

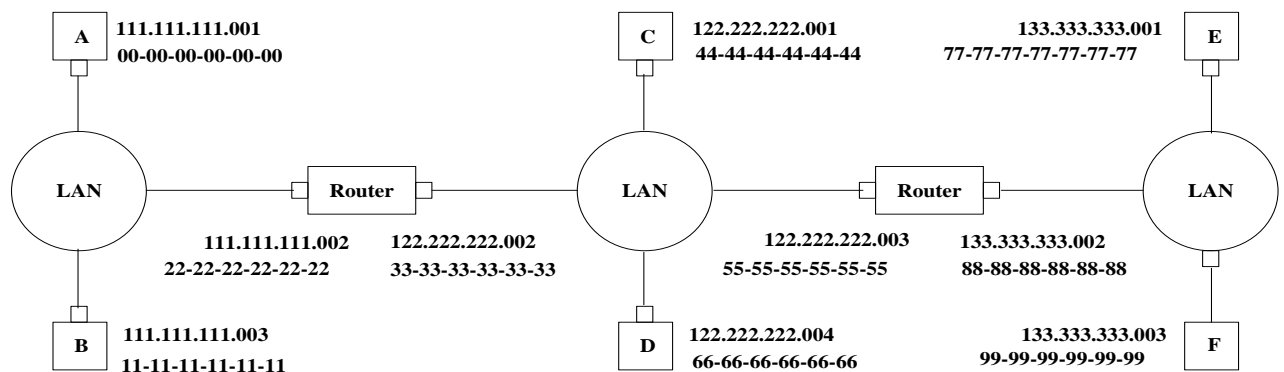
**ECE 465/565 Computer Networks and Protocols
Fall 05**

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**Solutions
Homework 4**

Problem 9.

a), b), c) See figure below.



d)

1. Forwarding table in *A* determines that the datagram should be routed to interface 111.111.111.002.
2. Host *A* uses ARP to determine the LAN address for 111.111.111.002, namely 22-22-22-22-22-22.
3. The adapter in *A* creates an Ethernet packet with Ethernet destination address 22-22-22-22-22-22.
4. The first router receives the packet and extracts the datagram. The forwarding table in this router indicates that the datagram is to be routed to 122.222.222.003.
5. The first router then uses ARP to obtain the associated Ethernet address, namely 55-55-55-55-55-55.
6. The process continues until the packet has reached Host *F*.

e)

ARP in *A* must now determine the LAN address of 111.111.111.002. Host *A* sends out an ARP query packet within a broadcast Ethernet frame. The first router receives the query packet and sends to Host *A* an ARP response packet. This ARP response packet is carried by an Ethernet frame with Ethernet destination address 00-00-00-00-00-00.

Problem 12.

Time, t	Event
0	A and B begin transmission
225	A and B detect collision
273	A and B finish transmitting jam signal
$273+225 = 498$	B 's last bit arrives at A ; A detects an idle channel
$498+96=594$	A starts transmitting
$273+512 = 785$	B returns to Step2 B must sense idle channel for 96 bit times before it transmits
$594+225=819$	A 's transmission reaches B

Because A 's retransmission reaches B before B 's scheduled retransmission time, 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 13.

We want $1/(1+5a) = .5$ or, equivalently, $a = .2 = t_{prop} / t_{trans}$. $t_{prop} = d / (1.8 \times 10^8)$ m/sec and $t_{trans} = (576 \text{ bits}) / (10^8 \text{ bits/sec}) = 5.76 \mu \text{ sec}$. Solving for d we obtain $d = 265$ meters. For the 100 Mbps Ethernet standard, the maximum distance between two hosts is 200 m.

For transmitting station A to detect whether any other station transmitted during A 's interval, t_{trans} must be greater than $2t_{prop} = 2 \cdot 265 \text{ m} / 1.8 \times 10^8 \text{ m/sec} = 2.94 \mu \text{ sec}$. Because $2.94 < 5.76$, A will detect B 's signal before the end of its transmission.

Problem 15.

a)

$$\frac{900m}{2 \cdot 10^8 m / \text{sec}} + 4 \cdot \frac{20bits}{10 \times 10^6 bps}$$

$$= (4.5 \times 10^{-6} + 8 \times 10^{-6}) \text{sec}$$

$$= 12.5 \mu \text{sec}$$

b)

- At time $t = 0$, both A and B transmit.
- At time $t = 12.5\mu\text{sec}$, A detects a collision.
- At time $t = 25\mu\text{sec}$ last bit of B 's aborted transmission arrives at A .
- At time $t = 37.5\mu\text{sec}$ first bit of A 's retransmission arrives at B .
- At time $t = 37.5\mu\text{sec} + \frac{1000\text{bits}}{10 \times 10^6\text{bps}} = 137.5\mu\text{sec}$ A 's packet is completely delivered at B .

c) $12.5\mu\text{sec} + 5 \cdot 100\mu\text{sec} = 512.5\mu\text{sec}$

Chapter 6 Problems

Problem 1

Output corresponding to bit $d_1 = [-1, 1, -1, 1, -1, 1, -1, 1]$

Output corresponding to bit $d_0 = [1, -1, 1, -1, 1, -1, 1, -1]$

Problem 5.

Suppose that wireless station H1 has 1000 long frames to transmit. (H1 may be an AP that is forwarding an MP3 to some other wireless station.) Suppose initially H1 is the only station that wants to transmit, but that while half-way through transmitting its first frame, H2 wants to transmit a frame. For simplicity, also suppose every station can hear every other station's signal (that is, no hidden terminals). Before transmitting, H2 will sense that the channel is busy, and therefore choose a random backoff value.

Now suppose that after sending its first frame, H1 returns to step 1; that is, it waits a short period of times (DIFS) and then starts to transmit the second frame. H1's second frame will then be transmitted while H2 is stuck in backoff, waiting for an idle channel. Thus, H1 should get to transmit all of its 1000 frames before H2 has a chance to access the channel. On the other hand, if H1 goes to step 2 after transmitting a frame, then it too chooses a random backoff value, thereby giving a fair chance to H2. Thus, fairness was the rationale behind this design choice.

Bonus problem

a)

Let Y be a random variable denoting the number of slots until a success:

$$P(Y = m) = \beta(1 - \beta)^{m-1},$$

where β is the probability of a success.

This is a geometric distribution, which has mean $1/\beta$. The number of consecutive wasted slots is $X = Y - 1$ that

$$x = E[X] = E[Y] - 1 = \frac{1 - \beta}{\beta}$$

$$\beta = Np(1 - p)^{N-1}$$

$$x = \frac{1 - Np(1 - p)^{N-1}}{Np(1 - p)^{N-1}}$$

$$\text{efficiency} = \frac{k}{k + x} = \frac{k}{k + \frac{1 - Np(1 - p)^{N-1}}{Np(1 - p)^{N-1}}}$$

b)

Maximizing efficiency is equivalent to minimizing x , which is equivalent to maximizing β . We know from the text that β is maximized at $p = \frac{1}{N}$.

c)

$$\text{efficiency} = \frac{k}{k + \frac{1 - (1 - \frac{1}{N})^{N-1}}{(1 - \frac{1}{N})^{N-1}}}$$

$$\lim_{N \rightarrow \infty} \text{efficiency} = \frac{k}{k + \frac{1 - 1/e}{1/e}} = \frac{k}{k + e - 1}$$

d) Clearly, $\frac{k}{k + e - 1}$ approaches 1 as $k \rightarrow \infty$.