Chap 1.

Review Questions

- R1. What is the difference between a host and an end system? List several different types of end systems. Is a Web server an end system?

- R2. The word protocol is often used to describe diplomatic relations. Give an example of a diplomatic protocol.

- R3. What advantage does a circuit-switched network have over a packet-switched network? What advantages does TDM have over FDM in a circuit-switched network?

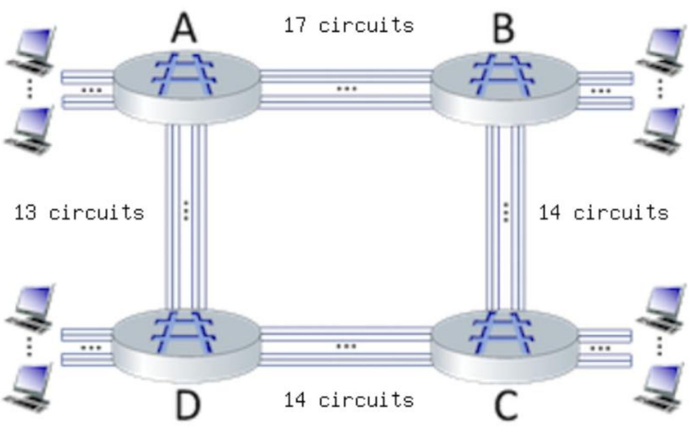
- R4. What is the difference between routing and forwarding?

- R5. What is the difference between non-persistent HTTP and persistent HTTP?

Problems

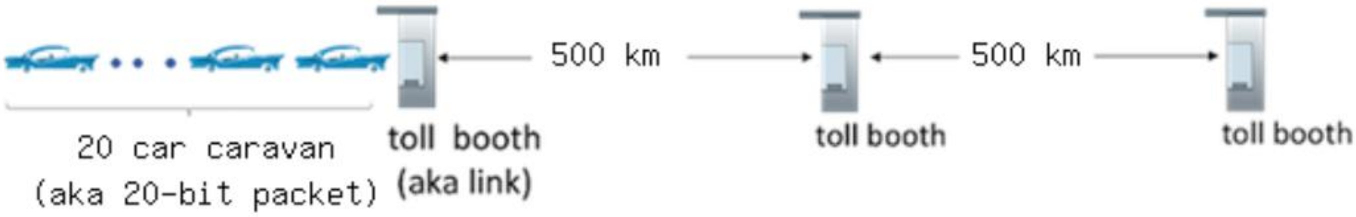
- P1(1pt). Write the names of the layers of the TCP/IP protocol in order.

- P2(4pt). Consider the circuit-switched network shown in the figure below, with circuit switches A, B, C, and D. Suppose there are 17 circuits between A and B, 14 circuits between B and C, 14 circuits between C and D, and 13 circuits between D and A.



a) What is the maximum number of connections that can be ongoing in the network at any one time?
b) Suppose that these maximum number of connections are all ongoing. What happens when another call connection request arrives to the network, will it be accepted? Answer Yes or No
c) Suppose that every connection requires 2 consecutive hops, and calls are connected clockwise. For example, a connection can go from A to C, from B to D, from C to A, and from D to B. With these constraints, what is the is the maximum number of connections that can be ongoing in the network at any one time?
d) Suppose that 15 connections are needed from A to C, and 15 connections are needed from B to D. Can we route these calls through the four links to accommodate all 30 connections? Answer Yes or No

■ P3(7pt). Consider the figure below, which draws the analogy between store-and-forward link transmission and propagation of bits in packet along a link, and cars in a caravan being serviced at a toll booth and then driving along a road to the next tollbooth.



Suppose the caravan has 20 cars, and that the tollbooth services (that is, transmits) a car at a rate of one car per 5 seconds. Once receiving serving a car proceeds to the next tool both, which is 500 kilometers away at a rate of 10 kilometers per second. Also assume that whenever the first car of the caravan arrives at a tollbooth, it must wait at the entrance to the tollbooth until all of the other cars in its caravan have arrived, and lined up behind it before being serviced at the toll booth. (That is, the entire caravan must be stored at the tollbooth before the first car in the caravan can pay its toll and begin driving towards the next tollbooth).

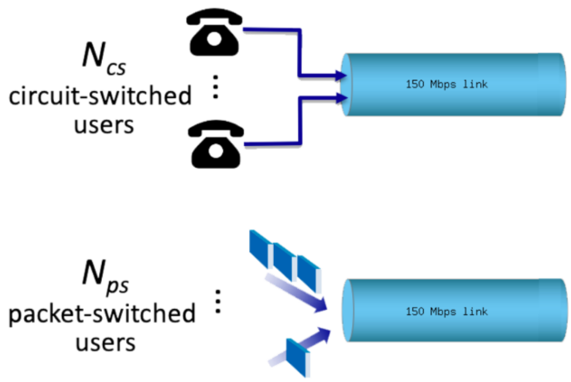
a) Once a car enters service at the tollbooth, how long does it take until it leaves service?
b) How long does it take for the entire caravan to receive service at the tollbooth (that is the time from when the first car enters service until the last car leaves the tollbooth)?
c) Once the first car leaves the tollbooth, how long does it take until it arrives at the next tollbooth?
d) Once the last car leaves the tollbooth, how long does it take until it arrives at the next tollbooth?
e) Once the first car leaves the tollbooth, how long does it take until it enters service at the next tollbooth?
f) Are there ever two cars in service at the same time, one at the first toll booth and one at the second toll booth? Answer Yes or No
g) Are there ever zero cars in service at the same time, i.e., the caravan of cars has finished at the first toll both but not yet arrived at the second tollbooth? Answer Yes or No

■ P4(3pt). This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.

a) Express the propagation delay, d_{prop}, in terms of m and s.
b) Determine the transmission time of the packet, d_{trans}, in terms of L and R.
c) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

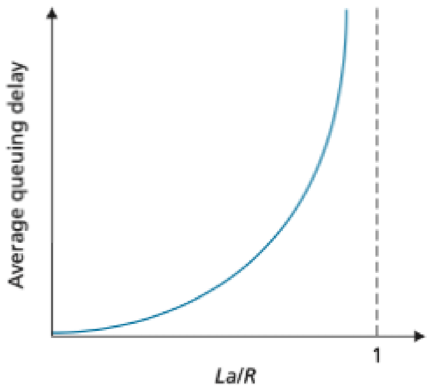
■ P5(7pt). This question requires a little bit of background in probability (but we'll try to help you though it in the solutions). Consider the two scenarios below:

- A circuit-switching scenario in which N_{cs} users, each requiring a bandwidth of 20 Mbps, must share a link of capacity 150 Mbps.
- A packet-switching scenario with N_{ps} users sharing a 150 Mbps link, where each user again requires 20 Mbps when transmitting, but only needs to transmit 30 percent of the time.



a) When circuit switching is used, what is the maximum number of users that can be supported?
b) Suppose packet switching is used. If there are 13 packet-switching users, can this many users be supported under circuit-switching? Yes or No.
c) Suppose packet switching is used. What is the probability that a given (specific) user is transmitting, and the remaining users are not transmitting?
d) Suppose packet switching is used. What is the probability that one user (*any* one among the 13 users) is transmitting, and the remaining users are not transmitting?
e) When one user is transmitting, what fraction of the link capacity will be used by this user? Write your answer as a decimal.
f) What is the probability that any 6 users (of the total 13 users) are transmitting and the remaining users are not transmitting?
g) What is the probability that *more* than 7 users are transmitting?

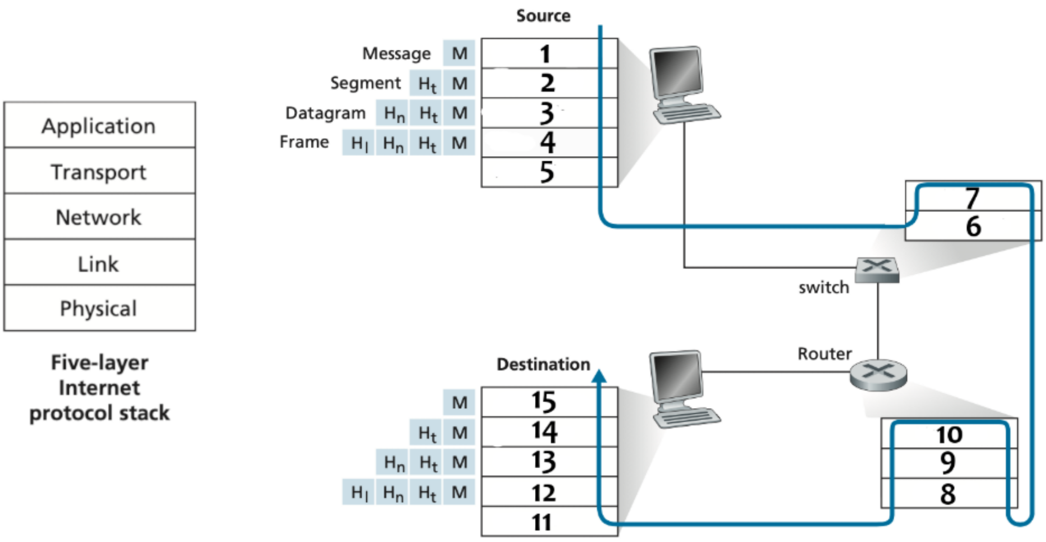
- P6(5pt). Consider the queuing delay in a router buffer, where the packet experiences a delay as it waits to be transmitted onto the link. The length of the queuing delay of a specific packet will depend on the number of earlier-arriving packets that are queued and waiting for transmission onto the link. If the queue is empty and no other packet is currently being transmitted, then our packet's queuing delay will be zero. On the other hand, if the traffic is heavy and many other packets are also waiting to be transmitted, the queuing delay will be long.



Assume a constant transmission rate of R = 1200000 bps, a constant packet-length L = 7900 bits, and a is the average rate of packets/second. Traffic intensity I = La/R, and the queuing delay is calculated as I(L/R)/(1 - I) for I < 1.

a) In practice, does the queuing delay tend to vary a lot? Answer with Yes or No
b) Assuming that a = 38, what is the queuing delay? Give your answer in milliseconds (ms)
c) Assuming that a = 54, what is the queuing delay? Give your answer in milliseconds (ms)
d) Assuming the router's buffer is infinite, the queuing delay is 1.5084 ms, and 739 packets arrive. How many packets will be in the buffer 1 second later?
e) If the buffer has a maximum size of 500 packets, how many of the 739 packets would be dropped upon arrival from the previous question?

■ P7(20pt). In the scenario below, imagine that you're sending an http request to another machine somewhere on the network.



a) What layer in the IP stack best corresponds to the phrase: 'handles messages from a variety of network applications'
b) What layer in the IP stack best corresponds to the phrase: 'moves datagrams from the source host to the destination host'
c) What layer in the IP stack best corresponds to the phrase: 'passes frames from one node to another across some medium'
d) What layer in the IP stack best corresponds to the phrase: 'bits live on the wire'
e) What layer in the IP stack best corresponds to the phrase: 'handles the delivery of segments from the application layer, may be reliable or unreliable'
f) What layer corresponds to box 1?
g) What layer corresponds to box 2?
h) What layer corresponds to box 3?
i) What layer corresponds to box 4?
j) What layer corresponds to box 5?
k) What layer corresponds to box 6?
l) What layer corresponds to box 7?
m) What layer corresponds to box 8?
n) What layer corresponds to box 9?
o) What layer corresponds to box 10?
p) What layer corresponds to box 11?
q) What layer corresponds to box 12?
r) What layer corresponds to box 13?
s) What layer corresponds to box 14?
t) What layer corresponds to box 15?

Chap 2.

Review Questions

- R6. For a P2P file-sharing application, do you agree with the statement, "There is no notion of client and server sides of a communication session?" Why or why not?

- R7. Why is it said that FTP sends control information "out-of-band"?

- R8. TCP and UDP is two types of internet transport protocol service. If user A wants to send an top secret file to user B, which one will be suitable and why?

- R9. What is the difference between network architecture and application architecture?

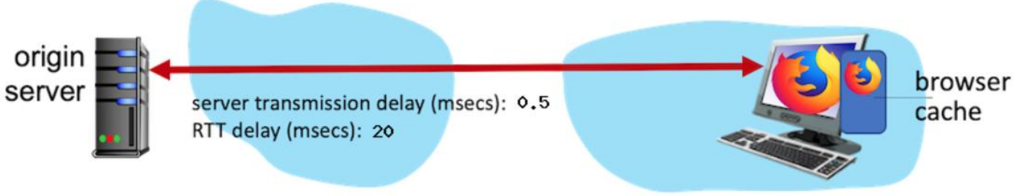
- R10. What is meant by a handshaking protocol?

Problems

- P8(1pt). Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of RTT_1 ..., RTT_n. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT_0 denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

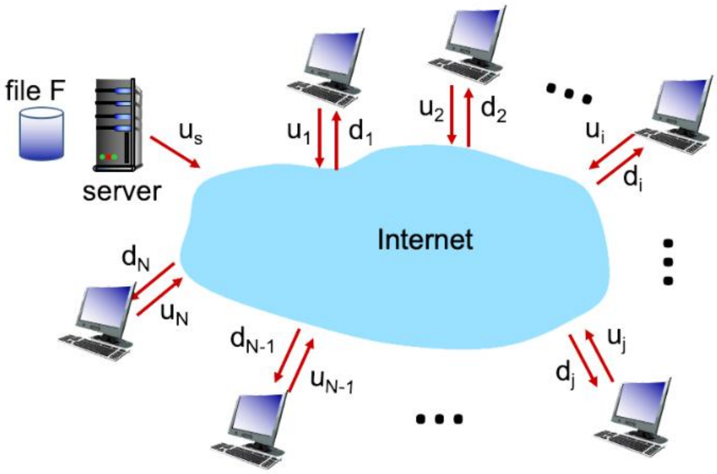
- P9(3pt). Referring to Problem P5, suppose the HTML file references eight very small objects on the same server. Neglecting transmission times, how much time elapses with
  a. Non-persistent HTTP with no parallel TCP connections?
  b. Non-persistent HTTP with the browser configured for 5 parallel connections?
  c. Persistent HTTP?

- P10(1pt). Consider an HTTP server and client as shown in the figure below. Suppose that the RTT delay between the client and server is 20 msecs; the time a server needs to transmit an object into its outgoing link is 0.5 msecs; and any other HTTP message not containing an object has a negligible (zero) transmission time. Suppose the client again makes 70 requests, one after the other, waiting for a reply to a request before sending the next request.



  Assume the client is using HTTP 1.1 and the IF-MODIFIED-SINCE header line. Assume 50% of the objects requested have NOT changed since the client downloaded them (before these 70 downloads are performed) How much time elapses (in milliseconds) between the client transmitting the first request, and the completion of the last request?

- P11(4pt). In this problem, you'll compare the time needed to distribute a file that is initially located at a server to clients via either client-server download or peer-to-peer download.



The problem is to distribute a file of size F = 9 Gbits to each of these 9 peers. Suppose the server has an upload rate of u = 64 Mbps.

The 9 peers have upload rates of: u_1 = 30 Mbps, u_2 = 23 Mbps, u_3 = 26 Mbps, u_4 = 16 Mbps, u_5 = 17 Mbps, u_6 = 13 Mbps, u_7 = 15 Mbps, u_8 = 21 Mbps, and u_9 = 17 Mbps

The 9 peers have download rates of: d_1 = 12 Mbps, d_2 = 18 Mbps, d_3 = 26 Mbps, d_4 = 21 Mbps, d_5 = 18 Mbps, d_6 = 27 Mbps, d_7 = 30 Mbps, d_8 = 20 Mbps, and d_9 = 38 Mbps

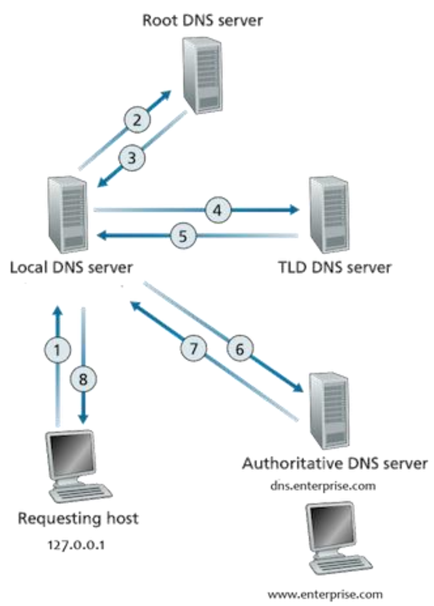
a) What is the minimum time needed to distribute this file from the central server to the 9 peers using the client-server model?
b) For the previous question, what is the root cause of this specific minimum time? Answer as 's' or 'ci' where 'i' is the client's number
c) What is the minimum time needed to distribute this file using peer-to-peer download?
d) For question c), what is the root case of this specific minimum time: the server (s), client (c), or the combined upload of the clients and the server (cu)

- P12(11pt). Imagine that you are trying to visit www.enterprise.com, but you don't remember the IP address the web-server is running on.

Assume the following records are on the TLD DNS server:
- (www.enterprise.com, dns.enterprise.com, NS)
- (dns.enterprise.com, 146.54.165.12, A)

Assume the following records are on the enterprise.com DNS server:
- (www.enterprise.com, east2.enterprise.com, CNAME)
- (east2.enterprise.com, 142.81.17.206, A)
- (enterprise.com, mail.enterprise.com, MX)
- (mail.enterprise.com, 247.29.20.204, A)

Assume your local DNS server only has the TLD DNS server cached.



a) What transport protocol(s) does DNS use: TCP, UDP, or Both?
b) What well-known port does DNS use?
c) In the above example, how many unique type of Resource Records (RR) are there at the authoritative enterprise.com DNS server?

d) Can you send multiple DNS questions and get multiple RR answers in one message? Answer with Yes or No
e) To which DNS server does a host send their requests to? Answer with the full name
f) Which type of DNS server holds a company's DNS records? Answer with the full name
g) In the example given in the problem, what is the name of the DNS server for enterprise.com?
h) When you make the request for www.enterprise.com, your local DNS requests the IP on your behalf. When it contacts the TLD server, how many answers (RR) are returned?
i) In the previous question, there were two responses, one was a NS record and the other an A record. What was the content of the A record? Answer with the format: "name, value"
j) Assume that the enterprise.com website is actually hosted on east2.enterprise.com, what type of record is needed for this?
k) Now imagine we are trying to send an email to admin@enterprise.com, and their mail server has the name mail.enterprise.com. What type of record will contain the name of the enterprise.com domain and the name of its mailserver(s)?