



ACS - short notes

Advanced Communication System (APJ Abdul Kalam Technological University)



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Evolution of wireless technologies 1G to 5G

in mobile communication

Mobile wireless communication system has gone through several evolution stages in the past few decades after the introduction of the first generation mobile network in early 1980s. Due to huge demand for more connections worldwide, mobile communication standards advanced rapidly to support more users.

1G – First generation mobile communication system

The first generation of mobile network was deployed in Japan by Nippon Telephone and Telegraph company (NTT) in Tokyo during 1979. In the beginning of 1980s, it gained popularity in the US, Finland, UK and Europe. This system used analogue signals and it had many disadvantages due to technology limitations.

Most popular 1G system during 1980s

- Advanced Mobile Phone System (AMPS)
- Nordic Mobile Phone System (NMTS)
- Total Access Communication System (TACS)
- European Total Access Communication System (ETACS)

Key features (technology) of 1G system

- Frequency 800 MHz and 900 MHz
- Bandwidth: 10 MHz (666 duplex channels with bandwidth of 30 KHz)
- Technology: Analogue switching
- Modulation: Frequency Modulation (FM)
- Mode of service: voice only
- Access technique: Frequency Division Multiple Access (FDMA)

Disadvantages of 1G system

- Poor voice quality due to interference
- Poor battery life
- Large sized mobile phones (not convenient to carry)
- Less security (calls could be decoded using an FM demodulator)
- Limited number of users and cell coverage
- Roaming was not possible between similar systems.

2G – Second generation communication system GSM

Second generation of mobile communication system introduced a new digital technology for wireless transmission also known as Global System for Mobile communication (GSM). GSM technology became the base standard for further development in wireless standards later. This standard was capable of supporting up to 14.4 to 64kbps (maximum) data rate which is sufficient for SMS and email services.

Code Division Multiple Access (CDMA) system developed by Qualcomm also introduced and implemented in the mid 1990s. CDMA has more features than GSM in terms of spectral efficiency, number of users and data rate.

Key features of 2G system

- Digital system (switching)
- SMS services is possible
- Roaming is possible
- Enhanced security
- Encrypted voice transmission
- First internet at lower data rate
- Disadvantages of 2G system
- Low data rate
- Limited mobility
- Less features on mobile devices
- Limited number of users and hardware capability

3G - Third generation communication system

Third generation mobile communication started with the introduction of UMTS - Universal Mobile Terrestrial / Telecommunication Systems. UMTS has the data rate of 384kbps and it support video calling for the first time on mobile devices.

After the introduction of 3G mobile communication system, smart phones became popular across the globe. Specific applications were developed for smartphones which handles multimedia chat, email, video calling, games, social media and healthcare.

Key features of 3G system

- Higher data rate
- Video calling
- Enhanced security, more number of users and coverage
- Mobile app support
- Multimedia message support
- Location tracking and maps
- Better web browsing
- TV streaming
- High quality 3D games

Disadvantages of 3G systems

- Expensive spectrum licenses
- Costly infrastructure, equipment and implementation
- Higher bandwidth requirements to support higher data rate
- Costly mobile devices
- Compatibility with older generation 2G system and frequency bands

4G - Fourth generation communication system

4G systems are enhanced version of 3G networks developed by IEEE, offers higher data rate and capable to handle more advanced multimedia services. LTE and LTE advanced wireless technology used in 4th generation systems. Furthermore, it has compatibility with previous version thus easier deployment and upgrade of LTE and LTE advanced networks are possible.

Simultaneous transmission of voice and data is possible with LTE system which significantly improve data rate. All services including voice services can be transmitted over IP packets. Complex modulation schemes and carrier aggregation is used to multiply uplink / downlink capacity.

Wireless transmission technologies like WiMax are introduced in 4G system to enhance data rate and network performance.

Key features of 4G system

- Much higher data rate up to 1Gbps
- Enhanced security and mobility
- Reduced latency for mission critical applications
- High definition video streaming and gaming
- Voice over LTE network VoLTE (use IP packets for voice)

Disadvantages of 4G system

- Expensive hardware and infrastructure
- Costly spectrum (most countries, frequency bands are too expensive)
- High end mobile devices compatible with 4G technology required, which is costly
- Wide deployment and upgrade is time consuming

5G – Fifth generation communication system

5G network is using advanced technologies to deliver ultra fast internet and multimedia experience for customers. Existing LTE advanced networks will transform into supercharged 5G networks in future.

In earlier deployments, 5G network will function in non standalone mode and standalone mode. In non standalone mode both LTE spectrum and 5G-NR spectrum will be used together. Control signaling will be connected to LTE core network in non standalone mode.

There will be a dedicated 5G core network higher bandwidth 5G - NR spectrum for standalone mode. Sub 6-GHz spectrum of FR1 ranges are used in the initial deployments of 5G networks.

In order to achieve higher data rate, 5G technology will use millimeter waves and unlicensed spectrum for data transmission. Complex modulation technique has been developed to support massive data rate for Internet of Things.

Cloud based network architecture will extend the functionalities and analytical capabilities for industries, autonomous driving, healthcare and security applications.

Key features of 5G technology

- Ultra fast mobile internet up to 10Gbps
- Low latency in milliseconds (significant for mission critical applications)
- Total cost deduction for data
- Higher security and reliable network
- Uses technologies like small cells, beam forming to improve efficiency
- Forward compatibility network offers further enhancements in future
- Cloud based infrastructure offers power efficiency, easy maintenance and upgrade of hardware