

① a) The Data Link layer is responsible for hop to hop delivery in the network. This means it manages the transfer of data between two directly connected devices, such as from one router to the next. It ensures that each intermediate node successfully receives and forwards the frame to the next device on the path. In contrast, host to host delivery is handled by the Network Layer, which is responsible for sending data from the source host to the destination host located on a different network. Hop delivery focuses on immediate reliable communication between host to host nodes using MAC addresses, while hop to hop delivery focuses on the transmission of packets across multiple networks using IP addresses.

(d)

$$\text{access delay} = 44 \text{ ms}$$

$$\text{Internet delay} = 3.05 \text{ ms} = 3050 \text{ ms}$$

$$\text{LAN delay} = 50 \text{ ms}$$

$$\text{Origin server request} = 40\% = 0.4$$

$$\text{Forwarded Proxy Server request} = 20\% = 0.2$$

$$\text{Business reasoning} = (100 - 60)\% = 40\% = 0.4$$

$$\text{Total delay} = 0.4(44 + 3050 + 50) + 0.2(44 + 50)$$

$$= 1.2764 \text{ ms}$$

② @ The previous searches did not appear at 6 PM because the cookies were session-based and expired after closing the browser. Cookies store browsing data temporarily, and session cookies are automatically deleted when the browsing session ends. In some cases, websites also use short-lived cookies that expire within a few hours for security reasons. As a result, when a user revisited the website later, the search info was not retrieved since the stored cookie data was no longer available.

(b)

IMAP is better for mobile use. It keeps emails on the server and syncs across multiple devices. Also, it allows partial downloads which is useful for low data. Whereas, POP3 downloads full deletes from device and often IMAP is preferred because it supports synchronization and storage across devices.

① RTT for recursive DNS lookup

$$= 4 \times 26 = 104 \text{ ms}$$

② RTT overhead = $4 \times 39 = 156 \text{ ms}$

RTT overhead for all objects

$$= 30 \times 156 = 4680 \text{ ms}$$

$$\therefore \text{Total RTT} = 104 + 4680$$

$$= 4784 \text{ ms}$$

work in between stopped message at
step 3. ~~Total RTT~~

Total time for PC-A to load

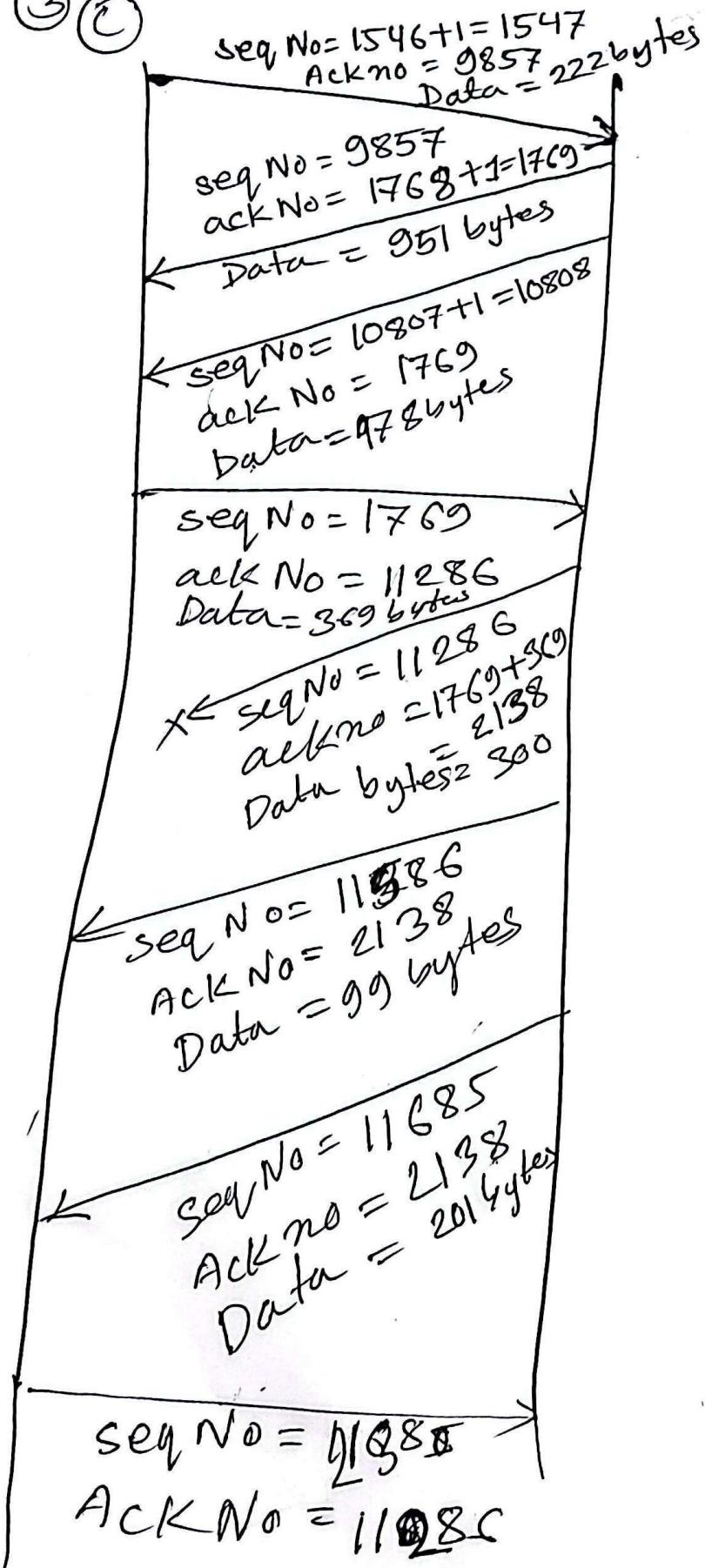
$$= 104 + (30 \times (156 + 41 + 215))$$

$$= 11354 \text{ ms}$$

③ (b) Destination port is the well known service port at the server, typically 80 for HTTP, 443 for HTTPS. All three tabs targeting the same web server will have the same destination port. However, the source port on the client side is chosen randomly from a range of ports assigned by the OS. These source ports are used to uniquely identify each connection.

Therefore, even though all three tabs communicate with the same server and destination port, each tab uses a different source port so the operating system can distinguish between the separate TCP connections.

③ ②



$$\begin{aligned} \text{ack No} &= 1547 + 222 - 1 \\ &= 1768 \\ \text{seq No} &= 9857 + 951 - 1 \\ &= 10807 \end{aligned}$$

① sequence = 11286

acknowledgment = ~~2138~~ 2138

② Client RWND = 1684 bytes

client has already handed DS1 and DS2 to the application, but still has DS3 sitting in the receive buffer.
 $\therefore \text{rwnd} = (1684 - 300) \text{ bytes}$
 $= 1384 \text{ bytes}$

③ sequence = 2138

ack no = 11286