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**Elect/Elect Engineering**

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**Digital Communications EEE512**

**Lockdown Assignment**

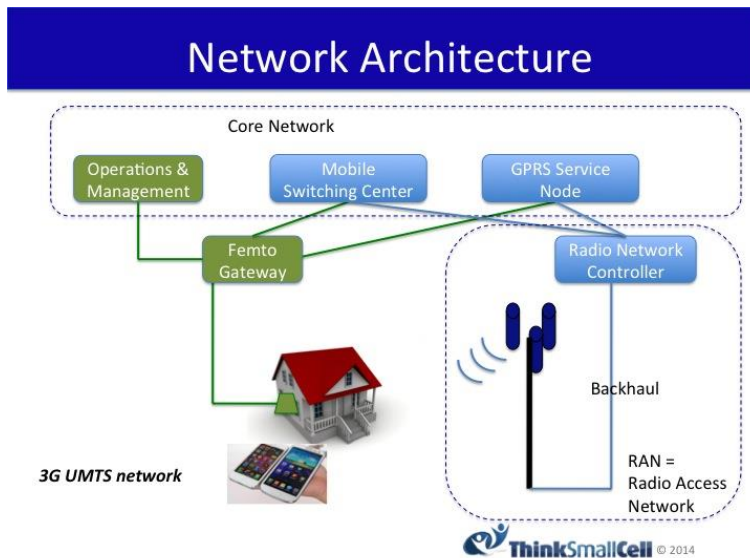


Figure 1: 3G Tech Femtocell (Chambers, 2017)

Typically, the 3G technology is intended for Smartphones, these feature increased bandwidth and transfer rates to accommodate Web-based applications and phone-based audio and video files. Examples of such phones are:- Sony Ericsson V800 3G phone, HP iPAQ, Blackberry, etc. 3G comprises several cellular access technologies. The three most common ones are:-

CDMA2000 - based on 2G Code

Division Multiple Access, WCDMA (UMTS) - Wideband Code Division Multiple Access, TD-SCDMA - Time-division Synchronous Code-division Multiple Access

3G networks have potential transfer speeds of up to 3 Mbps (about 15 seconds to download a 3-minute MP3 song). For comparison, the fastest 2G phones can achieve up to 144Kbps (about 8 minutes to download a 3-minute song).

3G's high data rates are ideal for downloading information from the Internet and sending and receiving large, multimedia files. 3G phones are like miniature laptops and can accommodate broadband applications like video conferencing, receiving streaming video from the Web, sending and receiving faxes and instantly downloading e-mail messages with attachments.

In actual sense, a number of these smartphones come complete with a windows environment.

Of course, none of this would be possible without those mobile phone masts or towers that carry cell-phone signals from phone to phone.

3G is a cell phone network protocol. Just like the voice calls, the 3G internet is transported along the Mobile phone network to the compliant mobile phones.

Just like you can move while talking on a mobile phone, the 3G internet is designed to connect from cell to cell on a mobile network.

The various Masts used by the provider are interconnected such that, they create a “cobweb” like structure. Just as is the case with the voice calls, the subscriber is identified when the phone / modem transmits the ESN and MIN to the network at the beginning of the call.

The MIN/ESN pair is a unique tag for your phone line or modem; this is how the phone company knows who to bill for the call.

When your phone transmits its MIN/ESN pair, it is possible for nefarious sorts to listen (with a scanner) and capture the pair. With the right equipment, it is fairly easy to modify another phone so that it contains your MIN/ESN pair, which allows the nefarious individual to make calls on your account.

The significant difference between the two is that, the former is voice while the latter is data.

This brings us to one factor, the use of 3G internet on the mobile phone network requires that, both the network and the handset (phone or modem) being used must be data compliant.

This compliance on the part of the mobile device is created by the manufacturer and on the network, the provider must activate it (New Times Newspaper, 2010).

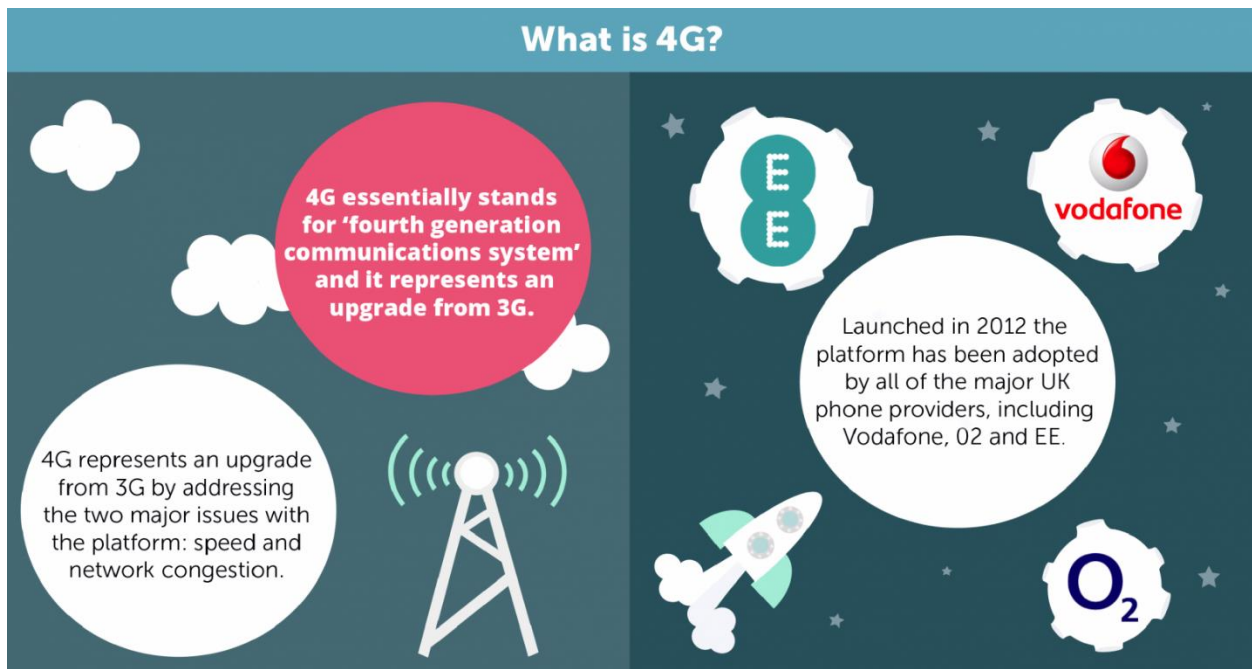


Figure 2: What is 4G?

4G essentially stands for ‘fourth generation communications system’ and it represents an upgrade from 3G by addressing the two major issues with the platform: speed and network congestion. Since it

launched in late 2012, the platform has been adopted by all of the major UK phone providers, including Vodafone, O2 and EE.

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 us users!

Like all mobile broadband, 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.

4G also features reduced latency, which if you're a mobile gamer is essential. With reduced latency, you'll see a much quicker response to your commands. So for gamers, if they are playing a fighting game, for example, this can mean the difference between winning and losing.

Once 4G infrastructures become more common, users will see more seamless streaming on the move from services like YouTube, better video calls and even better battery life. At the moment 4G signals are rarer outside of big cities, so phones expend a lot of energy looking around for a 4G signal.

How fast is 4G?

While 3G only really allowed for emails, maps and Facebook to be readily available, the rise of various technologies such as video calling and HD streaming has called for a faster option. 4G will allow you to do the vast majority of things you can do at home, including browsing YouTube, making calls on Skype and downloading music. As mentioned before, the highest speeds will be experienced in the most populated areas, with remote areas of the UK potentially seeing less of an effect.

A recent study from OFCOM found that the average speed for 4G in 5 major cities was 15.1 Mbit/s. This means that within the cities where the test was carried out, 4G was on average 2.5 times faster than the average 3G speed, which was 6.1Mbit/s. Across all of the networks in the 5 cities that were tested, half

of 4G download speeds were above 16Mbit/s, with Edinburgh having the highest average download speed across all the cities that were tested for both 4G and 3G.

OFCOM's test, although providing valuable insight into the question of how fast 4G actually is, is somewhat flawed due to its use of major metropolitan areas. It is not particularly representative of the experience that the majority of users will have in the UK outside these areas. However, as 4G coverage expands we can all expect to have speeds that fall into this average range.

Does 4G ever get congested?

One of the main criticisms of 3G was that it often got congested with the number of users trying to access it at once. With 17 million of us using our phones to get online every month, it's no wonder that less solid connections get overwhelmed. 4G can handle a much higher volume of traffic, so there's less chance of slower speeds at peak times (Broadband Compared, n.d.).

### Comparing 4G and 5G

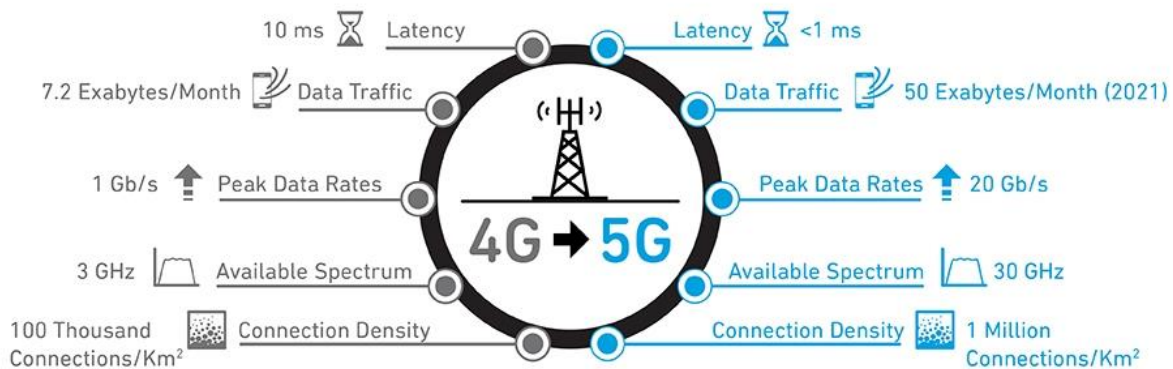


Figure 3: Comparing 4G and 5G

The world's connectivity needs are changing. Global mobile data traffic is expected to multiply by 5 before the end of 2024. Particularly in dense urban areas, the current 4G networks simply won't be able to keep up.

That's where a new G comes into play. With 5G commercial networks being switched on, the first use cases are enhanced mobile broadband, which will bring better experiences for smartphone users, and fixed wireless access, providing fiber speeds without fiber to homes. 5G smartphones will be available in beginning of 2019.

Being able to download a full-length HD movie in seconds and share your wow-moments with friends – that's just the beginning. The true value of 5G is the opportunity it presents for people, business and the world at large: industries, regions, towns and cities that are more connected, smarter and more sustainable.

It's allowing industries to reinvent themselves. It affects you. And it's starting now.

5G is a game changer: it will improve your network connection dramatically. You won't have to deal with disruptions when sharing videos from crowded arenas, nor will high-quality videos on your newsfeed cause frustration from all the buffering.

Instead, you'll get a faster, more stable, more secure connection – along with new services and experiences, just around the corner. More efficient capabilities and vastly increased capacity means you'll enjoy better performance than ever before.

Data rates

100 times faster, supporting instant access to services and applications.

Network latency

significantly reduced to 1-10ms.

Network slicing

technology, making it possible to dedicate a unique part of a 5G network for a service.

The introduction of 5G will make it possible for communications service providers to improve their business in various ways. Just as 4G shook up the landscape, whereby data packages became more important than voice and SMS packages, 5G brings opportunities for communications service providers to offer new services. 5G will also improve cost-efficiency. Our economic study of enhanced mobile broadband shows that evolution to 5G will enable 10 times lower cost per gigabyte than current 4G networks.

Meanwhile, Fixed Wireless Access (FWA) can provide connectivity for households and businesses.

5G is enabling a new wave of innovation. It has the potential for changing the world, further powering the hottest trends in tech today: IoT (Internet of Things), AI (Artificial Intelligence) and AR (Augmented Reality) – among many more (Ericsson, n.d.).

Beyond speed improvement, 5G is expected to unleash a **massive IoT (Internet of Things) ecosystem** where networks can serve communication needs for billions of connected devices, with the right trade-offs between speed, latency, and cost (Gemalto, 2020).

**5G technology is driven by 8 specification requirements:**

- Up to 10Gbps data rate -> 10 to 100x improvement over 4G and 4.5G networks
- 1-millisecond latency
- 1000x bandwidth per unit area
- Up to 100x number of connected devices per unit area (compared with 4G LTE)

- 99.999% availability
- 100% coverage
- 90% reduction in network energy usage
- Up to 10-year battery life for low power IoT device

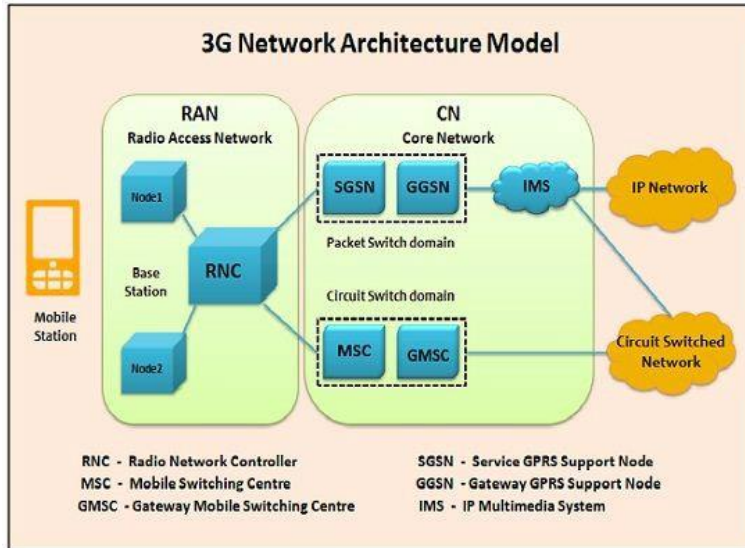


Figure 4:3G Network Architecture

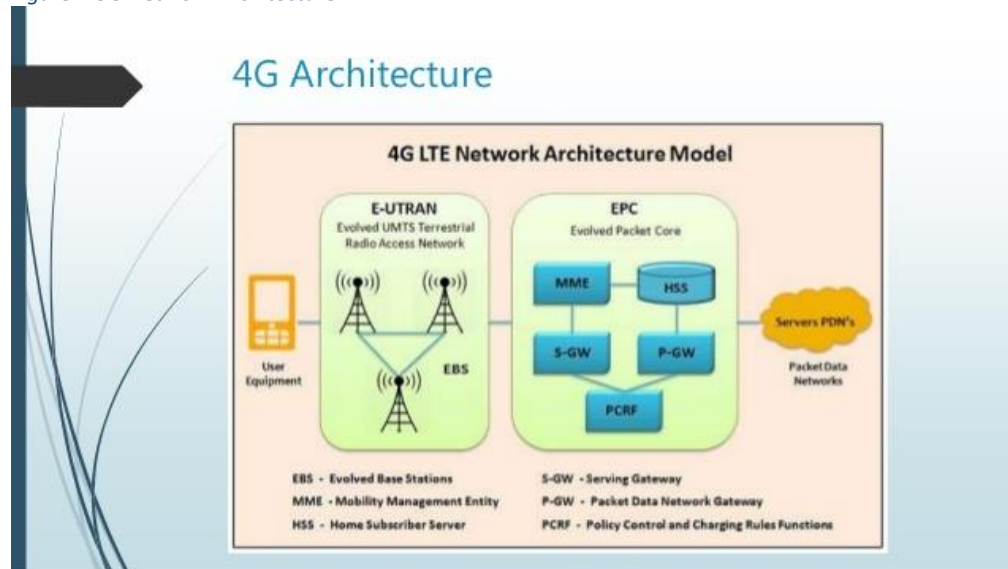


Figure 5: 4G Network Architecture

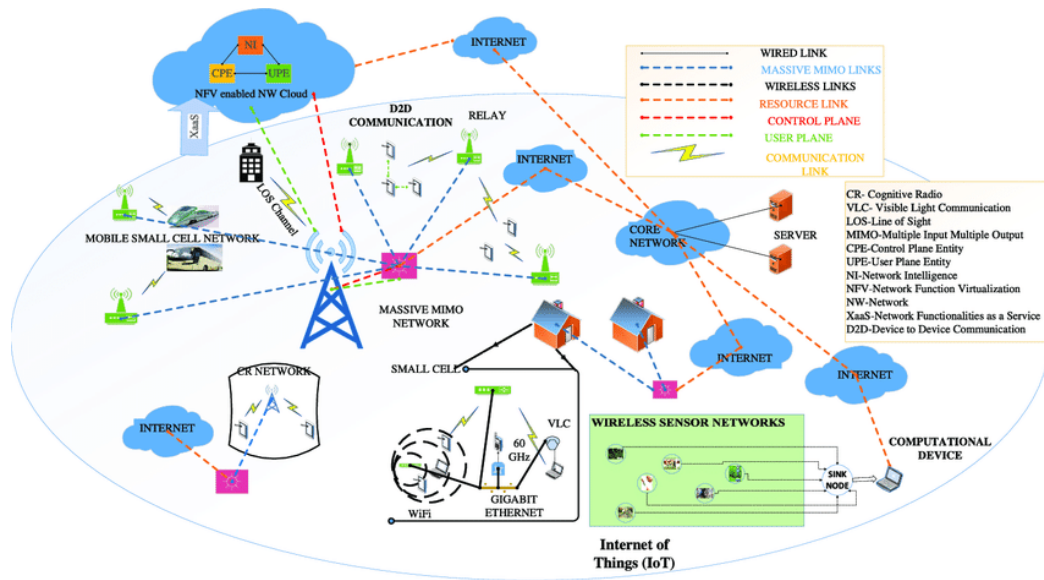


Figure 6:5G Network Architecture

3G

Advantages (compared to 2G)	Disadvantages
Portable high speed internet access	Cost
Greater bandwidth	Mobile device must be 3G enabled
Improved communications	Higher power requirement
Faster Data Transfer Speed	Requires closer base stations
GPS Navigation	
Always on technology	

4G

Advantages (compared to 3G)	Disadvantages
Speed	Device must have matching frequency band and settings for local carrier
Increased bandwidth leading to faster data transfer	Switching carriers can be difficult
Superior, uninterrupted connectivity	Network and software updates are routine and required to maintain service
Music, video streaming	4G mobile networks use multiple antennae and transmitters, so users may experience poorer battery life
Privacy, security and safety	Larger mobile devices with larger batteries are essential in order to stay online for longer periods of time
Affordability	

5G

Advantages (compared to all previous tech)	Disadvantages
High resolution and bi-directional large bandwidth shaping.	Many of the old devices would not be competent to 5G, hence, all of them need to be replaced with new one — expensive deal.
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.	Developing infrastructure needs high cost.
Most likely, will provide a huge broadcasting data (in Gigabit), which will support more than 60,000 connections.	Broadcast distance/building penetration: One catch is that these frequency waves can only travel a short distance.
Possible to provide uniform, uninterrupted, and consistent connectivity across the world.	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.
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.	
Technological sound to support heterogeneous services (including private network).	
More effective and efficient.	

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

	2G	3G	4G	5G
Deployment	1980/1999	1990/2002	2000/2010	2014/2015
Bandwidth	14-64kbps	2Mbps	200MBps	>1Gbps
Technology	Digital Cellular	Broadbandwidth/CDMA /IP Technology	Unified IP & seamless combo of LAN/WAN/WLAN	4G+WWWW
Service	Digital Voice, short messaging	Integrated high quality audio, video & data	Dynamic information access, variable devices	Dynamic information access, variable devices with AI capabilities
Core Network	PSTN	Packet Network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal



			Vertical	Vertical
Switching Circuit	Circuit	Packet	All packet	All Packet

3. According to scientific research, there is no link between corona virus and the advent of 5G technology. It's a conspiracy; rather unnecessary at this dire time the world is in.

I am strongly against the motion that 5G technology is the cause of the corona virus spread in Nigeria.

According to the verge.com, radio waves, of which the 5G technology is as well as its predecessors 4G and 3G are only capable of transmitting computer viruses and not human ones (Warren, 2020).

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".

The virus is spreading in countries that do not yet have access to 5G technology (Nigeria being part of the lot). The frequencies from the 5G technology are unable to harm the body, and corona virus has been revealed to be a contagious virus with no relation to neither having the properties of electromagnetic waves. The unfortunate link between these 2 phenomena is because they are both occurring at about the same time in our world today but observing the virus overtaking certain nations begs one to question; how ridiculous can this assertion be?

In order to understand why the virus and 5G are not linked, it is necessary to understand why 5G radio waves are not powerful enough to damage cells in the human body or transmit a virus. Much like 4G and 3G, radio waves used in 5G are low frequency and non-ionizing radiation. These are on the opposite end of the EM spectrum to ionizing waves such as X-ray, gamma and UV rays.

Furthermore, radio waves and viruses are not transmitted the same way. Coronavirus is spread from person to person through tiny droplets of saliva when an already infected person coughs, sneezes or breathes. Viruses transmitted through radio waves can only affect computers.

The final point that brings this conspiracy theory crashing down like dominoes is that the pandemic has affected countries where 5G is yet to be deployed such as Japan, Iran and India. Iran already has 66,00 cases of corona virus.

Also, there are regulations guiding the deployment of any technology. For such a third world country as Nigeria, its hilarious to think that such issues with an emerging technology would not have been discovered by technological heavyweights in the first world category like china, US and the UK.

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