Exercise 3

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Q1

- Please briefly describe the learning process that a switch uses to fill its tables.

Switch Learning Process

- Observation of traffic
  - When receiving a frame, location of sender is learned
    - Record that information as sender/location pair in **switch table**
- Forwarding Table: Mapping MAC addresses to ports
  - If it does not know where to forward to, it broadcasts the packet on all ports
    - If it gets an answer on one port, it updates the forwarding table (as when receiving a frame)

MAC address	Interface	TTL
12-34-56-78-9A-BC	1	60
AB-CD-EF-12-34-56	3	40

Q2

- What are the differences between a switch and a hub?

Hubs, Switches, Routers…

- Hub:
  - Sort of dump (e.g., no collision analysis)
  - operates as broadcaster
  - host NICs detect collisions

- Switch: Layer 2 device
  - Connects hosts inside one broadcasting domain
  - uses CSMA/CD for collision detection
  - learning process via switch tables (see slide before)

Q3

- What are the differences between a switch and a router?

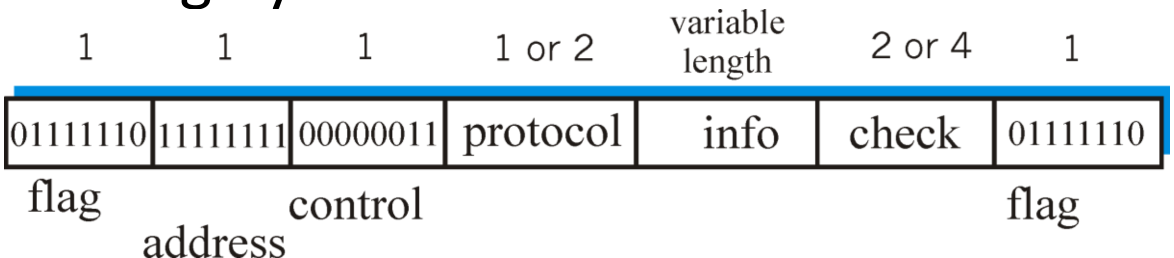
- both store-and-forward devices
  - routers: network layer devices (examine network layer headers)
  - switches are link layer devices
- routers maintain routing tables, implement routing algorithms - not plug and play, but more sophisticated
- switches maintain switch tables, implement filtering, learning algorithms - plug and play, fast

Q4

- What is the byte stuffing in PPP protocol?

- “data transparency” requirement: data field must be allowed to include flag pattern <01111110>
  - Q: is received <01111110> data or flag?
  - Solution: forbid higher layers to use pattern?
    - PPP should be transparent

- Sender: adds (“stuffs”) extra < 01111110> byte after each < 01111110> *data* byte
- Receiver:
  - two 01111110 bytes in a row: discard first byte, continue data reception
  - single 01111110: flag byte



Q5

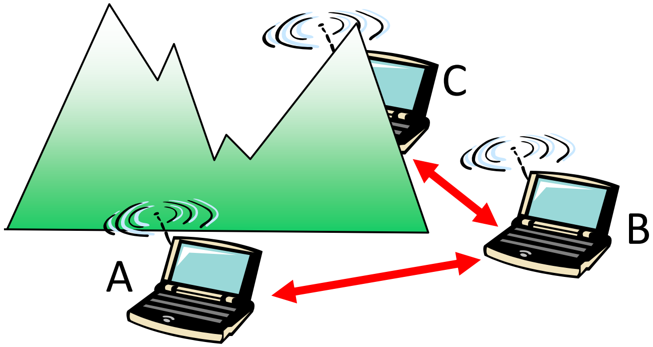
- Please explain the Hidden Terminal Problem

Hidden Terminal Problem

Hidden terminal problem

- B, A hear each other
- B, C hear each other
- A, C can not hear each other

> means A, C unaware of their interference at B



Q6

- Consider the IEEE 802.11 MAC Protocol: How does CSMA/CA tackle the problem of collisions (what steps are taken at the sender and receiver respectively)? What is the idea behind the RTS/CTS concept?

CSMA/CA Collision Avoidance

802.11 sender

```
1 if sense channel idle for **DIFS** then
    transmit entire frame (no CD)
2 if sense channel busy then
    start random backoff time
    timer counts down while channel idle
    transmit when timer expires
    if no ACK, increase random backoff interval, repeat 2
```

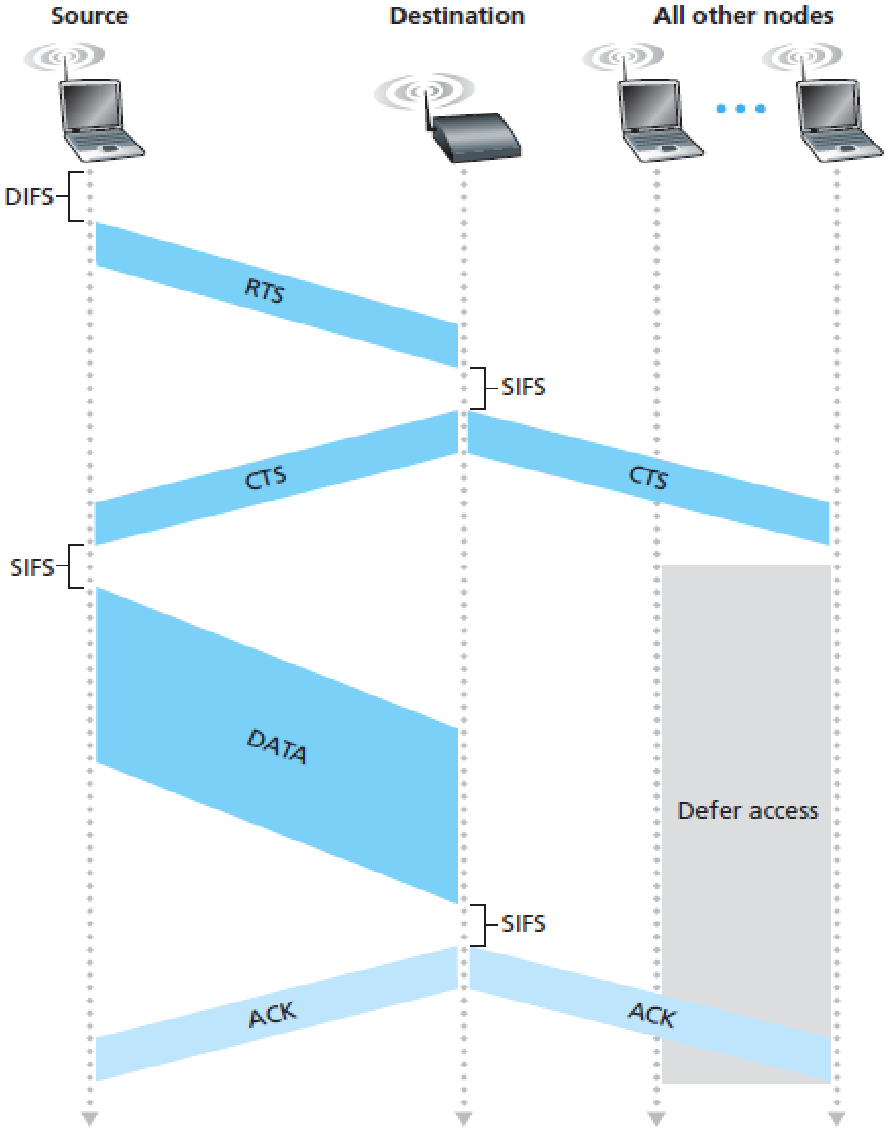
802.11 receiver

```
- if frame received OK
  return ACK after **SIFS** (ACK needed due to hidden terminal problem)
```

CSMA/CA RTS/CTS

- Goal: Avoid collsions of large data frames
- Idea:
  - Use reservation of channel instead of random access
  - Allow collisions of reservation packets (small!)
  - Only reservation packets collide, no data frames!
- Solution: Sender transmits Request-To-Send (RTS) to BS, BS broadcasts Clear-To-Send (CTS) as answer (notifies other nodes in range that channel is busy)

Collision Avoidance: RTS-CTS exchange



Q7

- What’s the main difference between Ethernet protocol and MPLS, ATM protocols?

- signaling protocol needed to set up forwarding in MPLS and ATM as they are virtual circuit switching protocols.