

Q1 A: 435

The acknowledgment number in the header is 436. This indicates that the sender has received all bytes up to sequence number 435. The byte with sequence number 435 has been received, but 436 is the next expected byte

Q2 2: No

The sender is about to send a segment starting at sequence number 1234 with 100 bytes, meaning it covers bytes 1234 to 1333. Since byte 1335 hasn't been sent yet, the receiver can't have received it

Q3 4: Whether it increased the timeout depends on the deviation

The SmoothedRTT will increase because the new SampleRTT is higher. However, the timeout depends on both the SmoothedRTT and the RTT deviation (RTTVar). If the deviation increases, the timeout will increase; otherwise, it might not.

Q4 133ms

$$\text{SmoothedRTT} = 100 + (0.125 \times (108 - 100)) = 101\text{ms}$$

$$\text{DevRTT} = 8\text{ms}$$

$$\text{RTO} = 101 + 4 \times 8 = 133\text{ms}$$

Q5 C: Flow control

The receive window tells the sender how much data the receiver can handle, preventing overload and managing the flow of data.

Q6 B: 1.5RTT

Q7 B: Triple duplicate ACKs

TCP uses triple duplicate ACKs to detect lost packets and retransmits only the specific lost packet instead of the entire window.

Q8 True

If a sender underestimates the round-trip time (RTT), it may set the retransmission timeout (RTO) too low. This can lead to premature timeouts, causing unnecessary retransmissions even when the original packet may still be on its way, thus reducing overall network efficiency.

Q9 SMTP: Uses TCP (port 25)

HTTP: Uses TCP (port 80)

FTP: Uses TCP (Ports 20 and 21)

Q10 C: 0.8 seconds

Time = Upload Rate / Buffer Size

Time = (125,000 bytes/second) / (100,000 bytes)

Time = 0.8 seconds

Q11 C: 4 seconds

Packet Size: 1,000 bytes

Packet Sending Rate: 150 packets/second

Upload Rate: 125,000 bytes/second

Buffer Size: 100,000 bytes

$$\begin{aligned}\text{Arrival Rate} &= (1,000 \text{ bytes/packet}) * (150 \text{ packets/second}) \\ &= 150,000 \text{ bytes/second}\end{aligned}$$

$$\begin{aligned}\text{Net Fill Rate} &= (150,000 \text{ bytes/second}) - (125,000 \text{ bytes/second}) \\ &= 25,000 \text{ bytes/seconds}\end{aligned}$$

$$\text{Time} = (100,000 \text{ bytes}) / (25,000 \text{ bytes/second}) = 4$$

Q12 B: 40 pkts/s

Window Size: 4 pkts

RTT: 100 ms (which is 0.1 seconds)

$$\text{Maximum Throughput} = (4 \text{ pkts}) / (0.1 \text{ seconds}) = 40 \text{ pkts/s}$$