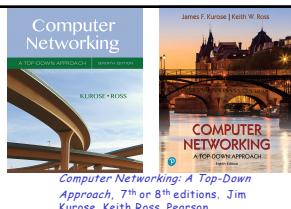


## CS 655 Computer Networks

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### Chapter 7 Wireless and Mobile Networks



6: Wireless and Mobile Networks 6-1

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### Challenges

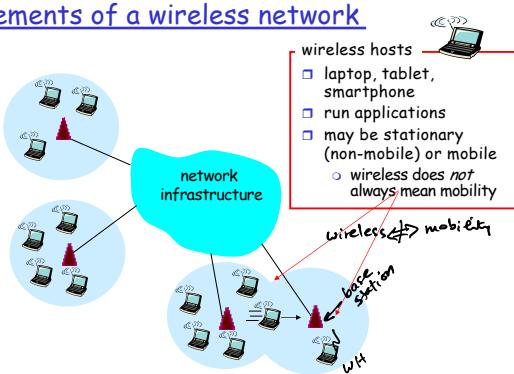
- r Higher BER (Bit Error Rate) over wireless link
  - m more susceptible to attenuation, noise
  - m usually link-level ARQ employed
- r Wireless devices (laptops, tablets, smartphones) can be mobile
  - m change point of attachment to network
  - m how to keep communication going?



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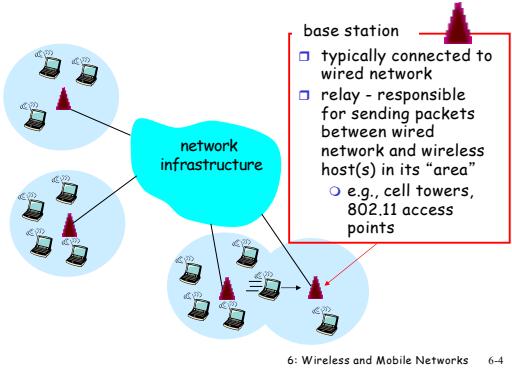
### Elements of a wireless network



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3

### Elements of a wireless network



4

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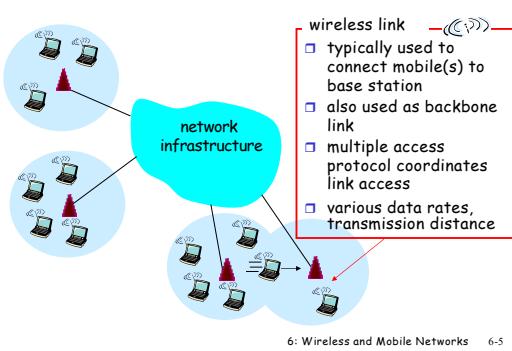
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### Elements of a wireless network



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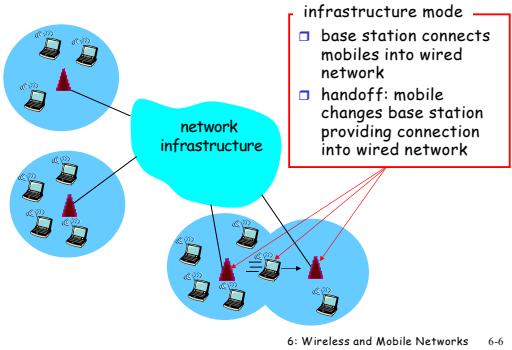
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### Elements of a wireless network



6

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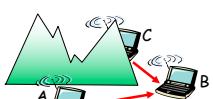
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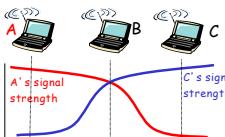
## Wireless network characteristics

Multiple wireless senders and receivers create additional problems (beyond multiple access):



### 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**



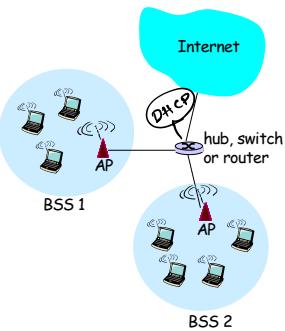
### Signal fading:

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

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## 802.11 LAN (Wi-Fi) architecture



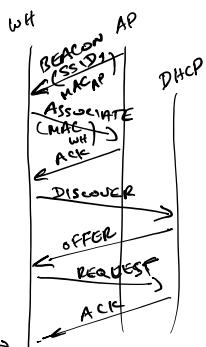
- wireless host communicates with base station
  - base station = access point (AP)
- Basic Service Set (BSS) (aka "cell") contains:
  - wireless hosts
  - access point (AP)

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## 802.11 association

- host must **associate** with an AP
  - listens for beacon frames containing AP's name (SSID: Service Set ID) and MAC address
  - selects AP to associate with
  - will typically run DHCP to get IP address in AP's subnet

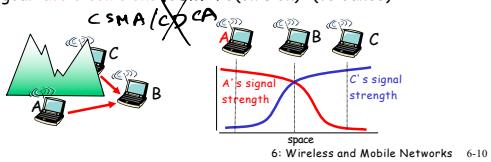


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## IEEE 802.11: multiple access

- avoid collisions: 2<sup>o</sup> nodes transmitting at same time
- CSMA - sense before transmitting
  - don't collide with ongoing transmission by other node
- no collision detection!
  - difficult to receive (sense collisions) while 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)



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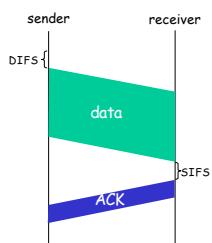
## IEEE 802.11 MAC Protocol: CSMA/CA

### 802.11 sender

- 1 if sense channel idle for **DIFS** then  
transmit entire frame (no CD)
- 2 if sense channel busy then
  - 2.1 start random backoff time  
timer counts down while channel idle  
transmit when timer expires
- 3 if no ACK, increase random backoff interval, repeat 2.1
- 4 if ACK and more to send, go to 2.1

### 802.11 receiver

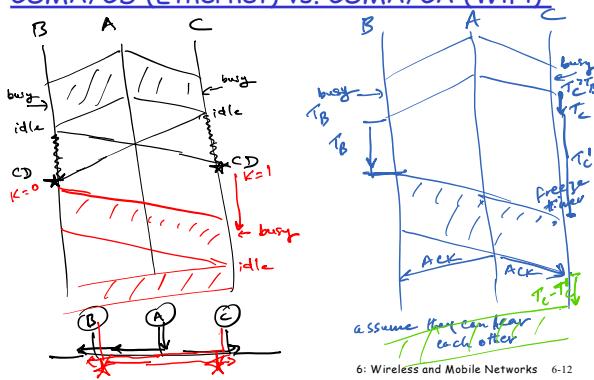
- if frame received OK  
return ACK after **SIFS** (ACK needed due to hidden terminal problem)



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## CSMA/CD (Ethernet) vs. CSMA/CA (WiFi)



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## Avoiding collisions (more)

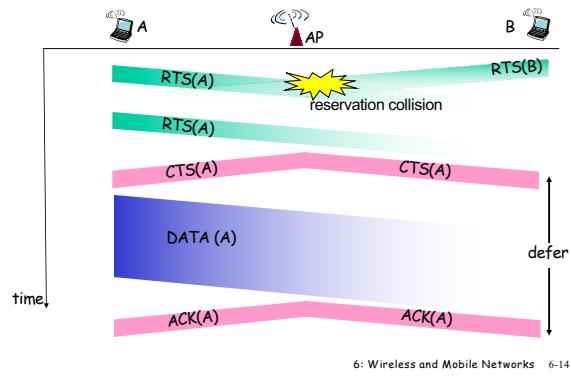
- idea:* allow sender to “reserve” channel rather than random access: avoid collisions of long data frames
- sender first transmits *small* request-to-send (RTS) packets to AP using CSMA
    - RTSs may still collide with each other (but they’re short)
  - BS broadcasts clear-to-send CTS in response to RTS
  - CTS heard by all nodes
    - sender transmits data frame
    - other stations defer transmissions

Avoid data frame collisions completely using small reservation packets!

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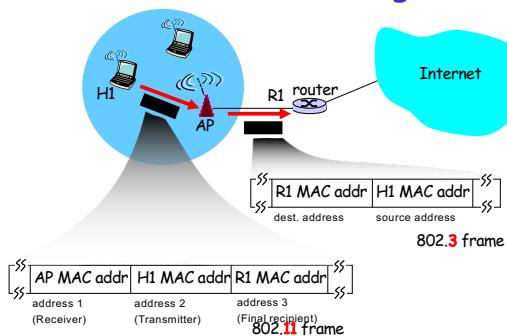
## Collision Avoidance: RTS-CTS exchange



6: Wireless and Mobile Networks 6-14

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## 802.11 frame: addressing

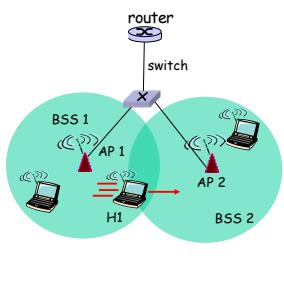


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## 802.11: mobility within same subnet

- H1 remains in same IP subnet: IP address can remain same
- switch: which AP is associated with H1?
  - self-learning (Ch. 6): switch will see frame from H1 and "remember" which switch port can be used to reach H1
- During handoff, some frames might get lost



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