Principles of Computer Networks

Tutorial 10

Problem 1 Solution:

Wait for 51,200 bit times. For 10 Mbps, this wait is

$$\frac{51.2 \times 10^3 \, bits}{10 \times 10^6 \, bps} = 5.12 \, \text{msec}$$

For 100 Mbps, the wait is 512 μsec.

Problem 2 Solution:

Time, t	Event
0	A and B begin transmission
245	A and B detect collision
293	A and B finish transmitting jam signal
293+245 = 538	B's last bit arrives at A; A detects an idle channel
538+96=634	A starts transmitting
293+512 = 805	B returns to Step2
	B must sense idle channel for 96 bit times before it transmits
634+245=879	A's transmission reaches B

Because A's retransmission reaches B before B's scheduled retransmission time (805+96), B refrains from transmitting while A retransmits. Thus A and B do not collide. Thus the factor 512 appearing in the exponential backoff algorithm is sufficiently large.

Problem 3 Solution:

a) The time required to fill $L \cdot 8$ bits is

$$\frac{L \cdot 8}{128 \times 10^3} \sec = \frac{L}{16} m\sec.$$

b) For $L = 1{,}500,$ the packetization delay is

$$\frac{1500}{16} m\sec = 93.75 m\sec.$$

For $L = 50,$ the packetization delay is

$$\frac{50}{16} m\sec = 3.125 m\sec.$$

c) Store-and-forward delay $= \frac{L \cdot 8 + 40}{R}$

For $L = 1{,}500$, the delay is

$$\frac{1500 \cdot 8 + 40}{622 \times 10^6} \sec \approx 19.4 \mu\sec$$

For $L = 50,$ store-and-forward delay $< 1 \mu\sec$.

d) Store-and-forward delay is small for both cases for typical link speeds. However, packetization delay for $L = 1500$ is too large for real-time voice applications.

Problem 4 Solution:

I. The duration of a polling round is $N(L/R + d_p)$. The number of bits transmitted in a polling round is NL. The maximum throughput therefore is

$$\frac{NL}{N\left(\frac{L}{R}+d_p\right)} = \frac{R}{1+\frac{d_p R}{L}}$$

II.

a) Consider one of the nodes. It has a success if and only if it transmits and the other two nodes do not transmit. The probability that it transmits is p, the probability that the second node does not transmit is $(1- p)$, and the probability that the third node doesn't transmit is also $(1- p)$. Since each of these events are independent, the probability that only the first node transmits is $p.(1- p).(1- p) = p.(1- p)^2$. Now, a success occurs if any of three nodes have a success. Thus the overall probability of success is the probability that the first node has a success plus the probability that the second node has a success plus the probability that the third node has a success, which is $3p(1- p)^2$.

b) To find the p that maximizes the probability of success, we differentiate $f(p)=p.(1-p)^2$, set the result to zero, and solve for p. The derivative of $f(p)$ is $(1- p)^2 + 2p(1-p)$. The value $p = 1/3$ maximizes the probability.

c) With $p = 1/3$, the probability of success (equivalently, the efficiency) is

$3(1/3)(1-1/3)^2 = 4/9$.

Problem 5 Solution:

Your computer first uses DHCP to obtain an IP address. You computer first creates a special IP datagram destined to 255.255.255.255 in the DHCP server discovery step, and puts it in a Ethernet frame and broadcast it in the Ethernet. Then following the steps in the DHCP protocol, you computer is able to get an IP address with a given lease time.

Your computer will use ARP protocol to get the MAC addresses of the first-hop router and the local DNS server.

If the local DNS server does not have the IP address, then your computer will use DNS protocol to find the IP address of the Web page.

Once your computer has the IP address of the Web page, then it will send out the HTTP request via the first-hop router if the Web page does not reside in a local Web server. The HTTP request message will be segmented and encapsulated into TCP packets, and then further encapsulated into IP packets, and finally encapsulated into Ethernet frames. Your computer sends the Ethernet frames destined to the first-hop router. Once the router receives the frames, it passes them up into IP layer, checks its routing table, and then sends the packets to the right interface out of all of its interfaces.

Then your IP packets will be routed through the Internet until they reach the Web server. The server hosting the Web page will send back the Web page to your computer via HTTP response messages. Those messages will be encapsulated into TCP packets and then further into IP packets. Those IP packets follow IP routes and finally reach your first-hop router, and then the router will forward those IP packets to your computer by encapsulating them into Ethernet frames.