FOURTH GENERATION WIRELESS TECHNOLOGY

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Abstract- This manifesto of the paper is step by step evolution of cellular generation technologies in wireless communication. A comprehensive and detailed study of this paper is reported about 1G, 2G, 2.5G, 3G, 4G, 4GLTE, 5G. The world has reallocated its pattern from long wires to no wires. The 0th generation of mobile communications utilizing wireless technology initiated at 1970. Now it has reached till 5th Generation and several investigators are working on the designing and architectures of 5G. This paper presents a survey for the evolution of wireless network generations field in order to give the features and limitation and face up to concern in every cellular generation and also give the improvements were performed to these issues which starts from the preceding generations along to the succeeding generations.

Key words: 0G, 1G,2G,2.5G,3G,4G,4.5G LTE, 5G, Wireless communication.

I. INTRODUCTION

With meteoric development of Information and Communication Technologies (ICT), predominantly the Wireless communication technology, it is fitting very essential to examine the behavior of various generations of wireless technologies. A great progress of wireless services which we utilize every day have been seen in few years. The size of the transmitter and receiver shrunk and the concept of cell introduced was the evolution of 1G. GSM architecture that eliminated the roaming issues of 1G with extra function of SMS was introduced in 2G. 2.5G system includes HS, CSD, GPRS, EDGE was introduced. CS and PS both based on the kind of traffic available was developed in 3G.4G technology focus on OFDM and WiMAX. The core concept of 4.5GLTE is Gbps, Connection+, and Experience 4.0. 5G anticipated the development of World Wide Wireless Web and Dynamic Adhoc Wireless Network and Real Wireless World.

II. HISTORY OF WIRELESS

- 1888: In (1857–1894) the first electromagnetic radio waves was found by German physicist Heinrich Hertz.
- 1894: In (1851–1940) The first message using radio waves in Oxford, England sent by British physicist Sir Oliver Lodge.
- 1899: In (1874–1937) Radio waves across the English Channel send by Italian inventor Guglielmo Marconi. By 1901. Marconi has sent radio waves beyond the Atlantic in originated from Cornwall in England to Newfoundland.
- 1940: Taxi firms begin using two-way radios.
- 1970: First analog cell phones appear, developed by Illinois Bell and AT&T in Chicago.
- 1980: Global System for Mobile communications digital cell phones emerge in Europe, followed by phones Personal Communications Services in the United States.
- 1990: Wireless specialist working group starts work drafting the standard that will become Wi-Fi.
- 1994: Nokia, Finish cell phone maker, sends data over a cell phone network.
- 1994: WAP developed by Phone.com in the United States.
- 1997: Wi-Fi standard is recognized at globally.
- 1999: i-mode developed by Japanese Telecommunications Company NTT DoCoMo.
- 1999: An Incorporate version of Wi-Fi called AirPort keen on the iBook laptop, successfully making it the foremost mass-market Wi-Fi product decided by Steve Jobs of Apple Computer.
- 2005: Webster's Dictionary officially added Wi-Fi by Merriam-Webster.
- 2007: iPhone released by apple-tilting the stability of power from desktop PCs and cabled Internet to mobile devices and wireless Internet.
- 2010: iPad tablet released by Apple, giving users all the convenience of a wireless smart phone with a bigger display closer to that of a desktop PC.
- 2015: Mobile-Friendly algorithm update announced by Google, rewarding websites that reformat themselves appropriately for smart phones.
- 2015: 25th birthday was celebrated by Wi-Fi.

III. 0G (ZERO GENERATION MOBILE SYSTEM)

At 1940's, Pre-cell phone mobile telephony technology was introduced. It is the first radio telephone service such as radio telephones. It was devised in cars to the public land-line supported telephone network which was used by users. Voice Communication is only possible. These mobile telephones were usually built up in cars or trucks. Military Communication was used by mobile radio telephones. In this radio telephony single large transmitter is placed on peak of a tall building and the single channel used for transferring and getting the data. Enabled transmission and disabled reception user pushed a button to talk from one end to other end. This is known as push to talk in 1950. Technology was used by CB-radio, taxis, police cars. Bell Systems launched a system in 1960 called, Improved Mobile Telephone Service (IMTS). A few improvements like direct dialing and more bandwidth can be fetched. In the late 60s and early 70s the very first analog systems were based upon IMTS were formed. It was used 23 channels from 150 MHz to 450 MHz [2]

IV. 1G (FIRST GENERATION MOBILE SYSTEM)

1G was introduced in 1980 and completed in 1990. The first generation of wireless telephony technology was referred to as 1G.The speed of 1G was 2.4 kbps telecommunications. It allowed the voice call in one country. Analog Signal and AMPS was used. It was first launched in USA in 1G mobile system. In this system a Voice call gets transformed to a higher frequency of about 150MHz and it is conveyed between radio towers. Frequency-Division Multiple Access, Nordic Mobile Telephone, and Advanced Mobile Phone System were used in 1G. In some cell phones modems are exists but it has more noise when compared to conventional landlines to be fully functional and the transfer speed also very slow to work. In 1982 Bell labs was installed Advanced Mobile Phone Service.

The Key ideas behind in the 1G are exclusively analog and 10 to 25 km geographical area divided into cells. It has a small cell. In nearby cell frequency reuse could be exploited. But it could not exploit in adjacent cell. In Frequency reuse, the same area could be used from 5 to 10 times by more users as like as IMTS. [9]

 A. *Technologies under 1G*

As early cellular phone technology worked in 150 MHz of frequency band. Telephone Systems (AMTS), Push to Talk (PTT) and Improved Mobile Telephone Service (IMTS) are the technologies under 1G.

 B. *Features of 1G*

In voice call and text messages is available by use of analog narrow bandwidth.

C. *Drawbacks in 1G*

Analog cellular phones are not very protected. If any person who have all band radio receiver connected to a computer can hack the 32-bit serial numbers and phone numbers of subscribers and able to listen all voice call can be susceptible to unwanted eavesdropping by third parties.   It has a limited capacity, poor battery life, poor large phone size, poor handoff reliability, poor voice quality, and no security at all since voice call can be hacked by radio towers.

V. 2G (SECOND GENERATION MOBILE SYSTEM)

2G refers as the 2nd generation which is based on the GSM. End-to-end security by retaining the confidentiality of calls using Signaling and Data Confidentiality and Mobile station Authentication maintained by GSM. In 1991, 2G was first launched in Finland. Digital modulation signal was used in 2G.Its data speed is 14kbps to 64kbps Digital data can be compressed and multiplexed which is more efficient than analog voice encodings. In this multiple analog message signals or digital data streams are joint into one signal called multiplexing. The bandwidth of 1G and 2G standards is maximum 9.6 Kbit/sec, (i.e.), which is approximately 6 times slower than an ISDN. It can translate data from digital to analog and vice versa. The digital voice encoding allows digital error checking. In this generation Sound quality got improved, security got build up and total capacity was improved. It consists of many networks which supports text messaging and used the bandwidth range of 30 - 200 KHz.[5]

It has a fast data transfer at a speed of 14.4kbps which compared the speed of mid-nineties landline modem model. Other digital protocols including Personal Digital Com, Code Division Multiple Access, Multiple digital systems and Time Division Multiple Access was make use of 2G. Circuit-switched data allowed users to digitally dial-up calls and connect to the internet, though at very high cost which is supported by GSM.
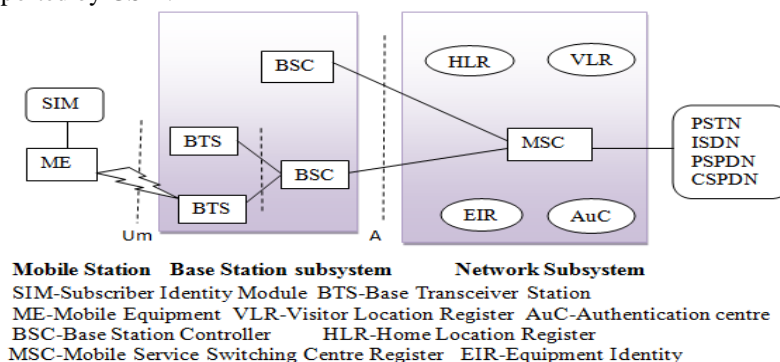

Mobile Station   Base Station subsystem   Network Subsystem
SIM-Subscriber Identity Module BTS-Base Transceiver Station
ME-Mobile Equipment VLR-Visitor Location Register AuC-Authentication centre
BSC-Base Station Controller   HLR-Home Location Register
MSC-Mobile Service Switching Centre Register EIR-Equipment Identity

Fig. 1 Network Components of 2G

A. Technologies under 2G

Personal Digital Com, Code Division Multiple Access (CDMA), Global System for Mobile Communication (GSM), Multiple Digital Systems, Time Division Multiple Access, General Packet Radio Service (GPRS), and Enhanced Data Rates for GSM Evolution (EDGE) are the Mobile technologies comprised in 2G.

B. Features Include in 2G

It includes Digital Text messages, picture messages and MMS. It provides better quality and capacity and consumes less battery power, improves the voice clarity, reduces noise in the line, and gives security and safety to the data and voice calls. Digital error checking allowed by digital voice encoding to increase sound quality and lowers the noise level

C. Drawbacks in 2G

2G needs strong digital signals. If there is a refusal of network coverage in any specific area, digital signals would weak. Complex data such as Videos are unable to handle.

It has a Jagged Decay curve such as Abrupt dropped calls and Analog – gradual sound reduction. It has a low transmission Quality, and Spotty Coverage.

VI. 2.5G (2.5TH GENERATION MOBILE SYSTEM)

A technology between the successor second (2G) and descendent third (3G) generation of mobile telephony called 2.5G.It is combined with GPRS. It introduced a packet of network to provide high speed data transfer & internet in 2.5G. It consists the standards of General Packet Radio Service (GPRS) & EDGE (Enhanced Data rates in GSM).It have a Frequency of 850 -1900 MHz Its Speed is up to 115kpbs (GPRS)/384kbps(EDGE). [5]

A.   Technology under 2.5G

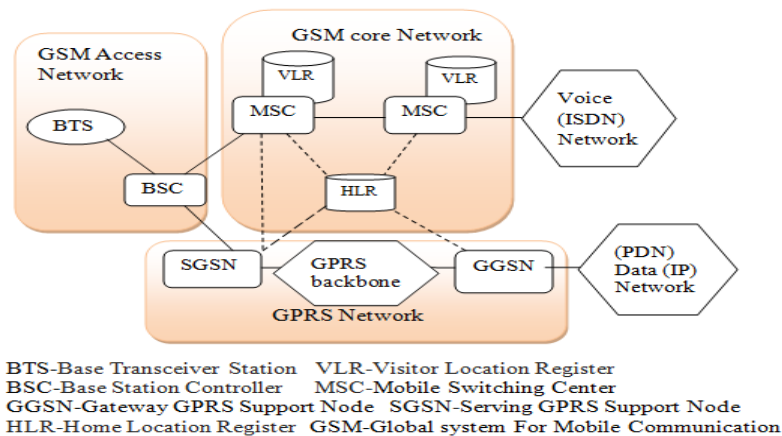Gaussian minimum shift keying-GMSK (GPRS) & EDGE (8-PSK), SGSN are the technologies under 2.5G.

BTS-Base Transceiver Station   VLR-Visitor Location Register
BSC-Base Station Controller   MSC-Mobile Switching Center
GGSN-Gateway GPRS Support Node SGSN-Serving GPRS Support Node
HLR-Home Location Register GSM-Global system For Mobile Communication

Fig. 2 Network Components of 2.5G

B. Features Include in 2.5G

It include the service of push to talk, multimedia, web based info entertainment, support SMS, WAP, mobile games, and search and directory, email access, MMS, video conferencing, Camera Phones. It also includes Send/Receive E-mail Messages and its Speed up to 64-144 kbps. Camera Phones can be used.

C. Drawbacks in 2.5G

A small percentage of time is inefficient to carry a data in 2.5G. Multiple new standards cannot support in this generation. GPRS steal extra time to access Email and Internet.

VII. 3G (THIRD GENERATION MOBILE SYSTEM)

3G system goal is to increase the data rates. In 2000s 3g technology was introduced. The speed of data transmission is 384kbps- 2Mbps. To provide accommodation web-based applications and audio and video files Smart Phones and its characteristics increased its bandwidth and data transfer rates.

It consists of large capacity and broadband capabilities. It increases the spectrum efficiency of 5MHz. It encodes the special code associated with each channel. It has a Frequency about 8 to 2.5GHz. Its bandwidth is 5 to 20MHz. It works under Multiplexing and Access technologies.

A.   Technology under 3G

WCDMA (Wideband Code Division Multiple Access) is a Radio interface and grants a speed of 14.4Mbit/s downward and 5.76Mbit/s upward which has an upgrade of HSPA theoretical peak data rates up to 168 Mbit/s in the downlink and 22 Mbit/s in the uplink can provided by HSPA which uses air interface improvements & multi-carrier HSPA and MIMO. Cdma2000 1X can support voice and data services. The maximum data rate can reach 153 kbps, belonging to 3G mobile communications.

B. Features Include in 3G

Faster Communication is provided in 3G. To Send/Receive the large Email messages faster and have a High Speed Web / More Security. It consists of Video Conferencing / 3D Gaming, Mobile, TV, Phone Calls, Large Capacities and Broadband Capabilities moreover 11 sec – 1.5 min and time to download a 3 min Mp3 song. It provide a service of Wireless voice telephony, fixed wireless Internet access, Location-based services, Telemedicine, high speed internet access, Web browsing, e-mail, paging, fax and navigational maps. The traffic and weather updates, Mobile office services, like virtual banking. It has a higher security features than 2G like User Domain, Application Security, Network Access and Domain Security can be restricted.

C. Drawbacks in 3G

It has overpriced fees for 3G Licenses Services. To build the infrastructure for 3G was challenged and need a Large Cell Phones. High Bandwidth Requirement and also works in Expensive 3G Phones.
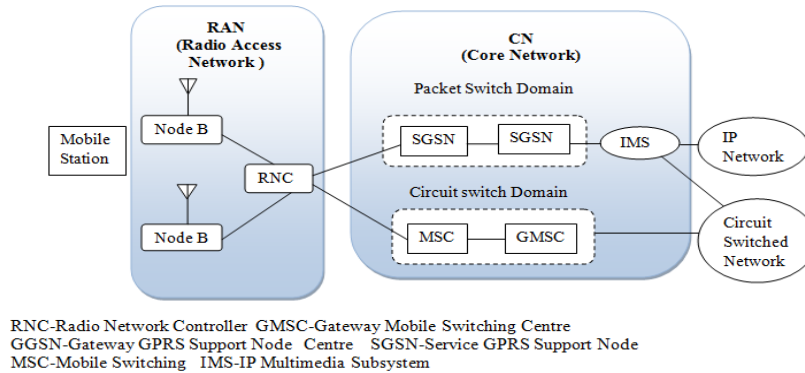

RNC-Radio Network Controller GMSC-Gateway Mobile Switching Centre
GGSN-Gateway GPRS Support Node Centre   SGSN-Service GPRS Support Node
MSC-Mobile Switching IMS-IP Multimedia Subsystem

Fig.3 Network Components of 3G

VIII. 4G (FORTH GENERATION MOBILE SYSTEM)

It was started as late 2000. An IP-based incorporated system which has a capacity to afford 100 Mbps for high mobility and 1 Gbps for low mobility with end toned Quality of service and gives an authentication process and it offers the various services as user requirements, anywhere that extends to which system and devices can exchange and interpret the data. A compilation of technologies to generate fully packet-switched networks optimized for data is 4G.
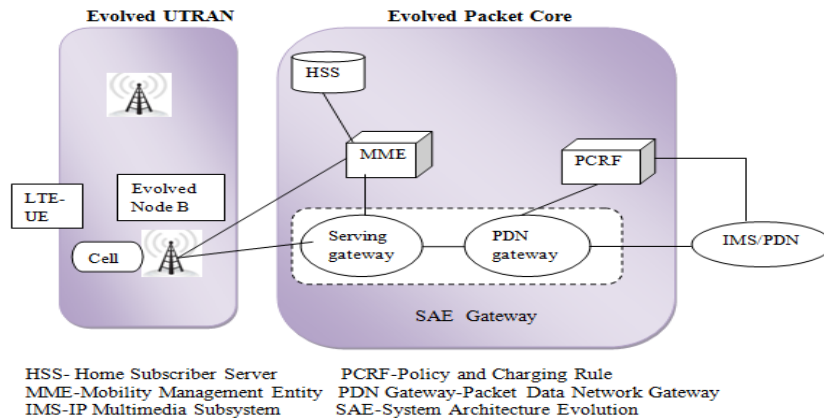

HSS- Home Subscriber Server   PCRF-Policy and Charging Rule
MME-Mobility Management Entity PDN Gateway-Packet Data Network Gateway
IMS-IP Multimedia Subsystem   SAE-System Architecture Evolution

Fig. 4 Network Components of 4G

A. Technology under 4G

Progressed UMTS Terrestrial Radio Access (E-UTRA) and new packet –switching based core network called as Evolved Packet Core (EPC) is a new physical radio interface which was introduced by 4G. The flawless handovers for data and voice to GSM, UMTS or CDMA2000 technology allowed by IP based architecture.

Fixing access points is helped by broadcast layer, (i.e.) microwave, fiber, or satellite (ISP) connecting cell tower. Ad-hoc/hot-spot layer is used for wireless LANs. Personal Layer Gateway contains devices that connect to upper layers, voice, data modem, cell phone, fax, PDAs and MP3 players. Info-Sensor layer is contains environmental sensors. Fiber-optic wire layer has high speed unfathomable tangle of fiber optic wires and repeaters. Ad Hoc Networks has a Spontaneous self organization of networks of devices and do not have any necessarily connected to internet. It consists of TDMA design, soft handoff, CDMA design, RAKE receiver, Handoff, Power Control, Traffic engineering, paging. Maximum vehicle speed (V_m) is 250 km/hr, Maximum coding delay is approx. 20 ms and Maximum delay spread (Δ_m): 10 μs.

B. Features Include in 4G

4G has a wireless broadband access, video chat, Digital Video Broadcasting (DVB), least services like voice and data, mobile TV, Multimedia Messaging Service (MMS) HDTV content, and other services that make use of bandwidth. It also consists of High Speed, High Capacity and Low Cost Per-bit etc. It is Capable to provide speed 100Mbps-1Gbps.It contains High QOS and High Security. As per the user requirements, any kind of service can be provided.

C. Drawbacks in 4G

4G is very hard to implement. It does need complicated hardware. The Battery uses of 4G are more and Expensive equipment required to implement next generation network.

IX. 4.5G LTE (4.5GENERATION MOBILE SYSTEM)

LTE stands for Long Term Evolution. The latest advertised technology and is receiving very close to the speeds that is required as the standards are set is called as 4G LTE. I4G LTE is XLTE has a bandwidth charger with a least amount of twice over the bandwidth and is available at anywhere which is initiated by the AWS spectrum. Packet Switching and is all IP Network is supported by LTE[8].Volte is based on the IP Multimedia Subsystem (IMS) network i.e. data flows within the LTE data bearer delivered the voice service. In Simultaneous voice and LTE (SVLTE) the handset and circuit switched modes works simultaneously in the LTE, the data services and the circuit switched mode providing the voice service was provided by the LTE mode.

X. 5G (FIFTH GENERATION MOBILE SYSTEM)

The initiation year of 5G is late 2010's. The new mobile revolution is happen in mobile market is 5G. It is wireless and does not have any limitations. WWWW (Wireless World Wide Web) is highly supportable. The Physical and Data Link layer indicates an Open Wireless Architecture (OWA). Virtual multi-wireless network can be maintained.

The Network layer is classified into two layers that are the upper network layer is for mobile terminal and lower network layer is for interface. In routing each one IP addresses which would be different in each one of IP network worldwide. Open Transport Protocol (OTP) overcomes a higher bit rate. Transport and Session layer is supported by it.
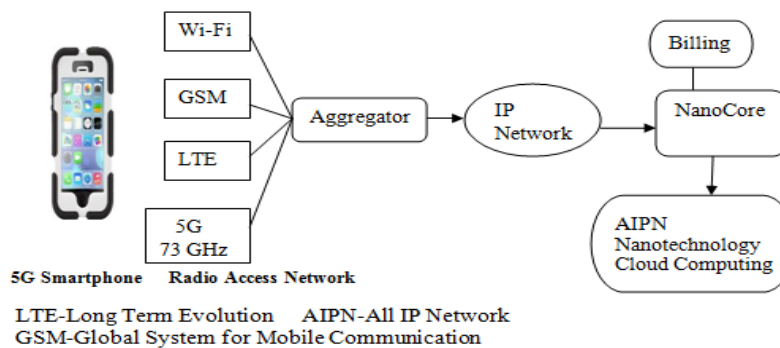

Fig.5 Network Components of 5G

A. Technology under 5G

5G Technology has Millimeter-Wave technologies which is using frequencies much higher in the frequency spectrum releases more spectrums and also gives the chance of having much wide channel bandwidth probably 1 - 2 and frequencies of beyond 50GHz are being used[10]. A number of other high data rate systems as well as in waveform, OFDM has been utilized very effectively in 4G LTE. Generalized Frequency Division Multiplexing, Universal Filtered Multicarrier and Filter Bank Multi-Carrier were included in the configuration. Schemes has a techniques include NOMA, PDMA, OFDMA, SCMA, MUSA and IDMA.

Techniques help to deployed as femtocells can operate satisfactorily and also ensure that small cells in the macro-network. It also consists of, Cognitive radio technology, Pervasive networks, Group cooperative relay Wireless mesh networking and dynamic ad-hoc networking and Smart antennas.

B. Features Include in 5G

The real time performance has Fast response, Low Jitter, latency & delay. It provides large broadcasting of data in Gbps and high quality coverage. The Virtualized Infrastructure has Software defined network, scalable and low cost system.

It supports IoT & M2M and also enormous amount of connected devices, Deep Indoor Coverage & Signaling efficiency. As per the connected network and geographical position, it assigned the Mobile IP address. Higher altitude Radio signal knowing weather and location while talking by use of Parallel multiple services. A great feature is Remote diagnostics.

C. Drawbacks in 5G

To develop an infrastructure is very expensive. There are some issues occur in privacy and Security.

TABLE 1
Comparison of 1G, 2G, 3G, 4G, 5G

TECHNOLOGY	1G	2G/2.5G	3G	4G/4.5GLTE	5G
DEPLOYMENT	1970/1984	1980/1999	1990/2002	2000/2010	2014/2015
BANDWIDTH	2kpbs	14-64Kpbs	2mbps	200 Mbps	>1gbps
TECHNOLOGY	Analog Cellular	Digital cellular	Broadband width/ CDMA/ ip technology	Unified ip& seamless combo of LAN/WAN/WLAN/ PAN	4G+WWWW
SERVICE	Mobile telephony	Digital voice, Short Messaging, Data connectivity	Universal access to different mobile devices made possible along with multimedia & streaming service	High Definition Streaming supported. Probability increased further.	Dynamic information access variable devices with all capabilities
MULTIPLEXING	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
SWITCHING	Circuit	Circuit/Circuit for access networks & air interface	Packet except for air interface	All packet	All packet
CORE NETWORK	PSTN	PSTN	Packet network	Internet	Internet
HANDOFF	Horizontal	Horizontal	Horizontal	Horizontal & vertical	Horizontal & vertical
STANDARDS	AMPS,TACS, NMT	TDMA, CDMA, GSM, PDC	GPRS,EDGE,,1xRTT	WCDMA, CDMA2000	Single standard
WEB STANDARD	–	www	www(IPv4)	www(IPv4)	wwww(IPv6)
Advantage	Simpler network elements	Multimedia features (SMS, MMS). Internet access and SIM introduced	High security, International roaming	Speed, High speed handoffs, MIMO technology, Global mobility	Globally accessible, Dynamic information access
SHORTFALLS	Low capacity, unreliable handoff, Poor Voice links, Less secure	Digital signals were reliant on location & proximity, required strong digital signals to help mobile phones	Need to accommodate higher network capacity	Being Deployed	Developing infrastructure needs high cost. Security and privacy issue yet to be solved.

XI. FUTURE ENHANCEMENT

To incorporate the satellite networks to make an available of network position identifier, multimedia with internet connectivity, services to the mobile users and weather information. At different geographical locations specially designed nano antennas will be implemented. Fly sensors will be implemented to provide information to remote observed station and to resolve the problem of security and provide the fast internet at the speed up to 11Gbps.

XII. CONCLUSION

In this paper we have detailed survey of development of various wireless technologies and generation bands of 0G, 1G, 2G, 2.5G, 3G, 4G, 4.5, 5G. This paper shows the evolution of wireless technologies, and its techniques, network components, features and disadvantages. Amongst 5G provides a high data transfer. Evolution of Wireless technology is the greatest boon to the telecommunication sector. At last I conclude wireless technology helps to support stronger links between people working in diverse fields creating upcoming concepts of mobile communication, internet service, cloud computing and nanotechnology.

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