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MATRIC: 16/ENG04/068

EEE 512 ASSIGNMENT

QUESTION 1(i)

3G Working Principle

3G data technology uses a network of phone towers to pass signals, ensuring a stable and relatively fast connection over long distances. The tower nearest to the user's mobile phone passes data to it. While it may not sound complex, 3G technology was revolutionary at the time it was released.

Now we enjoy more advanced 4G technology which itself is soon to be eclipsed by robust 5G networks. Many people still use 3G when 4G is unavailable, so the technology still holds up even after almost two decades of use. On your own mobile phone, you might have noticed your connection changing from 4G to 3G depending on which connection is more readily available at a given location.

3G offers speeds that are several times faster or higher than any of its predecessors, including the short-lived 2.5G network which offered internet connectivity. 3G speeds are high enough to allow for audio and video streaming. They've been shown to be perfectly adequate for remote collaboration tools, such as Unified Communications, while offering clear and responsive voice clarity across the line.

But what specific speeds does 3G offer? Keep in mind that specific speeds are determined by the tower networks and individual capabilities of the provider. According to some estimates, 3G offers a real-world maximum speed of 7.2 Mbps for downloads and 2 Mbps for uploads.

While today these numbers may not seem impressive, especially compared to 4G or 5G networks, sometimes 4G technology simply is not available. In these cases, 3G is the default option.

In most instances, 3G is more than capable of providing a stable network connection for tasks including calls, web browsing, and video and audio streaming.

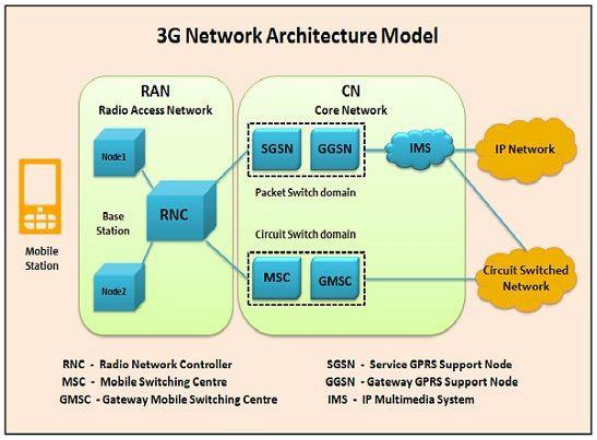

Figure 1: 3G Network architecture

4GWorking Principle

4G works much in the same way as 3G, simply faster. Using high-speed download and upload packets, 4G allows you to access broadband style speeds whilst away from your Wi-Fi. Users can often access speeds of up to 21Mb on the go, but this is, however, affected by location. A larger city, for example, will exhibit faster speeds than a small village.

4G is essentially a highly advanced radio system. You may even have seen masts dotted around the landscape. These masts broadcast the signals necessary for 4G to work and the challenge is for engineers and coders is to cram as much data into these signals as possible. By extension, this means the network is faster and more efficient.

Like 3G, 4G is a protocol that sends and receives data in packets. However, 4G differs from 3G in how it works. 4G is entirely IP based, which means it uses internet protocols even for voice data. Conforming to this one standard means it is less likely for data to become scrambled while traversing the various networks, meaning a more seamless experience for users. 4G works through your device communicating with a base station. Base stations are technical speak for the masts that we've all seen popping up throughout the country. This mast relays data from your device to the internet and back again.

One of the aspects that makes 4G an upgrade to 3G is its higher capacity. 4G can support a greater number of users, even at peak times. For example, a 3G tower may only be able to give 100 people the best possible connection speed, but a 4G tower can theoretically give 400 people the best service.

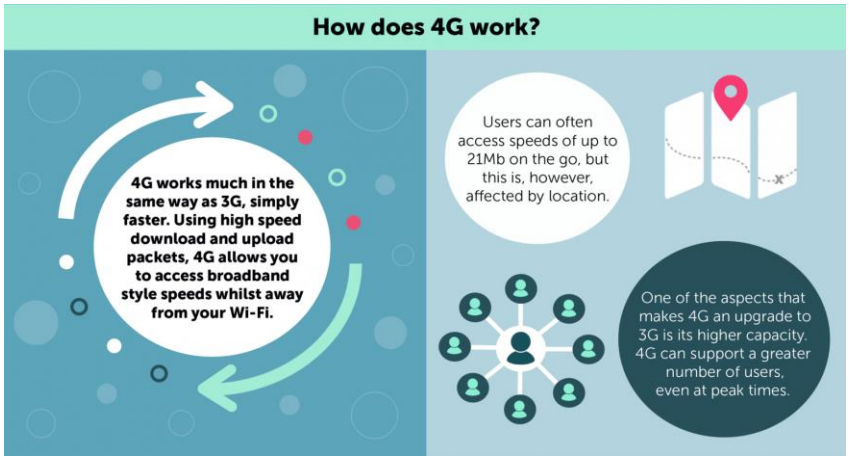

Figure 2: How 4G works

5G Working Principle

Like other cellular networks, 5G networks use a system of cell sites that divide their territory into sectors and send encoded data through radio waves. Each cell site must be connected to a network backbone, whether through a wired or wireless backhaul connection.

5G networks use a type of encoding called OFDM, which is similar to the encoding that 4G LTE uses. The air interface is designed for much lower latency and greater flexibility than LTE, though.

With the same airwaves as 4G, the 5G radio system can get about 30 percent better speeds thanks to more efficient encoding. The crazy gigabit speeds you hear about are because 5G is designed to use much larger channels than 4G does. While most 4G channels are 20MHz, bonded together into up to 140MHz at a time, 5G channels can be up to 100MHz, with Verizon using as much as 800MHz at a time. That's a much broader highway, but it also requires larger, clear blocks of airwaves than were available for 4G.

That's where the higher, short-distance millimeter-wave frequencies come in. While lower frequencies are occupied by 4G, by TV stations, by satellite firms, or by the military, there had been a huge amount of essentially unused higher frequencies available in the US, so carriers could easily construct wide roads for high speeds. 5G networks need to be much smarter than previous systems, as they're juggling many more, smaller cells that can change size and shape. But even with existing macro cells, Qualcomm says 5G will be able to boost capacity by four times over current systems by leveraging wider bandwidths and advanced antenna technologies.

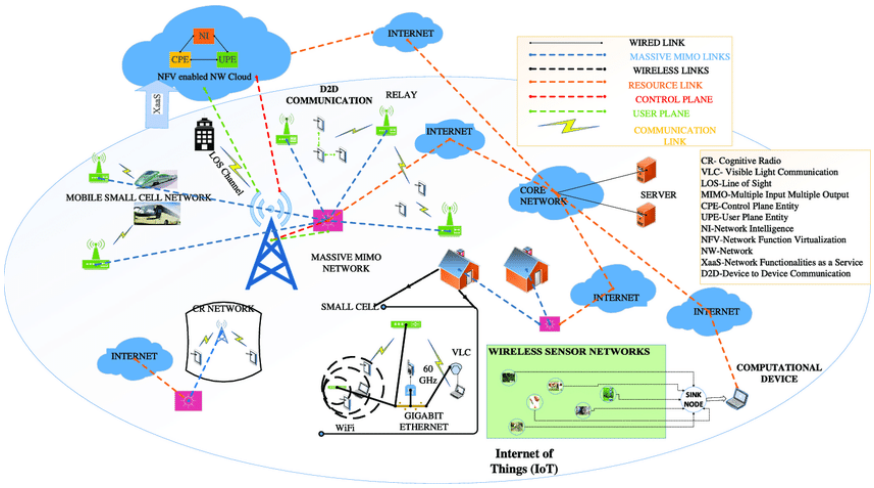

Figure 3: A general 5G cellular network architecture

QUESTION 1 (ii)

3G

Advantages

1. Portable high speed internet access
2. Greater bandwidth
3. Improved communications
4. Faster Data Transfer Speed
5. GPS Navigation
6. Always on technology

Disadvantages

1. More expensive than 2G
2. Mobile device must be 3G enabled
3. Higher power requirement

4. Requires closer base stations

4G

Advantages

1. Speed
2. Increased bandwidth leading to faster data transfer
3. Superior, uninterrupted connectivity
4. Music, video streaming
5. Privacy, security and safety
6. Affordability

Disadvantages

1. Device must have matching frequency band and settings for local carrier
2. Switching carriers can be difficult
3. Network and software updates are routine and required to maintain service
4. 4G mobile networks use multiple antennae and transmitters, so users may experience poorer battery life
5. Larger mobile devices with larger batteries are essential in order to stay online for longer periods of time

5G

Advantages

1. High resolution and bi-directional large bandwidth shaping.
2. Less tower congestion: With current 4G LTE technology, when thousands of people descend on a small area, towers tend to get congested and reach capacity. On 5G, this will no longer be an issue.
3. Most likely, will provide a huge broadcasting data (in Gigabit), which will support more than 60,000 connections.
4. Possible to provide uniform, uninterrupted, and consistent connectivity across the world.
5. New technology options: As network speeds have increased, more and more tasks are being transitioned from the world of computers to the world of smart devices. With the increasing network speeds, this could open new doors for smart device technology that may not have been available. We're talking AI, VR and much more.
6. Technological sound to support heterogeneous services (including private network).
7. More effective and efficient.

Disadvantages

1. Many of the old devices would not be competent to 5G, hence, all of them need to be replaced with new one — expensive deal.
2. Developing infrastructure needs high cost.

3. Broadcast distance/building penetration: One catch is that these frequency waves can only travel a short distance.
4. Battery drain/heat: Phones running on 5G will experience a huge battery drain. Better battery technology will be needed if the object is to run your phone a full day on a single charge running a 5G connection.

QUESTION 2

COMPARISON	**2G**	**3G**	**4G**	**5G**
Year Introduces	1993	2001	2009	2018
Technology	GSM	WCDMA	LTE, WiMAX	MIMO, mm waves
Access system	TDMA, CDMA	CDMA	CDMA	OFDM, BDMA
Switching type	Circuits switching for voice and packet switching for data	Packet switching except for air interference	Packet switching	Packet switching
Internet service	Narrowband	Broadband	Ultra broadband	Wireless world wide web
Bandwidth	25 MHz	25 MHz	100 MHz	30 GHz to 300 GHz
Applications	Voice calls, short messages	Video conferencing, mobile TV, GPS	High speed applications, mobile TV, wearable devices	High resolution video streaming, remote control of vehicles, robots, and medical procedures

QUESTION 3 (i)

In my opinion, based on my knowledge on electromagnetic waves, there should not be any link between the 5G network and the Coronavirus (COVID19). In addition to that, Scientists brand 5G claims 'complete rubbish', **BBC News** reported on the 15th of April 2020.

QUESTION 3 (ii)

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.

On April 15, 2020, BBC published an article written by Rachel Schraer & Eleanor Lawrie. In this article, Adam Finn, a professor of pediatrics at the University of Bristol was quoted as follows;

"The present epidemic is caused by a virus that is passed from one infected person to another. We know this is true. 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 different things. As different as chalk and cheese,"

And as a result of the false widespread conspiracy theory of the link between coronavirus and 5G; which is not limited to Nigeria but has also been propagated in the west, the US Federal Emergency Management Agency (FEMA) and Federal Communications Commission (FCC) have now clearly stated “5G technology does not cause coronavirus”.