

# Evolution of LTE - Advance towards 5G

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## Abstract

The paper throws light on the evolution and development of various generations of mobile wireless technology along with their significance and advantages of one over the other. The network architecture developed by the Third Generation Partnership Project (3GPP), which supports the integration of current and future radio access technologies, is highlighted. Then, the technologies for LTE-Advanced are explained. Mobile wireless technology has reached to 5<sup>th</sup> Generation of Technology. Currently 5G term is not officially used. 5G research is being made on development of World Wide Wireless Web (WWWW), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World. This paper explains basic protocol and evolution of 5G.

**Keywords:** LTE, LTE-A, Evolution of 5G, 5G networks, Mobile networks etc

## Introduction

Mobile and wireless networks have made tremendous growth in the last fifteen years. The ancient stone-age sounding 1G, or analog cellular, then like 80's rock came 2G, or digital cellular; 3G wireless, 4G and so on. The development of 4G systems started in 2002. The real new revolution started with 3GPP in December 1998. 3GPP systems are designed for multimedia communication, with them person-to-person communication can be enhanced with high quality images and video, and access to information and services on public and private networks will be enhanced by the higher data rates and new flexible communication capabilities of third generation systems. The next step was 3GPP Long-Term Evolution (LTE). LTE aims to improving the Universal Mobile Telecommunication System (UMTS) mobile phone standard to cope with future requirements. The LTE project is not a standard itself, but it will result in the new evolved Release 8 of the UMTS standard, including most or all of the extensions and modifications of the UMTS system. With the deployment of LTE, the wireless revolution will achieve an important milestone.

The 5G terminals will have software defined radio and modulation scheme as well as new error-control schemes can be defined from the Internet on the run. The development is seen towards the user terminals as a focus of the 5G mobile networks. 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. 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. The most advance cellular technology in the coming years might be 5G. Mobile phones in 5G are configured to use very high bandwidth and are packet switched based wireless system. Area coverage in 5G is very large and throughput of the system is also very high. 5G technology uses CDMA (code division multiple access) and BDMA (beam division multiple access) that enables data rate greater than 100 Mbps at high mobility and higher than 1Gbps at low mobility. 5G includes some advance features like it is the most powerful and high demanding in the near future.

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## Evolution of Mobile Technologies

Mobile communication has become more popular in last few years due to fast revolution in mobile technology. This revolution takes place due to very high increase in telecom customers. From 1G to 2.75G and from 3G to 5G the world of telecommunication has seen a number of improvements along with performance and quality of service with every passing day.

### 1G and 2G

1G was the initial wireless telecom network system. It works on TDMA and FDMA (Time Division Multiple Access and Frequency Division Multiple Access). It is not in use now days as it is out of date. The analog brick phones and bag phones are under 1G technology. Cell phones era began with 1G. The next era was 2G, it was the major upgrade in communication as it takes cell phones from analog to digital. 2G and 2.5G were versions of the GSM and CDMA connections. And GSM is still the most popular technology, but with no internet. Fortunately, GPRS, an additional service, is provided over GSM for the purpose of internet access. GPRS has been developed and thus, EGPRS was created. It's more secure and faster than GPRS.

### 3G

The new wireless CDMA technology 3G is introduced. The International Telecommunications Union (ITU) defined the third generation (3G) of mobile telephony standards IMT-2000 to facilitate growth, increase bandwidth, and support more diverse applications. For example, GSM could deliver not only voice, but also circuit-switched data at speeds up to 14.4 Kbps. But to support mobile multimedia applications, 3G had to deliver packet-switched data with better spectral efficiency, at far greater speeds. GPRS deployments began in 2000, followed by EDGE in 2003. While these technologies are defined by IMT-2000, they are sometimes called "2.5G" because they did not offer multi-megabit data rates. EDGE has now been suppressed by HSDPA (and its uplink partner HSUPA). According to the 3GPP, there were 166 HSDPA networks in 75 countries at the end of 2007.

### 4G

It is a high-speed broadband wireless network that offered comprehensive & secure all IP based services.

According to the ITU, requirements for 4G standards were specified by IMT-Advanced (International Mobile Telecommunication-Advanced). The data rate of 4G service for high mobility communication was up to 100 Mbps and low mobility communication was 1 Gbps. The 4G architecture comprises of 3 crucial area of connectivity namely PAN (Personal Area Network), WAN (Wide Area Network) and Cellular Connectivity.

It focuses on cellular system with extremely high data rates & the concept of seamless technology in all wireless systems. Carriers that are using OFDM (Orthogonal Frequency-Division Multiplexing) as an alternative to TDMA and CDMA are promoting their services as 4G even though their data rates are not high according to the ITU.

### LTE and LTE-advanced

LTE (Long Term Evolution) is a mobile communication standard, submitted as the candidate of 4G (4<sup>th</sup> Generation) system to ITU (International Telecommunication Union) in late 2009. It was approved by ITU, IMT-advanced (International Mobile Telecommunication) and was finalized by 3GPP (3<sup>rd</sup> Generation Partnership Project) in March 2011. The key features of LTE- Advanced is the spectrum use, it support scalable bandwidth, it supports high data rate i.e. up to 100 Mbps and up to 1Gbps peak data rate at low mobility with maximum uploading speed of 500 Mbps. LTE Advanced further improves the capacity and coverage and ensures user fairness. LTE Advanced introduces multicarrier by which it can use ultra wide bandwidth, up to 100 MHz of spectrum supporting very high data rates.

Now research is going on 5th generation wireless system (5G). It is expected that, it will fulfill the entire requirement that has not been fulfilled by 4G. 5G technology has changed the means to use cell phones within very high bandwidth. User never encountered ever before such a high value technology. All kind of advanced features which makes 5G technology most powerful and in huge demand in near future. 5th generation technologies which are on hand held telephone offering more power and features than at least 1000 lunar modules. A user can also attach their 5G technology cell phone with their Laptop to get broadband internet access.

## Network architecture

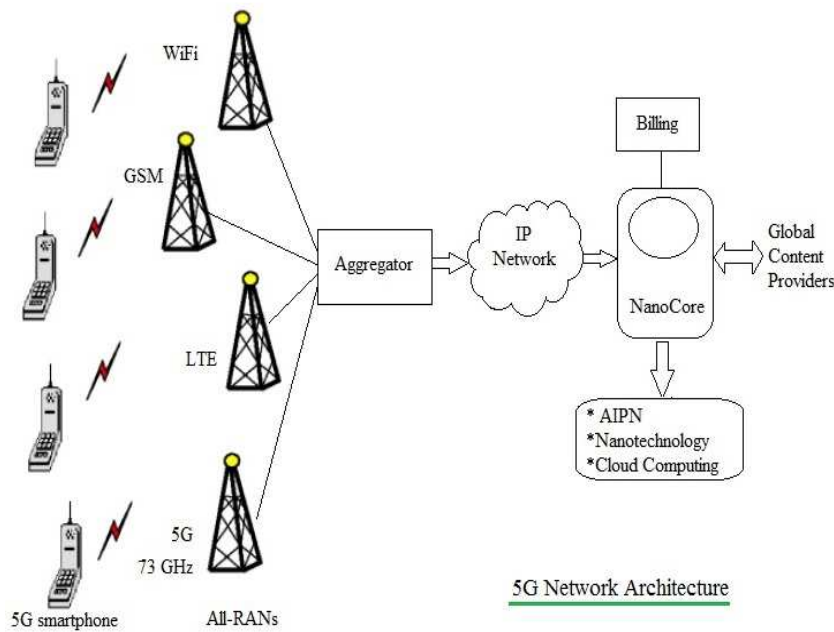


Figure 1. Network architecture of 5G

As shown 5G network uses flat IP concept so that different RANs (Radio Access Networks) can use the same single nanocore for communication. RANs supported by 5G architecture are GSM, GPRS/EDGE, UMTS, LTE, LTE-advanced, WiMAX, WiFi, CDMA 2000, EV-DO, CDMA One, IS-95 etc. Flat IP architecture identifies devices using symbolic names unlike hierarchical architecture where in normal IP addresses are used. This architecture reduces number of network elements in data path and hence reduces cost to greater extent. It also minimizes latency.

5G aggregator aggregates all the RAN traffics and route it to gateway. 5G aggregator is located at BSC/RNC place. 5G mobile terminal houses different radio interfaces for each RAT in order to provide support for all the spectrum access and wireless technologies. Another component in the 5G network architecture is 5G nanocore. It consists of nanotechnology, cloud computing, All IP architecture. Cloud computing utilizes internet as well as central remote servers to maintain data and applications of the users. It allows consumers to use applications without any installation and access their files from any computer across the globe with the use of internet. The IP technology is designed exclusively to ensure sufficient control data for appropriate routing of IP packets related to a certain application connections i.e. sessions between client applications and servers somewhere on the Internet. Architecture of 5G is highly advanced; its network elements and various terminals are characteristically upgraded to afford a new situation. Likewise, service providers can

implement the advance technology to adopt the value-added services easily.

### Network protocol

The fig.3.2 depicts 5G protocol stacks mentioning 5G protocol layers mapped with OSI stack. As shown 5G protocol stack consists of OWA layer, network layer, Open transport layer and application layer.

#### OWA Layer

OWA layer is the short form of Open Wireless Architecture layer. It functions as physical layer and data link layer of OSI stack.

#### Network Layer

It is used to route data from source IP device to the destination IP device/system. It is divided into lower and upper network layers.

#### Open Transport Layer

It combines functionality of both transport layer and session layer.

#### Application Layer

It marks the data as per proper format required. It also does encryption and decryption of the data. It selects the best wireless connection for given service.

Specifications	5G	LTE Advanced
3GPP Standard Release	3GPP Release 15 and Beyond	3GPP Release 13 and beyond
Total carrier Bandwidth	100MHz carrier BW for Gb backhaul and 500MHz for multi Gb backhaul	640 MHz, aggregates up to 32 carriers each of 20MHz bandwidth
Data rate	About 10 Gbps	More than 3 Gbps
Latency	less than 1ms round trip time	less than 2ms round trip time and less than 1ms one way delay
Control Plane	Same as LTE	Same as LTE
Frequency Spectrum	450 MHz to 6 GHz	3 to 6 GHz

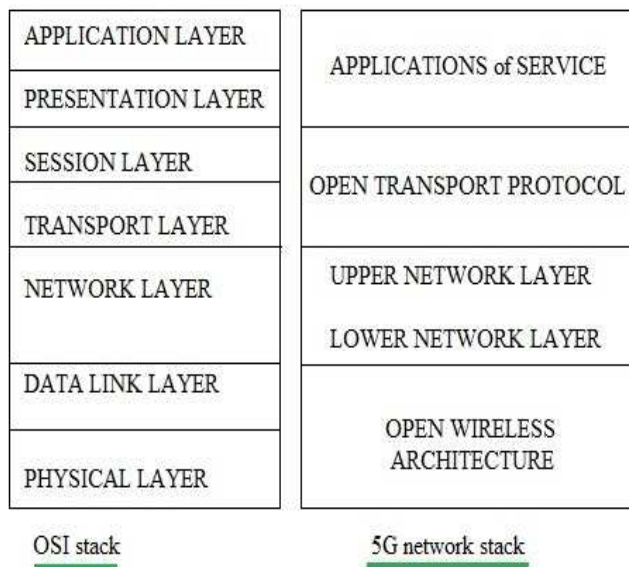


Figure 2. Network Protocol Stack

### Comparison between LTE-a and 5G

Figure given below shows the comparison between Specifications of LTE advanced and 5G

### Features and application of 5G technology

5G technology (5<sup>th</sup> Generation) based on 3GPP Release 15, it offers high quality for mobile phone users worldwide and uses large bidirectional bandwidth shaping. It will also make room for the thousands of internet-connected devices entering our everyday world. It is assumed that 5G technology may use frequency band (frequency spectrum up to 6 GHz, the reason behind this is new wireless technology which uses high frequency band as they are not in use so they transfer information at much higher rate. But the limitation with higher frequency band is that the signal do not travel distance as it travel at lower frequencies, to overcome this problem MIMO (Multiple input multiple output antennas will be used.

Applications of 5G technology are given:

- Real wireless world with no more limitation with access and zone issues.
- Wearable devices with AI (artificial intelligence) capabilities.
- Internet protocol version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network.
- One unified global standard. The user can simultaneously be connected to several wireless access technologies and seamlessly move between them these access technologies can be a 2.5G,3G, 4G or 5G mobile networks, Wi-Fi, WPAN or any other future access technology.

### Conclusion

In this paper, we conclude that 5G network is very fast and reliable. Fifth generation is based on LTE-A technologies. I briefly introduced the history background of 1G to 5G, compared the differences of LTE-advanced and 5G. A new revolution of 5G technology is about to begin because 5G technology

going to give tough completion to normal computer and laptops whose marketplace value will be effected. There are lots of improvements from 1G, 2G, 3G, 4G, LTE and LTE-A to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable. The 5G mobile phone is designed as an open platform on different layers, from physical layer up to the application. Currently, the ongoing work is on the modules that shall provide the best QoS and lowest cost for a given service using one or more than one wireless technology at the same time from the 5G mobile phone.

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