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Chapter:	1
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Computer Networks
Assignment Chapter №1

Task 1. *Calculate the total time required to transfer 1000-kB file in the following cases, assuming an RTT of 100 ms, a packet size of 1 kB data, and an initial 2 × RTT of "handshaking" before data are sent.*
(a) The bandwidth is 1.5 Mbps, and data packets can be sent continuously.
(b) The bandwidth is 1.5 Mbps, but after we finish sending each data packet, we must wait one RTT before sending the next.
(c) The bandwidth is "infinite," meaning that we take transmit time to be zero, and up to 20 packets can be sent per RTT.
(d) The bandwidth is infinite, and during the first RTT, we can send one packet (2^{1-1}), during the second RTT we can send two packets (2^{2-1}), during the third we can send four (2^{3-1}), and so on.

Solution. a) $0.1 \cdot 2 + \frac{1000 \cdot 2^{13}}{1.5 \cdot 10^6} = 0.2 + \frac{8192}{1500} = \frac{2123}{375} = 5.661$ seconds
b) $0.1 \cdot 2 + (\frac{1000}{1} - 1) \cdot 0.1 + \frac{1000 \cdot 2^{13}}{1.5 \cdot 10^6} = \frac{39623}{365} = 105.561$ seconds $(\frac{1000}{1} - 1)$ because we do not need RTT after sending last packet
c) $0.1 \cdot 2 + (\frac{1000}{20} - 1) \cdot 0.1 + \frac{1000 \cdot 2^{13}}{\infty} = 5.1$ seconds
d) We need 10 RTT's to send 1000 KB of data
$1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 + 256 + 512 = 1023$
$0.2 + 10 \cdot 0.1 = 1.2$ seconds □

Task 2. *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.
(d) Suppose Host A begins to transmit the packet at time t=0. At time t=d_{trans} , where is the last bit of the packet?
(e) Suppose d_prop is greater than d_{trans} . At time t=d_{trans} , where is the first bit of the packet?
(f) Suppose d_prop is less than d_{trans} . At time t=d_{trans} , where is the first bit of the packet?
(g) Suppose s=2.5 × 10^8 , L=120 bits , and R=56 kbps . Find the distance m so that d_prop equals d_{trans} .

Solution. a) $d_{prop} = \frac{m}{s}$
b) $d_{trans} = \frac{L}{R}$
c) $d_{endtoend} = \frac{m}{s} + \frac{L}{R}$
d) The last bit of the packet has just been transmitted from host A
e) The first bit has not reached the host B
f) The first bit has already reached the host A
g) $d_{prop} = \frac{m}{2.5 \cdot 10^8}$
$d_{trans} = \frac{120}{56000}$
$\frac{m}{2.5 \cdot 10^8} = \frac{120}{56000}$
$m = \frac{2.5 \cdot 10^8 \cdot 120}{56000} = 535714\frac{2}{7}$ meters ≈ 536 km

□

Task 3. *Compare the delay in sending an x-bit message over a k-hop path in a circuit-switched network and in a (lightly loaded) packet-switched network. The circuit setup time is s sec, the propagation delay is d sec per hop, the packet size is p bits, and the data rate is b bps. Under what conditions does the packet network have a lower delay?*

Solution. In circuit-switched networks we have 3 delays: setup, time to put the entire message on the wire and propagation delay per hope $s + \frac{x}{b} + d \cdot k$
In packet-switched we have 3 delays: time to put the entire message on the wire, transmission delay and propagation delay per hope $\frac{x}{b} + d \cdot k + \frac{p}{b} \cdot (k-1)$
We use $\frac{p}{b} \cdot (k-1)$ because we have k hops and k - 1 connections between them on our path
Packet network has a lower delay in condition if $\frac{p}{b} \cdot (k-1) < s$

□

Task 4. *A system has an n-layer protocol hierarchy. Applications generate messages of length M bytes. At each of the layers, an h-byte header is added. What fraction of the network bandwidth is filled with headers?*

Solution. Since we add a header for each layer, we have a header size of $h \cdot n$ bytes
The total package size will be $M + h \cdot n$ bytes
The fraction will be $\frac{h \cdot n}{M + h \cdot n}$

□

Task 5. *What are two reasons for using layered protocols? What is one possible disadvantage of using layered protocols?*

Solution. Advantages:
1. Modularization eases maintenance, updating of the system (no need to implement app for every network technology)
2. The explicit structure makes it possible to identify the interconnections of parts of a complex system
Disadvantage:
1. Information between layers is hidden from each other, which can lead to inefficient implementations. What is more, overhead both in computation and in message headers caused by the abstraction barriers between layers. Because a message often has to pass through many protocol layers the overhead of the boundaries (headers) is often more than the actual computation being done

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