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Disciplina de Redes de Computadores (CK0061 / CK0249)
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Lista de Exercícios da Unidade 2
Camada de Aplicação

1) [2] Consider sending a packet of F bits over a path of Q links. Each link transmits at R bps. The network is lightly loaded so that there are no queuing delays. Propagation delay is also negligible.

a) Suppose the network is a packet-switched datagram network and a connection-oriented service is used. Suppose each packet has $h \times F$ bits of header where $0 < h < 1$. Assuming ts setup time, how long does it take to send the packet?

b) Suppose that the network is a circuit-switched network. Furthermore, suppose that the transmission rate of the circuit between source and destination is $R/24$ bps. Assuming ts setup time and no bits of header appended to the packet, how long does it take to send the packet?

c) When is the delay longer for packet switching than for circuit switching assuming $h = 0.5$? Interpret your result.

2) [5] Consider a packet of length L which begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i, s_i and R_i denote the length, propagation speed, and transmission rate of link i, for $i = 1, 2, 3$. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, $(i = 1, 2, 3)$ and L, what is the total end-to-end delay for the packet? Suppose the packet is 1.500 bytes, the propagation speed on all three links is 2.5×10^8 m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5.000 km, the length of the second link is 4.000 km, and the length of the last link is 1.000 km. For these values, what is the end-to-end delay?

3) [9] Consider a link of rate $R = 1$ Mbps. Suppose packets of size $L = 1.250$ bytes arrive "randomly" to the link at a rate of 1 packet/sec. Let $I = La/R$ denote the traffic intensity. Suppose the average queuing delays at the input to this link can be modeled as $[I/(1 - I)] \times [L/R]$ as long as $I < 1$. The average total delay is the queuing delay plus the transmission delay. Find the average queuing delay and average total delay for $a = 30$, 60, 90, and 99 packets/sec.

4) **[10]** Here, we consider the performance of HTTP, comparing non-persistent HTTP with persistent HTTP. Suppose the page your browser wants to download is $100K$ bits long, and contains 10 embedded images (with file names img01.jpg, img02.jpg, ... img10.jpg), each of which is also $100K$ bits long. The page and the 10 images are stored on the same server, which has a 300 msec roundtrip time (RTT) from your browser. We will abstract the network path between your browser and the Web server as a 100 Mbps link. You can assume that the time it takes to transmit a GET message into the link is zero, but you should account for the time it takes to transmit the base file and the embedded objects into the "link". This means that the server-to-client "link" has both a 150 msec one-way propagation delay, as well as a transmission delay associated with it. In your answer, be sure to account for the time needed to set up a TCP connection (1 RTT).

- **a)** Assuming non-persistent HTTP (and assuming no parallel connections are open between the browser and the server), how long is the *response time* - the time from when the user requests the URL to the time when the page and its embedded images are displayed? Be sure to describe the various components that contribute to this delay.
- **b)** Again, assume non-persistent HTTP, but now assume that the browser can open as many parallel TCP connections to the server as it wants. What is the response time in this case?
- **c)** Now assume persistent HTTP (HTTP1.1). What is the response time, assuming no pipelining?
- **d)** Now suppose persistent HTTP with pipelining is used. What is the response time?

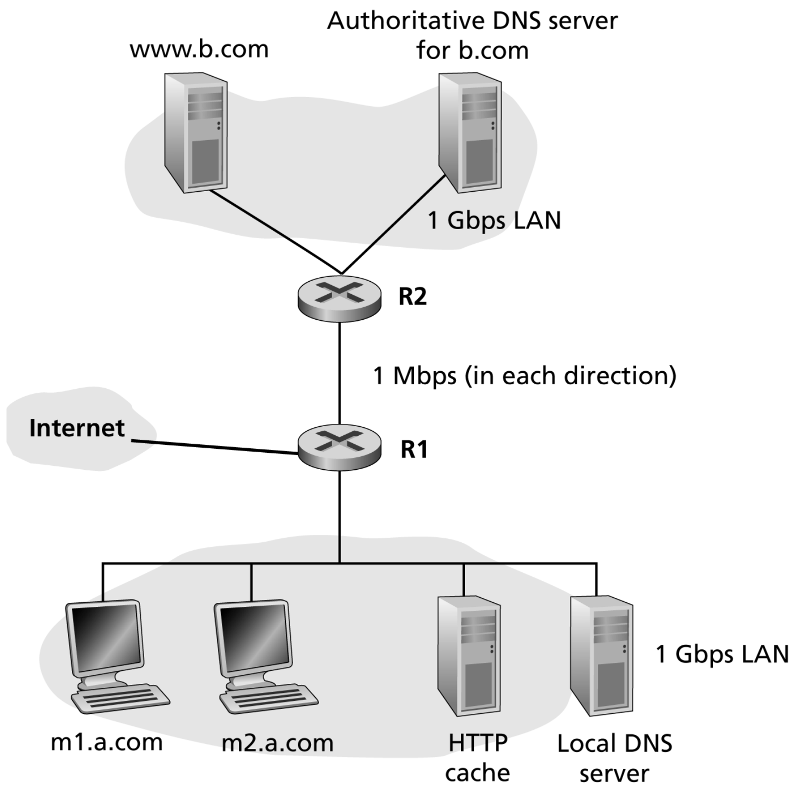
5) **[11]** Consider the networks shown in the figure below. There are two user machines - m1.a.com and m2.a.com in the network a.com. Suppose the user at m1.a.com types in the URL www.b.com/bigfile.htm into a browser to retrieve a 1 Gbit (1000 Mbit) file from www.b.com.

- **a)** List the sequence of DNS and HTTP messages sent/received from/by m1.a.com, as well as any other messages that leave/enter the a.com network that are not directly sent/received by m1.a.com from the point that the URL is entered into the browser until the file is completely received. Indicate the source and destination of each message. You can assume that every HTTP request by m1.a.com is first directed to the HTTP cache in a.com, that the cache is initially empty, and that all DNS requests are iterated queries.
- **b)** How long does it take to accomplish the steps you outlined in your answer to the previous question regarding the m1a.com HTTP and DNS messages. Explain how you arrived at your answer. In answering this question, you can assume the following:
  - The packets containing DNS commands and HTTP commands such as GET are very small compared to the size of the file. Therefore, their transmission times (but not their propagation times) can be neglected.

- Propagation delays within the local area networks (LANs) are small enough to be ignored. The propagation from router R1 to router R2 is 100 msec.
- The one-way propagation delay from anywhere in a.com to any other site in the Internet (except b.com) is 500 msec.

c) Now assume that machine m2.a.com makes a request to the same URL that m1.a.com requested. List the sequence of DNS and HTTP messages sent/received from/by m2.a.com as well as other messages that leave/enter the a.com network that are not directly sent/received by m2.a.com from the point that the URL is entered into the browser until the file is completely received. Indicate the source and destination of each message. (Hint: be sure to consider caching.)

d) Now suppose there is no HTTP cache in network a.com. What is the maximum rate at which machines in a.com can make requests for the file www.b.com/bigfile.htm while keeping the time from when a request is made to when it is satisfied non-infinite in the long run?



Referências

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[3] STALLINGS, W.; "Data and Computer Communications"; 8.ª edição; 2007.