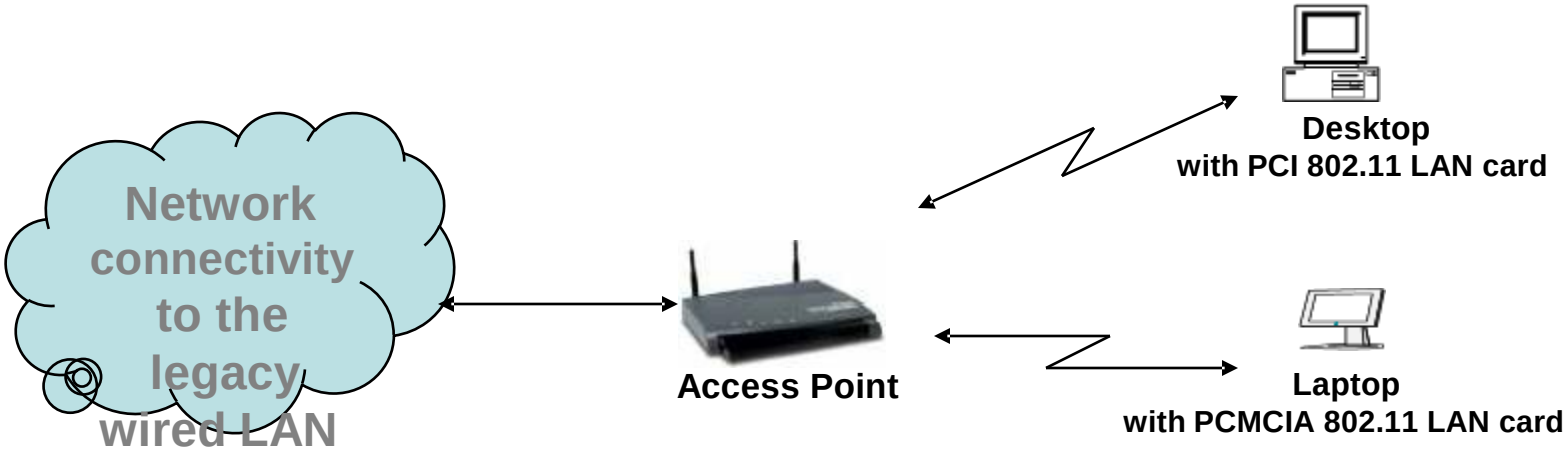
# 802.11 Wireless LAN

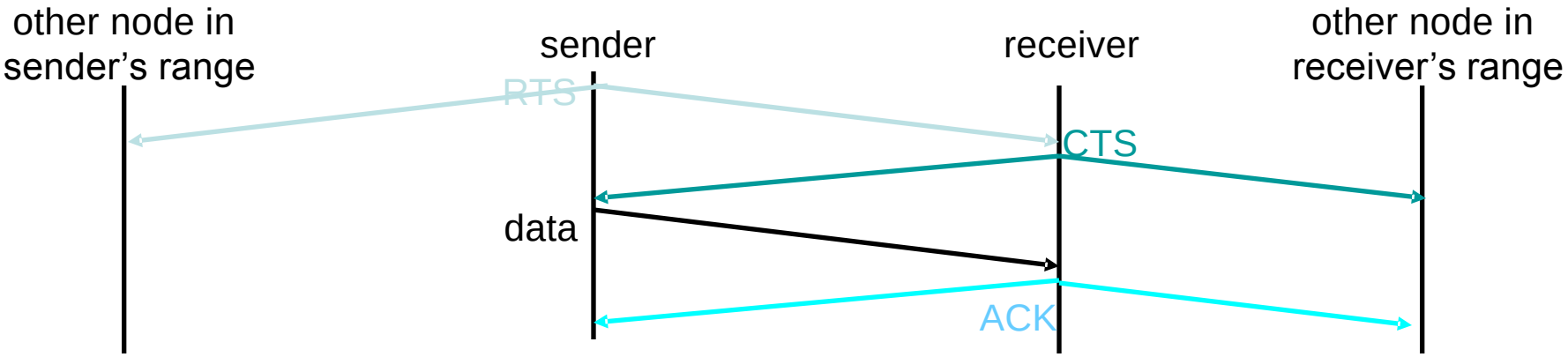



- Provides network connectivity over wireless media
- An Access Point (AP) is installed to act as Bridge between Wireless and Wired Network
- The AP is connected to wired network and is equipped with antennae to provide wireless connectivity

# 802.11 Wireless LAN

- Range ( Distance between Access Point and WLAN client) depends on structural hindrances and RF gain of the antenna at the Access Point
- To service larger areas, multiple APs may be installed with a 20-30% overlap
- A client is always associated with one AP and when the client moves closer to another AP, it associates with the new AP (Hand-Off)
- Three flavors:
  - 802.11b
  - 802.11a
  - 802.11g

# Multiple Access with Collision Avoidance (MACA)




- **Before every data transmission**
  - Sender sends a Request to Send (RTS) frame containing the length of the transmission
  - Receiver respond with a Clear to Send (CTS) frame
  - Sender sends data
  - Receiver sends an ACK; now another sender can send data
- **When sender doesn't get a CTS back, it assumes collision**

# WLAN : 802.11b

- The most popular 802.11 standard currently in deployment.
- Supports 1, 2, 5.5 and 11 Mbps data rates in the 2.4 GHz ISM (Industrial-Scientific-Medical) band

# WLAN : 802.11a

- Operates in the 5 GHz UNII (Unlicensed National Information Infrastructure) band
- Incompatible with devices operating in 2.4GHz
- Supports Data rates up to 54 Mbps.

# WLAN : 802.11g

- Supports data rates as high as 54 Mbps on the 2.4 GHz band
- Provides backward compatibility with 802.11b equipment

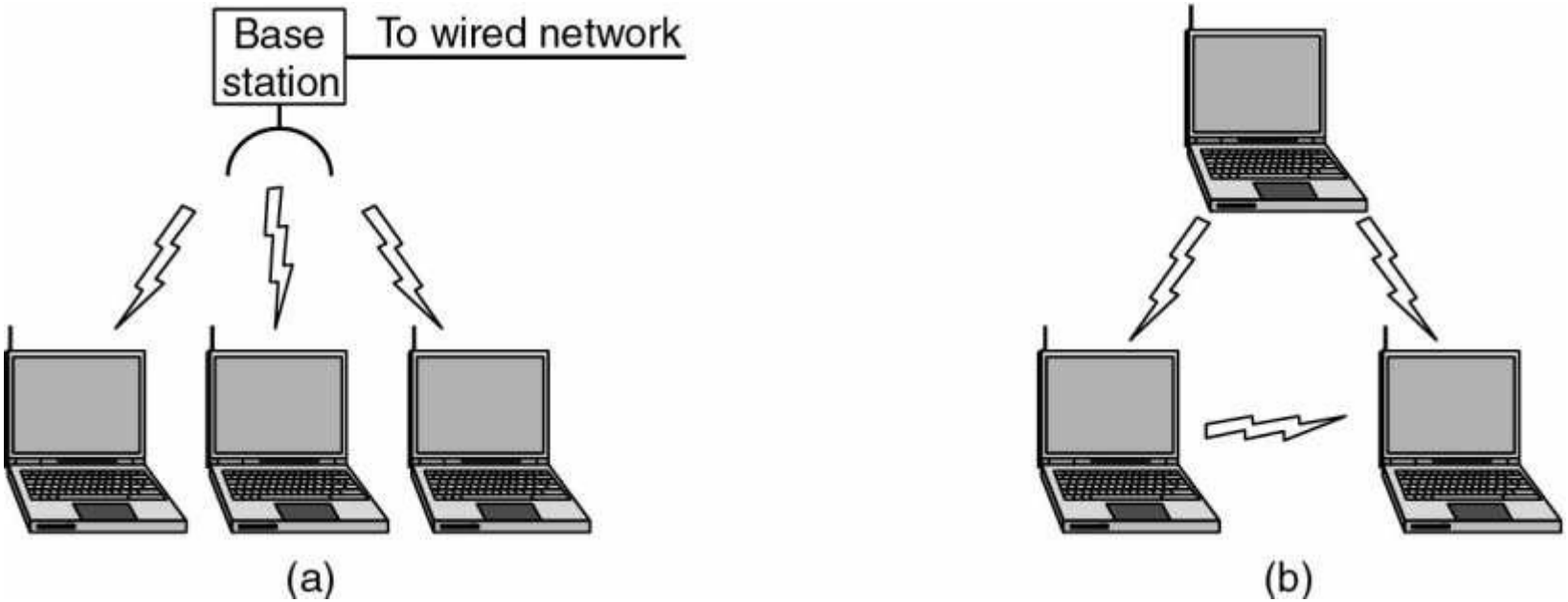
# IEEE 802 Standards Working Groups

| Number | Topic |
|---|---|
| 802.1 | Overview and architecture of LANs |
| 802.2 ↓ | Logical link control |
| 802.3 * | Ethernet |
| 802.4 ↓ | Token bus (was briefly used in manufacturing plants) |
| 802.5 | Token ring (IBM's entry into the LAN world) |
| 802.6 ↓ | Dual queue dual bus (early metropolitan area network) |
| 802.7 ↓ | Technical advisory group on broadband technologies |
| 802.8 † | Technical advisory group on fiber optic technologies |
| 802.9 ↓ | Isochronous LANs (for real-time applications) |
| 802.10 ↓ | Virtual LANs and security |
| 802.11 * | Wireless LANs |
| 802.12 ↓ | Demand priority (Hewlett-Packard's AnyLAN) |
| 802.13 | Unlucky number. Nobody wanted it |
| 802.14 ↓ | Cable modems (defunct: an industry consortium got there first) |
| 802.15 * | Personal area networks (Bluetooth) |
| 802.16 * | Broadband wireless |
| 802.17 | Resilient packet ring |

# Categories of Wireless Networks

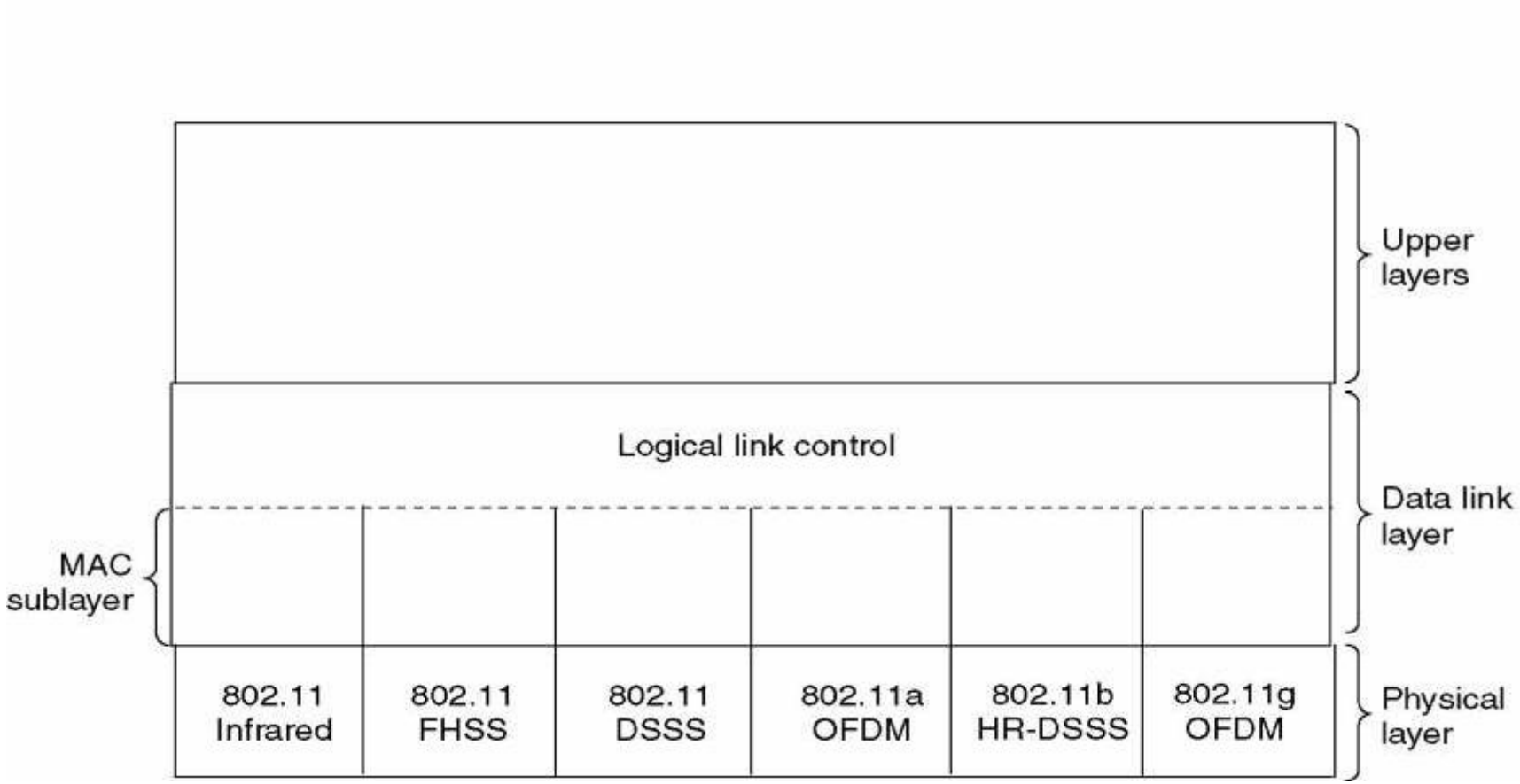
- ***Base Station*** **:: all communication through an *access point*. Other nodes can be fixed or mobile.**
- ***Infrastructure Wireless*** **:: base station network is connected to the wired Internet.**
- ***Ad hoc Wireless*** **:: wireless nodes communicate directly with one another.**
- ***MANETs*** **(Mobile Ad Hoc Networks) :: ad hoc nodes are mobile.**

# Wireless LANs




.(a) Wireless networking with a base station. (b) Ad hoc networking.

# The 802.11 Protocol Stack




Part of the 802.11 protocol stack.

# Wireless Physical Layer

- **802.11 *Infrared***
  - Two capacities 1 Mbps or 2 Mbps.
  - Range is 10 to 20 meters and cannot penetrate walls.
  - Does not work outdoors.
- **802.11 *FHSS* (*Frequence Hopping Spread Spectrum*)**
  - **The main issue is multipath fading.**
  - 79 non-overlapping channels, each 1 Mhz wide at low end of 2.4 GHz ISM band.
  - Same pseudo-random number generator used by all stations.
  - Dwell time: min. time on channel before hopping (400msec).

# Wireless Physical Layer

- **802.11 *DSSS* (*Direct Sequence Spread Spectrum*)**
  - Spreads signal over entire spectrum using pseudo-random sequence (similar to CDMA see Tanenbaum sec. 2.6.2).
  - Each bit transmitted using an 11 chips Barker sequence, PSK at 1Mbaud.
  - 1 or 2 Mbps.
- **802.11a *OFDM* (Orthogonal Frequency Divisional Multiplexing)**
  - Compatible with European HiperLan2.
  - 54Mbps in wider 5.5 GHz band ➔ transmission range is limited.
  - Uses 52 FDM channels (48 for data; 4 for synchronization).
  - Encoding is complex ( PSM up to 18 Mbps and QAM above this capacity).
  - E.g., at 54Mbps 216 data bits encoded into into 288-bit symbols.
  - More difficulty penetrating walls.

# Wireless Physical Layer

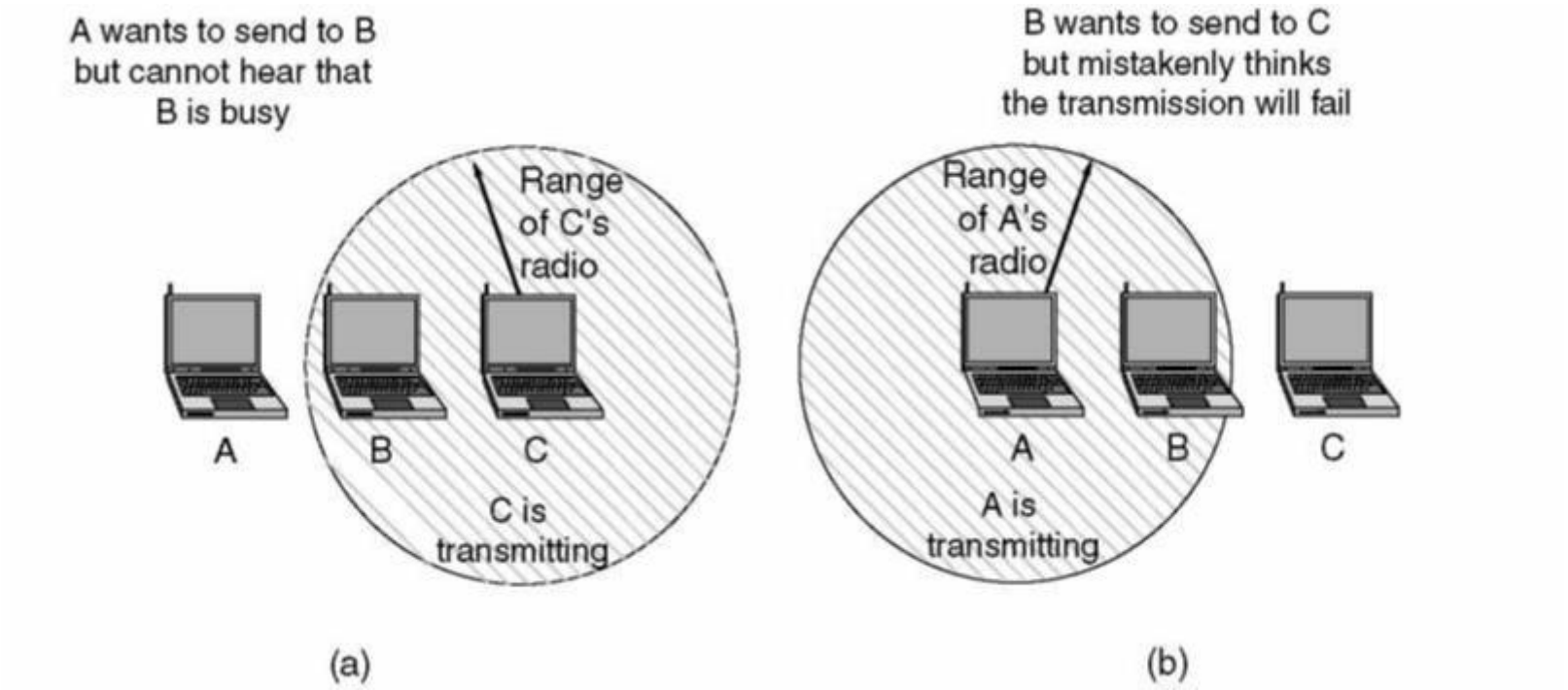
- **802.11b *HR-DSSS* (*High Rate Direct Sequence Spread Spectrum*)**
  - **11a and 11b** *shows a split in the standards committee.*
  - **11b** approved and hit the market before **11a.**
  - Up to 11 Mbps in 2.4 GHz band using 11 million chips/sec.
  - Note in this bandwidth all these protocols have to deal with interference from microwave ovens, cordless phones and garage door openers.
  - Range is 7 times greater than **11a.**
  - **11b and 11a are incompatible!!**

# Wireless Physical Layer

- **802.11g *OFDM*(*Orthogonal Frequency Division Multiplexing*)**
  - **An attempt to combine the best of both 802.11a and 802.11b.**
  - Supports bandwidths up to 54 Mbps.
  - Uses 2.4 GHz frequency for greater range.
  - Is backward compatible with 802.11b.

# 802.11 MAC Sublayer Protocol

- In 802.11 wireless LANs, “seizing channel” does not exist as in 802.3 wired Ethernet.
- Two additional problems:
  - Hidden Terminal Problem
  - Exposed Station Problem
- To deal with these two problems 802.11 supports two modes of operation **DCF (Distributed Coordination Function)** and **PCF (Point Coordination Function).**
- **All implementations must support DCF, but PCF is optional.**



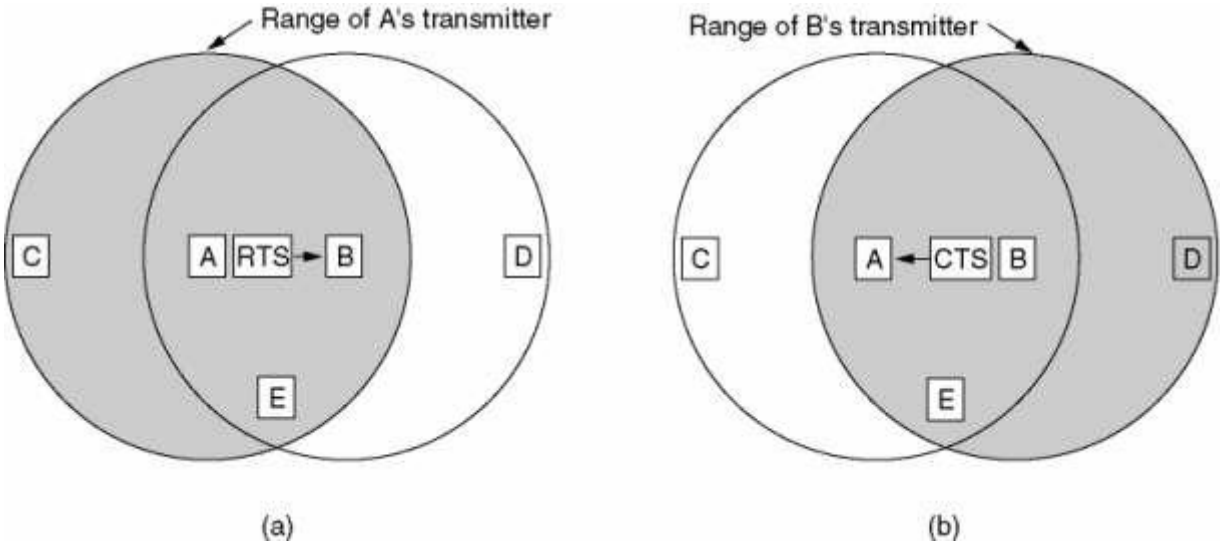

.(a)The hidden station problem. (b) The exposed station problem.

# Wireless LAN Protocols

- MACA protocol solved hidden, exposed terminal:
  - Send Ready-to-Send (*RTS*) and Clear-to-Send (*CTS*) first
  - RTS, CTS helps determine who else is in range or busy (Collision avoidance).
  - Can a collision still occur?

# Wireless LAN Protocols

- MACAW added ACKs and CSMA (no RTS at same time)




(a) A sending an RTS to B.

(b) B responding with a CTS to A.

# 1-Persistent Physical Carrier Sensing

- Station *senses* the channel when it wants to send.
- If idle, station transmits.
  - *Station does not sense channel while transmitting.*
- If the channel is busy, station defers until idle and then transmits.
- Upon collision, wait a *random time* using binary exponential backoff.

# THANK YOU