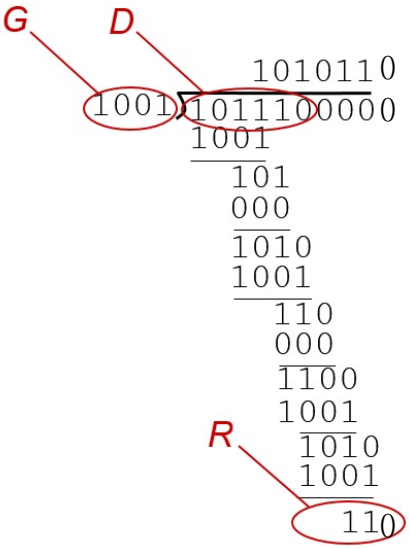
1. If the data bit is 1011100 and the generator is 1001, how to calculate the Cyclic Redundancy Check (CRC)? (要寫出計算過程, 10%)

Ans:

First, we append 000 to the end of 1011100. (2%) Then we divide 1001 into 1011100000 we get 1010110 (6%，計算過程一步驟一分), with a remainder of R = 110. (2%)



2. (a) List three types of multiple access protocols and describe how they work briefly. (9%) (b) Which type of the multiple access protocol does slotted ALOHA, Token Passing, TDMA, polling and CSMA/CD belong to? (5%) (14% total)

Ans:

(a) Three broad classes:

a. Channel Partitioning (2%)
   divide channel into smaller "pieces" (time slots, frequency, code) to node for exclusive use (1%)

b. Random Access (2%)
   channel not divided, allow collisions (1%)

c. "Taking turns" (2%)
   Nodes take turns, but nodes with more to send can take longer turns (1%)

(b) a. Channel Partitioning: TDMA (1%)

b. Random Access: slotted ALOHA, CSMA/CD (1% each)

c. "Taking turns": polling, Token Passing (1% each)

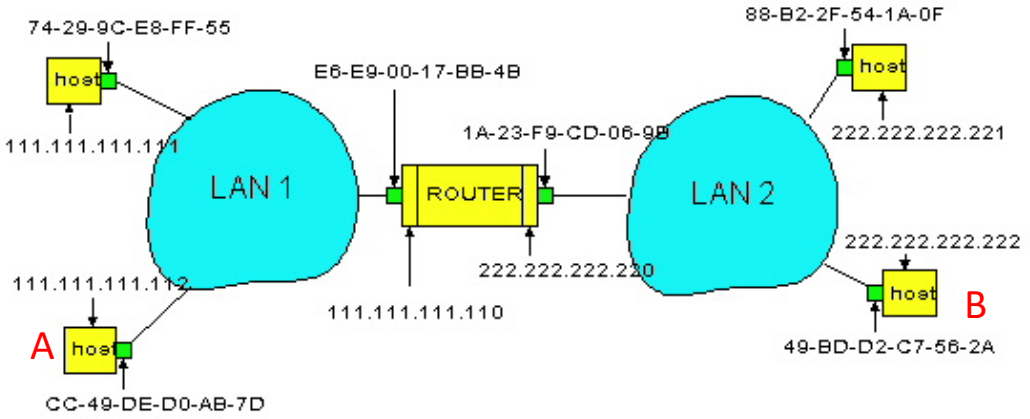
3. Describe how Ethernet uses CSMA/CD with exponential backoff (要寫出碰撞後如何動作) in detail (8%)

Ans:

- adapter doesn't transmit if it senses that some other adapter is transmitting, that is, carrier sense (2%)
- transmitting adapter aborts when it senses that another adapter is transmitting, that is, collision detection (2%)
- Before attempting a retransmission, adapter waits a random time, that is, random access with Exponential Backoff. (2%)
  - after *m*th collision, NIC chooses *K* at random from $\{0,1,2, \ldots, 2^m-1\}$. (2%) NIC waits K·512 bit times

4. Consider sending an IP datagram from host B to host A in the LANs shown below. Write down two

generated frame headers (B->Router and Router->A) with the Destination MAC address and Source MAC address and the IP header with the Source IP address and Destination IP address. (1% each, 8% total)



Ans:

From source B to Router

Destination MAC address	Source MAC address	Source IP address	Destination IP address
1A-23-F9-CD-06-9D	49-BD-D2-C7-56-2A	222.222.222.222	111.111.111.112

From Router to A

Destination MAC address	Source MAC address	Source IP address	Destination IP address
CC-49-DE-D0-AB-7D	E6-E9-00-17-BB-4B	222.222.222.222	111.111.111.112

5. 平時我們用的雙絞線 Ethernet 網路線是由(a)幾根不同顏色的線?分成幾對絞合在一起? (2%) 列出所有四種顏色。(4%) (b) 雙絞線 Ethernet 網路線的插頭是一種只能沿固定方向插入並自動防止脫落的塑料接頭，這種接頭的專有名詞是？(1%) (c) Ethernet 標準的名稱是 IEEE？wifi 標準的名稱是 IEEE？Bluetooth 標準的名稱是 IEEE？(3%) (d) Describe and draw two topologies of Ethernet. (列出其名稱且畫圖，4%) (14% total)

Ans (a) 8 根不同顏色的線(1%)，分成 4 對絞合在一起 (1%) 橙、藍、綠、棕 (4%)

(b) RJ45 (1%)

(c) 802.3, 802.11, 802.15 (3%)

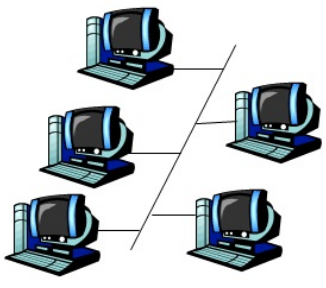
(d) bus topology (1%, 圖1%)

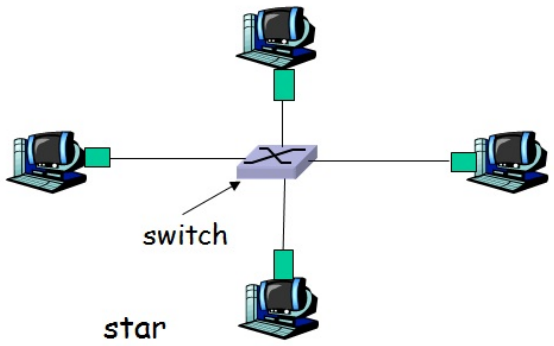
all nodes in same collision domain (can collide with each other)

star topology (1%, 圖 1%)

active *switch* in center

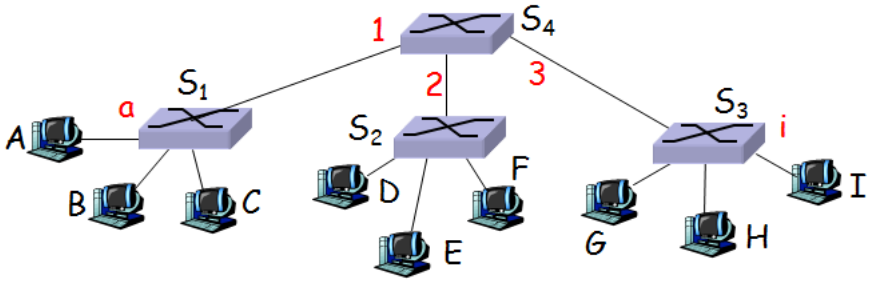
each "spoke" runs a (separate) Ethernet protocol (nodes do not collide with each other)





6. Describe the filtering/forwarding operations of four switches when (a) node A sends a frame to I (8%)

(說明時要提到 frame 經過每個 switch 時的詳細動作與列出 switch table 的內容) (8% total)



Ans:

(a) When the frame received, S1 records link associated with sending host A in S1's table (1%)

MAC address	Interface	TTL
A	α	XX

index switch table using MAC dest address **I**
entry not found for destination, then flood to B, C and interface 1! (1%)

When the frame received, S4 records link associated with sending host A in S4's table (1%)

MAC address	Interface	TTL
A	1	XX

index switch table using MAC dest address **I**
entry not found for destination, then flood to interfaces 2 and 3! (1%)

When the frame received, S2 records link associated with sending host A in S2's table (1%)

MAC address	Interface	TTL
A	2	XX

index switch table using MAC dest address **I**
entry not found for destination, then flood to D, E and F! (1%)

When the frame received, S3 records link associated with sending host A in S3's table (1%)

MAC address	Interface	TTL
A	3	XX

index switch table using MAC dest address **I**
entry not found for destination, then flood to G, H and I! (1%)

7. (a) What is the ARP protocol used for? (2%) (b) If A wants to send datagram to B and B's MAC address is not in A's ARP table, how A uses ARP to find B's MAC address? (6%, 8% total)

Ans:

(a) ARP: Address Resolution Protocol => IP/MAC address mappings for LAN nodes (2%)
(b) A wants to send datagram to B, and B's MAC address not in A's ARP table.

- A broadcasts ARP query packet, containing B's IP address (2%)
  - Dest MAC address = FF-FF-FF-FF-FF-FF ~~(1%)~~
  - all machines on LAN receive ARP query ~~(1%)~~
- B receives ARP packet, replies to A with its (B's) MAC address (2%)
  - frame sent to A's MAC address (unicast) ~~(1%)~~
- A caches (saves) IP-to-MAC address pair in its ARP table until information becomes old (times out) (2%)

8. Compare the switch and router (10%)

Ans:

both store-and-forward devices (2%)

routers: network layer devices (examine network layer headers) (2%)

switches are link layer devices (2%)

routers maintain routing tables, implement routing algorithms (2%)
switches maintain switch tables, implement filtering, learning algorithms (2%)

9. (a) Why the hierarchical routing is needed? (4%)
(b) What is the Intra-AS routing protocol? (2%) What routing entries are set by it? (2%)
(c) List two Intra-AS routing protocols. (4%) (12% total)

Ans:

(a) scale: with 200 million destinations:
can't store all dest's in routing tables! (2%)
routing table exchange would swamp links! (2%)

(b) routers in same AS run same "intra-AS" routing protocol (2%); routers in different AS can run different intra-AS routing protocol.
Intra-AS sets entries for internal dests (2%)

(c) RIP, OSPF (4%)

10. (a) Explain the main function of the base station (3%) (b) Explain the handoff (3%) (c) List the relationship among the maximum transmission speed of 802.11b, 802.11g, 802.11n. (用<符號, 2%) (8% total)

Ans:

(a) relay - responsible for sending packets between wired network and wireless host(s) in its "area" (3%)

(b) handoff: mobile changes base station providing connection into wired network (3%)

(c) 802.11b < 802.11g < 802.11n (2%)