1.

a) False, Host B sends acknowledgements to Host A if the data received is in order. The acknowledgement number is based on the order of the data received from Host A, so Host B does not need to send data in order to acknowledge receipt of the data.

b) True, while the number of unacknowledged packets depends on the size of the congestion window, the maximum size for the congestion window is limited by the size of the receive window, which is the amount of free space in the receiving buffer of the host receiving the data.

c) True, if the 10 packets are in order, it will increment the acknowledgement number for the last packet in the list by one and send that as the acknowledgement number. This indicates all packets with an acknowledgement number lower than that have been received.

d) True, a CDN is a collection of caches that are spread out geographically which can be used as local caches for static objects. This provides fault tolerance so that if one cache fails, another can be accessed.

e) True, under TCP congestion control, loss of packets is used to indicate congestion.

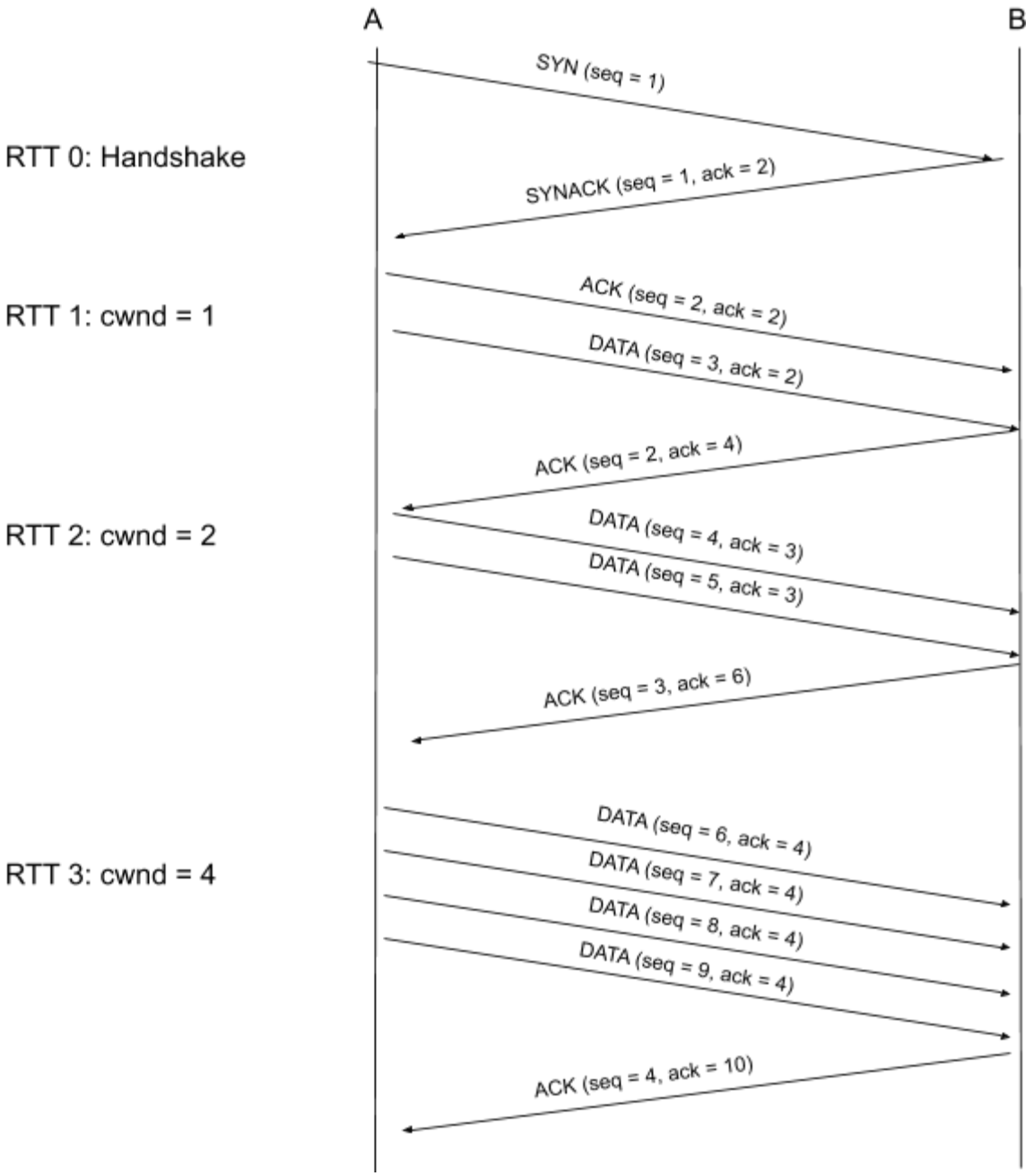
2.

$$
\begin{aligned}
&RTT\ 0\ :\ Handshake\\
&RTT\ 1\ :\ cwnd\ =\ 1\\
&RTT\ 2\ :\ cwnd\ =\ 2\\
&RTT\ 3\ :\ cwnd\ =\ 4\\
&RTT\ 4\ :\ cwnd\ =\ 8\\
&RTT\ 5\ :\ cwnd\ =\ 16\\
&RTT\ 6\ :\ cwnd\ =\ 32\\
&RTT\ 7\ :\ cwnd\ =\ 64\\
&RTT\ 8\ :\ cwnd\ =\ 128
\end{aligned}
$$

$$50ms\ \times 9\ RTTs\ =\ 450ms$$

3.

a)



b)

ii) In TCP Reno, if three duplicate ACKs (ACKs with the same acknowledgement number) are received, it assumes that the next sequential packet (in terms of sequence number) has been lost, which causes the packet to be resent and TCP switches to congestion avoidance phase.

ii) In both TCP Reno and Tahoe, if a timeout occurs due to packet loss, the CWND is reset to the ICWND (which in this case is 1), and the slow start threshold becomes CWND/2.

4.

i) The transport layer provides a connection directly between hosts (end-to-end) and de-multiplexing through port numbers which allows the other layers to not worry about the services being used, since the transport layer handles which services use which port.

ii) TCP provides reliability through the Automatic Repeat Request system which starts a timer after a packet is sent, called the Retransmission Timeout, which is twice the estimated RTT. If the timer finishes before an acknowledgement is sent back, the packet is sent again. In-order delivery is achieved through sequence numbers on each packet sent out.

iii) An example in which I would rather use UDP is one where I wouldn't need reliability and in-order delivery, usually due to a large number of packets needing to be sent out where loss of one packet is not a huge issue, such as video streaming.

5.

i) The CNAME it receives provides an alias from img1.foo.com to the CDN hosted URL, so whenever someone accesses img1.foo.com, they are redirected to the CDN URL under which the image is hosted.

ii) A way in which the server can avoid redirection is through including URLs directly to the CDN hosted image on www.foo.com, which would require changing the image URLs from the existing img1.foo.com to the URL under which the CDN is hosting the image.