THE DEBUT OF 5G WIRELESS TECHNOLOGY

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Abstract
The technology promises to transmit a high volume of data to mobile and IoT devices, like connected traffic lights. By some estimates, 5g wireless networks could deliver data to nearly 10 gigabits per second, several orders of magnitude faster than current 4G networks which peak at 100 megabits per second. Since speed is usually the most discerning factors between the changing generations of wireless cellular technology hence the debut of 5g wireless technology.

***Keywords**: Iteration, Cellular technology, Latency, Bandwidth, Wireless broadband*

Introduction:
Fifth generation wireless (5g) is the latest iteration of cellular technology, engineered by greatly increase the speed and responsiveness of wireless network (Margaret, 2019). With 5g, data transmitted over wireless broadband connections could travel at rates as high as 20Gbps by some estimates exceeding wireline network speeds as well as after latency of 1ms or lower the uses of required real-time feedback. 5g will also enable a sharp increase in the amount of data transmitted over wireless system due to more available bandwidth and advanced antenna technology. In addition to improvement is speed, capacity and latency, 5g offers network management features, among them is the network slicing, which allows mobile operators, to create multiple virtual networks within a single physical 5g network. This capability will enable wireless network connections to support specific uses or business cards and could be sold on an as a service basis. A self-driving car, for example, would require a network slice that offers extremely fast, low latency connections so a vehicle could navigate in real-time. A home appliance, however could be connected via a lower power, slower connection because high performance is

not crucial. The interest of things (IOT) could use secure, data only connections. 5g networks and service will be deployed in stages over the next several years to accommodate the increasing reliance on mobile and internet enabled devices. Overall, 5g is expected to generate a variety of new applications, uses and business cases as the technology is rolled out.

Background

Mobile communication has become more popular in last few years due to fast reform from 1G to 5G in mobile technology (Neha, 2013). This reform is due to requirement of service compatible transmission technology and very high increase in telecoms customers. Generation refers change in nature of service compatible transmission technology and new frequency bands. In 1980 the mobile cellular era had started, and since then mobile communications have undergone considerable changes and experienced massive growth.

First Generation (1G)

These phones were the first mobile phones to be used, which was introduced in 1982 and completed in early 1990. It was used for voice services and was based on technology called as Advanced Mobile Phone System (AMPS). The AMPS system was frequency modulated and used frequency division multiple access (FDMA) with a channel capacity of 30 KHz and frequency band of 824-894MHz. (Lopa, 2015). In summary the basic features of 1G are highlighted as follows:

- Speed-2.4 kbps
- Allows voice calls in 1 country
- Use analog signal.
- Poor voice quality
- Poor battery life
- Large phone size
- Limited capacity
- Poor handoff reliability
- Poor security
- Offered very low level of spectrum efficiency

It introduces mobile technologies such as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone

Service (IMTS), and Push to Talk (PTT). It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties (Anju, 2015).

Second Generation (2G)

2G refers to the second generation based on GSM and was emerged in late 1980s. It uses digital signals for voice transmission. Main focus of this technology was on digital signals and provides services to deliver text and picture message at low speed (in kbps). It uses the bandwidth of 30 to 200 KHz. Next to 2G, 2.5G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. e.g. GPRS, CDMA and EDGE (Akhilesh et al, 2012). The main features of 2G and 2.5G are:

2G

- Data speed was upto 64kbps
- Use digital signals
- Enables services such as text messages, picture messages and MMS (Multimedia message)
- Provides better quality and capacity
- Unable to handle complex data such as videos.
- Required strong digital signals to help mobile phones work. If there is no network coverage in any specific area, digital signals would weak.

2.5G:

The GSM technology was continuously improved to provide better services which led to development of advanced Technology between 2g and 3g

- Provides phone calls
- end/receive e-mail messages
- Web browsing
- Speed: 64-144 kbps
- Camera phones
- Take a time of 6-9 mins. to download a 3 mins. MP3 song. =

Third Generation (3G)

3G is based on GSM and was launched in 2000. The aim of this technology was to offer high speed data. The original technology was improved to allow data up to 14 Mbps and more using packet switching. It uses Wide Band Wireless Network with which clarity is increased. It also offers data services, access to television/video, new services like Global Roaming. It operates at a range of 2100MHz and has a bandwidth of 15-20MHz used for High-speed internet service, video chatting (Akhilesh et al, 2012).

The main features of 3G are:

- Speed 2 Mbps
- Typically called smart phones
- Increased bandwidth and data transfer rates to accommodate web-based applications and audio and video files.
- Provides faster communication
- Send/receive large email messages
- High speed web/more security/video conferencing/3D gaming
- Large capacities and broadband capabilities
- TV streaming/mobile TV/Phone calls
- To download a 3minute MP3 song only 11 sec-1.5 mins time required.
- Expensive fees for 3G licenses services
- It was challenge to build the infrastructure for 3G
- High bandwidth requirement
- Expensive 3G phones
- Large cell phones

3G mobile system was called as UMTS (Universal Mobile Telecommunication System) in Europe, while CDMA2000 is the name of American 3G variant. Also, the IMT2000 has accepted a new 3G standard from China, that is, TD-SCDMA. WCDMA is the air-interface technology for UMTS. (Anju, 2015)

Fourth Generation (4G)

4G offers a downloading speed of 100Mbps. 4G provides same feature as 3G and additional services like Multi-Media Newspapers, to watch T.V programs with more clarity and send Data much faster than previous generations (Reshma, 2013). LTE (Long Term Evolution) is considered as 4G technology.

4G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth (Meenal et al, 2014). The main features of 4G are:

- Capable of provide 10Mbps-1Gbps speed
- High quality streaming video
- Combination of Wi-Fi and Wi-Max
- High security
- Provide any kind of service at any time as per user requirements anywhere
- Expanded multimedia services
- Low cost per-bit
- Battery uses is more
- Hard to implement
- Need complicated hardware
- Expensive equipment required to implement next generation network

Fifth Generation (5G)

5G refer to Fifth Generation which was started from late 2010s. Facilities that might be seen with 5G technology includes far better levels of connectivity and coverage. The main focus of 5G will be on world-Wireless World Wide Web (WWWW). It is a complete wireless communication with no limitations.

In summary, the basic features of 5G are highlighted as follows:

- It is highly supportable to WWWW (wireless World Wide Web)
- High speed, high capacity
- Provides large broadcasting of data in Gbps.
- Multi-media newspapers, watch TV programs with the clarity (HD Clarity)
- Faster data transmission that of the previous generation
- Large phone memory, dialing speed, clarity in audio/video Support interactive multimedia, voice, streaming video, internet and other
- More effective and attractive

Technology	1G	2G	3G	4G	5G
Start/ Deployment	1970 – 1980	1990 -2004	2004 – 2010	Now	Soon Probably 2020
Data Bandwidth	2Kbps	64Kps	2Mbps	1Gbps	Higher than 1 Gbps
Technology	Analog	Digital	CDMA2000, UMTs, EDGE	Wi-max, Wi-fi, LTE	WWW
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, packet	Packet	All packet	All packet
Primary service	Analog phone calls	Digital phone calls & messaging	Phone calls & messaging, data	All- IP service including voice message	High speed, high capacity, large broadband
Key differentiator	Mobility	Secure, mass adoption	Better, internet experience	Faster broadband, internet lower latency	Better coverage and no drop calls, much latency
Weakness	Poor spectral efficiency, major security issues	Limited data rates, difficult support to email	Real performance fails to match type	Battery user more	?

Table 1: Generation of 5g wireless technology (Adapted from Lopa, 2015)

Problem Statement

With every new generation of wireless technology, the biggest problem is increased speed. 5g networks have potential peak download speeds of 20gbps, with 10gbps being seen as typical. This is not just faster than current 4g networks, which currently top out at around 1gbps, but also faster than cable

internet connections that deliver broadband to many people's homes (Josh, 2019).

Also, throughout alone is not 5g only important speed improvement, it also features a huge reduction in network latency which measures how long it would take to download a large file. Overall, 5g latency will be lower than 4g's by a factor of 60 to 120, that will make possible a number of applications such as virtual reality that delay makes impractical today. Overall, 5g should significantly improve the bandwidth capability and reliability of cellular broadband for more than previous generational shifts

WHAT IS 5G?

5G Technology stands for 5th Generation Mobile technology. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system (Lopa, 2015). 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market. 5G Technologies have an extraordinary capability to support Software and Consultancy. The Router and switch technology used in 5G network providing high connectivity. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. In near future 5G technology provides a cell phone which is like a PDA and then the whole office will be in our finger tips/in our phone. In a few years, we may be able to download a full-length HD movie in six seconds, while 4G require seven minutes and 3G require more than an hour to download the same. Also, video chats will be so immersive that it will feel like we can reach out and touch the other person right through the screen. 5G is a packet switched wireless system with wide area coverage and high throughput. 5G wireless uses OFDM and millimeter wireless that enables data rate of 20 mbps and frequency band of 2-8 GHz. The 5G communication system is envisioned as the real wireless network, capable of supporting wireless World Wide Web (WWWW).

The uncertainty around 5G is because it's still largely a concept at this point, and the wireless industry hasn't settled on any standards around the new network. But it is looking to achieve some key goals with 5G:

- Significantly faster data speeds: Currently, 4G networks are capable of achieving peak download speeds of one gigabit per second, though in actual practice it is never that fast. With 5G, this would increase to 10Gbps.
- Ultra-low latency: "Latency" refers to the time it takes one device to send a packet of data to another device. In 4G, the latency rate is around 50 milliseconds, but 5G will reduce that to about one millisecond. This will be very much important for industrial applications and driverless cars.
- A more "connected world*"*: The Internet of Things (smart home appliances, connected cars etc.) is expected to grow exponentially over the next 10 years, and it will need a network that can have capacity for billions of connected devices. 5G will provide capacity and bandwidth as per the needs of user.
- The technology is still a long way from becoming a reality, but it has the potential to completely change the way we interact with wireless devices, from the Smartphone in our pockets to the cars we drive.

Hardware and Software Requirements

The following hardware and software requirements are explained as follows:

5G Hardware

- **Ultra-wideband networks (UWB)**

  It is already known that Wi-Fi, Wi-Max and cellular wide area communications are long-range radio technologies. But systems like WPAN need short-range radio technology, which helps in achieving higher bandwidths (around 4000 Mbps) but at low energy levels (UWB network) for relaying data from host devices to devices in the immediate vicinity, i.e., distances of around 10 meters or so. This higher bandwidth (4000 Mbps) level is almost 400 times faster than today's wireless networks. Each network will be responsible for handling user-mobility while the user terminal will make the final choice among different wireless/mobile access network providers for a given service.
- **Smart antennae**: These include the following:

  Switched beam antenna: This type of antenna supports radio positioning via angle of arrival (AOA). Information is collected from nearby devices.

Adaptive array antennae: Such antennae promise to improve the capacity of wireless systems by providing improved safety through position-location capabilities. This technique rejects interference through spatial-altering-position location through direction-ending measurements and developing improved channel models through angle-of-arrival channel sounding measurement.

- **CDMA (code division multiple access) technique:** This technique converts audio analogue input signals into digital signals (ADC) in combination with spread spectrum technology. The signal is transmitted using modulation according to some predefined code (pattern), and is demodulated using the same pattern since there can be billions of code patterns which can provide privacy and sufficient security (Electronicsforu, 2014).

5G Software

5G will be a single unified IP standard of different wireless networks and a seamless combination of broadband, including wireless technologies, such as IEEE802.11, LAN, WAN, PAN and WWWW. 5G will enable software-defined radio, packet layers, implementation of packets, encryption flexibility, etc.

How 5G Works

Wireless networks are composed of cell sites divided into sectors that send data through radio waves. Fourth-generation (4G) Long-Term Evolution (LTE) wireless technology provides the foundation for 5G. Unlike 4G, which requires large, high-power cell towers to radiate signals over longer distances, 5G wireless signals will be transmitted via large numbers of small cell stations located in places like light poles or building roofs. The use of multiple small cells is necessary because the millimeter wave spectrum -- the band of spectrum between 30 GHz and 300 GHz that 5G relies on to generate high speeds -- can only travel over short distances and is subject to interference from weather and physical obstacles, like buildings (Margaret, 2019).

FEATURES OF 5G

The current trend of 5G technology has a following feature.

- The 5G technology is providing up to 25 Mbps connectivity speed

- 5G technology offer high resolution for cell phone user and bi-directional large bandwidth sharing.
- 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
- The uploading and downloading speed of 5G technology touching the peak
- The 5G technology also support virtual private network.
- The 5G terminals will have software defined radios and modulation schemes as well as new error control schemes that can be downloaded from the Internet.
- The development is seen towards the user terminals as a focus of the 5G mobile networks. For example, the advanced billing interfaces of 5G technology makes it more attractive and effective.
- The 5G technology network offering enhanced and available connectivity just about the world. The terminals will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. The vertical handovers should be avoided, because they are not feasible in a case when there are many technologies and many operators and service providers.
- In 5G, each network will be responsible for handling user-mobility, while the terminal will make the final choice among different wireless/mobile access network providers for a given service. Such choice will be based on open intelligent middleware in the mobile phone.
- The remote diagnostic is a great feature offered by 5G, through which a user can get better and fast solution.

TYPES OF 5G WIRELESS SERVICES

i. MILLIMETER WAVES

All wireless electronic communication devices use specific frequency band, which is called spectrum. Typically, it's up to 6GHz but nowadays this frequency spectrum gets more crowded because day by day number of user and devices are increase so high. Carrier going to send a large amount of data on same range of frequency spectrum. System going to provide slow service and more drooped connection. The solution is open some new range of frequency

and here millimeter waves comes into picture. Range of millimeter waves is up to 300 GHz. This section on spectrum is never been used before. If this new range of spectrum will be, open that mean a greater number of bandwidth foe a greater number of users. However, there is one main drawback of millimeter waves. These waves cannot travel through walls or any other obstacles. These waves easily observe by weather. Therefore, for solution need of small cells occurs.

ii. SMALL CELL

Today wireless network travel large high-power cell tower to broadcast signal, over long distance. Where, millimeter waves not able to traveling through obstacles, which means if devices are behind the any obstacles, they lose signal. Small cell networks solve that problem. Using thousands of small tower mini base station. These small cell mini base stations are much closer together then traditional tower. So small cell able to transmit signal around the obstacles. This is specially use in cities. As user moves around the obstacles this device, get automatically switched from one nearest small cell to another nearest small cell.

iii. MASSIVE MIMO

MIMO stand for multiple inputs multiple outputs. Today's cellular base stations have dozen port of antenna for handling cellular traffic. Where MIMO base station can support 100 ports of antennas. This can improve today's network capacity by factor of 22 or more. MIMO comes with its own drawback. MIMO antennas able to transmit information in all direction at ones and this entire signal get a serious interface which brings a new technology Beamforming.

iv BEAMFORMING

The Beamforming is like a traffic signal in system. Its broadcasting signal in every direction it would allow to base station to send focused stream data to specific user. This precision prevention system is more efficient. That mean station can handle more incoming and outgoing data at once. Process of this system is as follows. Supposed two or more devices are in city around the obstacles and make call. So, first massive MIMO collect that data and send to specific user with specific data sending algorithm that means Beamforming through which direction of data is where user want to send it which brings new technology full duplex communication.

iv FULL DUPLEX

In one scenario data can either transmit or either receives. This is call half duplex communication like walky-talky. Today's cellular base stations have

same that problem. This is because of reciprocity principle. If you transmit data on radio frequency then it travels forward or backward on same frequency. So, two devices are sent data at a same time so error occurs because of reciprocity principle. For solution researchers use silicon transistor to create high speed switches. This silicon transistor allows two users to transmit data at ones.

APPLICATIONS OF 5G

Applications of 5G are beyond our imagination. User never experienced ever before such high value technology which includes all type of advance features. Some of the applications of 5G are:

- We can able to charge our mobile using our own heart beat
- We can able to feel our grandmother's sugar level with our mobile
- We can able to know the exact time of our child birth in Nano seconds.
- Our mobile rings according to our mood.
- We can vote from our mobile
- We can able to visualize lively all the planets and universe. Also, we can able to navigate a train for which we are waiting.
- We can able to view our residence in our mobile when someone enters and also when some once opens our intelligent car.
- We can able pay all our bills in a single payment with our mobile.
- We can able to sense Tsunami/Earthquake before it occurs.
- We can access our office desktop, Laptop, car, bike using our mobile,
- We can identify our stolen mobile within nanoseconds
- Our mobile can share our workload, identify the best server and also intimate us before the call drops.
- We can able to expand our coverage using mobile phones.
- We can able to fold our mobile as per our desire (Singh & Pratap, 2012)

CONCLUSION

The emergence and implementation of new 5G mobile standards and the use of millimeter wave spectrum is expected to be revolutionary. The millimeter bands being made available for mobile networks will provide increased performance, better coverage, and a closer integration across multiple wireless technologies

from 4G LTE to Wi-Fi, to sub-6GHZ 5G, as well as extending to the higher frequency 5G millimeter wave bands.

As 5G millimeter wave starts to be deployed in low-cost, small cell networks using massive MIMO antennas to deliver as much as 20Gbps download rates to users, the immense promise of 5G will become apparent.

RECOMMENDATION

Though, many tests and trials need to be conducted before implementing 5G. 5G wireless technology is still in development stage in some countries like Africa but, there are some countries like South Korea, Japan, China, United State, Sweden turkey etc. which has already implemented this technology. The 5G wireless technology has a bright future and will be a revolution in the mobile market in the 2020 and beyond.

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