# hw6

P5, P9, P10, P15, P18, P26

P5. Consider the 5-bit generator, G = 10011, and suppose that D has the value 1010101010. What is the value of R?

D 附加 4 个 0 之后（即 1010101010 0000）除以 G(10011)，余数 R = 0100。 注意余数 R 应该填充为 4 位

P9. Show that the maximum efficiency of pure ALOHA is 1/(2e). Note: This problem is easy if you have completed the problem above!

效率 E(p)= 某个时刻正好有一个节点成功传输一帧的概率 = N 个节点中某个节点在该时刻传输，其他节点在该节点该时刻传输的帧的冲突危险区不传输的概率

冲突危险区= 2 个帧时

因此$E(p) = Np(1-p)^{2(N-1)}$

p=?时 E(p)取最大值？E(p)对 p 求导

$$E'(p) = N(1-p)^{2(N-1)} - NP \times 2(N-1)(1-p)^{2N-3}$$
$$= N(1-p)^{2N-3}(1-p-2(N-1)p)$$
$$= N(1-p)^{2N-3}(1-(2N-1)p)$$

$$E'(p) = 0 \Longrightarrow p^* = \frac{1}{2N-1}$$

当 N→∞时，最大效率$\lim_{N\to\infty} E(p^*) = \frac{N}{2N-1}(1-\frac{1}{2N-1})^{2(N-1)} = \frac{1}{2}\frac{1}{e} = \frac{1}{2e}$

P10. Consider two nodes, A and B, that use the slotted ALOHA protocol to contend for a channel. Suppose node A has more data to transmit than node B, and node A's retransmission probability $p_A$ is greater than node B's retransmission probability, $p_B$.

a. Provide a formula for node A's average throughput. What is the total efficiency of the protocol with these two nodes?

b. If $p_A = 2p_B$, is node A's average throughput twice as large as that of node B? Why or why not? If not, how can you choose pA and pB to make that happen?

c. In general, suppose there are N nodes, among which node A has retransmission probability 2p and all other nodes have retransmission probability p. Provide expressions to compute the average throughputs of node A and of any other node.

a. 节点 A 的平均吞吐率=A 传输成功的概率=$p_A(1-P_B)$

总的效率 = 节点 A 或者节点 B 传输成功的概率 = $p_A(1-P_B) + p_B(1-P_A)$

b.

节点 A 的平均吞吐率=$p_A(1-P_B)$

节点 B 的平均吞吐率=$p_B(1-P_A)$

如果 $p_A = 2p_B$，则$\frac{p_A(1-P_B)}{p_B(1-P_A)} = \frac{2p_B(1-P_B)}{p_B(1-2P_B)} = \frac{2(1-P_B)}{(1-2P_B)}$，显然不可能为 2

要使得$p_A(1-P_B) = 2p_B(1-P_A)$

化简后 $P_A = \frac{2P_B}{1+P_B}$

c. N 个节点，A 的重传概率为 2p，其他 N-1 个节点的重传概率为 p

节点 A 的吞吐率 = 节点 A 传输，其他 N-1 个节点不传输 = $2p(1-p)^{N-1}$

其他 N-1 个节点的某个节点的吞吐率 = 该节点传输，其他 N-2 个节点以及 A 不传输 = $p(1-2p)(1-p)^{N-2}$

P15. Consider Figure 6.33. Now we replace the router between subnets 1 and 2 with a switch S1, and label the router between subnets 2 and 3 as R1.

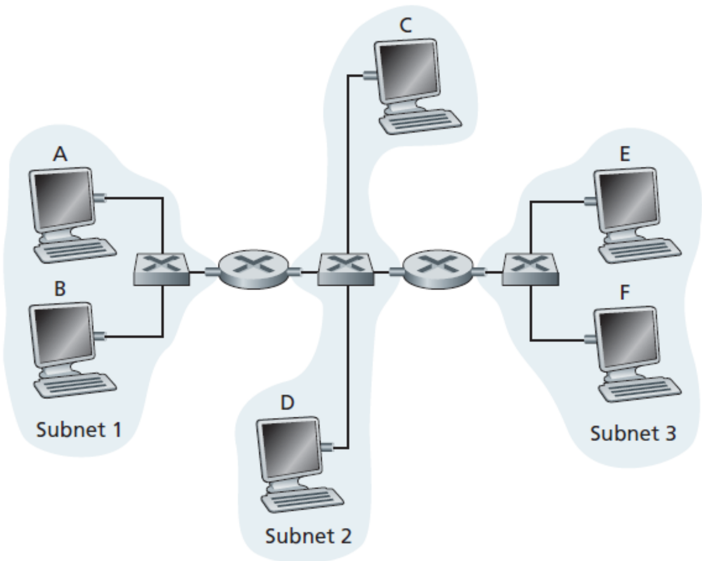


**Figure 6.33** ♦ Three subnets, interconnected by routers

a. Consider sending an IP datagram from Host E to Host F. Will Host E ask router R1 to help forward the datagram? Why? In the Ethernet frame containing the IP datagram, what are the source and destination IP and MAC addresses?

b. Suppose E would like to send an IP datagram to B, and assume that E's ARP cache does not contain B's MAC address. Will E perform an ARP query to find B's MAC address? Why? In the Ethernet frame (containing the IP datagram destined to B) that is delivered to router R1, what are the source and destination IP and MAC addresses?

c. Suppose Host A would like to send an IP datagram to Host B, and neither A's ARP cache contains B's MAC address nor does B's ARP cache contain A's MAC address. Further suppose that the switch S1's forwarding table contains entries for Host B and router R1 only. Thus, A will broadcast an ARP request message. What actions will switch S1 perform once it receives the ARP request message? Will router R1 also receive this ARP request message? If so, will R1 forward the message to Subnet 3? Once Host B receives this ARP request message, it will send back to Host A an ARP response message. But will it send an ARP query message to ask for A's MAC address? Why? What will switch S1 do once it receives an ARP response message from Host B?

a. 主机 E 发给主机 F 的 IP 分组不会通过 R1 转发。E 和 F 在同一个 IP 子网，可以直接递交。包含 IP 分组的以太网帧的相关字段：

源 IP 地址 = E 的 IP 地址，目的 IP 地址 = F 的 IP 地址

源 MAC 地址 = E 的 MAC 地址，目的 MAC 地址= F 的 MAC 地址

b. 主机 E 发给 B 的 IP 分组要通过 R1 转发。E 不会通过 ARP 解析 B 的 MAC 地址，而是首先确定 R1 的 MAC 地址，然后构造一个以太网帧，相关字段：

源 IP 地址= E 的 IP 地址，目的 IP 地址= B 的 IP 地址

源 MAC 地址=E 的 MAC 地址，目的 MAC 地址=R1 的 MAC 地址

c. 主机 A 发送 IP 分组给主机 B。首先发送 ARP 请求以解析 B 的 MAC 地址，该请求会到达交换机 S1（此时会学习到主机 A 在子网 1），由于是广播帧，S1 会扩散转发到主机 C 和 D 以及 R1。R1 收到之后不会向子网 3 转发。

主机 A 广播的 ARP 请求已经包含了主机 A 的 IP 地址和 MAC 地址。主机 B 收到 ARP 请求后发送 ARP 响应，并不需要广播 ARP 请求以解析主机 A 的 MAC 地址。

主机 B 发送给 A 的 ARP 响应会到达 S1，S1 学习到主机 B 在子网 1。S1 的转发表中 A 也在子网 1，即 ARP 响应(B→A)到达的端口与转发表中主机 A 所在的端口相同，因此会忽略该 ARP 响应，不会转发到其他端口。

P18. Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 325 bit times. Suppose CSMA/CD and Ethernet packets are used for this broadcast channel. Suppose node A begins transmitting a frame and, before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? If the answer is yes, then A incorrectly believes that its frame was successfully transmitted without a collision. Hint: Suppose at time t = 0 bits, A begins transmitting a frame. In the worst case, A transmits a minimum-sized frame of 512 + 64 bit times. So A would finish transmitting the frame at t = 512 + 64 bit times. Thus, the answer is no, if B's signal reaches A before bit time t = 512 + 64 bits. In the worst case, when does B's signal reach A?

节点 B 在 A 传输完成之前就开始传输，意味着在 A 传输完成之前的某个时刻，B 检测到媒体空闲，获得媒体访问权发送。B 要检测到媒体空闲，要求 A 传输的帧还没有到达 B，因此 B 要在 t = 325 时刻之前开始传输，最晚 t = 324 时刻开始传输。

| 时刻 | 事件 |
|---|---|
| t = 0 | A 开始传输 |
| t = 324 | B 开始传输 |
| t = 325 | A 传输的帧到达 B |
| t = 512 + 64 = 576 | 如果没有检测到冲突，A 传输完成 |

| | |
|---|---|
| t = 324 + 325 = 649 | B 传输的信号到达 A |

由于 B 传输的信号在 A 传输完成之后到达，即 A 检测到 B 的传输之前就完成了传输，A 错误地认为其传输的帧没有冲突，认为传输成功完成，所以答案为是的。

P26. Let's consider the operation of a learning switch in the context of a network in which 6 nodes labeled A through F are star connected into an Ethernet switch. Suppose that (i) B sends a frame to E, (ii) E replies with a frame to B, (iii) A sends a frame to B, (iv) B replies with a frame to A. The switch table is initially empty. Show the state of the switch table before and after each of these events. For each of these events, identify the link(s) on which the transmitted frame will be forwarded, and briefly justify your answers.

| 动作 | 转发表状态 | 转发 |
|---|---|---|
| 初始 | 转发表为空 | |
| B → E | 学习到 B 的位置，不知道 E 的位置，扩散 | 转发给除了 B 之外的其他端口 |
| E → B | 学习到 E 的位置，知道 B 的位置 | 转发给 B |
| A → B | 学习到 A 的位置，知道 B 的位置 | 转发给 B |
| B → A | 更新 B 的位置（不变），知道 A 的位置 | 转发给 A |