

Ubiquitous Networks

WLAN



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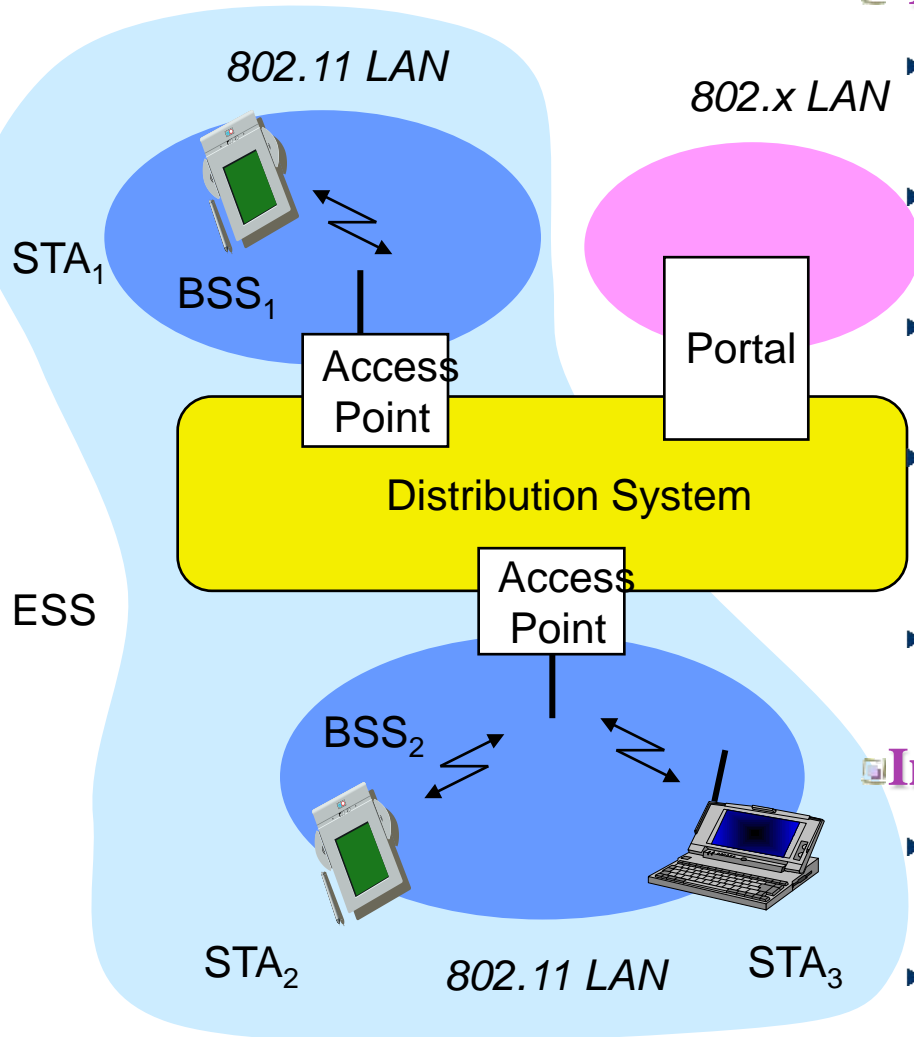


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802.11 - Infrastructure Mode



Terminology

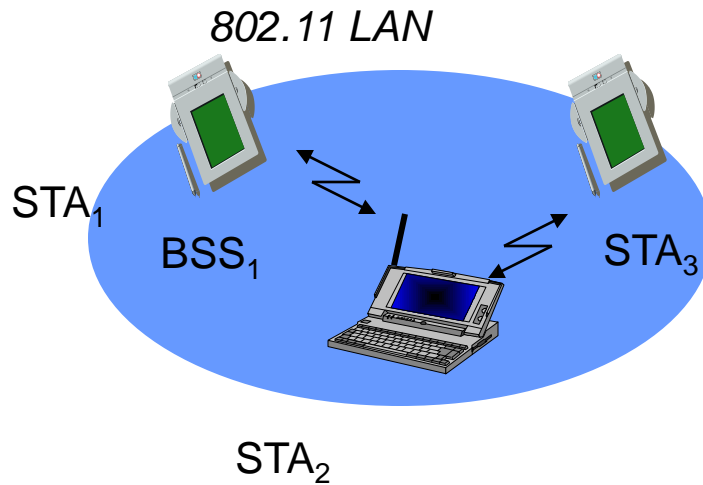
- ▶ Station (STA)
 - ◆ Wireless terminals
- ▶ Basic Service Area (BSA)
 - ◆ Coverage area of one access point
- ▶ Basic Service Set (BSS)
 - ◆ Group of stations controlled by the same AP
- ▶ Distribution System (DS)
 - ◆ Fixed infrastructure used to connect several BSS to create an Extended Service Set (ESS)
- ▶ Portal
 - ◆ Bridge to other (wired) networks

Infrastructure mode

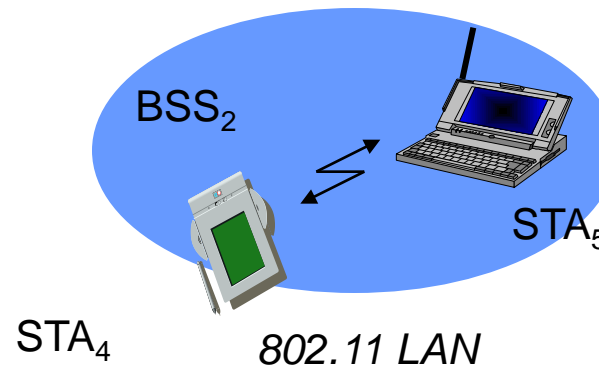
- ▶ Every transmission is with AP
 - ◆ No peer to peer communication
- ▶ Multiple BSSs form an ESS



802.11 – Ad Hoc mode



- Multiple stations and no AP
- Peer to peer communication only
- Independent BSS -> IBSS





Two Coordination Functions

❏ **DCF (Distributed Coordination Function)**

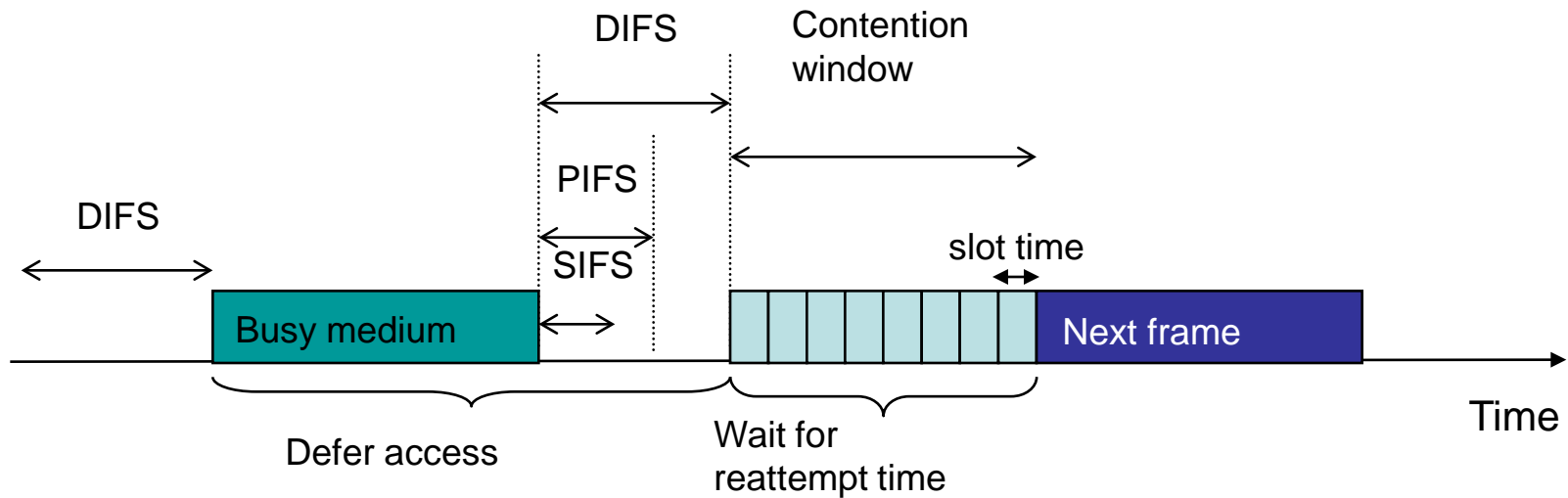
- ▶ *Mandatory function*
- ▶ For both infrastructure mode and ad hoc mode
 - ◆ 99% of WLAN implements DCF only
- ▶ For distributed contention-based channel access

❏ **PCF (Point Coordination Function)**

- ▶ *Optional*
- ▶ For infrastructure mode only
- ▶ For centralized contention-free channel access
 - ◆ Polling-based
 - ◆ Seldom-used



Distributed Coordination Function (DCF)



Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)

- ▶ Contention-based: all stations contend for access to medium
- ▶ Stations wait as long as channel is busy
- ▶ When channel becomes idle,
 - ◆ All stations must wait *Interframe Space (IFS)*
 - ✦ SIFS (Short IFS), PIFS (PCF IFS), DIFS (DCF IFS)
 - ◆ Use random backoff to avoid collision

	Slot Time	SIFS	PIFS	DIFS
802.11a	9 usec	16 usec	25 usec	34 usec
802.11b	20 usec	10 usec	30 usec	50 usec



CSMA (Carrier Sense Multiple Access)

❏ ALOHA

- ▶ Transmit whenever they have data.
- ▶ On a collision, wait a random amount of time and retransmit
- ▶ Pure ALOHA, slotted ALOHA

❏ CSMA

- ▶ Listen before transmit
 - ◆ If channel sensed idle, transmit entire frame
 - ◆ If channel sensed busy, defer transmission
- ▶ Don't interrupt others!



CSMA (Carrier Sense Multiple Access)

CSMA/CA (Collision Avoidance)

- ▶ Transmit after a random backoff even if an idle channel is detected
- ▶ A variation of this called CSMA-CA is used in WLAN

CSMA-CD

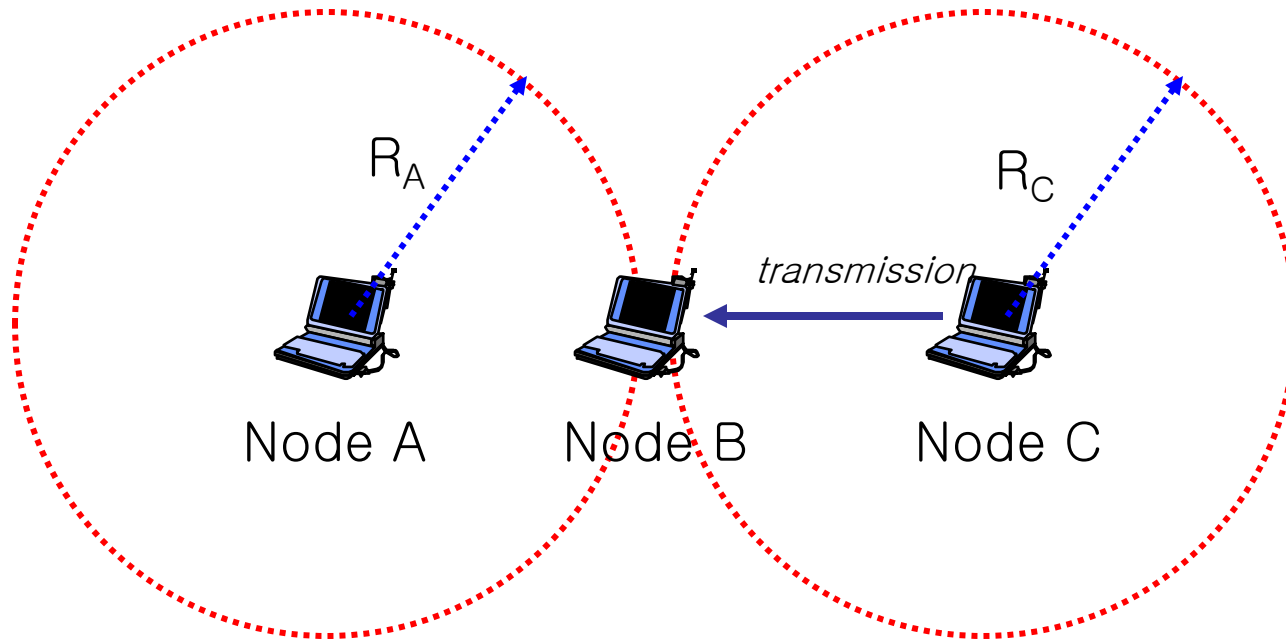
- ▶ Abort transmission as soon as they detect a collision
- ▶ Used in Ethernet (802.3)

Exponential backoff

- ▶ Backoff counter is randomly selected from $[0, CW]$, where CW is contention window
- ▶ For each unsuccessful transmission, CW doubles to reduce the collision probability



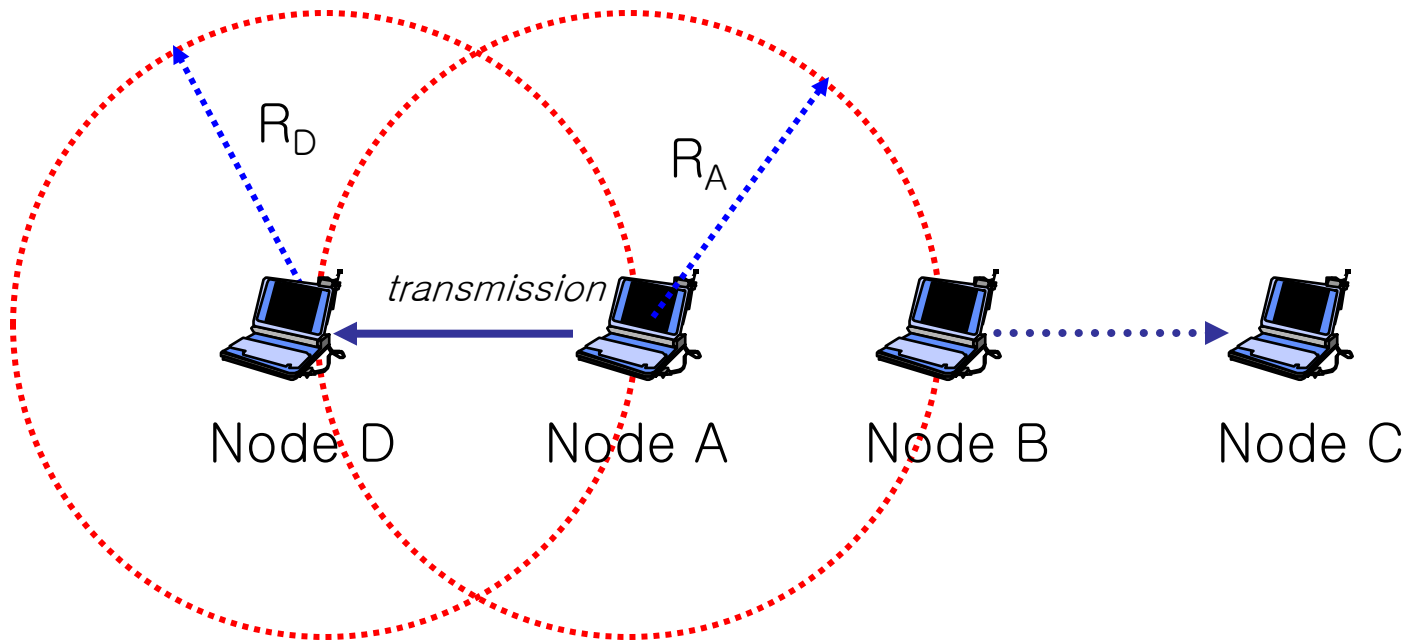
Hidden Terminal Problem



- Node A is not aware that node B is currently busy receiving from node C, and therefore may start its own transmission, causing a collision.



Exposed Node Problem

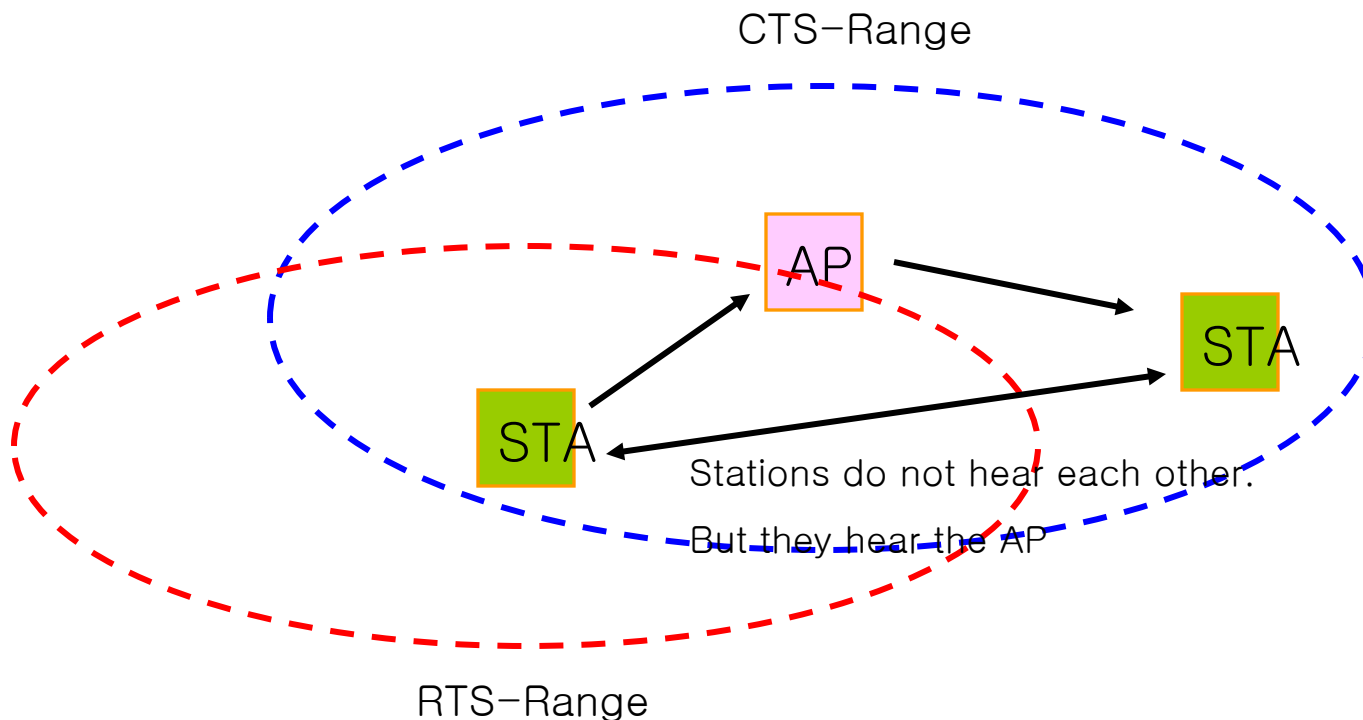


- Node B wants to transmit to node C but mistakenly thinks that this will interfere with A's transmission to D, so B refrains from transmitting (loss in efficiency).



RTS-CTS Exchange

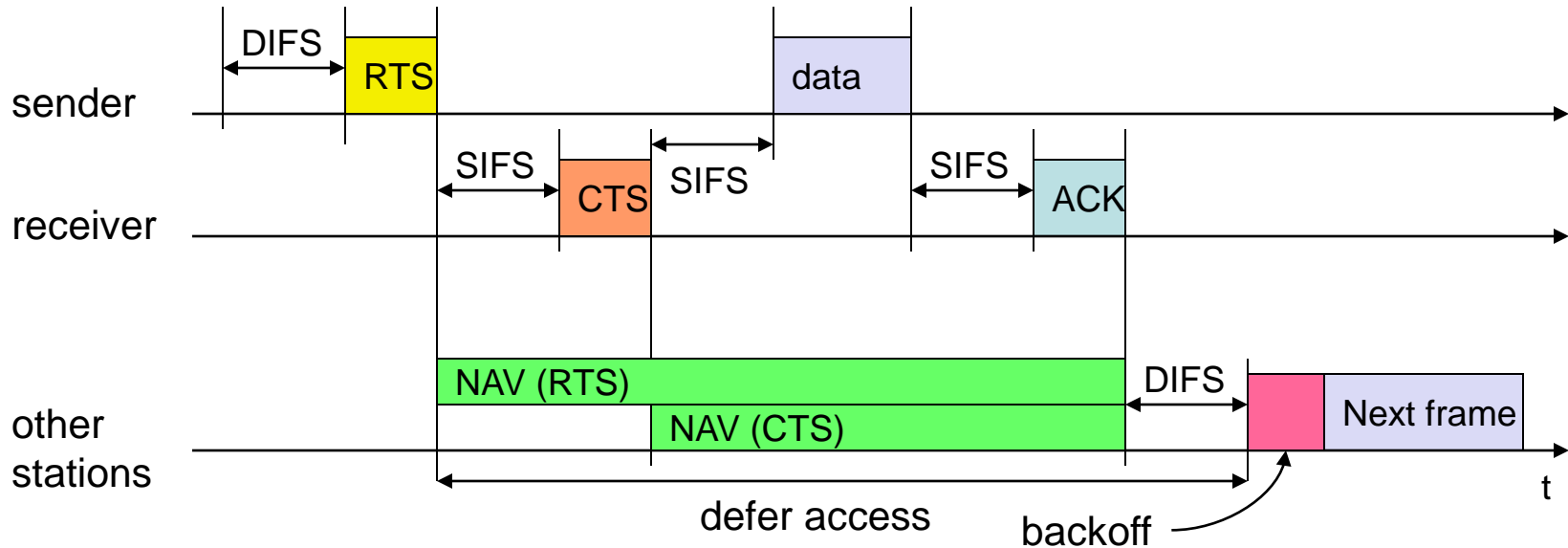
- A way to handle hidden terminal problem
 - RTS (Request to Send) / CTS (Clear to Send) to reserve medium
 - Work with virtual carrier sensing





Net Allocation Vector

This is called Virtual Carrier Sensing..



The RTS packet has a duration field, which consists of information about the length of data packet.

Other stations hear the RTS packet set their NAV accordingly.

The CTS packet also has the duration field.

Other stations hear the CTS packet set their NAV accordingly.



PHY Evolution History



11b

- ▶ Published in 1999, market introduction in 1999
- ▶ WLAN became popular due to 11b
- ▶ Up to 11Mbps (unregulated 2.4GHz band)



11a

- ▶ Published in 1999, market introduction in 2002
- ▶ Never have been popular
- ▶ Up to 54Mbps (OFDM-based) by using (5GHz band)



11g

- ▶ Published in 2003 (OFDM-based) to combine the best of 11a & 11b
- ▶ Market introduction in 2003
- ▶ Emerging as a dominating form
- ▶ Backward compatible with 11b
- ▶ Up to 54Mbps by using 2.4GHz band



11n

- ▶ Published in October 2009 (OFDM-based) to combine the best of 11a, 11b & 11g
- ▶ Add MIMO and 40MHz channel (compared to 20MHz channels in 802.11b) to the physical layer and frame aggregation to the MAC layer
- ▶ High data rate (54~600Mbps by using 2.4GHz band and lesser used 5GHz band)
- ▶ Backward compatible with 11g