Mustafa Alawadi

40217764

Theory Assignment 1

Dr Aiman Hanna

2025-02-02

1.

Circuit switching can be very useful for reserving a circuit for communication, however, because it's mainly focused on transmission and ensuring the best quality, it is not always the best option. Packet switching is in general a better choice for overall network utilization for example, when making phone calls overseas, it used to cost about $6/min, and it drastically went down to 2 cents/min when they switched from circuit to packet. Yes, the quality might get affected because it will be loaded and we're making sure not to waste much bandwidth, however, it's very bearable. If quality is extremely important, such as a communication between two presidents, then yes maybe we want circuit switching for the best possible quality. To demonstrate this, imagine a person making a phone call using a circuit switch network and the path is reserved from the moment it begins till the end. If the person's phone call only lasts 2 minutes, the circuit will remain tied for a bit longer and since they're not using the full capacity of the circuit and other people can't access the circuit, a large portion of resources is being wasted.

2.

In a layered architecture, networking systems are divided into smaller layers, each responsible for a specific function. This structure makes modifications easier without affecting other layers. However, redundancy can occur because each layer adds its own data. Additionally, you can’t skip any layers so data must pass through each one and be processed accordingly, which can slow things down. In terms of flexibility, it's possible to add more layers, but we should only do so if necessary. If an existing layer can handle the new functionality, there's no need to add extra layers. As for efficiency, while reliability isn’t a major concern, there’s a trade-off. For example, when watching a soccer game, it might be better to freeze for 2 seconds than lose packets and miss a goal just to wait for data to reload.

3.

Cable ISPs often provide superior service compared to DSL, especially during off-peak hours when fewer users are online. This is because cable connections share bandwidth among multiple users in a neighborhood. When fewer people are connected, each user can enjoy faster speeds. However, during peak times, the number of users increases, leading to congestion and slower speeds for everyone. On the other hand, DSL provides a dedicated connection to each user, meaning speeds are more stable and unaffected by the number of users in the area. However, DSL speeds can still be impacted by distance from the central office, and the quality of the copper wiring used. To improve DSL performance, one possible approach could be to adopt some features from cable ISPs, like better bandwidth management. By using technologies such as traffic shaping or implementing routers to allocate bandwidth more efficiently, DSL providers could improve service without entirely overhauling the infrastructure.

4.

In persistent HTTP, the server allows multiple requests and responses to occur over the same connection, which remains open until a set timeout. Some advantages include reduced overhead because there's no need to re-establish the connection for each request, lower latency due to the absence of handshaking, and less CPU and memory usage since fewer connections are needed. However, one downside is increased resource consumption, as keeping connections open uses server and client resources, even when they're not actively being used. Modern browsers like Google Chrome and Firefox rely on persistent connections, which is why I had to upgrade to 32GB of RAM otherwise, those browsers would consume all my system's RAM and CPU. In non-persistent HTTP, a new connection is established for each object that needs to be sent from the source to the destination. One advantage of this approach is that it minimizes resource wastage since a connection is only opened when there's data to send. Additionally, because requests are independent and HTTP is stateless, there's no need to worry about managing the state between multiple requests, which can slow down processing. It can also be argued that non-persistent HTTP is more secure, as the session is terminated immediately after the data is transmitted, reducing the opportunity for attacks. However, the downside is that non-persistent HTTP requires more CPU overhead to establish and close each TCP connection. Furthermore, the process of repeatedly opening and closing connections increases latency, as the handshake and teardown steps take time.

5.

Scenario A: Message switching is more suitable for this scenario because it involves sending the entire message at once, ensuring that the data is delivered in full for proper execution. Since the message is transmitted as a whole, there’s no need for reassembly on the receiving end, which is ideal for large files. Furthermore, since real-time communication is not required in this case, message switching works well. The system can store and forward the message through intermediate systems (such as routers) until it reaches its destination. Since timing is flexible, message switching can tolerate delays, and even if the message is lost at an intermediate point, it can be resent without the need for piecing parts together. While there is a possibility of message loss, the system's ability to retransmit the entire message ensures reliability.

Scenario B: Packet switching is more suitable for this scenario because it supports real-time communication through the transmission of small, frequent updates, such as location and resource status changes. Unlike message switching, which handles large files, packet switching breaks data into smaller packets that are sent independently, allowing for low-latency and efficient communication. This is crucial for real-time coordination, since each packet can take different paths through the network, ensuring that updates are delivered quickly, even if some packets are delayed or lost. Additionally, packet switching allows multiple field operators to send and receive updates simultaneously without requiring a dedicated connection, making it scalable and ideal for a distributed team that needs to communicate frequently and urgently.

6.

i)

a) The propagation delay is equal to Distance / Propagation speed. Therefore its 10000000 m / 2.5 x 10^8 m/s = 0.004 seconds which is 40 milliseconds.

b) The transmission delay is equal to Packet size / Link rate. Therefore its 4 Mbits / 5 Mbps = 0.8 seconds. For 8 packets the total transmission delay = 8 x 0.8 seconds = 6.4 seconds.

ii)

a) The propagation delay for each link is = Distance / Propagation speed. Thus, Distance per link = 10000000 m / 3 = 333333.33 m . Propagation for each link is now = 333333.33 m / 2.5 x 10^8 m/s = 0.0133 seconds = 13.3 milliseconds. The total propagation delay is = 3 x 13.3 ms = 40 ms.

b) Transmission delay A to Router 1 = 4 Mbits / 4 Mbits = 1 second. Router 1 to Router 2 is 4 Mbits / 5 Mbps = 0.8 seconds. Router 2 to B = 4 Mbits / 6 Mbps = 0.667 seconds.

   Total transmission delay per packet = 1 + 0.8 + 0.667 = 2.4667seconds.

c) Number of packets = 20 Mbits / 5 Mbits per packet = 5 packets

   Total transmission delay for 5 packets = 5 × 2.4667 seconds = 12.3335seconds

7.

In FDM, users are allocated separate frequency bands within a communication channel. Users transmit data but they do so on different frequency which allows them to send data simultaneously without interference. They are assigned a frequency ratio that is reserved for them, for example between 300hz and 3300hz which is 3000hz frequency and anything lower than 300hz or higher than 3300hz won't be heard. FDM has a low latency because users are transmitting in parallel frequencies, thus there is no need to wait for time slots. In TDM, however, users can share the same communication channel but transmit at different times reserving a whole cable for a short period of time during which they can send their data. Therefore, each user has access to the entire channel but only for the assigned time period.

Scenario 1: Since the satellite-based internet provided needs to allocate bandwidth to multiple users simultaneously, FDM is more suitable since it allows users to do so on different frequency bands without having to wait for time slot. It's also more efficient in handling unpredictable and varied data usage since TDM is generally better for scheduled time intervals and might perform poorly when there's unpredictable traffic. Lastly, since data is constantly being sent, FDM guarantees efficient use of bandwidth without unnecessary delays.

Scenario 2 : For a fixed telecommunication network where scheduled voice calls need to be managed, TDM is the obvious choice since it guarantees each user their own time slots. TDM also ensures low latency since they can guarantee that each voice call gets the necessary bandwidth for uninterrupted communication. FDM is not the best option since allocating a frequency band to each user may not perform well when bandwidth is needed only for a short burst of time since FDM reserves the bandwidth even when the user isn't actively transmitting data.

8.

For urban areas, transitioning to optical fiber is a logical decision due to the higher concentration of users and the greater demand for faster internet speeds. Optical fiber offers high bandwidth and low latency, ensuring that the telecom company can meet the needs of customers while providing long-term scalability. This investment is likely to pay off quickly, as the popularity of high-speed internet grows, allowing the company to expand into other areas as demand increases. In rural areas, the situation is more complex. The cost of laying fiber optic cables in these regions is high, but the potential customer base is smaller. With fewer people to support the infrastructure, the company may struggle to justify the high subscription fees needed to cover the costs of installation and maintenance. As a result, rural areas may not be as financially viable for fiber optic investment. If the company decides to invest in fiber for rural areas, it must ensure there are enough customers to make the investment worthwhile, or it risks making a significant financial gamble.