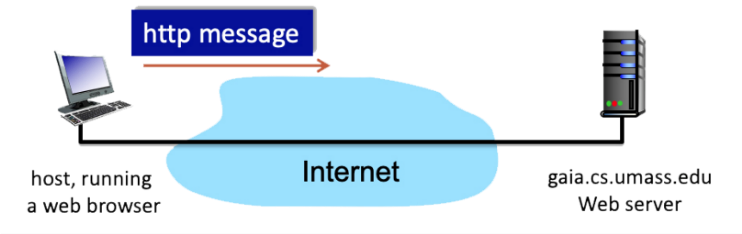
COMPUTER NETWORKS

Question Bank

Unit – 2
Application Layer

1) Consider the figure below, where a client is sending an HTTP GET message to a web server, gaia.cs.umass.edu



Suppose the client-to-server HTTP GET message is the following:

GET /kurose_ross_sandbox/interactive/quotation6.htm HTTP/1.0
Host: gaia.cs.umass.edu
If-Modified-Since: Mon, 20 Jul 2020 08:55:29 -0700

Questions

a) What is the name of the file that is being retrieved in this GET message?
b) What version of HTTP is the client running?
c) True or False: The client already has a cached copy of the file

Answers

a) The name of the file is quotation6.htm.
b) The client is running on HTTP/1.0
c) True. The client has a cached copy of the file that was updated on: Mon, 20 Jul 2020 08:55:29 -0700

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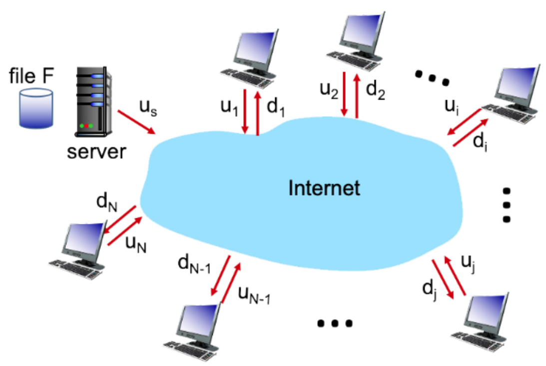
2) In this problem, you'll compare the time needed to distribute a file that is initially located at a server to clients via either client-server download or peer-to-peer download. Before beginning, you might want to first review Section 2.5 and the discussion surrounding Figure 2.22 in the text.



The problem is to distribute a file of size F = 4 Gbits to each of these 8 peers. Suppose the server has an upload rate of u = 50 Mbps.

The 8 peers have upload rates of: u1 = 30 Mbps, u2 = 15 Mbps, u3 = 29 Mbps, u4 = 26 Mbps, u5 = 20 Mbps, u6 = 28 Mbps, u7 = 16 Mbps, and u8 = 17 Mbps

The 8 peers have download rates of: d1 = 35 Mbps, d2 = 33 Mbps, d3 = 31 Mbps, d4 = 10 Mbps, d5 = 19 Mbps, d6 = 33 Mbps, d7 = 35 Mbps, and d8 = 24 Mbps

Questions

a) What is the minimum time needed to distribute this file from the central server to the 8 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 3, what is the root cause of this specific minimum time: the server (s), client (c), or the combined upload of the clients and the server (cu)

Answers

a) The minimum time needed to distribute the file = max of: F / US and F / dmin = 640 seconds.
b) The root cause of the minimum time was c4.
c) The minimum time needed to distribute the file = max of: F / US, F / dmin, and N * F / sum of ui for all i + uS = 400 seconds.
d) The root cause of the minimum time was c.

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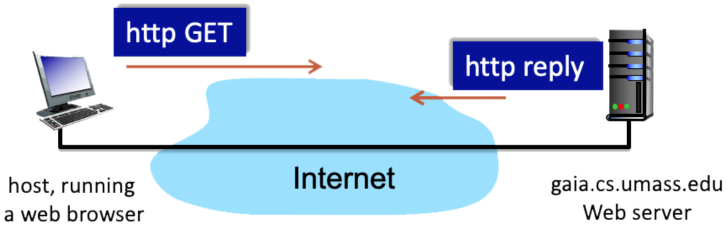
3) Consider the figure below, where the server is sending a HTTP RESPONSE message back the client.



Suppose the server-to-client HTTP RESPONSE message is the following:

HTTP/1.0 404 Not Found
Date: Mon, 20 Jul 2020 16:24:09 +0000
Server: Apache/2.2.3 (CentOS)
Content-Length: 772
Connection: Close
Content-type: image/html

Questions

a) Is the response message using HTTP 1.0 or HTTP 1.1?
b) Was the server able to send the document successfully? Yes or No
c) How big is the document in bytes?
d) Is the connection persistent or nonpersistent?
e) What is the type of file being sent by the server in response?

f) What is the name of the server and its version? Write your answer as server/x.y.z
g) Will the ETag change if the resource content at this particular resource location changes? Yes or No

Answers

a) The response is using HTTP/1.0
b) Since the response code is 404 Not Found, the document was NOT received successfully.
c) The document is 772 bytes.
d) The connection is nonpersistent.
e) The file type the server is sending is image/html.
f) The name and version of the server is Apache/2.2.3
g) Yes. The Etag is a string that uniquely identifies a resource. If a resource is updated, the Etag will change.

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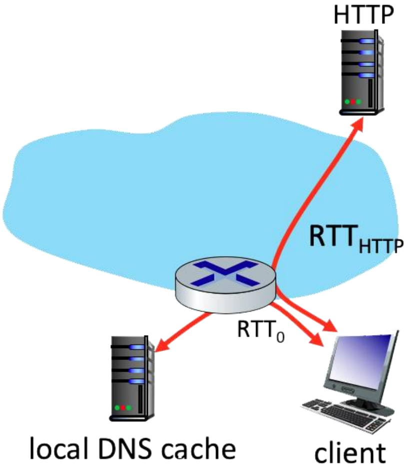
4) Before doing this question, you might want to review sections 2.2.1 and 2.2.2 on HTTP (in particular the text surrounding Figure 2.7) and the operation of the DNS (in particular the text surrounding Figure 2.19).

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 only one DNS server, the local DNS cache, is visited with an RTT delay of RTT_0 = 5 msecs. Initially, let's suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Suppose the RTT between the local host and the Web server containing the object is RTT_{HTTP} = 43 msecs.



Questions

a) Assuming zero transmission time for the HTML object, how much time (in msec) elapses from when the client clicks on the link until the client receives the object?
b) Now suppose the HTML object references 8 very small objects on the same server. Neglecting transmission times, how much time (in msec) elapses from when the client clicks on the link until the base object and all 8 additional objects are received from web server at the client, assuming non-persistent HTTP and no parallel TCP connections?
c) Suppose the HTML object references 8 very small objects on the same server, but assume that the client is configured to support a maximum of 5 parallel TCP connections, with non-persistent HTTP.

d) Suppose the HTML object references 8 very small objects on the same server, but assume that the client is configured to support a maximum of 5 parallel TCP connections, with persistent HTTP.
e) What's the fastest method we've explored: Nonpersistent-serial, Nonpersistent-parallel, or Persistent-parallel?

Answers

a) The time from when the Web request is made in the browser until the page is displayed in the browser is: $RTT_0 + 2*RTT_{HTTP} = 5 + 2*43 = 91$ msecs. Note that 2 RTT_{HTTP} are needed to fetch the HTML object - one RTT_{HTTP} to establish the TCP connection, and then one RTT_{HTTP} to perform the HTTP GET/response over that TCP connection.
b) The time from when the Web request is made in the browser until the page is displayed in the browser is: $RTT_0 + 2*RTT_{HTTP} + 2*8*RTT_{HTTP} = 5 + 2*43 + 2*8*43 = 779$ msecs. Note that two RTT_{HTTP} delays are needed to fetch the base HTML object - one RTT_{HTTP} to establish the TCP connection, and one RTT_{HTTP} to send the HTTP request, and receive the HTTP reply. Then, serially, for *each* of the 8 embedded objects, a delay of $2*RTT_{HTTP}$ is needed - one RTT_{HTTP} to establish the TCP connection and then one RTT_{HTTP} to perform the HTTP GET/response over that TCP connection.
c) Since there are 8 objects, there's a delay of 5 msec for the DNS query, two RTT_{HTTP} for the base page, and $4*RTT_{HTTP}$ for the objects since the requests for 5 of these objects can be run in parallel (2 RTT_{HTTP}) and the rest can be done after (2 RTT_{HTTP}). The total is 5 + 86 + 86 + 86 = 263 msec. As in 2 above, 2 RTTHTTP are needed to fetch the base HTML object - one RTT_{HTTP} to establish the TCP connection, and one RTT_{HTTP} to send the HTTP request and receive the HTTP reply containing the base HTML object. Once the base object is received at the client, the 8 HTTP GETS for the embedded objects can proceed in parallel. Each (in parallel) requires two RTT_{HTTP} delays - one RTT_{HTTP} to set up the TCP connection, and one RTT_{HTTP} to perform the HTTP GET/response for an embedded object.
d) Since there are 8 objects, there's a delay of 5 msec for the DNS query. There's also a delay of two RTT_{HTTP} for the base page, and 2 RTT_{HTTP} for the objects. The total is 5 + 86 + 86 = 177 msec. As in 2 and 3 above, two RTT_{HTTP} delays are needed to fetch the base HTML object - one RTT_{HTTP} to establish the TCP connection, and one RTT_{HTTP} to send the HTTP request, and receive the HTTP reply containing the base HTML object. However, with persistent HTTP, this TCP connection will remain open for future HTTP requests, which will therefore not incur a TCP establishment delay. Once the base object is received at the client, the maximum of five requests can proceed in parallel, each retrieving one of the 8 embedded objects. Each (in parallel) requires only one RTT_{HTTP} delay to perform the HTTP GET/response for an embedded object. Once these first five objects have been retrieved, (if necessary) the remaining embedded objects can be retrieved (in parallel). This second round of HTTP GET/response to retrieve the remaining embedded objects takes only one more RTT_{HTTP}, since the TCP connection has remained open.
e) The delay when using persistent parallel connections is faster than using nonpersistent parallel connections, which is faster than using nonpersistent serial connections.

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5) Perform a Traceroute between source and destination on the same continent at three different hours of the day.

a) Find the average and standard deviation of the round-trip delays at each of the three hours.
b) Find the number of routers in the path at each of the three hours. Did the paths change during any of the hours?
c) Try to identify the number of ISP networks that the Traceroute packets pass through from source to destination. Routers with similar names and/or similar IP addresses should be considered as part of the same ISP. In your experiments, do the largest delays occur at the peering interfaces between adjacent ISPs?
d) Repeat the above for a source and destination on different continents. Compare the intra-continent and inter-continent results.

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6) Suppose users share a 2 Mbps link. Also suppose each user transmits continuously at 1 Mbps when transmitting, but each user transmits only 20 percent of the time. (See the discussion of statistical multiplexing in Section 1.3.)
   a) When circuit switching is used, how many users can be supported?
   b) For the remainder of this problem, suppose packet switching is used. Why will there be essentially no queuing delay before the link if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?
   c) Find the probability that a given user is transmitting.
   d) Suppose now there are three users. Find the probability that at any given time, all three users are transmitting simultaneously. Find the fraction of time during which the queue grows.

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7) Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R_1 = 500 kbps, R_2 = 2 Mbps, and R_3 = 1 Mbps.
   a) Assuming no other traffic in the network, what is the throughput for the file transfer?
   b) Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?
   c) Repeat (a) and (b), but now with R_2 reduced to 100 kbps.

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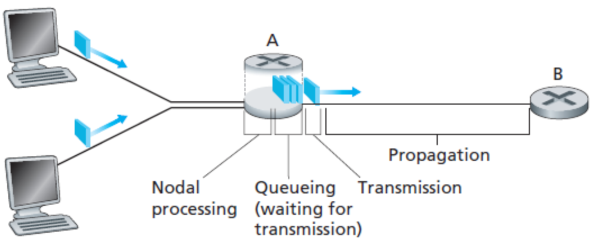
8) Consider the network illustrated in figure below. Assume the two hosts on the left of the figure start transmitting packets of 1500 bytes at the same time towards Router B. Suppose the link rates between the hosts and Router A is 4-Mbps. One link has a 6-ms propagation delay and the other has a 2-ms propagation delay. Will queuing delay occur at Router A?



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9) Review the car-caravan analogy in Section 1.4. Assume a propagation speed of 100 km/hour.

a) Suppose the caravan travels 150 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third tollbooth. What is the end-to-end delay?
b) Repeat (a), now assuming that there are eight cars in the caravan instead of ten.

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10) Consider the network illustrated in Figure 1.16. Assume the two hosts on the left of the figure start transmitting packets of 1500 bytes at the same time towards Router B. Suppose the link rates between the hosts and Router A is 4-Mbps. One link has a 6-ms propagation delay and the other has a 2-ms propagation delay. Will queuing delay occur at Router A?

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11) Consider the scenario in Problem PIO again, but now assume the links between the hosts and Router A have different rates R I and R2 byte/s in addition to different propagation delays d1 and d2• Assume the packet lengths for the two hosts are of L bytes. For what values of the propagation delay will no queuing delay occur at Router A?

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12) Perform a Traceroute between source and destination on the same continent at three different hours of the day.
a) Find the average and standard deviation of the round-trip delays at each of the three hours.
b) Find the number of routers in the path at each of the three hours. Did the paths change during any of the hours?
c) Try to identify the number of lSP networks that the Traceroute packets pass through from source to destination. Routers with similar names and/or similar IP addresses should be considered as part of the same ISP. In your experiments, do the largest delays occur at the peering interfaces between adjacent ISPs?
d) Repeat the above for a source and destination on different continents. Compare the intra-continent and inter-continent results.

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13) Consider problem P25 but now with a link of R = 1 Gbps.
a) Calculate the bandwidth-delay product, R · dprop·
b) Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one big message. What is the maximum number of bits that will be in the link at any given time?
c) What is the width (in meters) of a bit in the link?

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14) Consider Problem P3 l and assume that the propagation delay is 250 ms. Recalculate the total time needed to transfer the source data with and without segmentation. Is segmentation more beneficial or less if there is propagation delay?

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15) Consider sending a large file of F bits from Host A to Host B. There are three links (and two switches) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of S bits each and adds 80 bits of header to each segment, forming packets of L = 80 + S bits. Each link has a transmission rate of R bps. Find the value of S that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.
