Name:Aftab khan ID:12985 Subject: Wireless Network

Question 1:

A) The five ways of increasing the capacity of a cellular system are:

1: Adding new channels: Typically, when a system is set up in a region, not all of the channels are used, and growth and expansion can be managed in an orderly fashion by adding new channels.

2: Frequency borrowing: In the simplest case, frequencies are taken from adjacent cells by congested cells. The frequencies can also be assigned to cells dynamically.

3: Cell splitting: Cell splitting is the process of sub dividing a congested cell into smaller cells, each with its own base station and corresponding reduction in antenna height and transmitted power. Cell splitting increases capacity of a cellular system since it increases number of times that channels are reused**.**

4: Cell sectoring: In cell sectoring a single omnidirectional antenna at base station is replaced by several directional antennas, each radiating within a specified sector.

5: Microcells: The increased number of hands off, increase load on the switching and control link because of sectoring. A solution to this problem is given by microcell zone concept.

B) Difference between 3G, 4G & 5G Cellular Networks:

3G: This generation set the standards for most of the wireless technology we have come to know and love. Web browsing, email, video downloading, picture sharing and other Smart phone technology were introduced in the third generation.
The 3G standard utilizes a new technology called UMTS as its core network architecture - Universal Mobile Telecommunications System.
One of requirements set by IMT-2000 was that speed should be at least 200Kbps to call it as 3G service.
The UN's International Telecommunications Union IMT-2000 standard requires stationary speeds of **2Mbps** and mobile speeds of **384kbps** for a "true" 3G. The theoretical max speed for **HSPA+ is 21.6 Mbps.**

4G: 4G is a very different technology as compared to 3G. 4G purpose is to provide high speed , high quality and high capacity to users while improving security and lower the cost of voice and data services, multimedia and internet over IP.
Mobile web access, IP telephony , gaming services, high-definition mobile TV, video conferencing, 3D television, and cloud computing are possible because of **MIMO** (Multiple Input Multiple Output) and **OFDM** (Orthogonal Frequency Division Multiplexing).

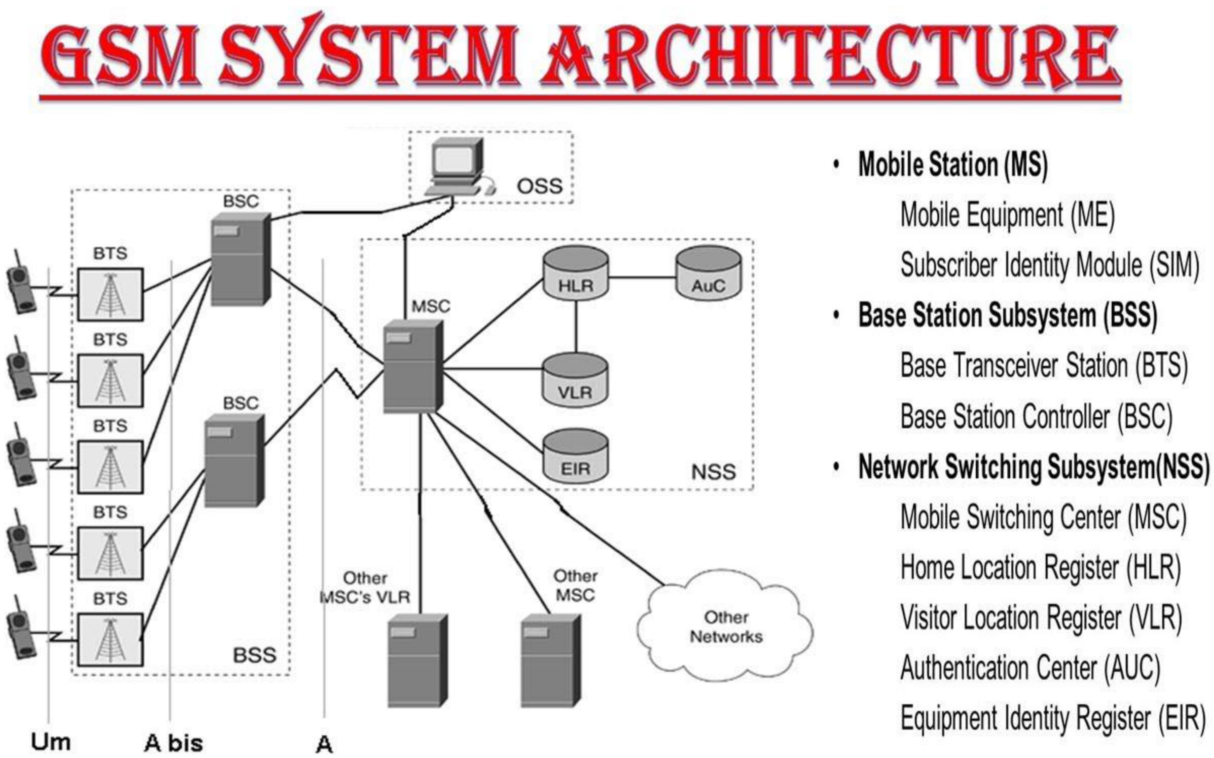
The two important 4G standards are **WiMAX** (has now fizzled out) and **LTE** (has seen widespread deployment).The max speed of a 4G network when the device is moving is **100 Mbps or 1 Gbps** for low mobility communication like when stationary or walking, latency reduced from around 300ms to less than 100ms, and significantly lower congestion.

5G: 5G is a generation currently under development , that's intended to improve on 4G. 5G promises significantly faster data rates, higher connection density, much lower latency, among other improvements.

Some of the plans for 5G include **device-to-device** communication, better battery consumption, and improved overall wireless coverage.
The max speed of 5G is aimed at being as fast as **35.46 Gbps** , which is over 35 times faster than 4G.

Key technologies to look out for: **Massive MIMO** , Millimeter Wave Mobile Communications etc. Massive MIMO, milimetre wave, small cells, Li-Fi all the new technologies from the previous decade could be used to give 10Gb/s to a user, with an unseen low latency, and allow connections for at least 100 billion devices

C) GSM architecture Diagram:



D)
This is the only connection made by this caller during the course of an hour"

Therefore it stated that only 1 call takes place.

So number of calls=1

Minutes of traffic in the hour=number of calls x duration

Minutes of traffic in the hour=1 x 35

Minutes of traffic in the hour=35

Hours of traffic in the hour=35 / 60

Hours of traffic in the hour=0.5833

Amount of Traffic =0.5833 Erlangs

E) Cellular network issues:

1: Traffic Volume Growth
2: WiFi Offload Not Effective
3: Traffic has Moved Indoors
4: Network Problems Can be Extremely Local
5: Networks are Operating too Many Technologies
6: Still Too Many Failures

Challenges facing today's cellular networks:
1:Cellular network management
2:Mobility
3:Energy efficiency
4:Spectrum shortage

Future cellular network design:
1:Architectures
2:Protocols
3:Algorithms
4:Security and privacy

All need to be improve in the for the bettering of Cellular network.

Question 2:

F) Mobile IP includes three basic capabilities:

Discovery: A mobile node uses a discovery procedure to identify prospective home agents and foreign agents.

Registration: A mobile node uses an authenticated registration procedure to inform its home agent of its care-of address.

Tunneling: Tunneling is used to forward IP data grams from a home address to a care-of address.

G) There are two different types of destination addresses that can be allocated to a mobile node while it is attached to a foreign Network are:
1: Home address
2: Care-of address

H) Tunneling: It is a protocol that allows for the secure movement of data from one network to another. Tunneling involves allowing private network communications to be sent across a public network, such as the Internet, through a process called encapsulation. The encapsulation process allows for data packets to appear as though they are of a public nature to a public network when they are actually private data packets, allowing them to pass through unnoticed.
Tunneling is also known as **port forwarding**.

I) The following diagram illustrates the general architecture of the WAP protocol stack:

Application Layer (WAE)

Session Layer (WSP)

Transaction Layer (WTP)

Security Layer (WTLS)

Transport Layer (WDP)

Bearers (GSM, CDMA,…)

The WAP protocol stack has a muti-layered architecture (this is very similar to the seven layers model of OSI).

Question 3:

A) In IEEE 802 terms, the OSI data link layer is divided into two sub layers: logical link control (LLC) and media access control (MAC).

The data link layer functions allocated to the LLC sub layer are:

Link establishment and termination
Frame traffic control
Frame sequencing
Frame acknowledgment

The data link layer functions allocated to the MAC sub layer are:

Frame delimiting
Frame error checking
Media access management

The low-level protocol standards defined by IEEE project 802 include 802.3 CSMA/CD, 802.4 token bus, and 802.5 token ring. These standards differ at the physical layer and media access control sub layer, but are compatible at the logical link control sub layer.

The 802 standards have been adopted by:

ANSI as American national standards
NBS as government standards
ISO as international standards (known as ISO 8802).

B)

IEEE 802.11:
In 1997, the Institute of Electrical and Electronics Engineers created the first WLAN standard. They called it 802.11 after the name of the group formed to oversee its development. Unfortunately, 802.11 only supported a maximum network bandwidth of 2 Mbps — too slow for most applications. For this reason, ordinary 802.11 wireless products are no longer manufactured. However, an entire family has sprung up from this initial standard.

802.11ax (Wi-Fi 6):
Branded as Wi-Fi 6, the 802.11ax standard went live in 2019 and will replace 802.11ac as the de facto wireless standard. Wi-Fi 6 maxes out at 10 Gbps, uses less power, is more reliable in congested environments, and supports better security

802.11aj:
Known as the China Millimeter Wave, this standard applies in China and is basically a rebranding of 802.11ad for use in certain areas of the world. The goal is to maintain backward compatibility with 802.11ad.

802.11ah:
Approved in May 2017, this standard targets lower energy consumption and creates extended-range Wi-Fi networks that can go beyond the reach of a typical 2.4 GHz or 5 GHz networks. It is expected to compete with Bluetooth given its lower power needs.

802.11ad:
Approved in December 2012, this standard is freakishly fast. However, the client device must be located within 11 feet of the access point.

802.11ac (Wi-Fi 5):
The generation of Wi-Fi that first signaled popular use, 802.11ac uses dual-band wireless technology, supporting simultaneous connections on both the 2.4 GHz and 5 GHz Wi-Fi bands. 802.11ac offers backward compatibility to 802.11b/g/n and bandwidth rated up to 1300 Mbps on the 5 GHz band plus up to 450 Mbps on 2.4 GHz. Most home wireless routers are compliant with this standard.

Pros of 802.11ac: Fastest maximum speed and best signal range; on par with standard wired connections

Cons of 802.11ac: Most expensive to implement; performance improvements only noticeable in high-bandwidth applications
802.11ac is also referred to as Wi-Fi 5.

802.11n:
802.11n (also sometimes known as Wireless N) was designed to improve on 802.11g in the amount of bandwidth it supports, by using several wireless signals and antennas (called MIMO technology) instead of one. Industry standards groups ratified 802.11n in 2009 with specifications providing for up to 300 Mbps of network bandwidth. 802.11n also offers a somewhat better range over earlier Wi-Fi standards due to its increased signal intensity, and it is backward-compatible with 802.11b/g gear.

Pros of 802.11n: Significant bandwidth improvement from previous standards; wide support across devices and network gear.

Cons of 802.11n: More expensive to implement than 802.11g; use of multiple signals may interfere with nearby 802.11b/g based networks
802.11n is also referred to as Wi-Fi 4.

802.11g:
In 2002 and 2003, WLAN products supporting a newer standard called 802.11g emerged on the market. 802.11g attempts to combine the best of both 802.11a and 802.11b. 802.11g supports bandwidth up to 54 Mbps, and it uses the 2.4 GHz frequency for greater range. 802.11g is backward compatible with 802.11b, meaning that 802.11g access points will work with 802.11b wireless network adapters and vice versa.

Pros of 802.11g: Supported by essentially all wireless devices and network equipment in use today; least expensive option.

Cons of 802.11g: Entire network slows to match any 802.11b devices on the network; slowest/oldest standard still in use
802.11g is also referred to as Wi-Fi 3.

802.11a:
While 802.11b was in development, IEEE created a second extension to the original 802.11 standard called 802.11a. Because 802.11b gained in popularity much faster than did 802.11a, some folks believe that 802.11a was created after 802.11b. In fact, 802.11a was created at the same time. Due to its higher cost, 802.11a is usually found on business networks whereas 802.11b better serves the home market.

802.11a supports bandwidth up to 54 Mbps and signals in a regulated frequency spectrum around 5 GHz. This higher frequency compared to 802.11b shortens the range of 802.11a networks. The higher frequency also means 802.11a signals have more difficulty penetrating walls and other obstructions.

Because 802.11a and 802.11b use different frequencies, the two technologies are incompatible with each other. Some vendors offer hybrid 802.11a/b network gear, but these products merely implement the two standards side by side (each connected device must use one or the other).
802.11a is also referred to as Wi-Fi 2.

802.11b:
IEEE expanded on the original 802.11 standard in July 1999, creating the 802.11b specification. 802.11b supports a theoretical speed up to 11 Mbps. A more realistic bandwidth of 5.9 Mbps (TCP) and 7.1 Mbps (UDP) should be expected.

802.11b uses the same unregulated radio signaling frequency (2.4 GHz) as the original 802.11 standard. Vendors often prefer using these frequencies to lower their production costs. Being unregulated, 802.11b gear can incur interference from microwave ovens, cordless phones, and other appliances using the same 2.4 GHz range. However, by installing 802.11b gear a reasonable distance from other appliances, interference can easily be avoided.

802.11b is also referred to as Wi-Fi 1.

Question 4:

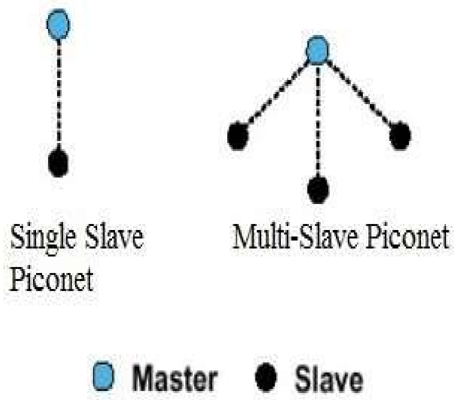
A) Bluetooth Low Energy (BLE) is a low power wireless communication technology that can be used over a short distance to enable smart devices to communicate. Some of the devices you interact with every day such as your smart phone, smart watch, fitness tracker, wireless headphones and computer are using BLE to create a seamless experience between your devices.

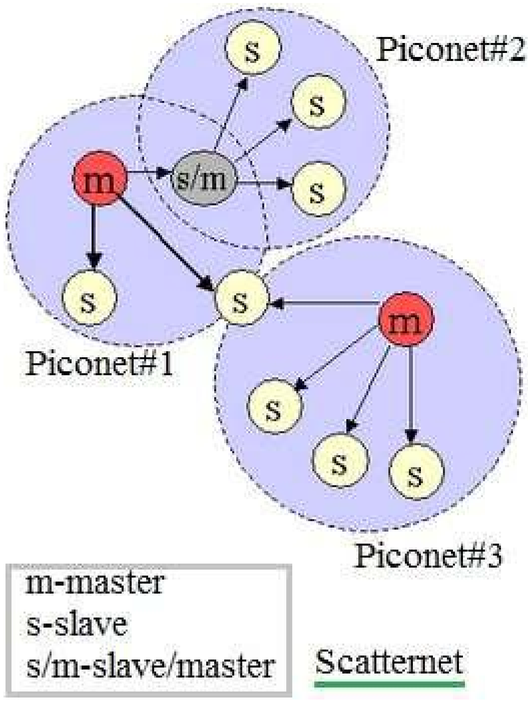
BLE is a relatively new Bluetooth standard defined by the Bluetooth Special Interest Group (SIG) with a focus on low energy. It has enabled device manufacturers to add a low power communications interface on existing solutions. It has also been used to create new low power devices such as beacons that can be powered by a small coin cell battery for months or even years.

BLE has a wide range of possibilities and is implemented in a broad set of fields such as health, fitness, security, home automation, home entertainment, smart industry and IoT (Internet of Things). It's also close at hand in the smartphones and laptops that we use every day.

B)

Piconet	Scatternet
In this bluetooth network, device can function either as master or slave.	In this bluetooth network, device can function as master or slave or (master+slave)
It serves smaller coverage area.	It serves larger coverage area.
It supports maximum 8 nodes.	It supports more than 8 nodes.
It allows less efficient use of available bluetooth channel bandwidth.	It allows more efficient use of available bluetooth channel bandwidth.





B) L2CAP data packet format:

The Logical Link Control and Adaptation Layer Protocol (L2CAP) is layered over the Baseband Protocol and resides in the data link layer. L2CAP provides connection-oriented and connectionless data services to upper layer protocols with protocol multiplexing capability, segmentation and reassembly operation, and group abstractions. L2CAP permits higher level protocols and applications to transmit and receive L2CAP data packets up to 64 kilobytes in length.

Two link types are supported for the Base band layer: Synchronous Connection-Oriented (SCO) links and Asynchronous Connection-Less (ACL) links. SCO links support real-time voice traffic using reserved bandwidth. ACL links support best effort traffic. The L2CAP Specification is defined for only ACL links and no support for SCO links is planned.