1G (First Generation)

Introduction:

The first-generation (1G) cellular network was introduced in the 1980s and was based on analog technology. The first commercial 1G network was launched in Japan in 1979.

Technology Used:

The main technology used in 1G networks was Advanced Mobile Phone System (AMPS). AMPS used Frequency Division Multiple Access (FDMA) to allocate channels to users. This means that each user was assigned a unique frequency band to transmit and receive calls.

Working Mechanism:

1G networks were primarily used for voice communication, and their analog technology provided limited data capabilities. The quality of voice calls was also not very good and often suffered from background noise.

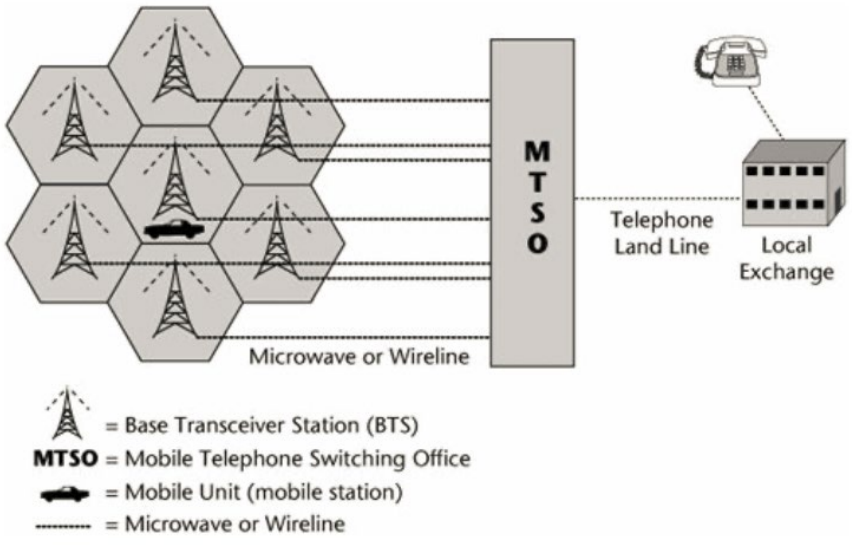


Figure.1 1G Architecture.

2G (Second Generation)

Introduction:

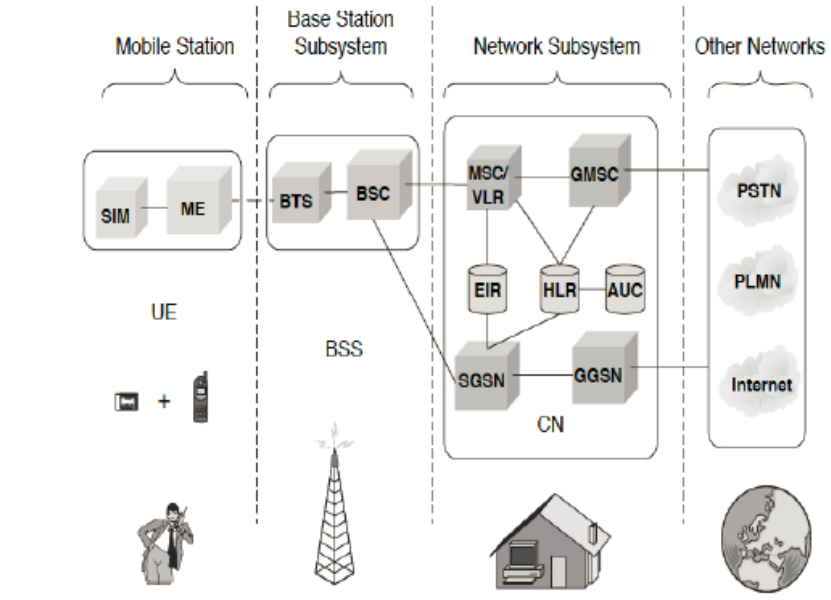
The second-generation (2G) cellular network was introduced in the 1990s and was based on digital technology. The first commercial 2G network was launched in Finland in 1991.

Technology Used:

The main technology used in 2G networks was Global System for Mobile Communications (GSM). GSM used Time Division Multiple Access (TDMA) to allocate channels to users. This means that each user was assigned a time slot to transmit and receive calls.

Working Mechanism:

2G networks introduced several new features such as SMS (Short Message Service) and improved voice quality. The digital technology used in 2G networks provided better voice quality and eliminated background noise. Data transfer rates were also improved in 2G networks, but they were still relatively slow.



SGSN: Serving GPRS Support Node
GGSN: Gateway GPRS Support Node
HLR: Home Location Register
VLR: Visitor Location Register
MSC: Mobile Switching Center
BSS: Base Station System
GMSC: Gateway MSC
EIR: Equipment Identity Register
ME: Mobile Equipment
SIM: Subscriber Identity Card
PLMN: Public Land Mobile Network

Figure.2 2G system.

3G (Third Generation)

Introduction:

The third-generation (3G) cellular network was introduced in the early 2000s and was designed to support both voice and data communication.

Technology Used:

The main technology used in 3G networks was Universal Mobile Telecommunications System (UMTS). UMTS used Code Division Multiple Access (CDMA) to allocate channels to users. This means that each user was assigned a unique code to transmit and receive calls.

Working Mechanism:

3G networks introduced several new features such as video calling, mobile internet, and higher data transfer rates. The data transfer rates in 3G networks were much faster than in 2G networks, which enabled users to browse the internet and stream videos on their mobile devices. The voice quality in 3G networks was also improved, but it was still not as good as in landline phones.

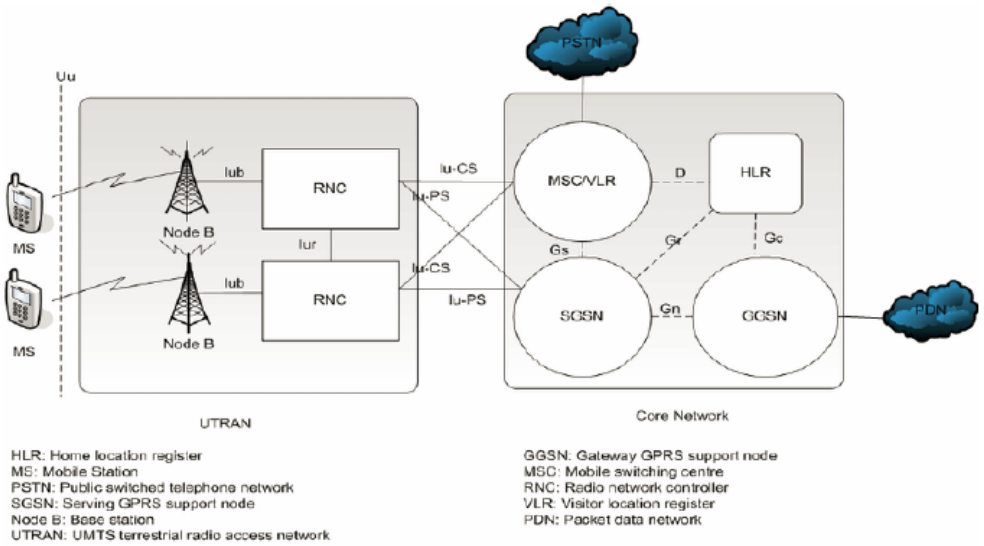


Figure.3 3G UMTS Architecture.

4G (Fourth Generation)

Introduction:

The fourth-generation (4G) cellular network was introduced in the late 2000s and was designed to provide faster data transfer rates and better network reliability.

Technology Used:

The main technology used in 4G networks was Long-Term Evolution (LTE). LTE used Orthogonal Frequency Division Multiplexing (OFDM) to allocate channels to users. This means that each user was assigned a unique frequency band that was divided into multiple subcarriers to transmit and receive calls.

Working Mechanism:

4G networks introduced several new features such as mobile TV, high-quality streaming, and lower latency. The data transfer rates in 4G networks were much faster than in 3G networks, which enabled users to download large files and stream high-quality videos on their mobile devices. The voice quality in 4G networks was also improved, and the network reliability was much better than in previous generations.

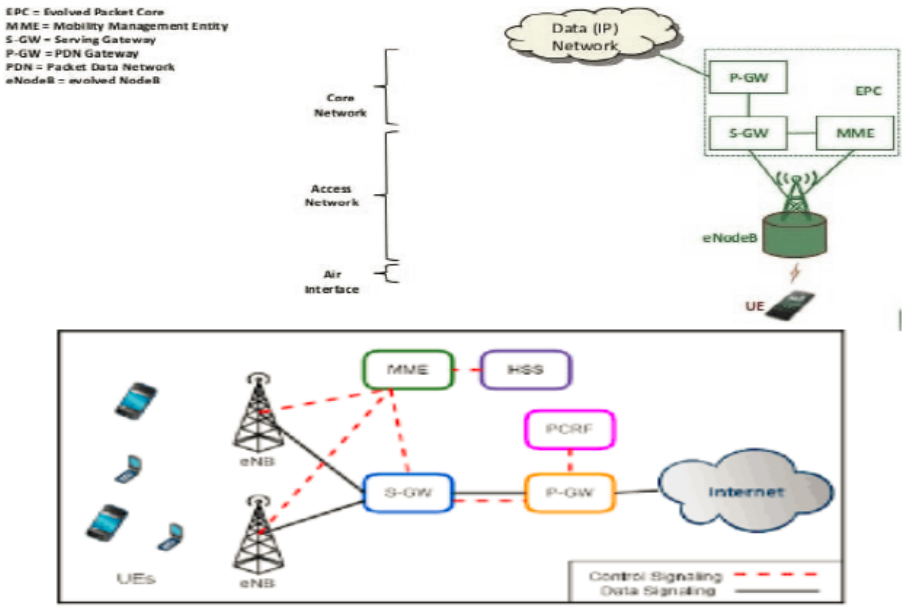


Figure.4 4G LTE Components and Architecture.

5G (Fifth Generation)

Introduction:

The fifth-generation (5G) cellular network was introduced in the 2010s and is designed to provide even faster data transfer rates, lower latency, and better network reliability than 4G.

Technology Used:

The main technology used in 5G networks is a combination of different techniques such as millimeter waves, Massive MIMO, and network slicing. Millimeter waves are higher frequency radio waves that can carry more data and enable faster data transfer rates. Massive MIMO (Multiple Input Multiple Output) is a technology that uses multiple antennas to transmit and receive data, which helps increase network capacity and improve network reliability. Network slicing is a technique that enables the creation of multiple virtual networks on a single physical network, which can be optimized for different use cases.

Working Mechanism:

5G networks use a combination of different technologies to provide faster data transfer rates, lower latency, and better network reliability. The use of higher frequency millimeter waves enables faster data transfer rates, but these waves have shorter range and are easily blocked by obstacles such as buildings and trees. To overcome this challenge, 5G networks use Massive MIMO technology, which enables the use of multiple antennas to transmit and receive data. This helps increase network capacity and improve network reliability. Network slicing enables the creation of multiple virtual networks on a single physical network, which can be optimized for different use cases such as IoT devices, autonomous vehicles, and virtual reality applications.

In short, 5G networks are designed to provide faster data transfer rates, lower latency, and better network reliability than 4G networks. They use a combination of different technologies such as millimeter waves, Massive MIMO, and network slicing to achieve these goals. The use of higher frequency millimeter waves, Massive MIMO, and network slicing enables the creation of multiple virtual networks on a single physical network, which can be optimized for different use cases.

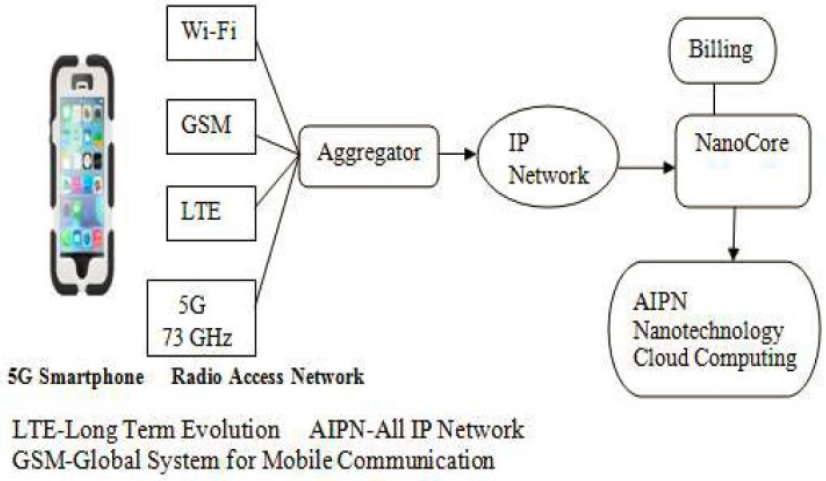


Figure.5 5G Architecture.

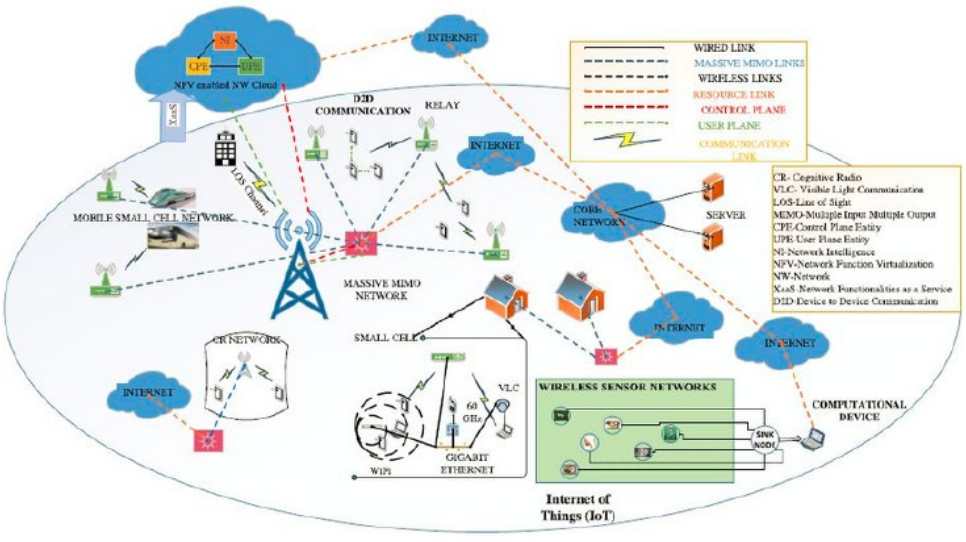


Figure.6 5G Cellular Network.

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