

DIGITAL COMMUNICATION (EEE 512) ASSIGNMENT.

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1. Working principles of 3G, 4G and 5G Networks.

3G NETWORK

The number three in 3G basically means it's the third generation of access technology that allows devices connect to the internet. Each generation is an improvement on the last. 3G connection-based networks were introduced in 2001, marking the start of widespread use of the internet on mobile phones. According to some estimates, 3G offers a real world maximum speed of 7.2 Mbps for download and 2 Mbps for upload

3G ARCHITECTURE

UMTS (Universal Mobile Telecommunications System) : UMTS, short for Universal Mobile Telecommunications System, is a 3G networking standard used throughout much of the world as an upgrade to existing GSM module.

1. UMTS makes use of WCDMA, a technology that shares much with CDMA networks used throughout the world, though it is not compatible with them.
2. Base level UMTS networks are generally capable of downlink speeds as 384 kbps.
3. The UMTS architecture takes advantage of the existing GSM and GPRS networks which serve as a core network in UMTS infrastructure.

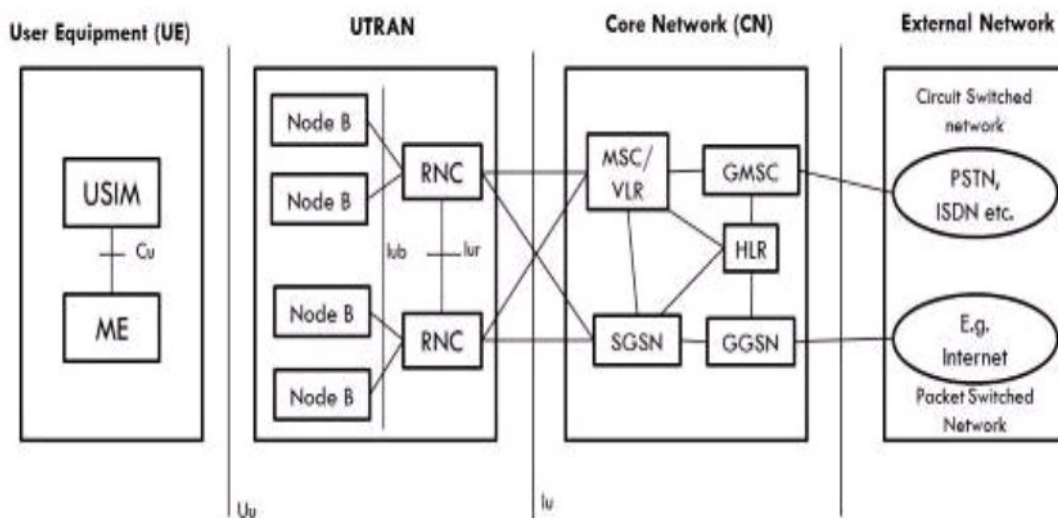
The UMTS is made up of 3 main components:

1. **USER EQUIPMENT:** The user equipment or UE is the name given to what was previously called the mobile or cellphone. The new name was chosen because it could be anything from a mobile phone used for talking to a data terminal attached to a computer with no voice capability.

The UE is a major element of the overall 3G UMTS network architecture. It forms the final phase with the user. It's assigned to a single user and contains all the functions needed to access UMTS services. There are a number of elements within the UE that can be described separately:

- **UE RF Circuitry:** The RF areas handle all elements of the signal, both for the receiver and transmitter It is a radio terminal which is used to connect the UMTS subscriber with the fixed part of UMTS system via the radio interface.
- **Baseband processing:** The baseband signal processing consists mainly of digital Circuitry. This is considerably more complicated than that used in phones for previous generations.
- **Battery:** while current consumption has been minimized as far as possible within the Circuitry of the phone, there has been an increase of current drain on the phone. This has necessitated the use of new and improved battery technology. Now lithium Ion (li-ion) batteries are used.
- **Universal subscriber identity module USIM:** This is a more advanced version of the sim card but embodies the same type of information.

- 2. UMTS TERRESTRIAL RADIO ACCESS NETWORK (UTRAN):** It handles cell-level mobility. It is a system of base station and controller handling function related to mobility. It interfaces the UE and the core network. It contains:
- **Nodes B (Base Stations):** It converts the data between radio interface and the interface connecting a Node B with the RNC. It performs physical level processing such as channel coding, data interleaving, rate matching, modulation etc.
 - **Radio Network Controllers (RNC):** RNC's controls and manages radio resources to Node B. RNC performs the data-link layer processing and participates in handover operations. RNC is considered a single access point of UTRAN for the core network. It's connected to a single MSC/VLR to route circuit-switched traffic and to a single SGSN to route packet-switched traffic.
- 3. CORE NETWORK (CN):** The core network is shared with GSM and GPRS. The CN contains functions for intersystem handover, gateways to other networks and performs location management. It contains:
1. Home Location Register (HLR)
 2. Mobile Station Controller / Visitor Location Register (MSC/VLR).
 3. Gateway MSC: Connect UMTS to external circuit switch n/w (e.g PSTN)
 4. Serving GPRS Support Node (SGSN): It serves the Packet-switched traffic.
 5. Gateway GPRS Support Node (GGSN): Connects UMTS to external packet switched. (e.g. Internet)



4G NETWORK

4G essentially stands for Fourth generation communication system and it is an upgrade from 3G addressing two major issues which are: speed and network congestion.

It works much in the same way as 3G, simply faster. Users can access speeds of up to 21Mb on the go but this is however affected by location

4G ARCHITECTURE

1. 4G stands for fourth generation cellular system.
2. 4G is evolution of 3G to meet the forecasted rising demand.
3. It is an integration of various technologies including GSM, CDMA, GPRS, IMT-2000, Wireless LAN.
4. Data rate in 4G system will range from 20 to 100 Mbps.

Features:

1. Fully IP based Mobile System.
2. It supports interactive multimedia, voice, streaming video, internet and other broadband service.
3. It has better spectrum efficiency.
4. It supports Ad-hoc and multi hop network.
5. 4G network is an integration of all heterogeneous wireless access networks such as Ad-hoc, cellular, hotspot and satellite radio component.
6. 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:

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

IPV6 Technology:

1. 4G uses IPV6 Technology in order to support a large number of wireless enable devices.
2. It enables a number of application with better multicast, security and route optimization capabilities.

VoIP:

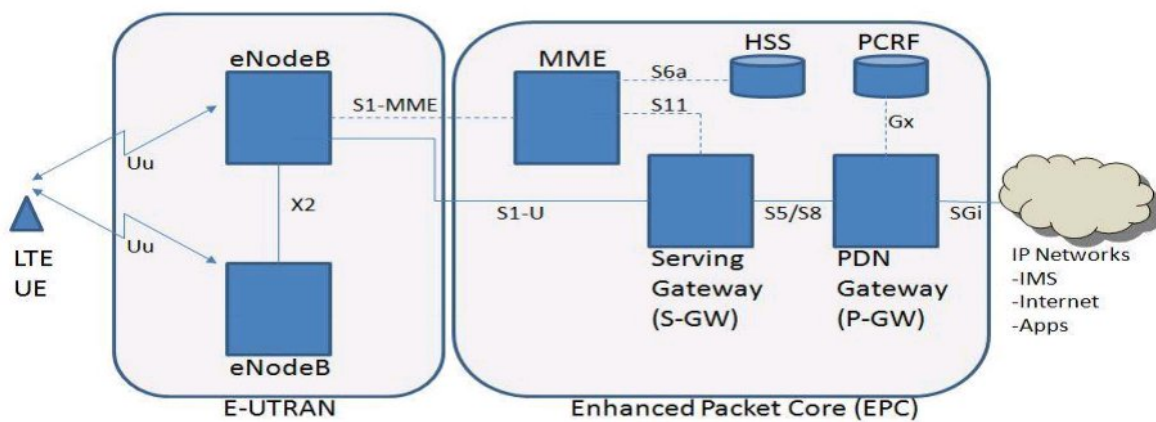
1. It stands for Voice over IP.
2. It allows only packet to be transferred eliminating complexity of 2 protocols over the same circuit.

OFDM:

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

SDR:

1. SDR stands for Software Defined Radio.
2. 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

5G NETWORK

5G is the fifth generation of mobile network a significant evolution of today's 4G LTE. 5G has been designed to meet the very large growth in data and connectivity of today's society. 5G will initially operate with the existing 4G before evolving to fully stand alone

5G ARCHITECTURE

Most operators will initially integrate 5G networks with existing 4G networks to provide a continuous connection. 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 millimeter 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. Where MIMO antennas use very large numbers of antenna elements they are often referred to as 'massive MIMO', however, the physical size is similar to existing 3G and 4G base station antennas.

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.

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 (NFV) – is the ability to instantiate network functions in real time at any desired location within the operator's 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. NFV is crucial to enable the speed efficiency and agility to support new business applications and is an important technology for a 5G ready core.

ADVANTAGES AND DISADVANTAGES OF 3G, 4G and 5G

Advantages of 3G:

- Faster data rates.
- Support multimedia applications such as video and photography.
- Value added services like mobile television, GPS, video call and video conference.
- High speed mobile internet access.
- Increased capacity.

Disadvantages of 3G:

- Requires 3G compatible handsets.
- The cost of upgrading to 3G device is expensive.
- Power consumption is high.
- 3G requires closer base stations which is expensive.

Advantages of 4G:

- It provides better spectral efficiency.
- It has high speed, high capacity and low cost per bit.
- Quickly download files over a wireless network
- Extremely high voice quality
- Easily access Internet, IM, social networks, streaming media, video calling
- Higher bandwidth
- 4G is 10 times faster than 3G

Disadvantages of 4G:

- 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
- Battery usage is more.
- Hard to implement.

Advantages of 5G:

- 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 of 5G

- 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

In tabular form, establish adequate differences between 2G, 3G, 4G and 5G

Technology	1G	2G	3G	4G	5G
Requirements	No official Requirements Analog technology	No official Requirements Digital Technology	ITU's IMT-2000 required 144 kbps mobile, 384 kbps pedestrian, 2 Mbps indoors	ITU's IMT Advanced requirements include ability to operate in up to 40 MHz radio channels and with very high spectral Efficiency.	at least 1 GB/s or more data rates to support ultra-high definition video and virtual reality, applications, 10 GB/s data rates to support mobile cloud service
Data Bandwidth	1.9 kbps	14.4 kbps to 384 kbps	2 Mbps	2 Mbps to 1 Gbps	1Gbps & Higher (as demand)
Core network	PSTN	PSTN Packet Network	Packet network	All IP Network	Flatter IP Network & 5G Network Interfacing(5G-NI)
Service	Analog voice	Digital voice Higher capacity, packetized data	Integrated high quality audio, video and data	Dynamic information access, wear-able devices, HD streaming; global roaming;	Dynamic information access, wear-able devices, HD streaming; any demand of users; upcoming all technologies; global roaming smoothly;
Standards	NMT, AMPS, Hicap, CDPD, TACS, ETACS	GSM,GPRS, EDGE ETC.	WCDMA, CDMA 2000.	All access convergence including: OFMDA,MC-CDMA Network-LMPS	CDMA & BDMA
Multiple access	FDMA	TDMA CDMA	CDMA	CDMA	CDMA & BDMA
Starts from	1970-84	1990	2001	2010	2015
Switching	Circuit	Circuit Packet	Circuit Packet	Packet	All Packet
Frequency	800-900 Reference Mhz	850-1900MHZ	1.6-2.5GHZ	2-8GHZ	

Is there any correlation between 5G and Corona?

No.

Do you support the state, if yes or No, in not more than 500 words, Justify your answer.

No I don't support the state

Very strong radio waves can cause heating, 5G is nowhere near strong enough to heat people up enough to have any meaningful effect. Radio waves can disrupt your physiology as they heat you up, meaning your immune system can't function. But the energy levels from 5G radio waves are tiny and they are nowhere near strong enough to affect the immune system.

The radio waves involved in 5G and other mobile phone technology sit on the low frequency end of the electromagnetic spectrum. Less powerful than visible light, they are not strong enough to damage cells -unlike radiation at the higher frequency end of the spectrum which includes the sun's rays and medical x-rays.

It would also be impossible for 5G to transmit the virus, the present epidemic is caused by a virus that is passed from one infected person to another. We even have the virus growing in our lab, obtained from a person with the illness. Viruses and electromagnetic waves that make mobile phones and internet connections work are entirely different.

It's also important to note another major flaw with the conspiracy theories is that coronavirus is spreading in cities where 5G has yet to be deployed, and in countries like Iran that have yet to roll out the technology.