordination between edge and core platforms. In response to those two changes, data centers will have to evolve. 6G capabilities in sensing, imaging and location determination will generate vast amounts of data that must be managed on behalf of the network owners, service providers and data owners.

-Prof. Ashwini Haryan