CN - Spring 2024 - Mid1 Solution

Question 1 (a): **[2 ×5=10 Points]**

Application Layer: Any application-specific headers are appended to the message.
Transport Layer: The segment is constituted by adding header infor. such as source/dest. no., seq. no., and checksum etc.
Network Layer: The IP datagram is constituted by adding source/dest. IP addresses, as well as other routing information.
Link Layer: The link layer encapsulates each IP packet into a frame suitable for transmission over the physical network medium. Link layer headers, including source and destination MAC addresses, are added to each frame.
Physical Layer: The bits are converted into the format, suitable to transmit the data over the transmission medium.

b.

HQ server to main office: Trans. Delay = 15000 bits / 100 Mbps = 0.15 ms, Prop. Delay = 60 ms, TotalD1 = 60.15 ms
Main office to Regional office: Trans. Delay = 15000 bits / 50 Mbps = 0.3 ms, Prop. Delay = 150 ms, TotalD2 = 150.3 ms
~~Regional office to Workstation: Trans. Delay = 15000 bits / 1000 Mbps = 0.015 ms, TotalD3 = 0.015 ms.~~
End-to-End Delay = 60.15 ms + 150.3 ms + 0.015 = 210.465 ms

c.

Max. rate is limited by slowest/Bottleneck link = 50 Mbps

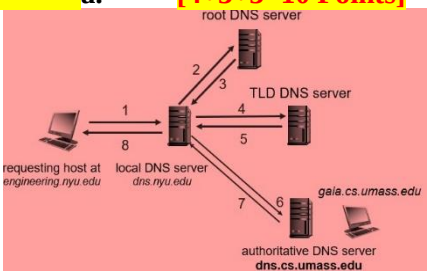
d.

Average End-to-end delay=(0.3*210.465)+(0.7*0.015 ms) = 63.1395 + 0.0105 = 63.15 ms

e.

1. The client sends a GET request to the server, including conditional headers i.e. If-Modified-Since.
2. If resource has not been modified, the server responds with a 304 Not Modified status. This response lacks the resource body, minimizing unnecessary data transfer and reducing network traffic. Else, it sends resource with a 200 OK status.

Question 2 **a.** **[4+3+3=10 Points]**



b.

1. The user's web browser sends a DNS query to the local DNS server for "www.paktech.com".
2. The local DNS resolver checks its cache and finds the IP address for "www.paktech.com" stored from a previous query.
3. Since the IP address is already cached, the local DNS server immediately returns the IP address to the user's web browser.

c.

The value of TTL determines the duration for which DNS records can be cached by local DNS servers, so that the response reduces query load on authoritative servers and thus impacts the network traffic.

Question 3 a. **[2.5×4=10 Points]**

Persistent Advantages:
1. Multiple objects to be fetched within a single connection, reduces the overhead of repeated connection establishments.
2. Minimize the number of TCP handshakes and reduce network congestion, thus improves overall network efficiency.

Disadvantages:
1. If a large number of images need to be fetched within a single connection, it may lead to resource blocking, where subsequent requests are queued until the connection becomes available.
2. It may remain open for longer durations, potentially consuming more server resources and increasing server load, especially in scenarios with a high volume of concurrent connections.

Non-Persistent Advantages:
1. It simplifies resource retrieval by establishing separate connections for each resource, and eliminates resource blocking.
2. It conserves server resources by closing connections after each request, preventing idle connections from consuming server resources unnecessarily.

Disadvantages:
1. It incurs additional overhead due to repeated connection establishments for each resource.
2. Each resource requires multiple RTTs for connection establishment, resulting in higher latency and slower performance.

b.

Non-Persistent HTTP: Each object takes 2 RTTs (conn. estab. + data transfer). Thus for 20 objects, 20*2 = 40 RTTs.
Persistent HTTP: 1 RTT for conn. estab. and then for each object retrieval 1 RTT. Thus for 20 objects, 1+20=21 RTTs.
Therefore, 1 RTT for connection establishment + 1 RTT for data transfer (for all 20 objects) = 21 RTTs

c.

The P2P improves scalability, as each user becomes a potential source for sharing images, leading to faster downloads and reduced server load.

d.

In HTTP/1.1, objects are sent in first-come-first-served (FCFS) manner, thus smaller objects are delayed behind larger ones. This delay is exacerbated by loss recovery mechanisms, which stall object transmission while retransmitting lost segments. HTTP/2 enables multiplexed transmission, dividing objects into smaller frames, and allowing prioritized transmission, thereby mitigating HOL blocking and minimizing the impact of TCP loss recovery on object delivery.