Computer Networks

Wired and Wireless LAN

Jianping Pan
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CSc 361

at parking lot e today
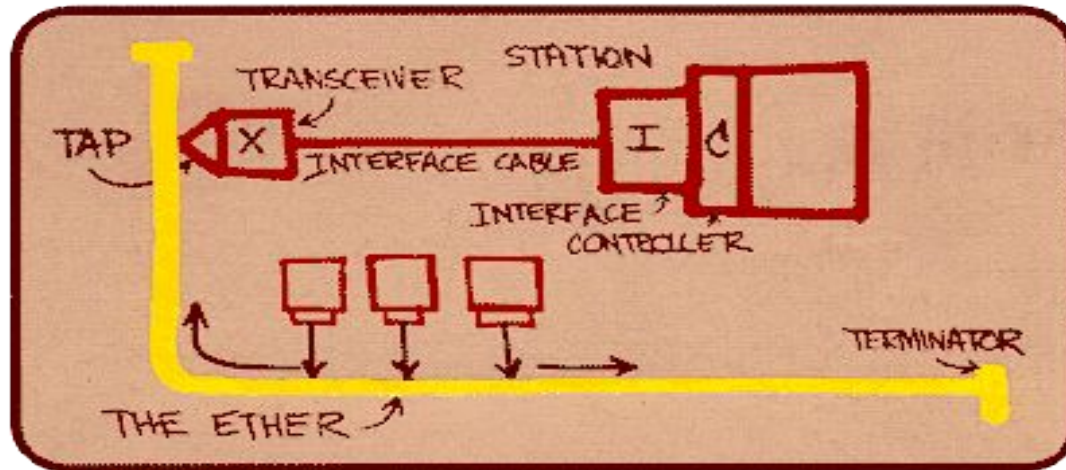
P2 marking issues?

- Please follow the following steps
  - Check the marking feedback on brightspace
    - It shows which test(s) you failed and why
  - If you have a bug preventing a full evaluation
    - Please provide a bugfix, so the rest is evaluated
    - The point(s) due to the bug will be deducted
  - Email me if you request a reevaluation
    - We may contact you to crosscheck

Review

- Media access control
  - Aloha
  - Slotted Aloha
  - CSMA
    - 1-persistent, p-persistent, non-persistent
  - CSMA/CD
  - *IEEE 802.3 Ethernet: CSMA/CD with BEB*
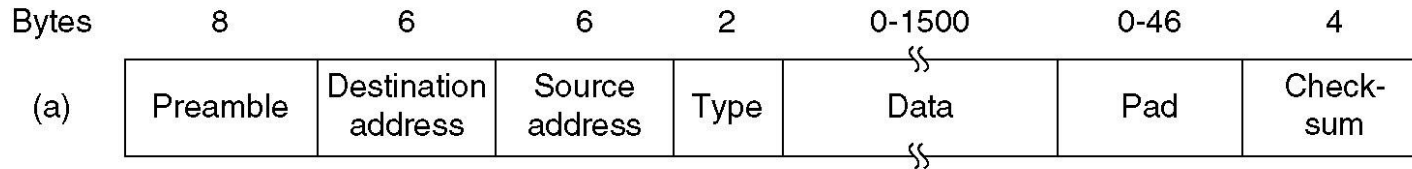   - *frame control, error detection*

Q: idle, busy, collision?

Ethernet

- Pervasive!
  - speed:10->100Mbps, 1->10->40->100Gbps
  - medium: coaxial, twist-pair, fiber
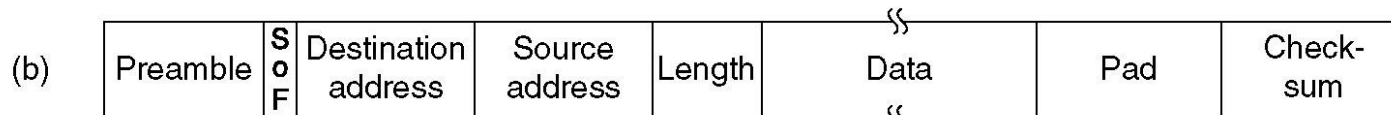 - topology: bus, tree, star; range: LAN, MAN

Ethernet frames

- DIX format
  - type
- IEEE 802.3 format
  - length

Bytes	8		6	6	2	0-1500	0-46	4	
(a)	Preamble		Destination address	Source address	Type	Data	Pad	Check-sum	DIX
(b)	Preamble	S O F	Destination address	Source address	Length	Data	Pad	Check-sum	802.3

* why pad? how to distinguish type vs length? * when busy, binary exponential backoff in csma/cd

Today's topics

- WiFi: wireless fidelity
  - CSMA/CA
  - RTS/CTS
  - IEEE 802.11 family
    - frame control, error detection
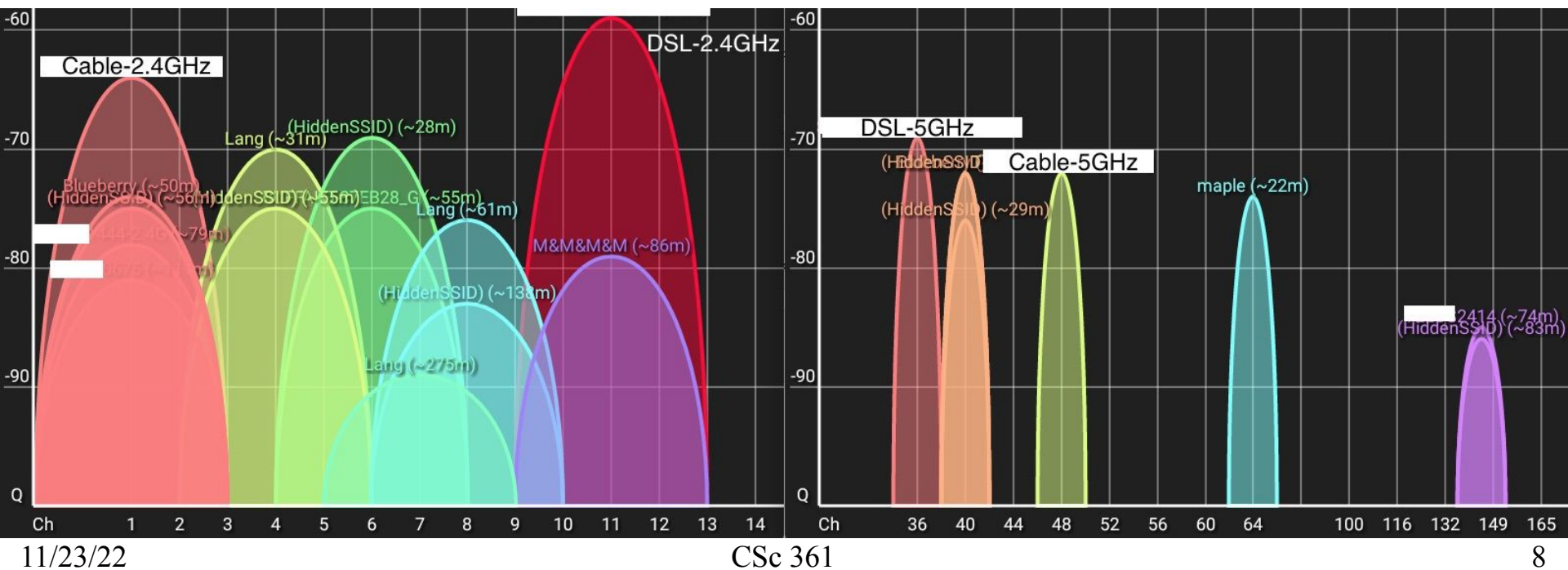
Wireless LAN

- IEEE 802.11 family
  - 802.11: 2.4GHz, 2Mbps
  - 802.11a: 5GHz, 54Mbps, 30ft
  - 802.11b: 2.4GHz, 11Mbps, 100ft
    - 11 channels in North America
    - 3 non-overlapping channels: 1, 6, 11
  - 802.11g: 2.4GHz, 54Mbps, 100ft
    - OFDM: frequency division
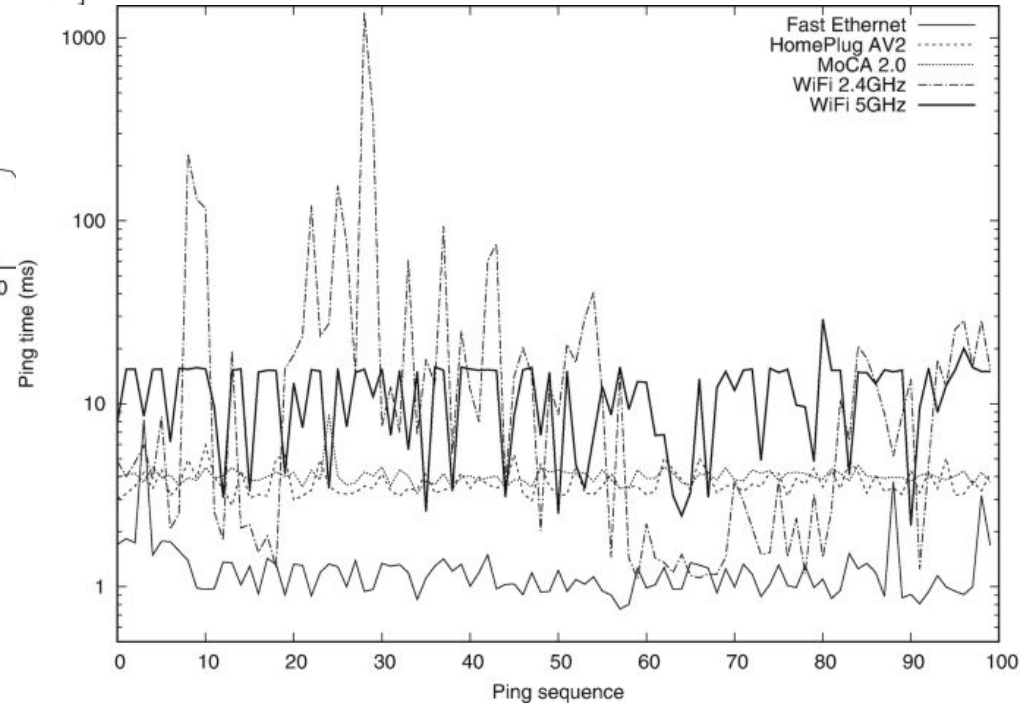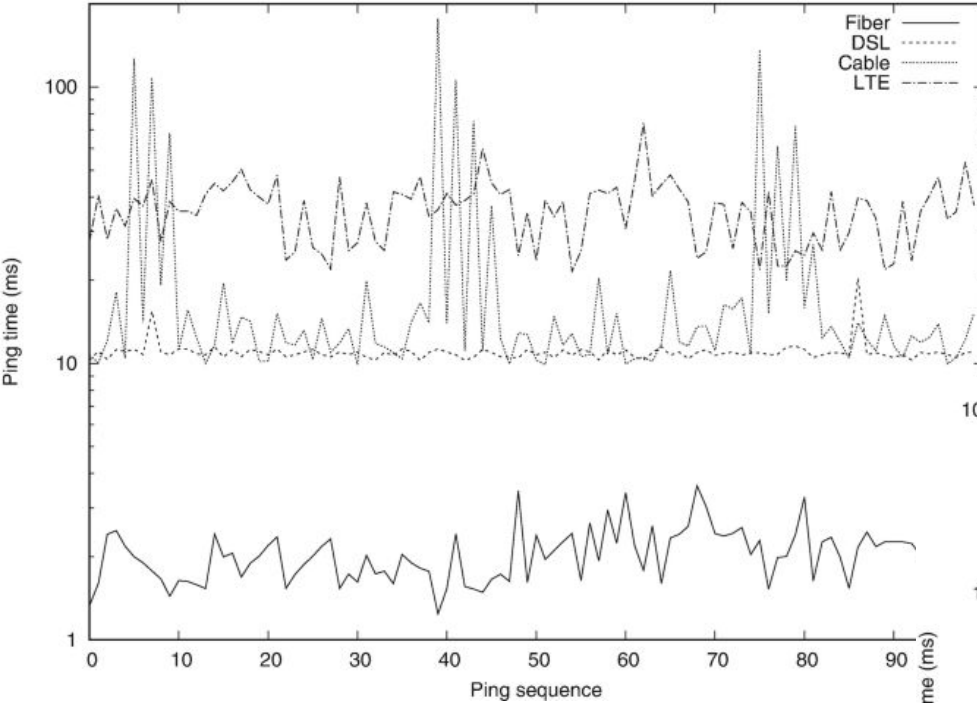 - 802.11n: new radio, 2.4GHz, 540Mbps

802.11ac: gigabit WiFi? * 802.11ax (WiFi 6) * 2.4GHz or 5GHz?

A neighborhood scan

- 2.4GHz vs 5GHz

* 2.4ghz is much more crowded than 5ghz

Internet access from home

* more (varying) delay at home than that to the internet?
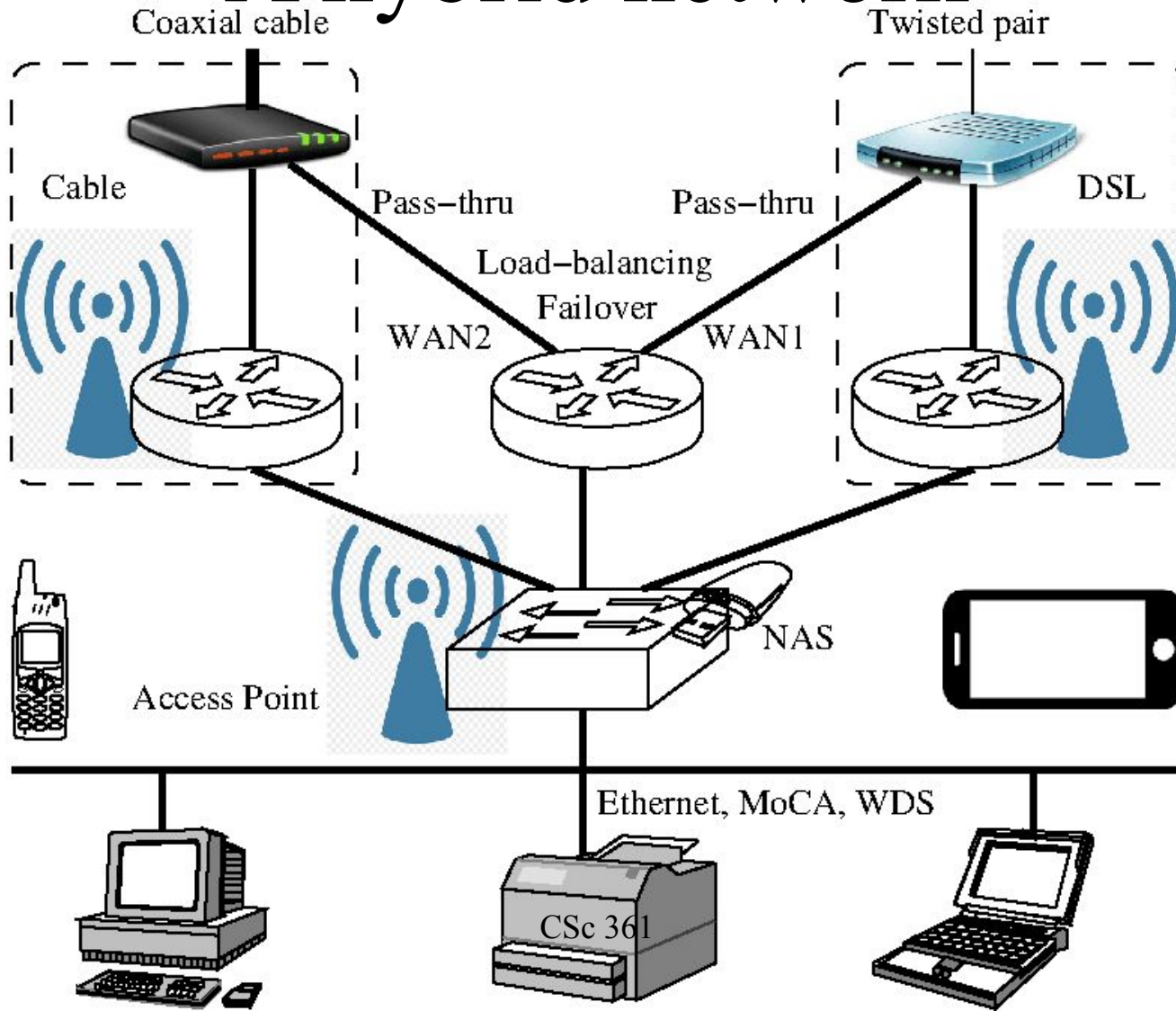
Operation modes

- Infrastructure mode
  - AP: access point
  - wireless station (sta)
  - BSS: basic service set
- Ad-hoc mode
  - no AP

Internet

hub, switch or router

AP

BSS 1

AP

BSS 2

* roaming on campus vs at home? http://tinyurl.com/tfhnsp
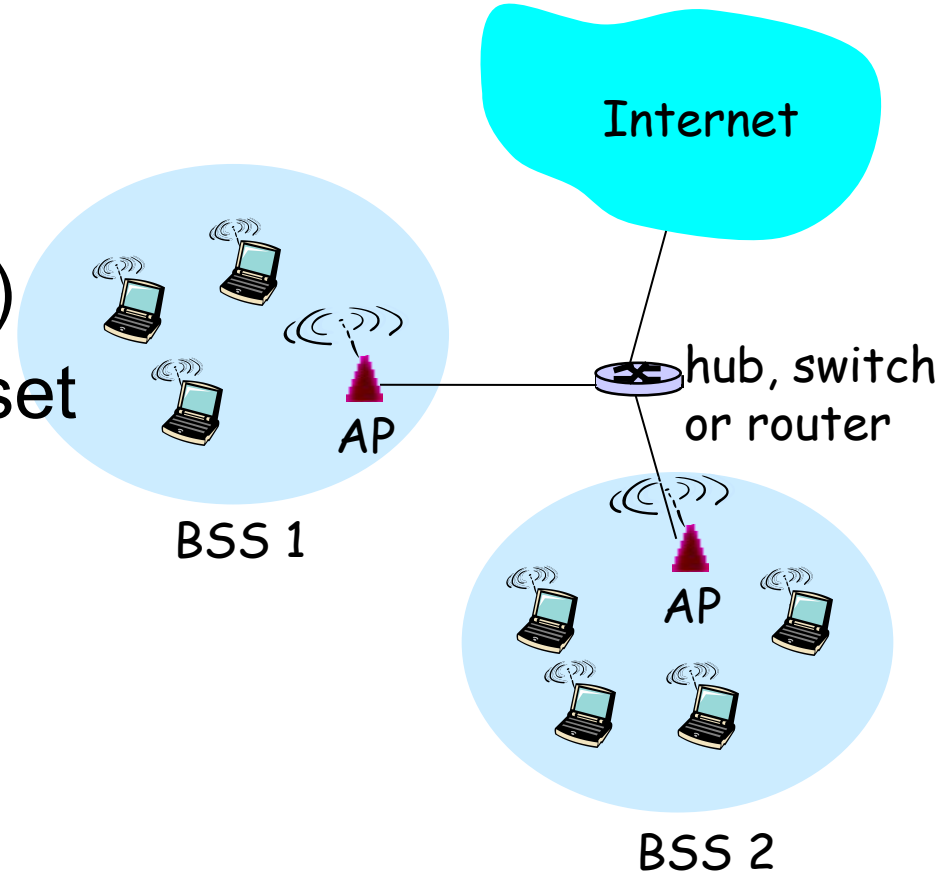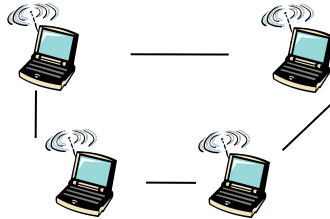
A hybrid network

Operation procedures

- Association
  - channel scanning
  - beacon frame from AP
  - list and select AP to associate
- Authentication
  - network/user authentication
  - and possibly encryption
- Configuration
  - e.g., DHCP to configure network parameters

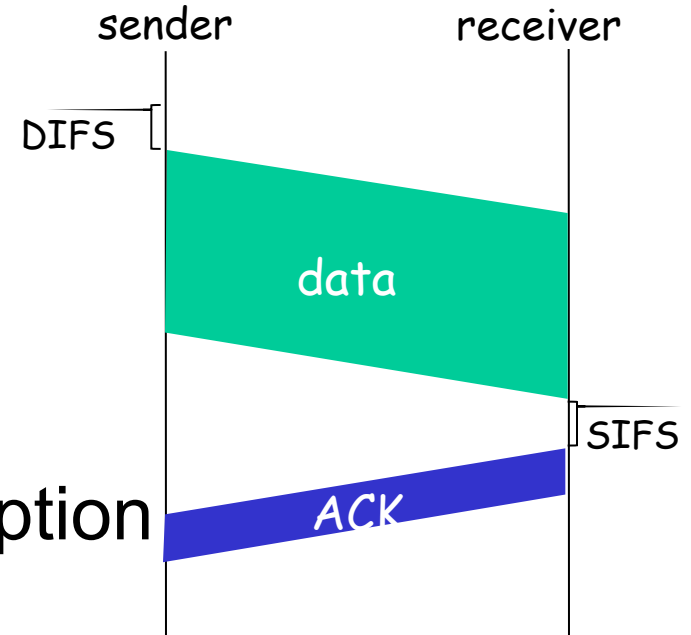Q: WEP (in)security

Media access control

- Contention-free
  - PCF: point coordination function
    - e.g., AP
  - optional (not widely implemented)
- Contention-based
  - DCF: distributed coordination function
  - widely implemented
  - CSMA/CA

DCF

- Like Ethernet, uses CSMA:
  - random access
  - carrier sense: don't collide with ongoing transmission
- Unlike Ethernet:
  - no collision detection – transmit all frames to completion
  - acknowledgment – because without collision detection, you don't know if your transmission collided or not
- Why no collision detection?
  - difficult to receive (sense collisions) when transmitting due to weak received signals (fading)
  - can't sense all collisions in any case: hidden terminal, fading
- Goal: *avoid collisions:* CSMA/C(ollision)A(voidance)
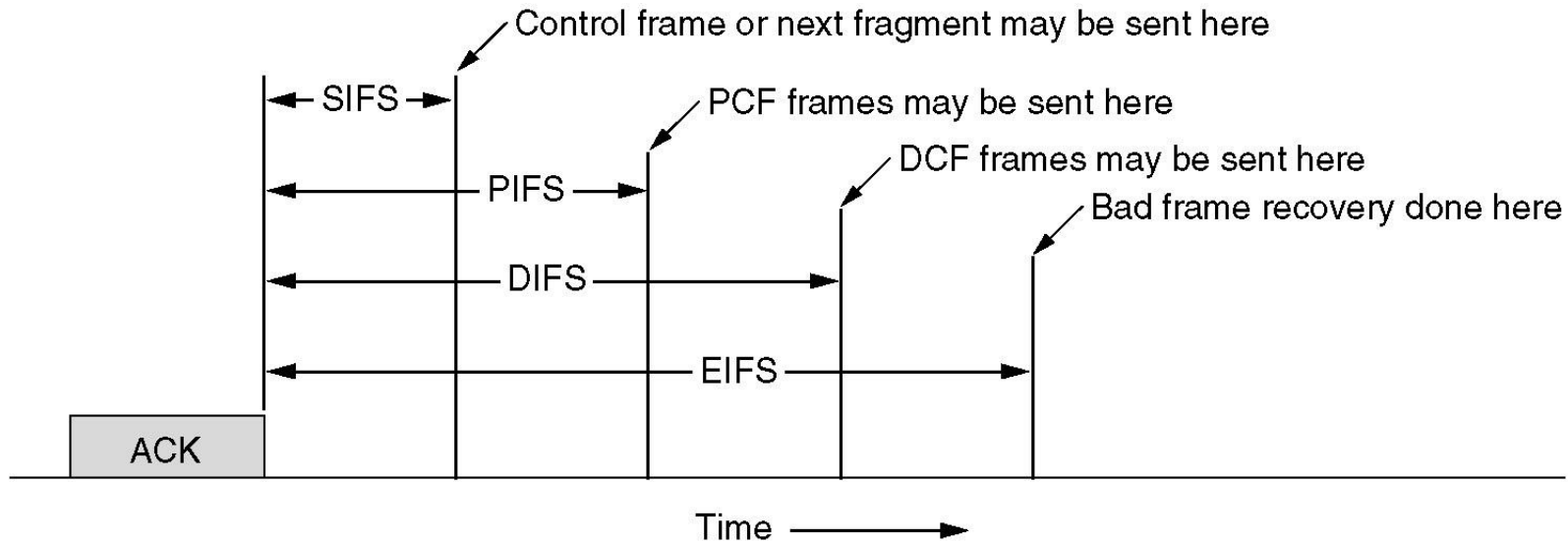
CSMA/CA

- CSMA

- CA: collision avoidance
  - if idle for DIFS, transmit
  - if busy, random back-off
    - count down when idle
    - transmit when count to 0
  - if no ack, collision or corruption
    - exponential backoff
    - CW: contention window

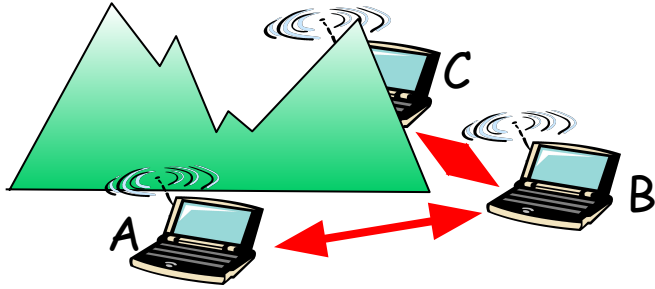# Inter-frame spacing

- SIFS: control frames or fragments
- DIFS: DCF frames

Control frame or next fragment may be sent here

SIFS

PCF frames may be sent here

PIFS

DCF frames may be sent here

DIFS

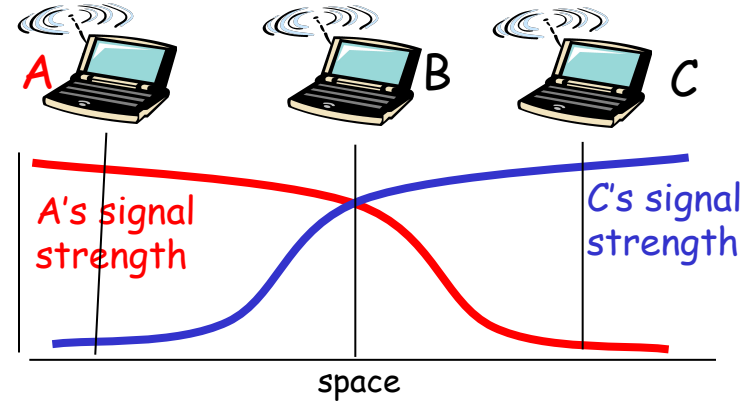Bad frame recovery done here

EIFS

ACK

Time

Hidden terminal problems

Hidden terminal problem

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

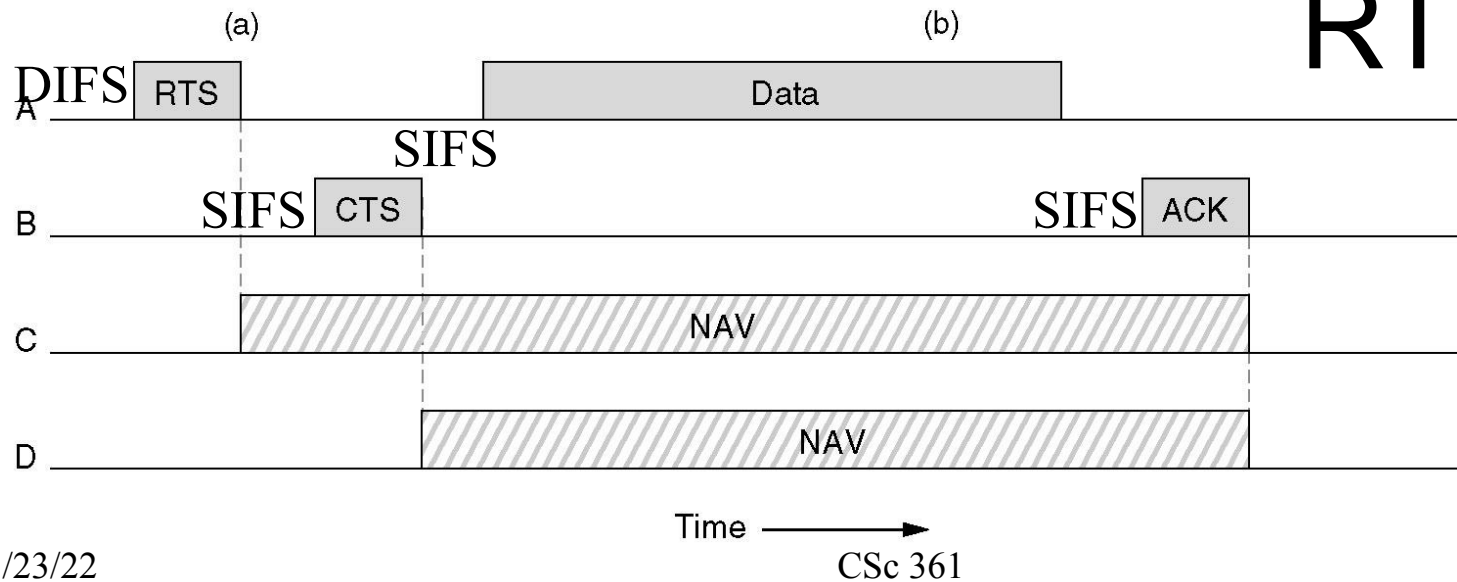means A, C unaware of their interference at B

Signal fading:

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

A wants to send to B but cannot hear that B is busy

Range of C's radio

A   B   C

C is transmitting

B wants to send to C but mistakenly thinks the transmission will fail

Range of A's radio

D   A   B   C

A is transmitting

Hidden vs exposed terminal

to D

RTS/CTS

(a)   (b)

DIFS | RTS | | Data |
A

SIFS

SIFS | CTS | SIFS | ACK |
B

C | NAV |

D | NAV |

Time →

* check whether RTS/CTS can improve your WiFi performance at home
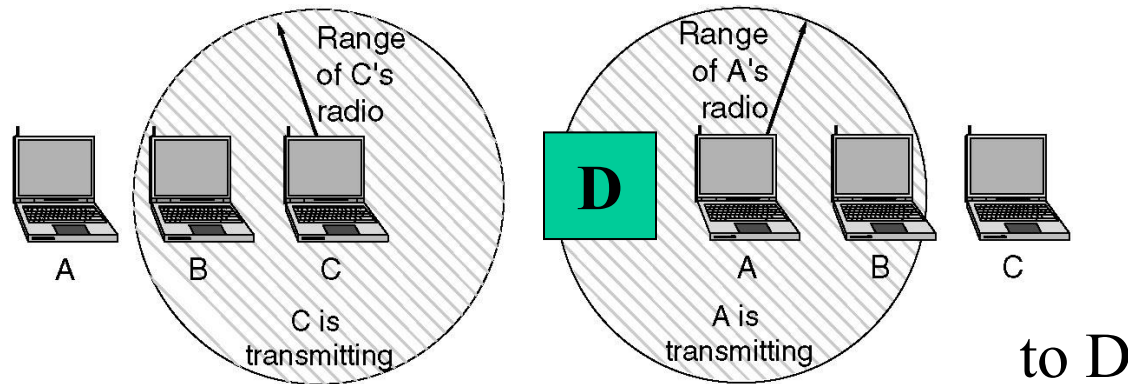
802.11 frame

- Frame control
- Duration: NAV (network allocation vector)
- Addresses: dst, src, receiving, transmitting

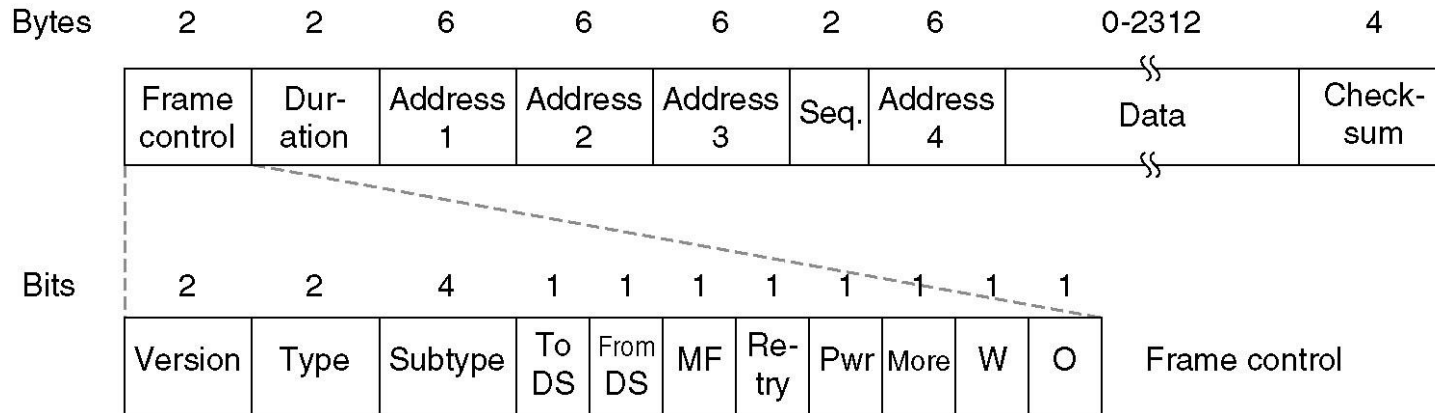| Bytes	2	2	6	6	6	2	6	0-2312	4
	Frame control	Dur-ation	Address 1	Address 2	Address 3	Seq.	Address 4	Data	Check-sum

Bits	2	2	4	1	1	1	1	1	1	1	1	
	Version	Type	Subtype	To DS	From DS	MF	Re-try	Pwr	More	W	O	Frame control

W: WEP'ed? O: ordered?

802.11 frame: addressing

Internet

router

R1

H1

AP

	R1 MAC addr	AP MAC addr	
	dest. address	source address	

802.**3** frame

	AP MAC addr	H1 MAC addr	R1 MAC addr	
	address 1	address 2	address 3	

802.**11** frame
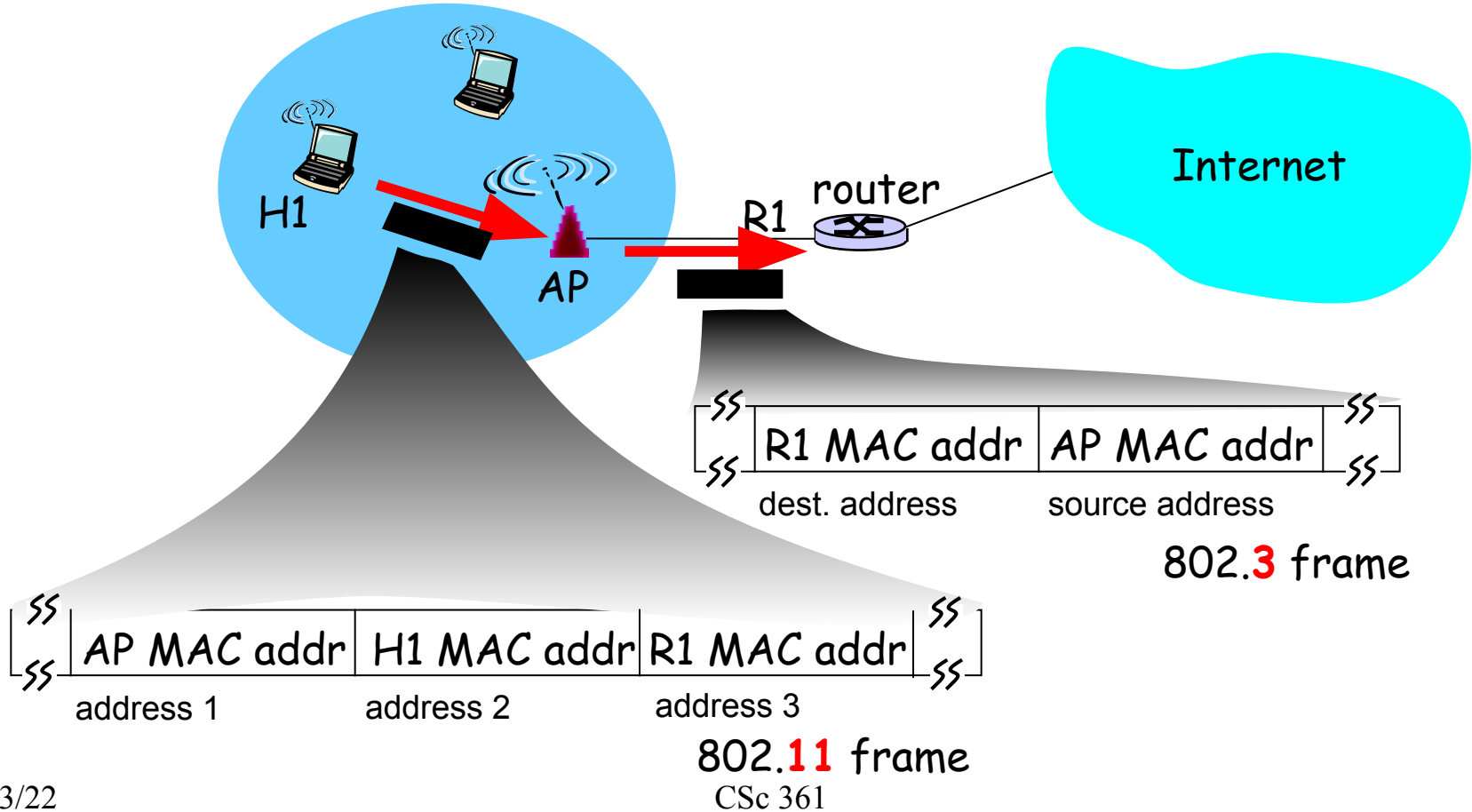
This lecture

- Wireless LAN
  - CSMA/CA
    - why not CSMA/CD
  - RTS/CTS
    - hidden vs exposed terminal
  - IEEE 802.11 family
    - 802.11a/b/g/n/ac/ax
- Explore further
  - CSC463: Wireless and Mobile Networks

Next few lectures

- **This Friday (Nov 25) 9:30am and 1:30pm**
  - Interworking: put all things together
  - M2 review
- **Next Tues&Wed (Nov 29&30) 9:30am**
  - Tutorial 10: ARP
    - Extra P3 help
- **Next Friday (Dec 2) 9:30am**
  - Term review; M3 hints
- **Following Tuesday (Dec 6) 9:30am: M3**