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COURSE: EEE 512 (ASSIGNMENT)

SOLUTION

QUESTION ONE

i. **THIRD GENERATION (3G)**

3G systems function using a technique called the Universal Mobile Telecommunication System (UMTS). UMTS was developed from GSM by completely changing the technology used on the air interface, while keeping the core network almost unchanged.

UMTS and GSM share a common network architecture.

There are three main components, namely:

The Core Network

The Radio Access Network

The mobile phone/User Equipment (UE)

The core network contains two domains: The circuit switched (CS) domain which transports phone calls across the geographical region that the network operator is covering, in the same way as a traditional fixed-line telecommunication system. It communicates with the public switched telephone network (PSTN) so that users can make calls to land lines and with the circuit switched domains of other network operators. The second being the packet switched (PS) domain transports data streams, such as web pages and emails, between the user and external packet data networks (PDNs) such as the internet.

The radio access network handles the core network's radio communications with the user. There are actually two separate radio access networks, namely the GSM EDGE radio access network (GERAN) and the UMTS terrestrial radio access network (UTRAN). These use the different radio communication techniques of GSM and UMTS, but share a common core network between them.

The system was later enhanced for data applications, by introducing the 3.5G technologies of high-speed downlink packet access (HSDPA) and high-speed uplink packet access (HSUPA), which are collectively known as high speed packet access (HSPA). The UMTS air interface has two slightly different implementations. Wideband code division multiple access (WCDMA) is the version that was originally specified, and the one that is currently used through most of the world. Time division synchronous code division multiple access (TD-SCDMA) is a derivative of WCDMA, which is also known as the low chip rate option of UMTS TDD mode.

There are two main technical differences between these implementations. Firstly, WCDMA usually segregates the base stations' and mobiles' transmissions by means of frequency division duplex, while TD-SCDMA uses time division duplex. Secondly, WCDMA uses a wide bandwidth of 5 MHz, while TD-SCDMA uses a smaller value of 1.6 MHz. cdma2000 was developed from IS-95 and is mainly used in North America. The original 3G technology was known as cdma2000 1x radio transmission technology (1xRTT). It was 8 An Introduction to LTE subsequently enhanced to a 3.5G system with two alternative names, cdma2000 high rate packet data (HRPD) or evolution data optimized (EV-DO), which uses similar techniques to high speed packet access. The specifications for IS-95 and cdma2000 are produced by a similar collaboration to 3GPP, which is known as the Third Generation Partnership Project 2 (3GPP2).

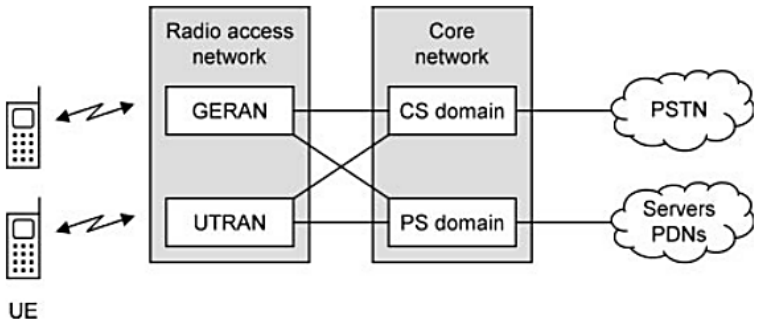

Figure 1: High level architecture of UMTS and GSM

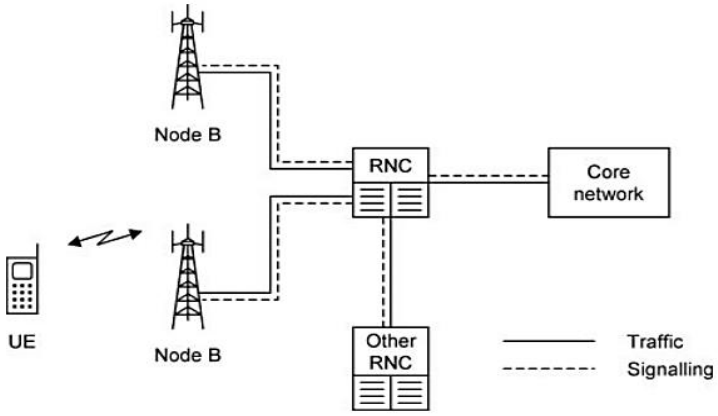

Figure 2: Architecture of the UMTS terrestrial radio access network

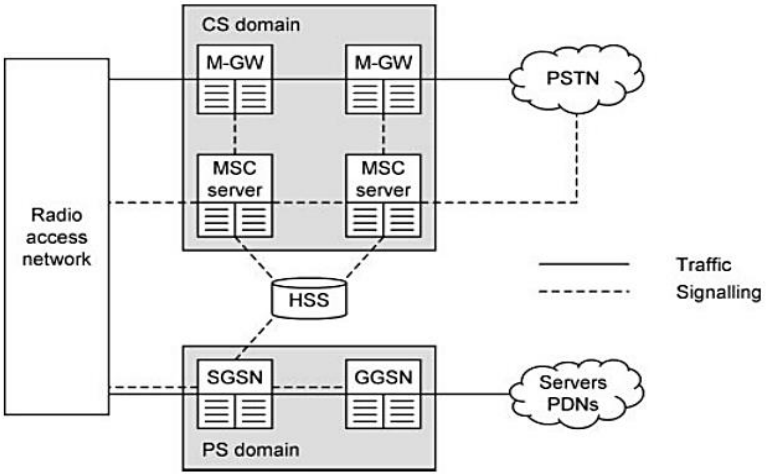

Figure 3: Architecture of the core networks of UMTS and GSM

FOURTH GENERATION (4G)/LTE

4G represents an upgrade from 3G by addressing the two major issues with the platform: speed and network congestion. It has a new architecture which is an advancement from the structure of 3G. In the new architecture, the evolved packet core (EPC) is a direct replacement for the packet switched domain of UMTS and GSM. It distributes all types of information to the user, voice as well as data, using the packet switching technologies that have traditionally been used for data alone. There is no equivalent to the circuit switched domain: instead, voice calls are transported using voice over IP. The evolved UMTS terrestrial radio access network (E-UTRAN) handles the EPC's radio communications with the mobile, so is a direct replacement for the UTRAN. The mobile is still known as the user equipment, though its internal operation is very different from

before. The new architecture was designed as part of two 3GPP work items, namely system architecture evolution (SAE), which covered the core network, and long-term evolution (LTE), which covered the radio access network, air interface and mobile. Officially, the whole system is known as the evolved packet system (EPS), while the acronym LTE refers only to the evolution of the air interface. Despite this official usage, LTE has become a colloquial name for the whole system, and is regularly used in this way by 3GPP.

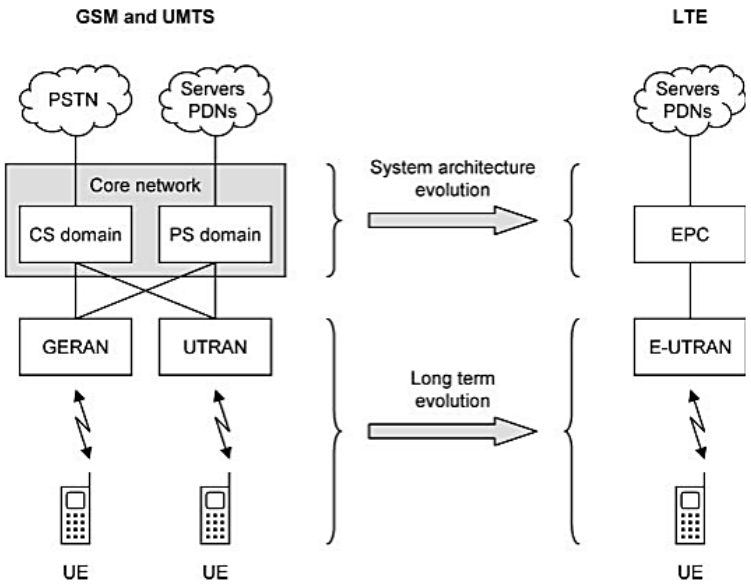

Figure 4: Architecture of Core networks of UMTS and GSM

FIFTH GENERATION (5G)

The 3rd Generation Partnership Project (3GPP) covers telecommunication technologies including radio access, core transport networks and service capabilities. Multiple frequency ranges are now being dedicated to 5G new radio (NR). The portion of the radio spectrum with frequencies between 30 GHz and 300 GHz is known as the millimeter wave, since wavelengths range from 1-10 mm. Frequencies between 24 GHz and 100 GHz are now being allocated to 5G in multiple regions worldwide. In addition to the millimeter wave, underutilized UHF frequencies between 300 MHz and 3 GHz are also being repurposed for 5G.

Multi-Access Edge Computing (MEC) is an important element of 5G architecture. MEC is an evolution in cloud computing that brings the applications from centralized data centers to the network edge, and therefore closer to the end users and their devices. This essentially creates a shortcut in content delivery between the user and host, and the long network path that once separated them. This technology is not exclusive to 5G but is certainly integral to its efficiency. Characteristics of the MEC include the low latency, high bandwidth and real time access to RAN information that distinguish 5G architecture from its predecessors.

The 5G core network architecture is at the heart of the new 5G specification and enables the increased throughput demand that 5G must support. The new 5G core, as defined by 3GPP, utilizes cloud-aligned, service-based architecture (SBA) that spans across all 5G functions and interactions including authentication, security, session management and aggregation of traffic from end devices. The 5G core further emphasizes NFV as an integral design concept with virtualized software functions capable of being deployed using the MEC infrastructure that is central to 5G architectural principles.

The concept of NFV extends to the radio access network (RAN) through for example network dis-aggregation promoted by alliances such as O-RAN. This enables flexibility and creates new opportunities for competition, provides open interfaces and open source development, ultimately to ease the deployment of new features and technology with scale. The O-RAN alliance objective is to allow multi-vendor deployment with off-the shelf hardware for the purposes of easier and faster inter-operability. Network dis-aggregation also allows components of the network to be virtualized, providing a means to scale and improve user experience as capacity grows. The benefits of virtualizing components of the RAN provide a means to be more cost effective from a hardware and software viewpoint especially for IoT applications where the number of devices is in the millions.

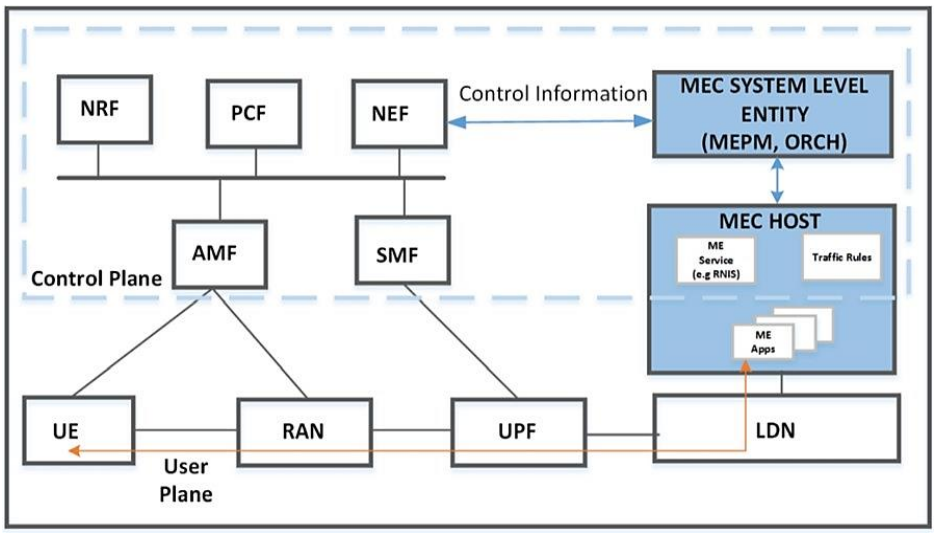

Figure 5: Network Architecture of 5G Systems.

ii. Advantages and Disadvantages of 3G,4G and 5G

3G

Advantages:

- It offers connectivity which is always on mode which means that
- The minimum bandwidth is 10 times faster than the maximum bandwidth of moving 2G devices.
- It supports multimedia applications such as video conferencing and photography.
- It allows value added services like mobile television, GPS, video call and video conference.
- It enables High speed mobile internet access.
- It has ncreased capacity compared to 2G

Disadvantages:

- Service providers have to pay high amount for 3G licensing & agreements,
- Low availability of handsets in few regions and their costs
- It requires different devices and the power consumption rate is high.
- It requires closer base stations, which are expensive to implement.

- The spectrum-licensing are very costly.
- The cost of cellular infrastructure and upgrading base stations is very high.
- The data plan prices for cell phones are much higher than 2G

4G

Advantages:

- It provides an end-to-end Internet Protocol connection which allows Cellular Service Providers have the opportunity to offer the data access to a wide variety of devices.
- It is more flexible, more reliable, easier to standardize and it offers more affordability than 3G networks.
- It allows for easy internet accessibility, IM, Social Networks, streaming media, video calling and the other broadband services.
- It offers very stable connection to the internet without any disruption.
- 4G LTE network is 10 times faster than the 3G network ,
- It offers extremely high voice quality.
- 4G technology is affordable when compared with 3G networks.
- It has higher bandwidth which leads to much faster data transfer speed.

Disadvantages:

- It involves the possibility of some interference, which means it is capable of being attacked (jamming frequencies), leading to the invasion of the privacy.
- Consumers are forced to buy new devices to support 4G LTE.
- It needs complex hardware and it is still limited to certain specified carriers,
- Users are forced to use 3G or Wi-Fi connectivity in the areas that do not yet have 4G mobile network coverage.
- It requires expensive infrastructure for operation.

5G

Advantages:

- It allows for increased response time, where 4G network responds in 50 MS, 5G can respond in 1 MS.
- Its average download speed will be 1GBps, it transmits data with 10 gigabits per second speed and in some cases 20 Gigabit per second.
- It enhances the mobile network, not only to connect people but also to connect and control the machines and objects efficiently.
- It offers to become the foundation of ultimate VR and IoT. Also, technologies such as self-driven cars and full factory automation by robots become easier to fully implement globally

Disadvantages

- Any obstacle like a tree, wall, building blocks or disrupts its high-frequency signal, even if you are standing closer to the node.
- It requires high bandwidth which means several towers will be required to be placed close to each other with residential areas to give better coverage. These will be led off radiofrequency radiations.
- Its infrastructure is very costly.

QUESTION TWO

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

S/N	FEATURES	2G	3G	4G	5G
1	Development	1980/1999	1990/2002	2000/2010	2010/2015
2	Data Bandwidth	14.4-16 Kbps	2 Mbps	100 Mbps	1 Gbps
3	Standards	TDMA, CDMS, GSM, GPRS, EDGE,1xRTT	WCDMA, CDMA-2000	Single Unified Standard	Single Unified Standard
4	Technology	Digital Cellular Technology	Broad bandwidth, CDMA Technology	Unified IP and seamless combination of broadband, LAN/WAN/PAN /WLAN	Unified IP and seamless combination of broadband, LAN/WAN/PAN/WLAN/wwww
5	Multiplexing	TDMA, CDMA	CDMA	CDMA	CDMA
6	Core Network	PSTN	Packet Network	Internet	Internet
7	Handoff	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical

QUESTION THREE

i. There are claims that there is, but nothing has been verified.

ii. No.

This is because there isn't enough evidence that proves there's a correlation between 5G and COVID-19.

There are several speculations on the cause of COVID-19 and how it's spread. One of these speculations is that new 5G networks caused the disease. The truth is that 5G hasn't been deployed in enough countries for one to conveniently accept the claims that 5G is connected to the ongoing COVID-19 Pandemic. This however doesn't mean there is no truth in these statements, which is why individuals and organizations that want to prove this connection shouldn't be shut down, but allowed to validate such claims with facts and evidence.

Several researchers; both individual and organizations gave their views:

5G mobile technology does promise a ten-fold increase in data transmission rates compared to current 4G networks, which will be achieved by using a higher transmission frequency. Also, 5G needs a large bandwidth, which means several towers will be required to be placed close to each other to give better coverage. These leads to radiofrequency radiations, thus, dangers increase the harm of EMR poisoning, resulting in headaches, nose bleeding, eye pains, nausea, vomiting, and flu-like symptoms. Many say this is the reason why there are claims that there is a correlation between 5G and COVID-19.

Some other researchers propose that there is insufficient data for a meaningful health risk assessment; saying that radio waves can't create a virus, which is what caused COVID-19.

Several Tech organizations have come out to say that there is no relationship between 5G and COVID-19 and Facebook was not left out, saying it's removing posts inaccurately connecting 5G to the coronavirus.
"We are taking aggressive steps to stop misinformation and harmful content from spreading on our platforms and connect people to accurate information about coronavirus," the company said in a statement. "Under our existing policies against harmful misinformation, we are starting to remove false claims which link COVID-19 to 5G technology and could lead to physical harm."

In March, a Facebook user named Ben Mackie falsely linked 5G to the coronavirus, saying in part that it's not actually a virus. "They are trying to get you scared of a fake virus when it’s the 5G towers being built around the world," he said. He also claimed that Microsoft co-founder Bill Gates invented the technology and that it's an effort to depopulate the world. And Mackie said that vaccines being developed for the coronavirus are actually chips that will be implanted in people.

Also, a senior scientist with the National Toxicology Program-a US Health and Human Services interagency program dedicated to testing and evaluating substances in the environment- said "It's a ridiculous concept. Each year, you get a new strain of flu that goes around. That's what viruses do, they mutate and move around that way, probably as long as there's been life."

In conclusion, everyone has a right to their opinions, this however doesn't mean that every opinion is right, hence the need for specific data and evidence which proves their claims on whether or not 5G caused COVID-19. It has become a debate, and each individual or organization that has an argument must come forth with sufficient data and proof, so further actions can be taken.

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