**1:**

**a**. Between the switch in the upper right and the switch in the upper left there are total of four connections. There are also four connections between each of the three other pairs of adjoining switches. In conclusion, the network can support up to sixteen connections.

**b.** Four connections passing through the switch in the upper left hand corner and another four connections passing through the switch in the lowerhand corner, thus a total of eight connections.

**c.** Yes, the connections between A and C, we route two connections through D and two connections through B. For the connections between D and B, we route two connections through C and two connections through A. In this way, there are at most four connections passing through any link.

**2:Throughput:** The throughput is described as the rate at which the bits are transferred between the receiver/sender. There are two types of Throughput: **Instantaneous throughput and Average throughput,** where Average throughput is the rate at which the receiver receives the file after a long time. On the other hand, instantaneous throughput is a rate at any instance of time when the receiver is receiving the files.

The server cannot send bits through its link at a rate faster than Ri (Rate of link between server and router is denoted by Ri) bps. The network links are denoted by R. The router cannot forward the bits at a rate faster than Rq (Rate of link between router and client is denoted by Rq bps.

When Ri<Rq the router cannot forwards bits as fast at a same speed while getting them. The bits has arrived at the router at a rate of Rqbps. The throughput for the network links in the network is min {R1, R2,…. RM}.The client- server pairs are denoted by M. For simple two-link network the throughput is min {Ri, Rq}. The network links depend on the client server links, there the M client server link in the network. Lastly, the pre-connection end-to-end throughput is min {Ri, Rq, R/M}.

**3:**  The transport-layer protocols that could be used is UDP for DNS and TCP for HTTP. DNS is used to regulate the 32-bit IP address of the server. The TCP is used to transport the HTTP request. The UDP is used to transport the DNS messages. So, the HTTP client need to get the IP address of the Http server hosting the document, but before they would the HTTP gets a request which can be sent to web document. The HTTP client first establish a TCP connection to the server, once the mapping is done. A get request for web document is sent to TCP, where protocols that are used are Applications- layer product (DNS and HTTP) and the transport-layer.   
  
**4:** The successive visit incur on RTT of RTT1,… RTTn, so the total time to get the IP address is RTT1 +RTT2+…. RTTN. When a person knows the IP address than the one RRT0 is elapsed for making the TCP connection and one RTT0for making requests and receives the object. After finishing that all the process listed above the total response time from starting is RTT0 + RTT0 + RTT1 + RTT2 +… RTTn. Another example is 2RTT0 + RTT1 + RTT2 + RTTn.

**5 i)** Non-persistent HTTP with no parallel TCP connection requires a time 2RTT0 + 8\*2RTT0 + RTT1.. + RTTn 🡪 2RTT0+ 16RTT0 +RTT1 +… RTTn 🡪 18 RTT0 + RTT1 +… + RTTn. In the equation there are two 2RTT0 because one is for receiving html file which the other for each of the eight objects.

ii) Non- persistent HTTP with browser configured for 5 parallel connection then requires the time of 2RTT0 + 2 \* 2 RTT0 + RTT1 + RTT2 +…. + RTTn 🡪 2RTT0 +4 RTT0 + RTT1 + RTT2 +… + RTTn 🡪 6 RTT0 + RTT1 + RTT2 +… + RTTn. There is one RTT0 for receiving the html file and then making a parallel TCP connection or object and for parallel connection which takes one RTT0.

iii) Persistent HTTP takes time RTT0, + 2RTT0 + RTT1 + RTT2 +…. RTTn 🡪 3RTT0 + RTT1 + RTT2 +… + RTTn. We use RTT0 for getting the eight files without any additional request and one for receiving the html file.

Figure 1: Shows the TCP connection for request and receive the HTML file.

Client Server

Connection Initialization

Time required for transmission

Transmission of file

RTT

RTT

Request for file

Granted Connection