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16/ENG04/065

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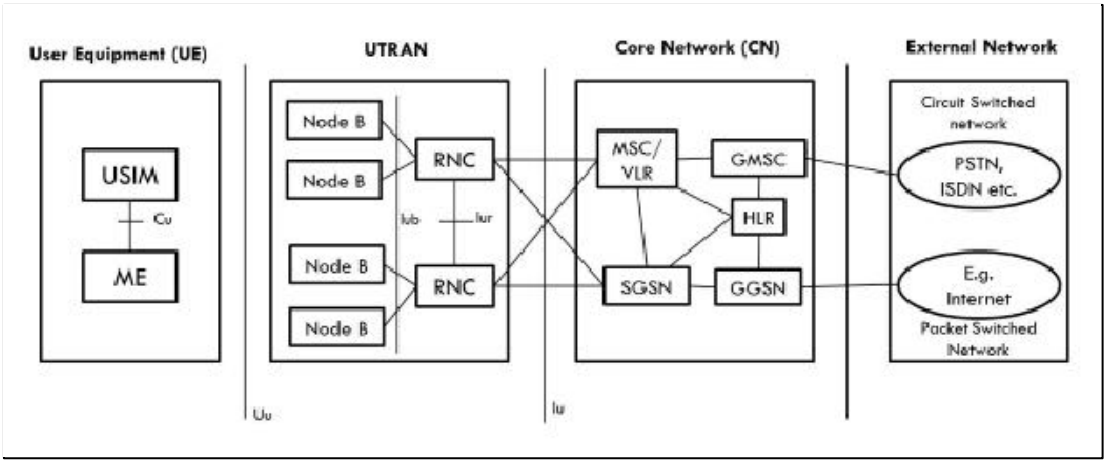
1(i) 3G



UMTS, Universal Mobile Telecommunications System, is a 3G networking standard used throughout much of the world as an upgrade to existing GSM(2G) module. The evolution from GSM towards UMTS happened slowly. The UMTS makes use of WCDMA, a technology which shares much with CDMA networks used throughout the world, though it isn't compatible with them. Base level UMTS networks are generally capable of downlink speeds as 384 kbps. The UMTS architecture takes advantage of the existing GSM and GPRS networks which serve as a core network in UMTS infrastructure. The UMTS is made up of 3 main components.

i. User Equipment(UE): It is assigned to a single user and contains all the functions needed to access UMTS services. It contains: — Mobile Equipment (ME) : It is a radio terminal which is used to connect the UMTS subscriber with the fixed part of UMTS system via the radio interface Uu. UMTS Subscriber Identity Module (USIM): A smartcard which contains the subscriber identity, authentication algorithms, encryption keys etc.

ii. UMTS Terrestrial Radio Access Network(UTRAN): This handles cell-level mobility. It is a system of base station and controller handling function related to mobility. It further contains:

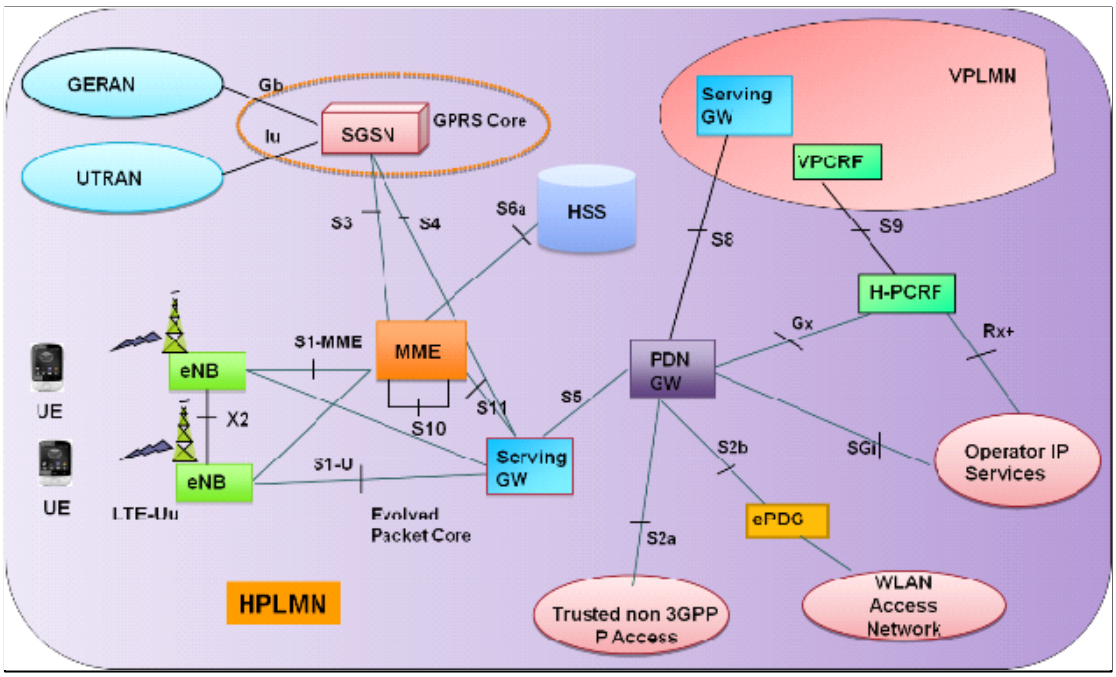
a. Nodes B (Base Stations): It converts the data between Uu radio interface and the Iub interface connecting a Node B with the RNC. It also performs physical level processing such as channel coding, data interleaving, rate matching, modulation, etc.

b. Radio Network Controllers(RNC): This controls and manages radio resources to Node B. It also performs the datalink layer processing and participates in handover operations. RNC is considered a single access point of UTRAN for the core network. Its connected to a single MSC/VLR to route circuit-switched traffic and to a single SGSN to route packet switched traffic.

iii. Core Network(CN): It is shared with GSM and GPRS. The CN contains functions for intersystem handover, gateways to other networks and performs location management. It contains:

- Home Location Register (HLR)
- Mobile Station Controller / Visitor Location Register (MSC/VLR).
- Gateway MSC: Connect UMTS to external circuit switch n/w (e.g PSTN)
- Serving GPRS Support Node (SGSN): It serves the Packet-switched traffic.
- Gateway GPRS Support Node (GGSN): Connects UMTS to external packet switched. (e.g. Internet).

4G



The figure above shows a Generic Mobile Communication architecture. 4G network is an integration of all heterogeneous wireless access network such as Ad-hoc, cellular, hotspot and satellite radio components. The technologies used in 4G are smart antennas for multiple input and multiple output (MIMO), IPv6, VoIP, OFDM and Software defined radio (SDR) System.

Smart Antennas:

- Smart Antennas are Transmitting and receiving antennas.
- It does not require increase power and additional frequency.

IPV6 Technology:

- 4G uses IPV6 Technology in order to support a large number of wireless enable devices.
- It enables a number of application with better multicast, security and route optimization capabilities.

VoIP:

- It stands for Voice over IP.
- It allows only packet to be transferred eliminating complexity of 2 protocols over the same circuit.

OFDM:

- OFDM stands for Orthogonal Frequency Division Multiplexing.
- It is currently used as WiMax and WiFi.

SDR:

- SDR stands for Software Defined Radio.
- It is the form of open wireless architecture.

MME- Mobility Management Entity

It is used for Paging ,Authentication, Handover and Selection of Serving Gateway

SGW- Serving gateway

It is used to Routing and Forwarding user data packet.

PDN-GW Packet Data Network Gateway

It is used for user equipment (UE) IP allocation

HSS -Home Subscriber Server

It is a user Database used for service subscriber, user identification and addressing

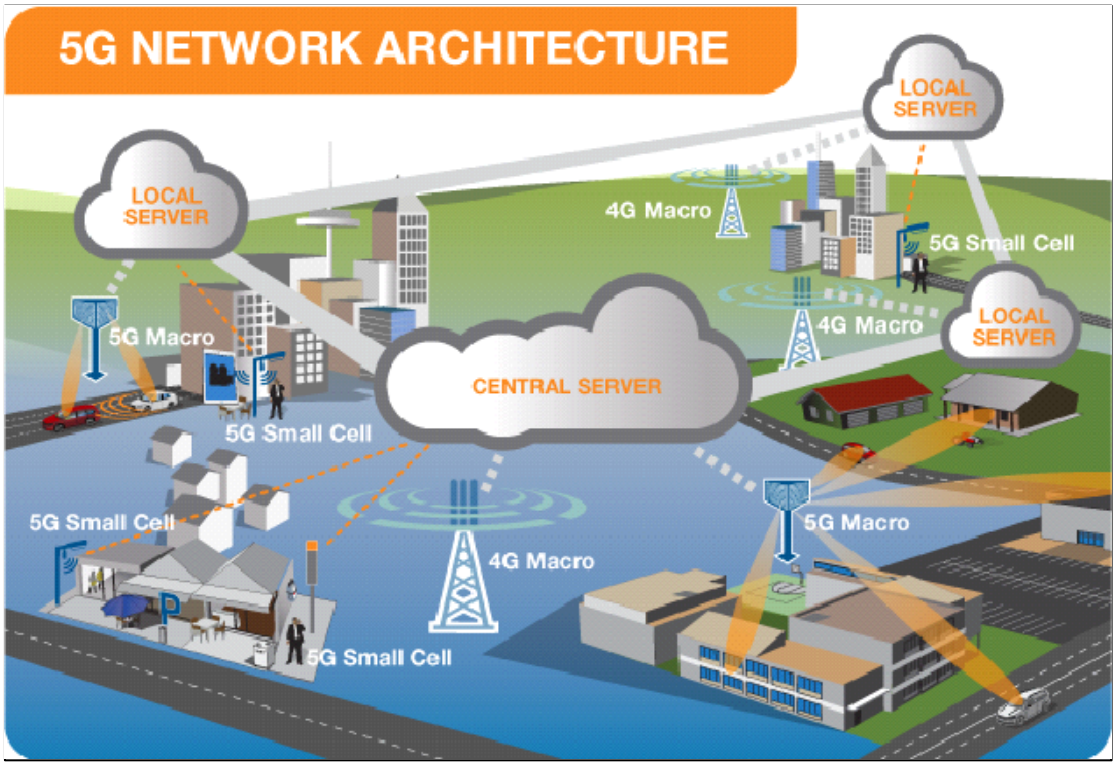
PCRF -Policy and Charging Rule Function

It provide quality of service and charging

eNode B-evolved Node B

It is used as radio resources management and radio bearer control

5G: It is the 5th generation of mobile wireless systems and it integrates perfectly with the internet of things like other cellular networks. 5G uses a system of cell sites that divide their territory into sectors and send encoded data through radio waves. Each cell site is connected to a network backbone whether it is either wired or wireless connection. It uses OFDM for encoding which is similar to the encoding 4G LTE uses.



5G network architecture illustrating 5G and 4G working together, with central and local servers providing faster content to users and low latency applications.

A mobile network has two main components, the Radio Access Network and the Core Network.

The Radio Access Network - consists of various types of facilities including small cells, towers, masts and dedicated in-building and home systems that connect mobile users and wireless devices to the main core network.

Small cells will be a major feature of 5G networks particularly at the new millimetre wave (mmWave) frequencies where the connection range is very short. To provide a continuous connection, small cells will be distributed in clusters depending on where users require connection which will complement the macro network that provides wide-area coverage.

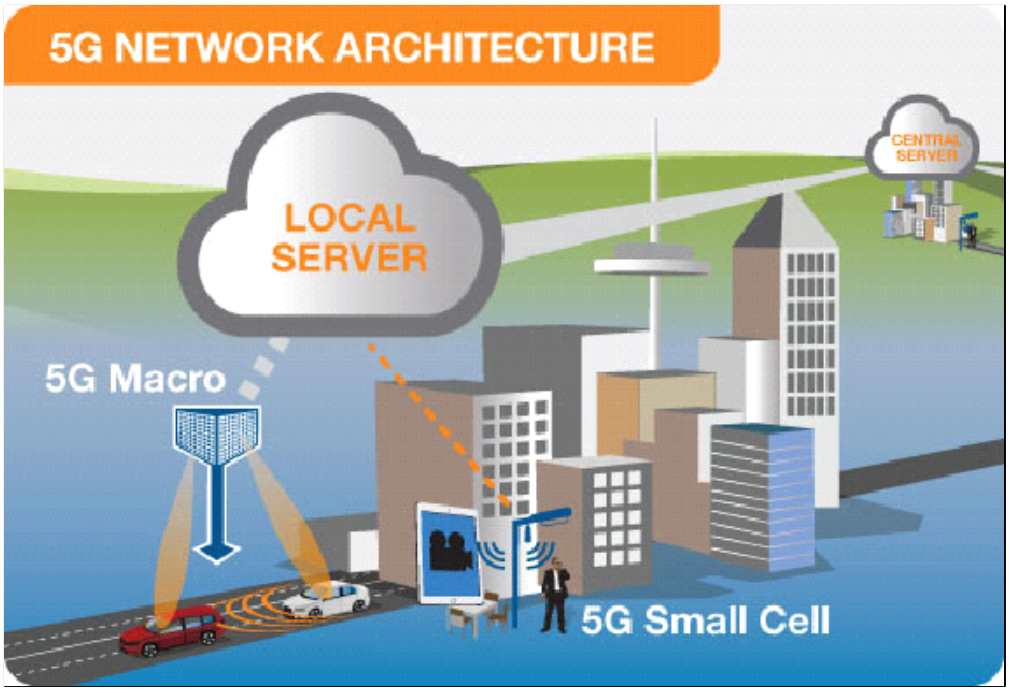
5G Macro Cells will use MIMO (multiple input, multiple output) antennas that

have multiple elements or connections to send and receive more data simultaneously. The benefit to users is that more people can simultaneously connect to the network and maintain high throughput.

The Core Network - is the mobile exchange and data network that manages all of the mobile voice, data and internet connections. For 5G, the core network is being redesigned to better integrate with the internet and cloud based services and also includes distributed servers across the network improving response times (reducing latency).

Many of the advanced features of 5G including network function virtualization and network slicing for different applications and services, will be managed in the core.

The following illustration shows examples of local cloud servers providing faster content to users (movie streaming) and low latency applications for vehicle collision avoidance systems.



Example of a local server in a 5G network providing faster connection and lower response times

Network Slicing — enables a smart way to segment the network for a particular industry, business or application. For example emergency services could operate on a network slice independently from other users.

Network Function Virtualization (NVF) - is the ability to instantiate network functions in real time at any desired location within the operators cloud platform.

Network functions that used to run on dedicated hardware for example a firewall and encryption at business premises can now operate on software on a virtual machine. NVF is crucial to enable the speed efficiency and agility to support new business applications and is an important technology for a 5G ready core.

(ii) 3G Advantages

- Internet access available and with high speed
- Had increased coverage for calls and text messaging
- Faster data rates due to its capability of carrying larger amounts of data.
- Made connecting to internet while on the move possible and realistic for the first time.
- Able to transmit packet switch data efficiently at better and increased bandwidth

Disadvantages

- High power consumption
- Reuires 3G compatible handsets
- Requires closer base stations which is expensive
- Download speeds can sometimes be slower than expected

4G Advantages

- Provides better spectral efficiency
- Quickly download files over a wireless network
- Extremely high voice quality
- Easily access Internet, IM, social networks, streaming media, video calling
- Higher bandwidth
- Typically around five times faster than 3G
- High speed, capacity and low cost per bit

DISADVANTAGES

- Hard to implement
- Higher power consumption than 3G
- New frequencies means new components in cell towers.
- Higher data prices for consumers
- Consumer is forced to buy a new device to support the 4G
- It is impossible to make your current equipment compatible with the 4G network
- Its more limited than 3G and certain older and cheaper phones dont support it.

5G Advantages

- High resolution and bi-directional large bandwidth shaping.
- Technology to gather all networks on one platform.
- More effective and efficient.
- Technology to facilitate subscriber supervision tools for the quick action.

Disadvantages

- 5G is more costly compared to other Mobile Network Technology because many technical/ official engineers are required to install and maintain it.
- The risk of overcrowding the frequency range of the 5G wireless spectrum is greater as more devices are connected to one channel.
- 5G network Technology will take more time for security and privacy issues.
- Coverage indoor distance up to 2 meters and 300 meters outdoors can be achieved due to greater losses at higher frequencies as 5Gmm wave influences from such losses (rain losses, attenuation due to rain, etc.).
- The high cost of 5G Infrastructure

2)

	2G	3G	4G	5G
Frequency Band	850 - 1900MHZ	1.6 - 2 GHZ	2 - 8GHZ	3 - 30GHZ
Bandwidth	5 - 20MHZ	5 - 20MHZ	100+ MHZ	
Data rate	14.4Kbps - 384Kbps	Around 3Mbps	Less than 1Gbps	Higher than 1Gbps
Access	TDMA/CDMA	Wideband CDMA	Multicarrier - CDMA or TDMA(OFDM)	CDMA & BDMA OFDMA
Switching	Circuit for voice Packet for data	Circuit/Packet	Packet Switching	All Packet
Core network	PSTN	Packet network	Internet	Internet
Service	Enabled the use of text messages (SMS) and partial browsing	Video calls and GPS	download speed got faster, wearable devices	HD streaming, global roaming smoothly.
Operational	Started in the 1990s	2003	2010	2019

3(i) No, there isn't.

(ii) There is no correlation between 5g and Corona virus. This is because it isn't scientifically possible for a RF signal to create or transmit a virus of any form. It just is not possible for an inanimate object which basically makes up the phone towers for signals to reproduce, create or even propagate a virus which are parasites. Parasites are living organisms which needs a host(another living organism to survive).