1)

Datagram = 5000 bytes, MTU = 1000 bytes, there will be 5 fragments, because of :

Frag1 : Length= 1000bytes, FragFlag= 1, Offset = 0

Frag2 : Length= 1000bytes, FragFlag= 1, Offset = 125

Frag3 : Length= 1000bytes, FragFlag= 1, Offset = 250

Frag4 : Length= 1000bytes, FragFlag= 1, Offset = 375

Frag5 : Length= 1000bytes, FragFlag= 1, Offset = 500

2)

A) “CIDR” refers to Classless InterDomain Routing, it tells the subnet portion & host portion in IP address.

B) “DHCP” refers to Dynamic Host Configuration Protocol, it tells how new host can get an IP address from network server when first join the network.

3)

2 ways to address shortage of IPv4 :

* Introduction of IPv6, it’s using 128bits addresses
* Efficient use of IPv4, like Network Address Translation, so multiple devices within private network can share 1 IPv4 public address.

4)

A) TCP socket, 4 tuples including: Source IP address, Destination IP address, Source Port number, Destination Port number

B) UDP socket, 2 tuples including: Destination IP address, Destination Port number.

C) Differences between TCP and UDP :

|  |  |
| --- | --- |
| TCP | UDP |
| * Handshaking, maintain connection state (Connection) * Reliable * Do have flow control & congestion control * More header information needed * HTTP, FTP, SMTP | * No handshaking, stateless (Connectionless) * Unreliable * No flow control & congestion control * Less header information needed * DNS, DHCP |

5) Reliable Data Transfer Protocol including:

i) Acknowledge Feedback: The sender sends data packets to the receiver and awaits acknowledgment (ACK) from the receiver. If the sender does not receive an ACK within a specified timeout period, it assumes that the packet was lost or corrupted and retransmits the data.

ii) Timer: The sender uses timers to measure the time between sending a packet and receiving an acknowledgment. If an acknowledgment is not received within a predefined timeout period, the sender assumes that the packet is lost or delayed and initiates a retransmission.

iii) Sequence number: Each data packet is assigned a sequence number, indicating its position in the overall sequence of packets. The receiver uses these sequence numbers to reassemble the data in the correct order. Acknowledgment packets also include the sequence number of the next expected packet.

6)

Packet size = 5000bits, Bandwidth = 5Mbits/sec, single trip delay = 0.005s

A) Utilization ratio if using stop and wait based protocol :

Usender = Tdata / Ttotal

Tdata = L/R = 5000/5000000 = 0.001s

Ttotal = RTT + L/R = (2\*0.005) + 0.001 = 0.011s

Usender = 0.001/0.011 = 0.09090909 = 9.09%

B) To improve utilization, we can try using pipelining, which allow multiple packets to be acknowledge.

Let’s assume maximum number of packets to be X, and full utilize meaning 100%

Usender = (X \* 0.001) / 0.011 = 100%

Solve above equation, we can get X = 11.

C) Difference between GNB protocol & selective repeat protocol:

|  |  |
| --- | --- |
| GNB protocol | Selective Repeat protocol |
| * No buffer at receiver * Will retransmit entire windows if lost. * Single accumulative acknowledge. | * Buffer at receiver * Only retransmit the missing one * Individuals acknowledge |

7)

A) Difference between TCP flow control & TCP congestion control

|  |  |
| --- | --- |
| TCP flow control | TCP congestion control |
| * It’s between sender & receiver. * Transport Layer * Happen when receiver buffer is full | * It’s not only between sender & receiver, but also consider the entire network. * Network Layer * Happen when the network is congested (for example, packet loss) |

B) TCP congestion control mechanism:

- AIMD: The sender linearly increases the congestion window for each successful acknowledgment (Additive Increase) and, in case of packet loss, decreases the window multiplicatively (Multiplicative Decrease).

- Slow Start: Slow Start is an initial phase of TCP connection establishment where the sender gradually (exponentially) increases its transmission rate.

- Conservative after timeout events: After a timeout (indicating network congestion), the sender significantly reduces its congestion window size to minimize the impact on the network.

C) TCP needs to perform fast retransmit after 3 duplicate acks because 3 duplicate acks indicating out of order packet arrival. Multiple packets has been received by receiver, but there’s a missing one need to be retransmit. Since receiver will send the highest number of acknowledge. Therefore, TCP do not wait until timeout event to waste resources, but direct retransmit for efficient utilization.

8)

A) DNS stands for Domain Name System.

B) The 2 query scheme including:

- Iterative Query

- Recursive Query