An Overview on 5G Technology

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Abstract - **The objective of this paper is to comprehensively study the 5G technology of Mobile Communication. Currently all the research work of Mobile Communication is related to 5G technology. Current researches in 5G are related to the development of WWWW (World Wide Wireless Web), DAWN (Dynamic Adhoc Wireless Networks), and Real Wireless Communication. 5G (Fifth Generation) technology of Mobile Communication is Consumer oriented. Mobile Consumer are given utmost priority as compared to others. 5G stands for 5th Generation Mobile technology. 5G technology uses a very high bandwidth. 5G technology is likely to include all types of advanced features which will make 5G the most dominant technology in near future. The implementation of 5G technology would likely be around 2020.The objective of this paper is to give a brief insight of 5G technology.**

Keywords - **5G, Evolution of Mobile Technology, 5G Architecture, Nanotechnology, Cloud Computing, Flat IP Network, BDMA**

I. INTRODUCTION

Mobile Communication has seen a lot of changes in recent years. Cell phones today have everything in them ranging from largest phone memory, speed dialing, Bluetooth, Video player, Audio player, Camera and so on. With the development of piconets and Bluetooth technology data sharing has become a child's play. Initially with infra red technology we were able to share data between two devices only if both of them are aligned properly and if not there were a lot of disturbance in transferring data between two gadgets.

There are broadly two thoughts going on with 5G :

a) A Service led view which gives 5G a upper hand over 2G, 3G, 4G, Wi-fi and other innovations providing far greater coverage and always-on reliability

b) Second view is driven by a step change in data speed and order of magnitude reduction in end-to-end latency.

Most recognized benefit of 5G technology over 4G will be the latency and not the speed of delivery – which reportedly could be between 10Gbps and 100Gbps. 4G provides a latency between 40ms and 60ms, which is low but not enough to provide real-time response. For example a Multiplayer Gaming requires a lower latency to ensure that when you hit a button, the remote server will respond instantly.

On the other hand it is predicted that 5G will provide ultra-low latency that could range between 1 ms to 10ms.

Also capacity is an important factor. Internet is becoming more and more important over time, where tablets, gadgets and other devices are becoming smarter. As a result strain on bandwidth is continuing to grow.

Initial idea and probably the main focus in deployment of 5G is to avoid this strain. 5G will be adaptable to consumer needs and demands and therefore be able to allocate more or less bandwidth based on the applications requirements.

It is predicted that by the year 2020, each person in UK will own and use 27 internet connected devices. Moreover there will be 50 billion connected devices worldwide. These devices can be smartphones, tablets and smartwatches, to fridges, cars, augmented reality specs and even smart clothes.

Some of these devices will need small packets of information to be sent and received while other devices will require huge amount of data to be shifted back and received. In such scenario bandwidth allocation becomes a difficult task. 5G will come up with a solution to this and allocate bandwidth as per requirements of each individual device. Thereby reducing strain on individual connection points.

II. EVOLUTION OF MOBILE TECHNOLOGIES

1G : 1G refers to First Generation Mobile telecommunication and were first introduced in 1980's and continued till 1990. These network used analog systems for communication. These were simple voice only cellular phones. The first generation of analog mobile phones had speed upto 2.4 Kbps. It allowed it's consumers to make voice calls only within same country. Advantages of 1G technology were limited but drawbacks were many like poor voice quality, handoff reliability, and battery life, large size of phones, no security mechanism and so on.

Limitation of 1G :
1. Limited capacity
2. Low calling capacity
3. No room for spectrum growth
4. Poor data communications
5. Minimal privacy
6. Inadequate fraud protection

2G : 2G wireless technology use digital signals and are based on GSM. The main difference between 1G and 2G is that former uses analog signals where latter uses digital signals. 2g mobile network technologies are whether time division multiple access (TDMA) or code division multiple access (CDMA). Both CDMA & TDMA have different platforms and access mechanisms. These networks have data speed up to 64Kbps. The concept of Short Message Services was invented by 2G communications.

Features of 2G :
1. Make use of CODEC (compression and multiplex algorithm) to compress and multiplex digital voice data.
2. It can handle more calls per amount of bandwidth vis a vis 1G systems. Handsets are usually smaller, lighter and more robust. It emits less radio power.
3. It is safer for consumers to use.

4. The battery life of handsets lasts longer.
5. It offers additional services like SMS, and emails.
6. The error checking has improved sound quality.
7. There is reduction in noise levels.
8. The digital voice encoding has made calls less susceptible to eaves dropping from third parties due to use of radio scanner.
9. It ensures rapid call set up.
10. It enables talking to number of parties simultaneously.
11. It enables to place a call on hold while one accesses another call.
12. It notifies one of another call whilst on a call Encrypted conversation that cannot be easily tapped.
13. It provides ability to use same phone in number of countries.
14. In GSM, carrier bit rate is 270.8 kbps speech coding bit rate is 13kbps, Channel Bandwidth 200 k Hz in GSM, 8 users per channel, Mobile Unit max power is 20 w.

Limitation of 2G :
1. Demands strong digital signals to assist connections of mobile phones
2. Unable to hold complex data such as videos.

3G : 3G refers to 3rd generation mobile telecommunication. It was established in 2000. As compared to 1G and 2G it provides highest speed of 144 Kbps to 2 Mbps. It is also known as Mobile Telecommunication 2000.

Features of 3G :
1. Enhanced multimedia (voice, data video and remote control)
2. Usability on all popular models (cellular phones, e-mails, pagers, fax, video conferencing and web browsing)
3. High speeds (upwards of 2 MBPS)
4. Bandwidth 5 – 20 Mbps
5. Access WCDMA / CDMA 2000
6. Frequency Band 16 – 25 G Hz
7. Component Design Optimized antenna multiband adapters
8. Has both circuit / packet switching
9. Routing flexibility (repeater , satellite and LAN)
10. International roaming capability
11. Excellent quality of voice
12. Applications include: Still photography, video data transmission service, file transfer from internet, multimedia e- mail, Web Browsing, on-line services, time schedules.

Limitation of 3G :
1. Expensive fees for 3G Licenses Services
2. Big size of mobile phones
3. Expensive in nature
4. Higher bandwidth requirements

4G : Fourth generation is a packet switched wireless system with wide area coverage and high throughput. It is designed to be cost effective and to provide high spectral efficiency. It provide data rate of 20Mbps. Mobile speed will be up to 200km/hr. Frequency band is 2-8 GHz. It gives the ability for world wide roaming to access cell anywhere

Features of 4G :
1. Support for interactive multimedia
2. Support for voice
3. Support for streaming video
4. High speed
5. High capacity
6. Low cost per bit
7. Global access
8. Better spectral efficiency
9. Service driven services.
10. Better scheduling
11. Better call admission control techniques

Limitations of 4G :
1. Expensive and hard to implement
2. Battery usage is more
3. Needs complex hardware

5G : 5G refers to 5th generation of wireless mobile network which began in late 2010. It has almost no limitations. This communication technology merges all enhanced benefits of mobile phones like dialing speed, MP3 recording, cloud storage, HD downloading in instant of seconds and much more that you had never imagined

5G Architecture :
Globalization is the latest offerings in today's world. Convergence in the technology is the main agenda of network systems for making it possible in the case of performing similar tasks. The simple explanation of the digitization is the transformation of atoms to bits, the digitization of all media content. The words, sounds, images, etc will get transformed into digital information and we will be able to expand the potential relationships between them and thereby enabling them to flow across the platforms available and newly introduced ones.

Fig 1 : Nanocore

The 5G Nancore is a convergence of below mention technologies. These technologies have their own impact on exiting wireless network, which makes them in to 5G.
• Nanotechnology.

• Cloud Computing.
• All IP Platform.

A) Nanotechnology :

The term nanotechnology was introduced in 1974 by Norio Taniguchi at the Tokyo International Conference on production engineering. Nanotechnology is the next industrial revolution, and the telecommunications industry will be radically transformed by it in a few years. Impact of nanotechnology has been on both mobile and on core network. Perfection in security and the better impact on the sensor makes the nanotechnology the most significant in its row. This is considered to be most significant in telecommunication.

Nanotechnology is the application of nano science to make the control process to a nano meter scale, which will be in between 0.1 and 100nm. This particular field is known as Molecular Nano Technology (MNT). Atom-by-atom and molecule-by-molecule based control of the structure of matter. The telecommunication industry will radically get changed into the latest Nanotechnology in little year time.

B) Cloud Computing :

Cloud computing uses the Internet and central remote server to maintain data and applications. In 5G networks this central remote server will be our content provider. Cloud computing allows consumers and business to use applications without installation and access their personal files at any computer with Internet access. The same concept is going to be used in Nano core where the user tries to access his private account form a global content provider through Nanocore in form of cloud.

This could make our user to obtain much more real-time application to utilize his 5G network efficiently. 5G will add on the real time applications through the Nanocore Clouding.

Cloud Computing has three segments as follows :
  a) Application
  b) Platform
  c) Infrastructure

C) All IP Platform :

We need a common platform to interact with the different technologies to form a single 5G Nanocore. Flat IP architecture acts as an essential part of 5G networks.

The All-IP Network (AIPN) is an evolution of the 3GPP system to meet the increasing demands of the mobile
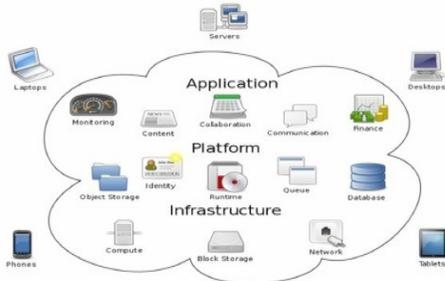

Fig 2 : Segments of Cloud Computing

telecommunications market. To meet customer demand for real-time data applications delivered over mobile broadband

networks, wireless operators are turning to flat IP network architectures. Primarily focused upon enhancements of packet switched technology, AIPN provides a continued evolution and optimization of the system concept in order to provide a competitive edge in terms of both performance and cost.

The key benefits of flat IP architectures are
  (i)   Lower costs
  (ii) Universal seamless access
  (iii) Improved user experience
  (iv) Reduced system latency
  (v)   Decoupled radio access
  (vi) Core network evolution

Beam Division Multiple Access (BDMA) for 5G technology :

BDMA (Beam Division Multiple Access) is the latest allocation technique in which an orthogonal beam is allocated to each mobile station. In this technique, an antenna beam will get divided and allocated into the locations of the mobile stations to provide multiple accesses and thereby increasing the capacity of the system. Since mobile stations and the base stations are in Line of Sight state, they can transmit beams, which directed to each other's position for proper communication, without making any kind of interference with cell edge mobile stations. When the mobile stations are positioned at different angles compared to the base station, the base station will transmit the beams in such a way that different angles will be covered and at the same time multiple mobile stations will be taken care. The working is like one mobile station does not use one beam exclusively, but the mobile stations positioned at similar angles will keep on sharing the one beam to communicate with the base station. Mobile stations that are sharing the same beam will divide the same frequency or time resources and will use the orthogonal resources.

Fig 3 : BDMA
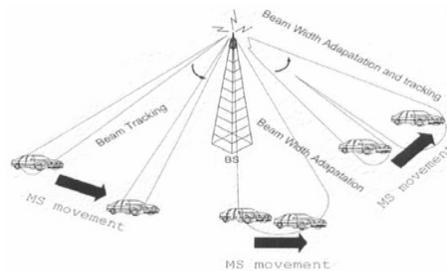
According to the mobile communication environment, a base station can change the direction, number and respective widths of the beams adaptively with most easiness. Three-dimensional mode of division will happen in the case of beams and hence a spatial reuse of frequency or time resources can be maximized. The first slot of communication is the base station and the mobile station does not know each other's position. The mobile station will detect their positions and the moving speeds and will transmit the entire information to the base station. The second stage is taken care by the base station. The base station will calculate the direction along with the width of a downlink beam, which is based on the position and moving speed information received from the mobile station. After the calculation part is over, the base station will transmit the

downlink beam to the mobile station with all the calculations regarding the direction and width.

CONCLUSION

The development of the mobile and wireless networks is going towards higher data rates and all- IP principle. Mobile terminals are obtaining each year more processing power, more memory on board, and longer battery life for the same applications. 5G include latest technologies such as cognitive radio, SDR, nanotechnology, cloud computing and based on All IP Platform. It is expected that the initial Internet philosophy of keeping the network simple as possible, and giving more functionalities to the end nodes, will become reality in the future generation of mobile networks, here referred to as 5G.

The following are the features of 5G that makes it extraordinary phone:

(i) Faster data transfer rate as compared with last generations.
(ii) Huge memory
(iii) Fast dialing speed.
(iv) HD quality picture.
(v) More attractive and more effective.
(vi) Peak uploading and downloading speed.
(vii) Remote diagnostics.
(viii) Up to 25 Mbps connection speed.
(ix) High quality services to avoid errors.
(x) Bi-directional large bandwidth.

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