DIGITAL COMMUNICATIONS

EEE 512 ASSIGNMENT

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SUBMITTED TO

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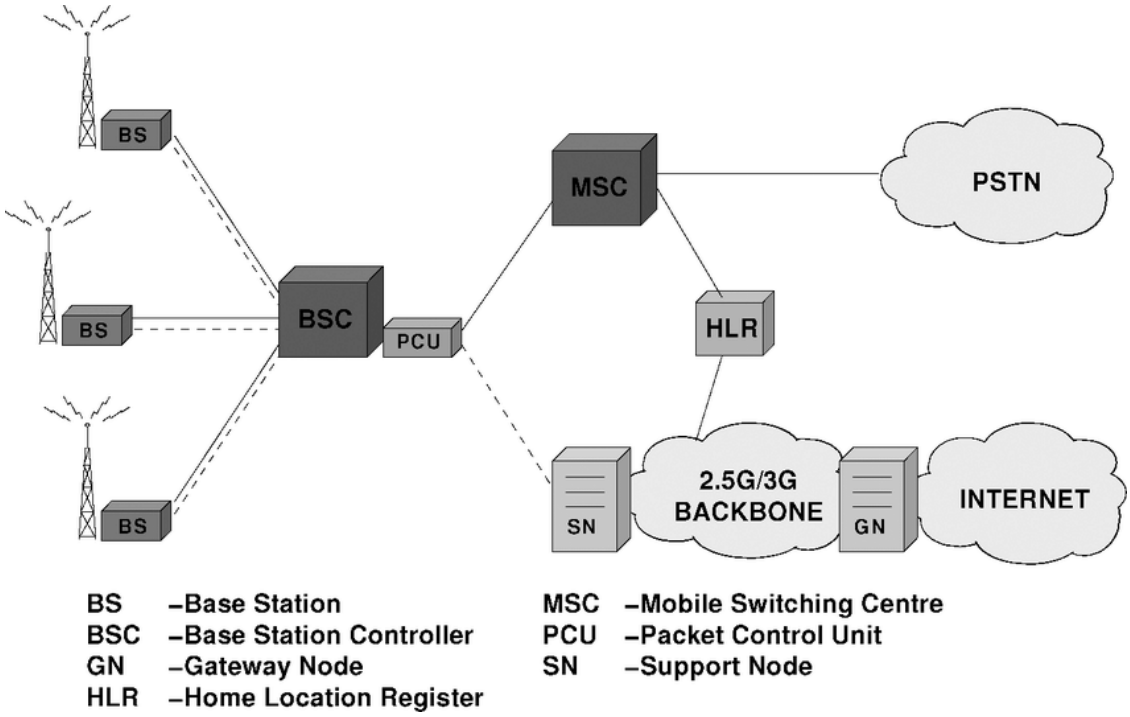
ANSWER

1. Working principle of 3G, 4G and 5G network

   3G Architecture



The 3G services work using a cellular based technology; signals are passed from phone tower to phone tower, and then the tower nearest the phone passes the signal to it. The foundations for the UMTS network had been set in place when GSM was launched. This provided the basic access elements as well as circuit switched voice. The addition of packet data with GPRS required additional network entities to be added. It was the combination of these two network elements that provided the basis for the 3G UMTS network architecture. The UMTS network architecture can be divided into three main elements:

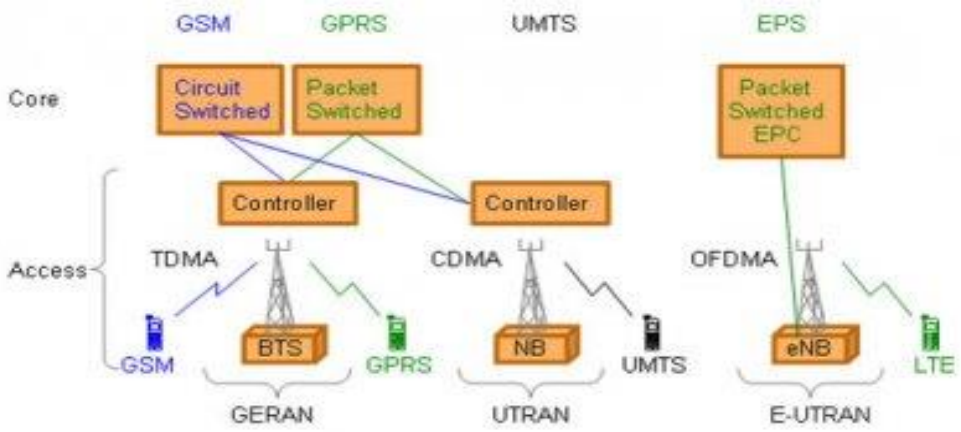
- User Equipment (UE): The User Equipment or UE is a major element of the overall 3G UMTS network architecture. It forms the final interface with the user. In view of the far greater number of applications and facilities that it can perform, the decision was made to call it a user equipment rather than a mobile. However,

it is essentially the handset although having access to much higher speed data communications, it can be much more versatile, containing many more applications. It consists of a variety of different elements including RF circuitry, processing, antenna, battery, etc.

- Radio Network Subsystem (RNS): The RNS also known as the UMTS Radio Access Network, UTRAN, is the equivalent of the previous Base Station Subsystem or BSS in GSM. It provides and manages the air interface for the overall network.
- Core Network: The core network provides all the central processing and management for the system. It is the equivalent of the GSM Network Switching Subsystem or NSS. The core network is then the overall entity that interfaces to external networks including the public phone network and other cellular telecommunications networks.

4G Architecture

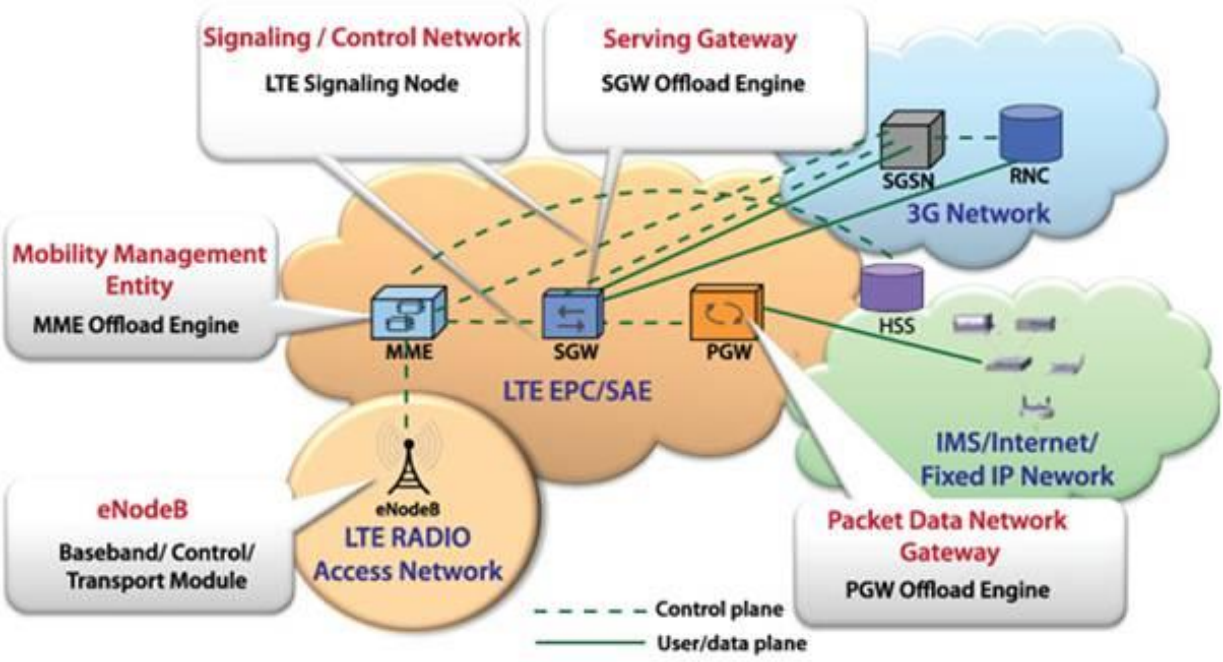
Wireless operators are rapidly expanding their LTE networks to take advantage of additional efficiency, lower latency and the ability to handle ever-increasing data traffic. The diagram below shows network evolution from GSM to LTE. The core technologies have moved from circuit-switching to the all-IP evolved packet core (moving left to right). Meanwhile, access has evolved from TDMA (Time Division Multiple Access) to OFDMA (Orthogonal Frequency Division Multiple Access) as the need for higher data speeds and volumes as increased.



The high-level network architecture of LTE is comprised of following three main components:

- The User Equipment (UE).
- The Evolved UMTS Terrestrial Radio Access Network (E-UTRAN).
- The Evolved Packet Core (EPC).

This LTE network architecture diagram (larger version) comes from testing company Breaking Point Systems. Again, it illustrates the connection points from the end user on the left, to the evolved base stations (eNodeB) and then traffic to and between the MME and SGW (Serving Gateway), to the HSS (Home Subscriber Servier) and ultimately to the Packet Data Network (PDN) on the right.



This diagram from Juniper Networks shows the relationship of the LTE radio access network (RAN) to the LTE Evolved Packet Core/System Architecture Evolution, with the PGW (packet data network gateway) connecting the EPC to the Internet in the user/data plane, which carries users' data traffic. Dotted lines represent network connections within the control plane.

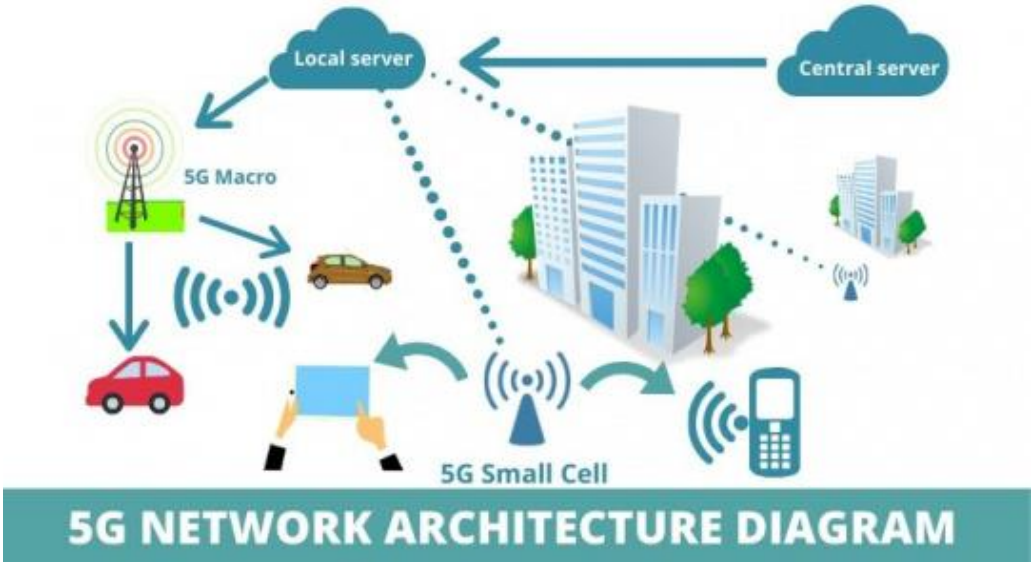
5G Architecture

The current network of 5G consists of two main components:

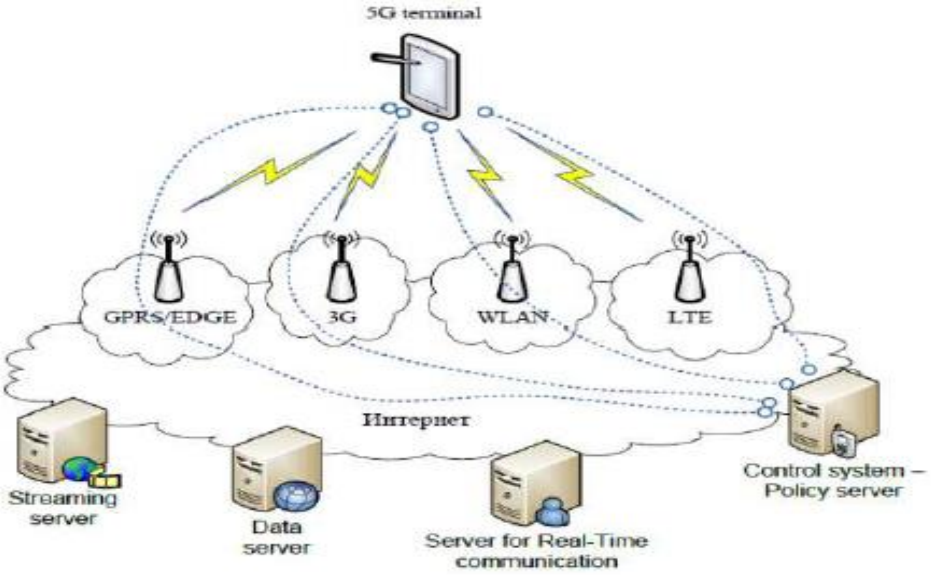
- Radio Access Network
- Core Network

To use a 4G network, a frequency of 2-6 GHz is needed, but that is only good for the traditional set of technologies. With the world adopting much better technologies, like 5G, the same frequency won't do any good. Therefore, in order to counter this issue, usage of millimeter waves is brought into action. Millimeter waves have a better frequency spectrum of 30-300 GHz, with the transmission through millimeter waves being fast. But the drawback of these waves is that they aren't able to penetrate through trees, building, and mountains. Thus smaller cells are introduced. Instead of opting for one powerful antenna these smaller cells are brought in to work together to counter the attenuation issues. In the radio access network, apart from millimeter waves and small cells, 5G closely depends on MIMO antennas as well. Earlier in 4G networks, there was the usage of approximately dozens of such antennas, but considering the concept of a faster network i.e. 5G, such antennas are increased multiple times. Thereby, allowing the faster transmissions to happen. MIMO antennas while making the faster transmission a reality, do encounter a glitch which is interference. Transference of many signals from same stations, leads to interference issues which are easily encountered by beamforming. Beamforming allows the transmission of higher beam signals through a single port, first in a particular direction thus reducing the issue of interference.

The core network, on the other hand, manages the data as well as the internet connection. As of now, the core network is being redesigned to work better with other platforms like a cloud. Core network also provides the facility of functions like network slicing and distributed servers that are responsible for better response



As shown in the image below, the system model of 5G is entirely IP based model designed for the wireless and mobile networks.



The system comprising of a main user terminal and then a number of independent and autonomous radio access technologies. Each of the radio technologies is considered as the IP link for the outside internet world. The IP technology is designed exclusively to ensure sufficient control data for appropriate routing of IP packets related to a certain application connection i.e. sessions between client applications and servers somewhere on the Internet.

2. Outline the advantages and disadvantages of 2G, 3G, 4G and 5G network

Advantages of 3G

1. New radio spectrum to relieve overcrowding in existing systems.
2. More bandwidth, security, and reliability.
3. Interoperability between service providers.
4. Fixed and variable data rates.
5. Asymmetric data rates.
6. Backward compatibility of devices with existing networks.

Disadvantages of 3G

1. Requires 3G compatible handsets.
2. The cost of upgrading to 3G device was expensive.
3. Power consumption was high.
4. 3G requires closer base stations which was expensive.

Advantages of 4G

1. Quickly download files over a wireless network.
2. Extremely high voice quality.
3. Easily access Internet, IM, social networks, streaming media, video calling.
4. Higher bandwidth.
5. 4G is 10 times faster than 3G.

Disadvantages of 4G

1. New frequencies mean new components in cell towers.
2. Higher data prices for consumers
3. Consumer is forced to buy a new device to support the 4G
4. It is impossible to make your current equipment compatible with the 4G network

Advantages of 5G

1. High resolution and bi-directional large bandwidth shaping.

2. Technology to gather all networks on one platform.
3. More effective and efficient.
4. Technology to facilitate subscriber supervision tools for the quick action.
5. Most likely, will provide a huge broadcasting data (in Gigabit), which will support more than 60,000 connections.
6. Easily manageable with the previous generations.
7. Technological sound to support heterogeneous services (including private network).
8. Possible to provide uniform, uninterrupted, and consistent connectivity across the world.

Disadvantages of 5G

1. Technology is still under process and research on its viability is going on.
2. Many of the old devices would not be competent to 5G, hence, all of them need to be replaced with new one — expensive deal.
3. Developing infrastructure needs high cost.
4. Security and privacy issue yet to be solved.
5. More cell towers will be required to produce this immense bandwidth because the cells are not able to cover as much space as a 3G or 4G cell.

3. Differences between 2G, 3G, 4G and 5G

Features	2G	3G	4G	5G
Deployment	1980/1999	1990/2002	200/2010	2014/2015
Bandwidth	14-64Kbps	2Mbps	200Mbps	> 1Gbps
Multiplexing	TDMA/CDMA	CDMA	CDMA	CDMA
Core network	PSTN	Packet network	Internet	Internet
Frequency	1.8Ghz	1.6-2Ghz	2-8Ghz	3-30Ghz
Technology	GSM	WCDMA	LTE, WiMax	MIMO, mm waves
Handoff	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical

4. No, there is no correlation between 5G and Corona virus.

   No, I do not support the state.

   why?

   A coronavirus is a type of virus that's spread from person-to-person contact. It doesn't travel through something like radio waves. The coronavirus pandemic is fertile ground for conspiracy theories from the one that says it was created in a laboratory with obscure geopolitical and/or business objectives, to the idea that the recent expansion of 5G networks has caused the rapid spread of the pathogen.

   5G represents the fifth-generation of the wireless telecom technology that smartphones and other devices use for communication and connecting to the internet. As with 4G LTE, 3G, and everything before it, the wireless network is transmitted over radio waves, a non-harmful part of the electromagnetic spectrum. 5G radio waves are called millimetre waves, because their wavelength is measured in millimetres and because these waves are short, 5G cell towers need to be relatively close together - about 250 metres apart. They are organized as a collection of small cells (a cell is an area covered by radio signals). For 5G to cover a larger geographic area, more base stations are needed in comparison to 4G and this increase in the number of base stations, and their proximity to humans, is one factor that may stir unfounded fears about 5G's potential health impacts.

   The argument that 5G weakens the immune system by emitting harmful radiation and therefore facilitates the entry of the coronavirus into the system. If we consider the electromagnetic spectrum, at its low frequency end we find the radio waves. This confirms that they do not produce ionizing radiation and therefore cannot damage human DNA, unlike other frequencies such as x-rays and ultraviolet light, responsible for causing diseases such as cancer. In fact, the radiation emitted by radio waves is at a level similar to that produced by televisions and natural light. It is true that this new generation emits a little more than its predecessors but it is also true, according to Ofcom (the telecommunications regulator in the UK) that the maximum it can generate is 66 times below the safety limit. To top it off, coronavirus is already present across the majority of the inhabited parts of the planet, and this includes Africa and South America where the presence of 5G is still rare or, in most instances, non-existent. There is also no

penetration of this technology in Iran, which has reported more than 90,000 cases of infection and well over 5,000 deaths.

The confusion really took off when celebrities and social media influencers started to tell their followers about the supposed link between of 5G and the pandemic. In Nigeria, Senator Dino Melaye and BBNaija contestant Tasha were among the people who talked about the links.

Coronavirus is a virus. That is a fact. Scientists around the world have been researching the disease since its first appearance on the global stage and are looking for treatments and to help stop its spread. Any claim that 5G cause the health issues being reported are all false and ultimately harmful in themselves.

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