SECTION A

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1. 3
2. 2 D
3. 2 C
4. 2 D
5. 2
6. 4 A
7. 1 C
8. 4
9. 2
10. 4
11. 3 C
12. 1 A

7 scored

SECTION B

Q.1 Explain the followings:

1. Net Neutrality according to the Act 1996
2. The USA Patriot Act, according to the Act of 2001
3. Communications Assistance for Law Enforcement Act (CALEA), according to the Act of 1994, expanded in 2005
4. Cable TV Consumer Protection & Competition Act, according to the Act of 1992

Ans.

1. Net Neutrality -   
   Every ISP provider should allow equal rights and access to every website, content and application at the same speed and with same conditions without blocking or discrimination of preference to any content for evert individual.

According to Act 1996-

* + It deregulates cable industry to increase competition
  + Anyone can start communication business
  + No discrimination is withhold with any telecom services and unfair prioritization of one communication over other
  + All customers should have access to law enforcement and similar necessities

1. USA Patriot Act –
   * This act allows the national authority to access certain communication in the wake of national interest
   * This is purely meant for national security purpose
2. Communication Assistance for Law Enforcement Act –
   * This Act was passed to protect consumer privacy of information for the surveillance by investigation agencies to keep a check for scope outside of investigations.
   * This act mentions to have checked the regulatory body for their equipment facilities and services to comply with legal reques of information
   * It is also responsible to review commission regulations and analyse hoe regulation applies per network architecture
   * It was accounted for wiretapping of the user communications
3. Cable TV Consumer Protection & Competition Act, according to the Act of 1992
   * It allowed broadcast local television station for the communication channels

**Q. 3** For any telecom operator, what are the major cost busters? What steps can an operator take to reduce cost, and how has technological advancement contributed to cost reduction?

Ans.

For any telecom operator the major cost busters are –

1. Capital Cost
2. Operation Cost
3. Spectrum

Steps can an operator take to reduce cost –

1. Use shared equipment among different operators like having the same signal tower / bs to serve multiple network services
2. Shared resource – utilizing same resources for better utilization
3. Efficiently use the allotted bandwidth of the spectrum

Technological Advancement contributed to cost reduction –

1. High Speed network/ data rate transfer – GPRS->EDGE ->ECDMA ->LTE
2. Use of advanced Frequency modulations -

FDMA -> TDMA -> CDMA->OFDMA

1. Low Latency - better frequency modulations led to lower latency and faster speed
2. Enhanced QoS - Lower bit error, jitter rate,
3. Packet Switching - moving from circuit switching to packet switching has greatly enhanced the effective and reliable data transmission
4. Technology has boosted effective use of the resource
5. Better use of communication channel/ medium

Efficient and shared use of resources have overall reduced the cost of telecommunication

Q. 4 What are six brand-new technologies emerging as the foundation of 5G? Name each and provide one-line explanation of each.

 Ans.   
Six brand-new technologies emerging as the foundation of 5G are-

1. Millimetre wave – 5G will expand usage of frequencies 30kHz- 300GHz which will expand the utilization of unused bandwidth
2. Small Cell – since data cannot be transferred in beyond barriers smaller distances antennas will act as cells and provide constant communication within 5G networks
3. Massive MIMO – as there will be faster and large data transfer between the networks there will be multiple antennas serving the communication between the networks and eventally cause Multiple Input and Multiple Output streams to handle at each level
4. Beam Formation – as there is a lot of interference observed in the communication medium in wireless, there is a need of effectiveness with which a beam forming between the source will focus and target its communication to only destination which it wish to communicate to
5. Full Duplex – Until now the same channel was not possible to be used for 2 way communication, now with 5G service the same channel can be used for two way transmission with advanced routing mechanism on the same frequency band.
6. Network Virtualization – As we progress in faster networks, optimized and efficient performance and reliable virtual networks will be in demand and will be required to boost the use of 5G networks Further

SECTION C

Q.1

1. What triggered the 1st communication act (i.e., the Act of 1910), and what did it mandate?
2. FCC was established in according to the ACT of 1934. Act of 1934 evolved and was amended several times. However, even the current regulations have several problems. Explain any four problems related to regulations as seen by the current service providers?

Ans.

1. the 1st communication act (i.e., the Act of 1910) was triggered due to –
   * Radio technology was used to communicate between the ships at wartimes since 1902
   * At times it was difficult to communicate since multiple ships used the same radio frequency to communicate
   * However it was difficult to track if a ship travels further than 200 miles of range. Hence it was required to regulate the rules and amend to the ships travelling through sea.
   * In order to have better communication method this rule was applied to mandate every ship travelling with 60 passengers or more to be equipped with wireless radio device to communicate at a distance of 100 miles.

Hence the 1st communication mandates every ship travelling 200 miles off the coast with 60 passengers to have a wireless radio equipment of range 100 miles to communicate over the channel.

But over the time it was observed this act led to lot of interference of signals to communicate in the sea and led to advancement of rules and regulations in wireless communication.

1. Problems related to regulations as seen by the current service providers-
   1. Acts are outdated – Mobiles and technologies have evolved, and same rules no more apply to the modern service providers
   2. The list of rules and regulation is too long and constantly growing – hard to take any action with long rule book to the lawyers, it constantly adds instead of replacing previous legislation to simplify these rules.
   3. Service Provider are not happy and provide no input- modern TSPs don’t like the fact that FCC has unchecked the control over rules & regulation of industry hence they provide no feedback.
   4. Laws are passed based on Political interest and their benefits these should be more inclined to the consumer interests instead.
   5. These regulations are too harsh to promote innovation in the telecommunication industry. Consumer protection organisatio claim FCC is not doing enough to help TSP to govern and innovate.

**Q.** **2**.

1. Define Circuit Switching (CS) and Packet Switching (PS). Draw a figure of each switching technology to explain the concept.
2. One of the drawbacks of PS is that it is delay-sensitive; how is this drawback overcome?

Ans.

1. Circuit Switching (CS) – Circuit switching is the way of communication happens over the network in which the source and destinations are connected by wire, over a circuit either manually or in an automated way. The source request to connect to a destination through connector(automated way) or an operator which is later found out a route through which they can connect to the destination. Once they are connected can initiate communication.

This is age old way of communication which is outdated since it was slow and had drawbacks for delay in connecting to the destination

Diagram, engineering drawing

Description automatically generated

Packet Switching (PS) – is the advanced way of communication in which following data is transmitted from source to destination where—

* 1. A long message of input (data) from the source is broken down/ dissembled into smaller segments of data to send over the communication channel to the destination
  2. These data segments are sent over the communication channel towards the destination and the router routes these packets in efficient way to reach the destination
  3. At the destination, all the data packets are reassembled to for the exact data as sent from the receiver

Diagram

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Overcoming Delay Sensitivity in Packet switching-

* + QoS can be overcome by Prioritising the data packets transferred with following way –
    1. Voice communications
    2. Streaming data
    3. Web browsing
    4. Email
  + QoS depends on bit rate, error rate, delay, jitter
  + In order to overcome the delay sensitivity in case of Packet switching we can use the Orthogonal Frequency Division Multiple Access modulation technique which will allowing to use time and frequency division at the same time to effectively communicate within the network channels.
  + This improves the wireless network performance by independently modulating subcarriers within frequencies, it allows simultaneous transmission to multiple clients

**Q. 3** Draw and label the network architecture for 4G and 5G mobile communication systems. Also, explain the Homogeneous and Heterogeneous Handovers in these communication systems?

Ans.

4G Network Architecture-

A picture containing text, whiteboard

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5G Network Architecture

Diagram

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**Handover in general**

When the person moves from one cell to another within call duration and the call is transfer to the new cell’s base-station without any interruption, this process of changing the point of attachment is termed as handover or we can say that it is a process by which a Mobile Node keeps its connection active when it moves from one AP to another. There are three phases in Handoff process :

1. **Handover initiation** – A mobile terminal starts searching for new links. After neighbouring networks are discovered, the mobile terminal will select the most appropriate network according to certain handover criteria and then handover negotiation will be underway.

2. **Handover preparation**– After a new network is selected; a new link between the mobile terminal and a base station located in the new network is setup.

3. **Handover execution** – After a new link is setup, all the communications associated with the old link are transferred to the new link. The control signals and data packets are allocated to the connection associated with the new base station or access point.

**Homogenous Handover –**

It is intra technology handover where the user switch between different base stations of the same access network within same network.

e.g. 2G to 3G switching in different networks

**Heterogenous Handover –**

It is Inter technology handover where user switch between base stations of different access network within different network models

e.g Mobile device/ user end device changing Network from Wifi broadband to LTE / Mobile 3G/4G network.