6G WIRELESS TECHNOLOGIES USING RADIO ACCESS NETWORKS

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Abstract: Wireless and Telecommunication have become an integration part of each other to provide wireless communication that helps people located in any part of the world communicate easily. Wireless communication technology uses Infrared , radio waves, satellitefor exchanging information .For example, GPS, Wi-Fi, satellite television, wireless computer parts, wireless phones that include 3G and 4G networks, and Bluetooth. Mobile-phone technology has changed the way humans understand and interact with the world and with each other. It's hard to considerof a technology that has more strongly shaped 21st-century living.

The latest technology—the fifth generation of mobile standards, or 5G—is currently being deployed in select locations around the world. The paper discusses about what factors will drive the development of the sixth generation of mobile technology? How will 6G differ from 5G? Advantages and disadvantages of 6G.

Introduction

6G (sixth-generation wireless) is the beneficiary to 5G cellular technology.6G networks will have the power of higher frequencies, lower latency, and high capacity than the 5G networks. One of the goals of the 6G Internet will be to support one micro-second latency communications, representing 1,000 times faster -- or 1/1000th the latency -- than one millisecond throughput.

The 6G technology market is expected to make possible large improvements in the areas of imaging, present technology and location awareness. Working in conjunction with AI, the computational infrastructure of 6G will be able to autonomously determine the best location for computing to occur; this includes decisions about data storage, processing and sharing.

The goal of 6G is to fulfil 5G vision as well as to meet following.

- Intelligent connectivity called wisdom connection with the help of AI (Artificial Intelligence)
- Depth connection (Deep connectivity)
- Holographic connection (Holographic connectivity) refers to seamless coverage anywhere using AR (Augmented Reality)/VR (Virtual Reality)
- Ubiquitous connection (Ubiquitous connectivity) to cover Space, Air, Ground and Sea.

Evolution Of Technology

Simply, the "G" stands for "GENERATION". When a user connected to internet, the speed is depends upon the signal strength that has been shown in alphabets like 2G, 3G, 4G etc. Up right next to the signal bar on your home screen. Every Generation is stated as a group of mobile network standards, which feature the technological execution of a particular mobile system. The speed increases and therefore the technology wont to achieve that speed also changes. For example, 1G offers 2.4 kbps, 2G offers 64 Kbps and is based on GSM, 3G offers 144 kbps-2 mbps whereas 4G offers 100 Mbps - 1 Gbps and is based on LTE technology .

The aim of wireless communication is to provide high quality, reliable communication just like wired communication(optical fibre) and each new generation of services represents a big step(a leap rather) in that direction. This evolution journey was started in 1979 from 1G and its still continuing to 5G. Every Generation has quality that has to be met to public usethe G terminology. There are institutions in charge of standardizing each generation of mobile technology. Every generation has requirements like throughput, delay, etc. that need to be met to be considered part of that generation. Each generation took a growth on research and development which happened since the last generation. 1G wasn't wanted to identify wireless technology until 2G, or the second generation, was released. That was a serious jumpwithin the technology when the wireless networks went fromanalog to digital.

Why 6G Over 5G?

6G is expected to support 1 terabyte per second (Tbps) speeds. The known level of capacity and latency will not be known before and will extend the presentation of 5G applications along with enlarge therange of capabilities in support of progressively new and innovative applications across the realms of wireless cognition, sensing and imaging. 6G's higher frequencies will enable much faster sampling rates in addition to providing significantly better throughput. The combination of sub-mmWave (e.g. wavelengths smaller than one millimeter) and the use of frequency selectivity to determine relative electromagnetic absorption rates is expected to lead to potentially significant advances in wireless sensing solutions.

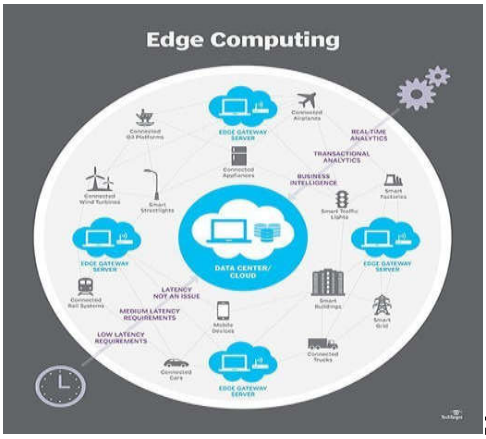
Moreover, in contrast the inclusion of mobile edge computing (MEC) is a point of contemplation as an addinginto 5G networks, MEC will be construct into all 6G networks. Edgecomputing will become much more smoothlyunsegregated as part of a combined communications/calculation structure framework by the time 6G networks are establish. This will provide many potential advantages as 6G technology becomes operational, including improved access to artificial intelligence (AI) proficiency.

Technology beyond 6g

Mobile edge computing

Edge computing is a spread out information technology (IT) construction in which user data is at the border of the network, as close to the arise source as possible. The move on the way to edge computing is operated by mobile computing, the fewer in cost of computer integrant and the absolute number of networked devices in the internet of things (IoT). To be determined by the execution, time-sensitive data in an edge computing architecture may be processed at the point of origin by an intelligent device or sent to an intermediary server located in close geographical proximity to the client. Data uses less time tosent the cloud for historical analysis, big data analytics and long-lastingstorage. In some cases, it is much better organised to action data near its source and deliveries that has value over the network to a remote data center.

The name "edge" in edge computing is, the margin in a network graphicmark the point at which traffic enters or exits the network. The edge is also the hidden protocol for transporting data change. The OpenFog alliances utilize the term fog computing to describe edge computing. The word "fog" is meant to transfer the idea.Edge computing also has a advantage remote office&branch office (ROBO) conditions and organisations. It is Depend on the vendor and technical usage, the intermediary may be referred to one of edge gateway, base station, hub, cloudlet or aggregator.



Securitychallenges: Edge computing's architecture increases the total number of attack vectors. The more intelligence an edge client has, the more vulnerable it becomes to malwares infections and security utilize.

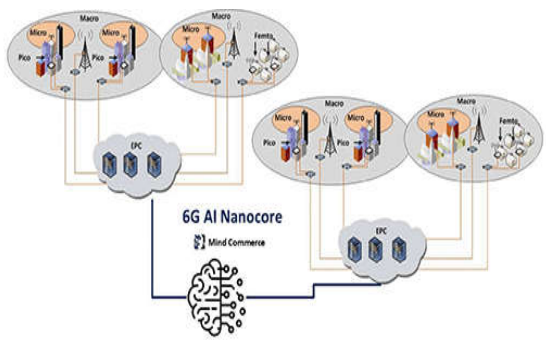
Licensingchallenges: Smart clients can haveconcealed licensing costs. While the bottom version of an edge client strength to start a low ticket price, addedutility may be licensed individually and drive the price up.

Configurationchallenges: Unless device management isdevolve and robust the controllers may unintentionallydesign security holes by fault to vary the levant password on every edge device or uncared to modernize firmware in a consistent manner, result in organization drift.

2. Changes On Core Networks

To some extent, 6G networks will continue the evolutionary path driven by 5G, which includes increasingly more autonomous networks, advanced quality of service and experience optimization, edge computing, and a service-based architecture approach. However, there is also the potential for much more profound core network changes with 6G, which may occur coincident with the technology convergence.

For example, Mind Commerce and others have discussed in the past the potential for a so called “nano-core” to emerge as a common computing core that encompasses elements of high performance computing (HPC) and artificial intelligence (AI).



Assuming this potential vision is realized, the nano-core need not be a physical network element, but rather a logical comprised of a web of computational resources, shared by many networks/systems.

New Spectrum And Frequency

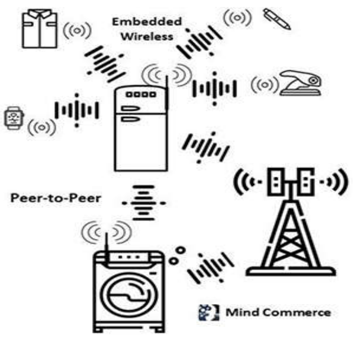
6G research is already underway in industry and academia. While 5G introduces mmWave frequencies with wider bandwidths for higher data rates and enables new applications in wireless factory automation (Industrial IoT) and for autonomous vehicles, the aim of 6G is to push the boundaries of transmission bandwidths even higher.

Despite it is not clear so far which technologies 6G will demand, it is already evident that frequency bandwidths need to be farther increased to allow terabit class data rates. Wide neighbouring frequency blocks can uniquely found at sub-THz and THz bands, i.e. in the frequency range above 100 GHz. The utilizations of THz frequencies for 6G isapproximate to mergetrade in the next 8 to 10 years. The system was also displayed at the EuMW2019 in Paris as part of a workshop on mmWave and THz Wireless Communication, where it consisted of 300 GHz transceiver frontends, the R&S SMW200A vector signal generator and R&S FSW43 signal and spectrum analyzer as well as of units for synchronization of transmitter and receivers.

Features	6G	Features	6G
Frequency Bands	• Sub 6 GHz, • mmwave for mobile accessm exploration of THz bands (above 140 GHz), • Non-RF bands (e.g. optical, VLC) etc.	Device types	• Sensors & DLT devices • CRAS • XR and BCI equipment • Smart implants
Data rate	1 Tbps	Spectral and energy efficiency gain	1000 x in bps/Hz/m^3
Latency (End to End Delay)	< 1 ms (Radio : 0.1 msec)	Traffic Capacity	1 to 10 Gbps/m^2
Architecture	• Cell free smart surfaces at high frequencies (mmwave tiny cells are used for fixed and mobile access) • Temporary hotspots served by drone mounted BSs or tethered Balloons. • Trials of tiny THz cells (under progress)	Reliability	10^{-9}
		Localization precision	1 cm on 3D
		User experience	10 Gbps 3D everywhere
		Application types	• MBRLLC • mURLLC • HCS • MPS

Just as the jump from 4G to 5G represents an expansion of spectrums used and introduction of new frequencies, so will the evolution between 5G and 6G communications. Whereas 5G leverages mmWave in the microwave frequency range, 6G will take advantage of even smaller wavelengths at the Terahertz (THz) band, which is typically referred to as 100 GHz to 3 THz.

Just as there have been, and will continue to be, many challenges with 5G, so will there be many new challenges with 6G. One of those challenges will be developing commercial transceivers at the to-be utilized THz frequencies. This is largely an area in which electronics component providers will need to innovate. For example, semiconductor providers will need to deal with extremely small wavelengths and correspondingly small physical size of RF transistors and how they will interwork with



element spacing of THz antenna arrays.

Many More Radio Access Points

While the impact to the Radio Access Network (RAN) for 5G is substantial, it will potentially be even bigger with 6G networks, which is driven largely once again by a substantial increase in frequency causing the need for antennas virtually everywhere. This has a huge implication for the current site planning and the hosting business as the trend towards increasingly more distributed service access, which started with 5G (e.g., neutral hosts and distributed service providers), will accelerate dramatically with 6G.

It's highly likely that wireless networks will evolve to become more of a communications mesh as opposed to the current hub-and-spoke type configuration. In this mesh arrangement, there may be a complex interconnected web of RF signals that serve as access points as well as node-to-node connectivity and backhaul for larger frequency aggregation hubs, currently known as cell sites. In other words, the future of the RAN may evolve from today's world (e.g., dependency on legacy carrier hubs for macro WAN communications and Wi-Fi for local hotspots) to a much more distributed radio access system.

Putting this into perspective in today's world, the connected home represents the ability for consumer durable goods to

communicate wirelessly to a gateway for wide area network (WAN) communications, typically via cellular or fixed network Internet access as shown in Figure 1. In tomorrow's world, each of these items will likely have the ability to function as a 6G access point to the WAN.

Implementation Of 6G

It's expected that 6G wireless sensing solutions will selectively use different frequencies to measure absorption and adjust frequencies accordingly. This 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 solutions in public safety and critical asset protection such as:

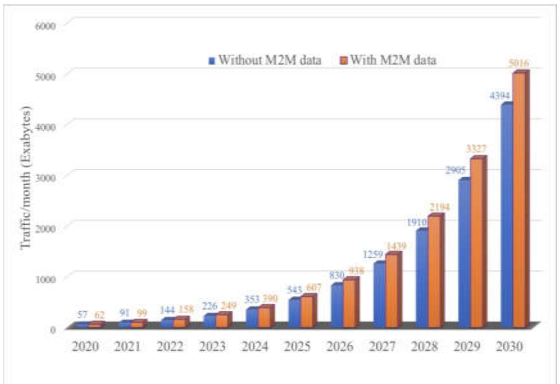
- Threat detection
- Health monitoring
- Feature and facial recognition
- Decision making (in areas like law enforcement and social credit systems)
- Air quality measurement
- Gas and toxicity sensing

Growth Of 6G

It's been distinctive for aintroduced mobile network grade to take the spotlight every decade. That means that 6G networks might roll out sometime around 2030, or at least that's when most telecom companies will be running 6G trials and when we'll see phone manufacturers tease 6G-capable phones. However, it's common for work to start as long as a decade prior to any real implementation of a new network technology, which might be why you'll start hearing about 6G before you even have your hands on a 5G phone!

Progress won't start and finish overnight, though. For the same reasons 5G rollouts are slow, 6G networks might not come out as quickly as we'd like. There are frequency bands to wrangle over, spectrum licenses to acquire.

Despite 6G being just a decade away, few telecom companies are actually looking into it seriously right now, but 6G experimentation is expected to really kick into high gear as we identify where 5G fails.



6G will improve on the inevitable weaknesses and limitations of 5G, so it won't take long for the powers that be to start deciding what to do next.

Here are some clues that 6G development is already in its early stages:

The FCC has taken the first steps of opening up terahertz wave spectrum (frequencies between 95 GHz and 3 THz), citing that it will "expedite the deployment of new services in the spectrum above 95 GHz."

In early 2018, the University of Oulu in Finland announced the funding of their 6G Flagship program to research materials, antennas, software, and more that will be required to launch 6G. The scheme is to beginelaborating the hardware that need to implement in 6G and know how the new technology might be used in future.

6G research has begun from Virginia Tech and companies like Samsung and LG.

Shortly after China launched 5G in 2019, the Ministry of Science and Technology announced that they'd be starting 6G research and development through the help of government departments, research institutes, universities, and enterprises.

Advantages

- It is outline to pillarhigh up number of mobile connections huge than the 5G capacity with respect to 10 x 105 per Km2.

- 6G will revolutionize the health-care sector which eliminates time and space barriers through remote surgery and guaranteed health-care workflow optimizations.

- As most of the mobile traffic is generated indoors. Additionally cellular networks have no way really beenplan to target indoor coverages efficiently. 6G control these provocations using fem to cells or Distributed Antenna Systems (DASs).

- 6G uses THz (Terahertz) frequencies which has many advantages as follows: THz waves can simply take up moisture in the air thus it is helpful for high speed, short scope wireless communications. Terahertz provides small beam and better directivity resulting into secure communication which is achieved due to strong anti interference capability. High wireless bandwidth (several tens of GHz) from 108 to 1013 GHz can dispatch higher communication rate in Tb/sec. In space communication, terahertz waves are used to possible transmission between satellites.

Beamforming and massive MIMO multiplexing get helps to overcome rain effect and dim propagation in order to meet city coverage requirements.

- 6G wireless uses visible lights which leverage benefits of LEDs like illumination and high speed data communication. VLC does not produce EM (electromagnetic) radiation. Hence it is not vulnerable to external EM interference. VLC also helps in building network security.

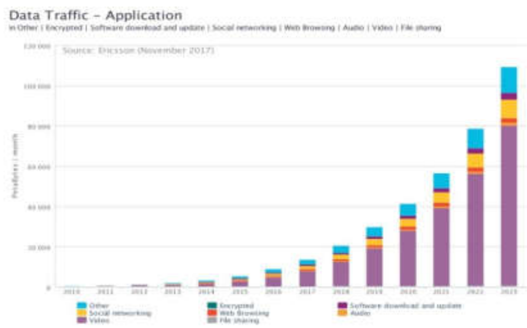
- 6G offers high rate (Tb/sec) and very low latency (sub-ms). Thus number of applications can make use of 6G wireless networks.

Disadvantages

- As the technology is under research and development we can not conclude any particular drawbacks or disadvantages of 6G now until we will have 6G system installed for trial and testing.

- 6G uses cell-less architecture and multi-connectivity. Thus seamless mobility and combination of various kinds of links (THz, VLC, mm wave, sub-6GHz) need perfect scheduling. The challenge here is to design new network architecture.

- 6G uses THz (Terahertz) frequencies as a part of its communications, thus hitch of THz can be appraise as drawbacks of 6G wireless technology. The terahertz frequency mention to the spectrum between 0.1 to 10 THz EM (electromagnetic) wave with wavelength of 30 to 3000 micro meters. THz signal is more sensitive to the shadows which have a greatcrash on coverage. Although lower frequency terahertz frequency incurs larger free space fading. Ultra-large-scale antenna is a main challenge in THz which needs high bandwidth and massive quantitative high resolution. Processing power is main challenge in



planning low power and low cost 6G devices.

- 6G make use of visible light frequencies as a part of its communications, thus drawback of VLC can be mentioned as drawbacks of 6G wireless technology. Visible light uses wavelength from 390-700 nm.

- In order to manage large number of terminals and networking equipments more efficient and less energy consuming 6G system is a must. In order to fulfill this, network and terminal equipments circuitry and the communication protocol stack design is a challenge.

6G Economic and Cultural Impacts

In today's world, wireless communications remains largely human-related. This is changing rapidly with the expansion of machine-to-machine (M2M) communications and the implementation of 5G and its support of massively scalable IoT networks. This trend will continue with 6G as machine-oriented communications becomes a high-growth area for the industry.

In terms of how people use wireless, we have witnessed fundamental shifts in behavior from primarily voice communication towards digital exchanges involving messaging and use of data for social sharing. This shift towards non-voice oriented human communications has still relied upon active involvement by phone users such as posting an update on Facebook or sharing a picture or video. This is poised to change with 6G as systems may autonomously sense human behaviours and digitally catalog everything. Rather than relying upon humans to share social information manually, systems may be able to digitize all human events. With 6G systems, one will only need to subscribe to receive information or interest. More likely, AI will be used to determine what events are most relevant, and automatically supply as a news/information update to interested parties.

Countries Are To Implement

The race to 6G will draw the attention of many industry constituents, such as major test and measurement vendor Key sight Technologies who has also indicated a commitment to its development. This will make the race to extend 5G power look minor compared to the other countries can beat the 6G technology trade and its related applications, services and solutions.

The University of Oulu in Finland is carrying out a 6G research initiative mentioned as 6Genesis. The project will be conducted for the next eight years and will develop a vision for 2037.

South Korea’s Electronics and Telecommunications Research Institute is conducting research on Terahertz band for 6G and envisions making it 100 times faster than 4G LTE networks and 5 times faster than 5G networks.

The Ministry of Industry and Information Technology (MIIT) in China is directly investing and monitoring the research and development process.

The United States is planning to open up 6G frequency for R&D purposes pending approval from the Federal Communications Commission (FCC) for frequencies over 95 gigahertz (GHz) to 3 THz.

The major vendordedication to 6G, such as Huawei, Nokia and Samsung will have all signalled that R&D in the works.

: **Future Scope**

About ten years ago, the phrase 'Beyond 4G' (B4G) was coined to refer to the need to move beyond what was currently envisioned as part of the evolution for 4G via the LTE standard. Since 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 feasible and potentialuseful beyond 4G.

Beyond 5G it is the pathway to 6Gtechnologies.One of the ways in which 5G is laying the groundwork for 6G solutions is the many private wireless implementations involving evolved LTE, 5G and edge computing for enterprise and industrial customers. Next generation 6G networks will take this one step further with a web of communications providers -- many of which will be self-providers -- much in the way that photovoltaic (PV) solar power has engendered co-generation within the smart grid.

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

6G radio networks will provide the means of communication and data gathering necessary to accumulate information, but a systems approach will be required for the 6G technology market as a whole involving data analytics, artificial intelligence, and next generation computation capabilities via 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. Most notably, AI will take center stage with 6G. There is discussion regarding the potential for a so called "nano-core" to emerge as a common computing core that encompasses elements of both HPC and AI. Assuming this potential vision is realized, the nano-core does not need to be a physical network element, but rather a logical collection comprised of a web of computational resources, shared by many networks and systems.

With substantially more data created by 6G than 5G networks, and the evolution of computing to include coordination between edge and core platforms, the need for data centre evolution will be paramount. Next spawning 6G capability in the areas of sensing, imaging and location resolution will generate huge amounts of data that must be managed on behalf of the network owners, service providers and data owners.

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