CMSC414 Spring 2016 Lecture #24 5/4/2016

Agenda

=> p5 is due Wednesday, May 11th
=> final exam is Monday, May 16th
  - 4-6 pm
  - in this room

=> OpenFlow/SDN cont'd
=> Wireless MAC

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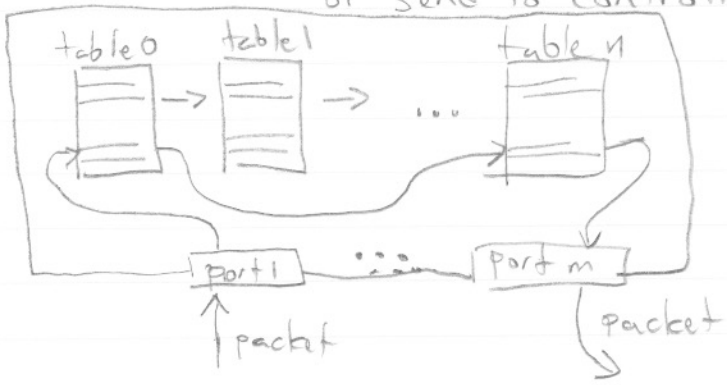
OpenFlow

⇒ one standard protocol to speak between the control plane (controller) and data plane

⇒ model of a device is a sequence of tables with match-action rules as table entries

- match: e.g., destination IP addr = 192.168.0.1, or IP-proto = TCP or TCP port = 80, or any combination
- action: e.g., output port 4, or set src MAC to Y, or send to controller



⇒ can also capture packets via "send to controller" action and then a packet_in message from the switch/router to controller

⇒ can send packets from controller to network using a packet_out message to the switch/router with the port(s) to send it out

⇒ controller can use capture/sending to replicate features of control planes

- capture ARP to learn host IP, MAC, location
- capture/send routing protocols to interoperate with non-SDN devices
- ...

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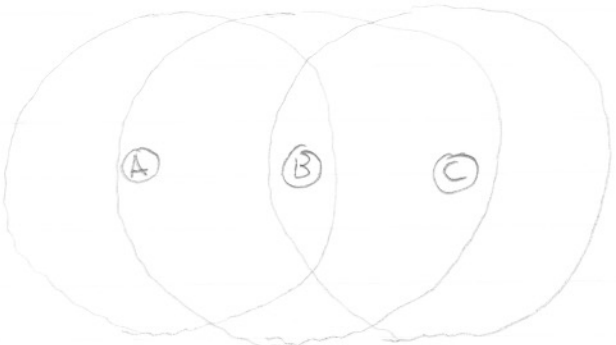
Wireless!

⇒ 802.11 is the current standard
- a, b, g, n, ac all substandards
- BSS - base service set is the set of devices that can directly talk
- DESS - extended service set is the devices that can indirectly talk via a Distribution System (DS)
- DS - usually a wired network connecting access points (APs)
- AP - access point (sometimes called base station) is how clients attach to the wireless network ~= switch
- infrastructure mode - clients connect to APs
- ad-hoc mode - clients talk directly peer-to-peer

⇒ CSMA/CA
- Collision Avoidance (CA) not Detection (CD)
- why?
  - signal has a range (diff from Ethernet)



hidden node
or
hidden terminal

- A/B can hear each other, B/C can hear each other
- A/C can't and so can collide at B
- can't do node-local collision detection

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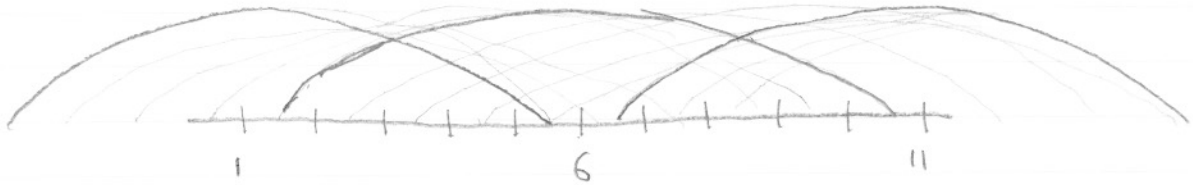
Channels)

⇒ 802.11 b/g operate at 2.4 GHz
⇒ actually 2.4-2.5 GHz
⇒ 802.11a uses 5 GHz; n and ac use both
⇒ divided into "channels"
  - 11 channels for 2.4 GHz (more in europe)
  - some overlap ⇒ generally 4 channels worth
    - 1 overlaps from 1-5 (really -3-5)
    - 6 overlaps from 2-10
    - 11 overlaps from 7-11 (really 7-15)



- 3 independent channels: 1, 6, 11

Virtual Wires)

⇒ APs broadcast their ID (called SSID) perodically
⇒ clients join an AP and create a virtual wire between the pair
  - link-level retransmission to reduce loss
  - sometimes encryption to avoid snooping
⇒ different standards have different rates
  - b: 1, 2, 5, 11 Mbps
  - a/g: up to 54 Mbps
  - n: up to ~600 Mbps
  - ac: up to 1.7 Gbps / device and 6.8 Gbps / AP
⇒ lower rates ⇒ higher noise tolerance or longer range
  - up to devices to pick best rate

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DCF (Distributed Coordination Function)

⇒ 802.11 MAC

DIFS = DCF Inter-Frame Space
SIFS = Short Inter-Frame Space

Algorithm

1) sense channel
2) if busy, backoff
3) else, wait DIFS while sensing
4) if busy, backoff
5) else, send data, wait SIFS, listen for ACK

backoff

1) wait for channel to be free
2) wait DIFS
3) random wait (exponential backoff)
4) transmit if channel is idle

SIFS

⇒ time it takes to process a frame and send an ACK back
- 10 μs on 2.4 GHz, 16 μs on 5 GHz

DIFS

⇒ defined to be 2x slot_time + SIFS
- slot time is 20 μs for 802.11 b and 9 μs for all others unless it's 802.11 g/n being compatible with 802.11 b
- DIFS is thus one of
  - 50 μs (slot = 20, SIFS = 10)
  - 34 μs (slot = 9, SIFS = 16)
  - 28 μs (slot = 9, SIFS = 10)

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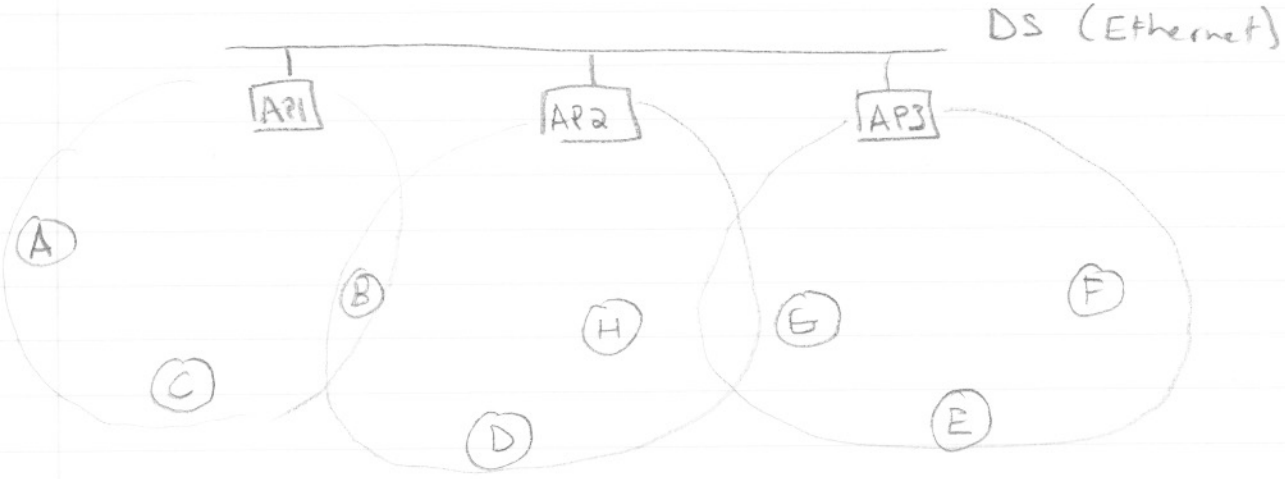
Distribution System

⇒ multiple APs
- usually connected by wired infrastructure
- can also use wireless (called WDS)



⇒ clients send probe requests
⇒ APs send probe responses
⇒ clients pick most preffered AP (usually based on signal strength)

} active scanning

⇒ APs send periodic beacons
⇒ clients can pick a new AP from this

} passive scanning

Addressing

⇒ uses MAC addresses from Ethernet
⇒ frames have 4 addresses
- source and target are the original source and final target
- optional intermediate sender and destination can be used by the DS