

CS 725/825 & IT 725

Lecture 25

Link Layer

December 6, 2023

Wireless Networks

- ▶ Radio Frequency (RF) transmission
 - Omnidirectional (broadcast and select)
 - Point to point (directional antennas)
- ▶ Organization
 - WLAN
 - Cellular networks (LTE, 5G, 6G ...)
 - Personal area networks / home automation / Internet of Things (Thread/Matter) ...
 - Access network

Wireless Networks

▶ Free Space Optical Networks

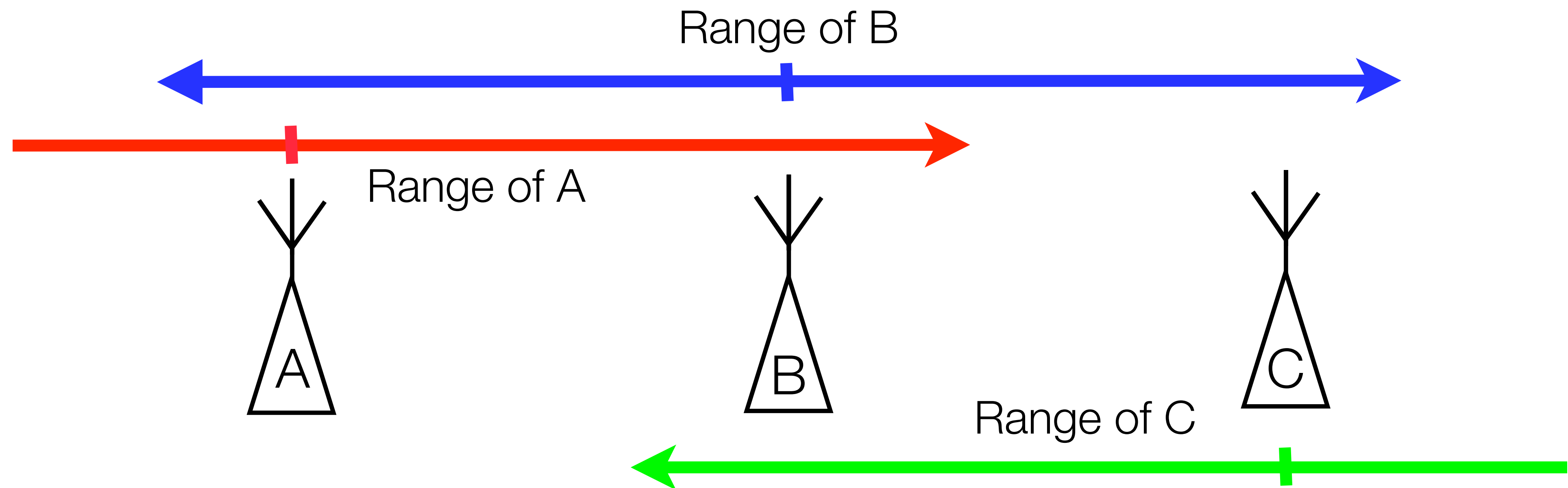
- point to point laser links
- HPC interconnects

▶ Acoustic Networks

- underwater communication

Wireless Link Layer

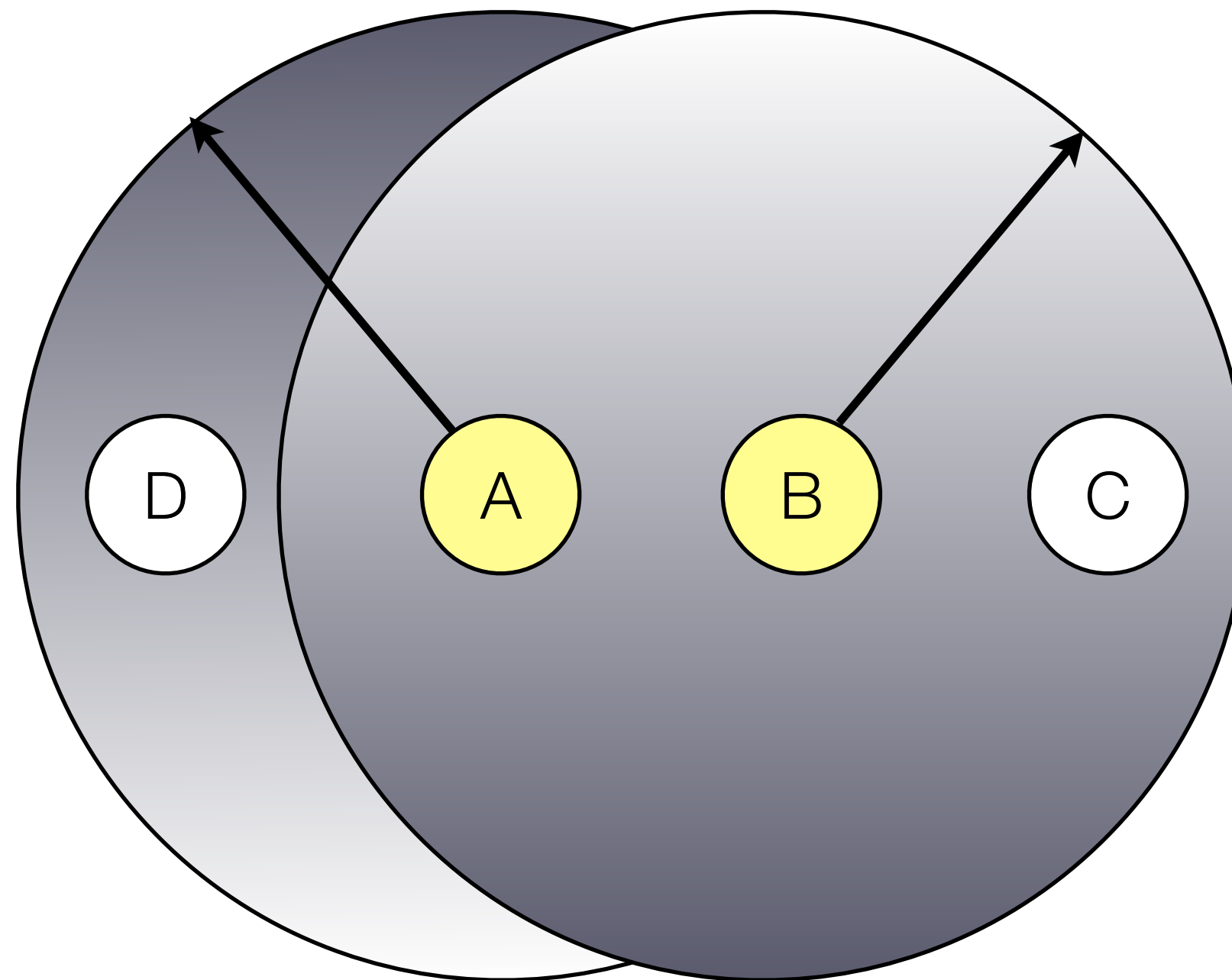
► Hidden Terminal Problem



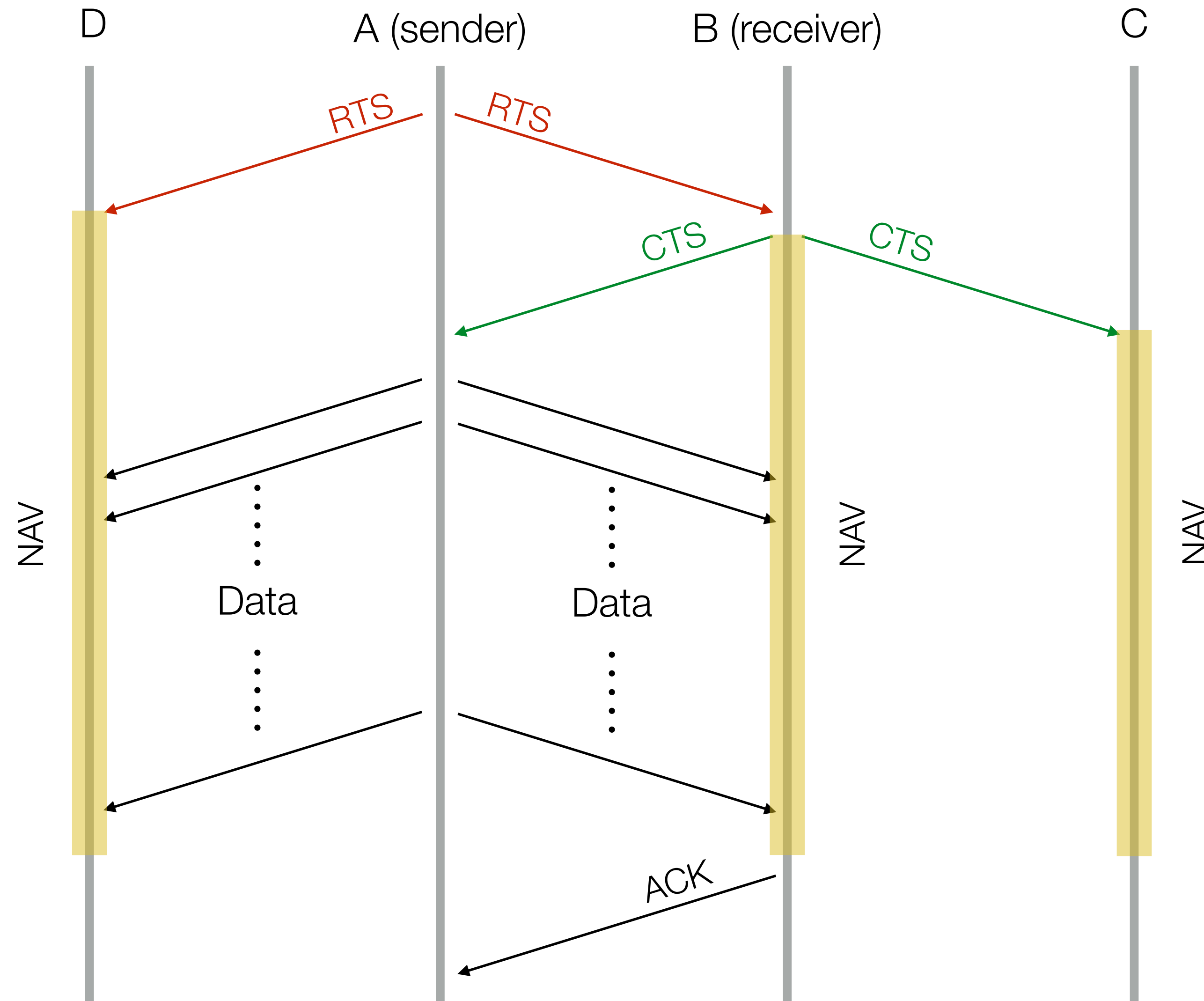
Solution: CSMA/CA

► Collision Avoidance (CA)

- make sure that all nodes in the ranges of both source and destination are allowed to transmit



CSMA/CA



RTS - request to send
CTS - clear to send
NAV - node cannot send

IEEE 802.11 (WiFi)

- ▶ IEEE 802.11: a, b, g, n, ac, ax, be ...
- ▶ 2.4, 5, 6 GHz bands

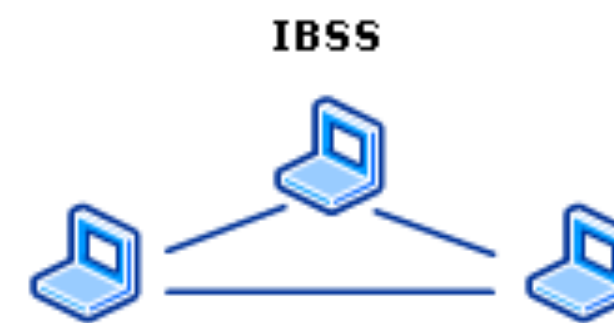
Protocol*	Generational name	Release	Bands(s) (GHz)
IEEE 802.11n	WiFi 4	2009	2.4/5
IEEE 802.11ac	WiFi 5	2013	5
IEEE 802.11ax	WiFi 6	2019	2.4/5
IEEE 802.11ax	WiFi 6E	2020	2.4/5/6
IEEE 802.11be	WiFi 7	2024 ?	2.4/5/6

(*) Early versions (a, b, and g) omitted

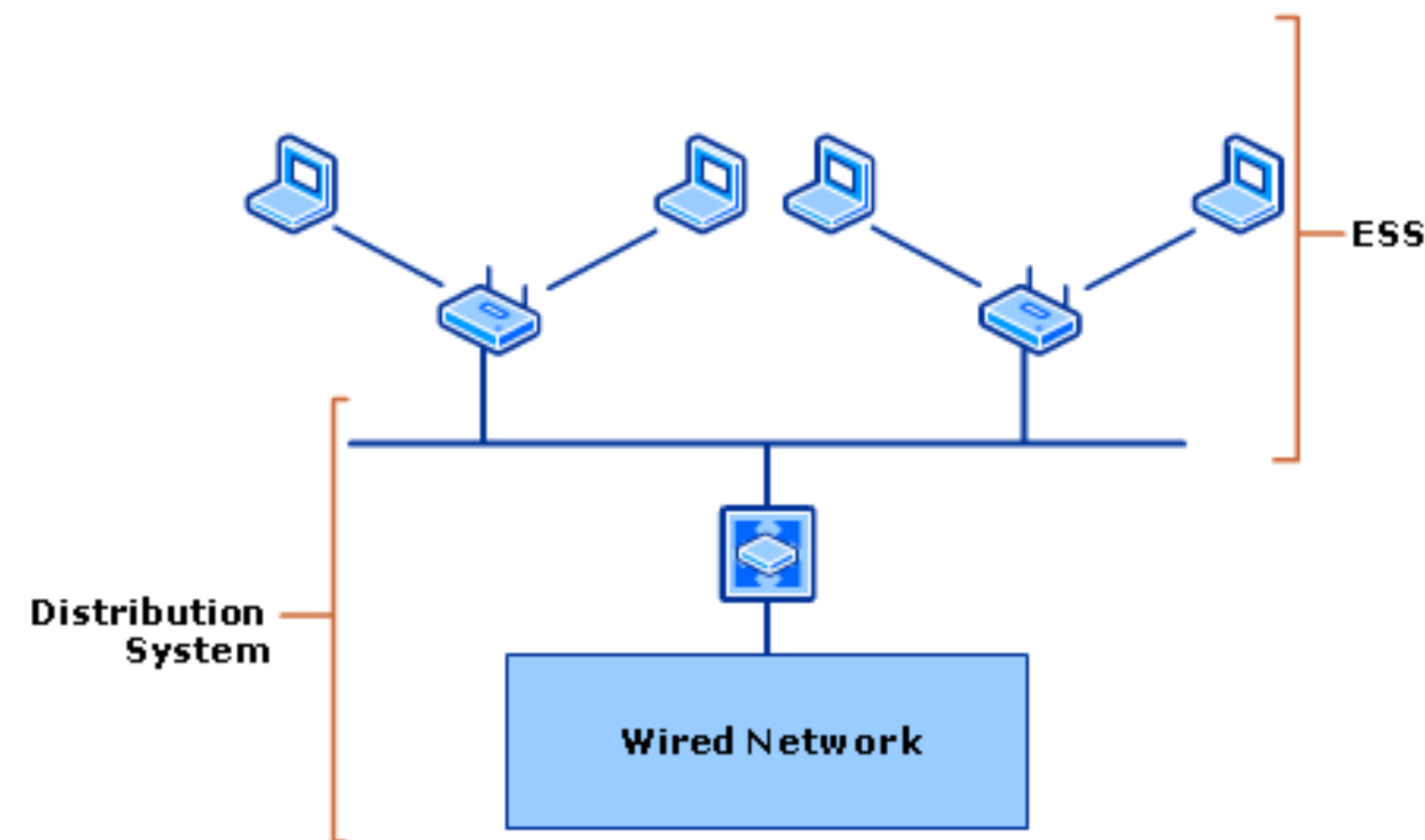
IEEE 802.11 (WiFi)

► Modes of operation:

- ad hoc mode



- infrastructure mode



IEEE 802.11 Terminology

- ▶ station (STA)
- ▶ wireless access point (AP)
- ▶ basic service set (BSS)
- ▶ independent basic service set (IBSS)
- ▶ distribution system (DS)
- ▶ extended service set (ESS)

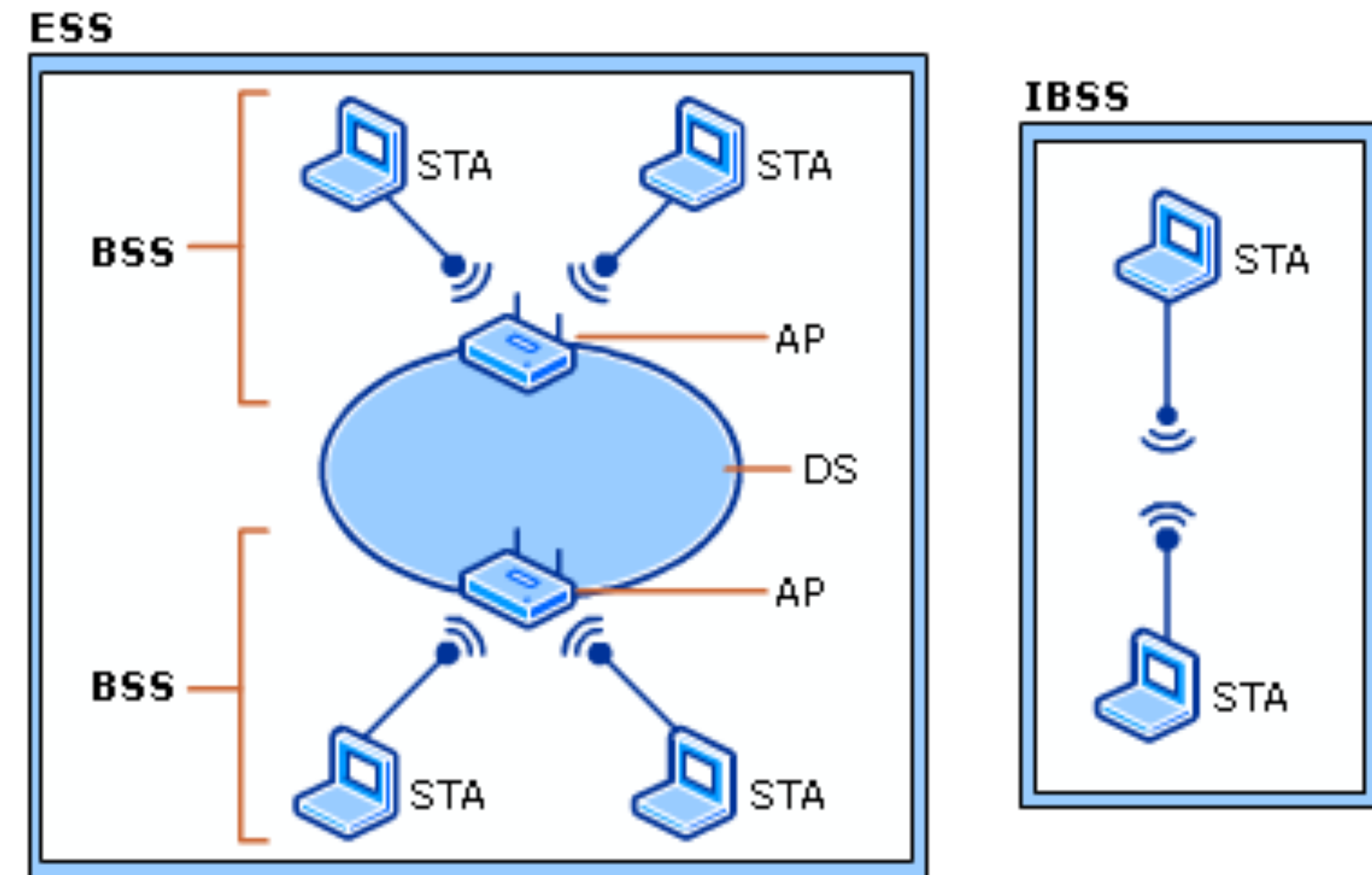
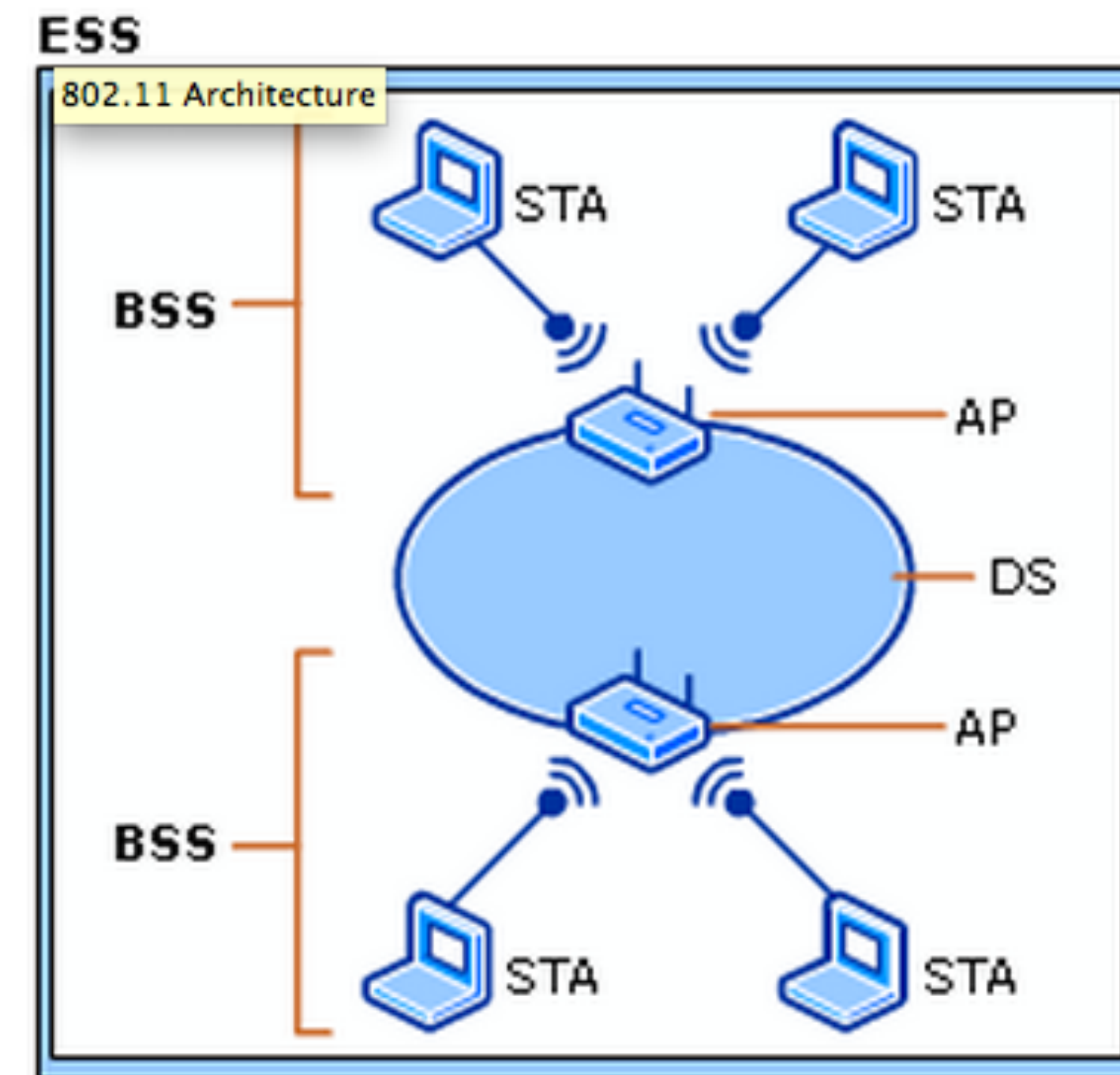
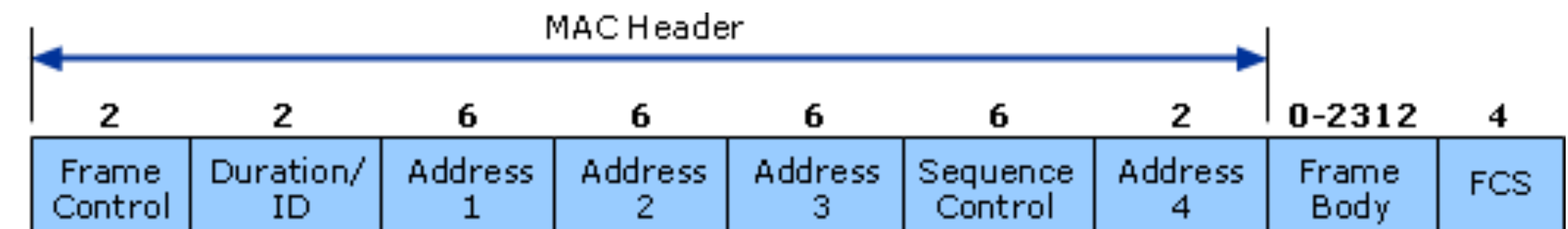


Image source: <http://technet.microsoft.com/en-us/library/cc757419.aspx>

IEEE 802.11 Frame Format

- **Destination Address (DA)**: final destination to receive the frame.
- **Source Address (SA)**: the original source that initially transmitted the frame.
- **Receiver Address (RA)**: next immediate STA on the wireless medium to receive the frame
- **Transmitter Address (TA)**: STA that transmitted the frame onto the wireless medium



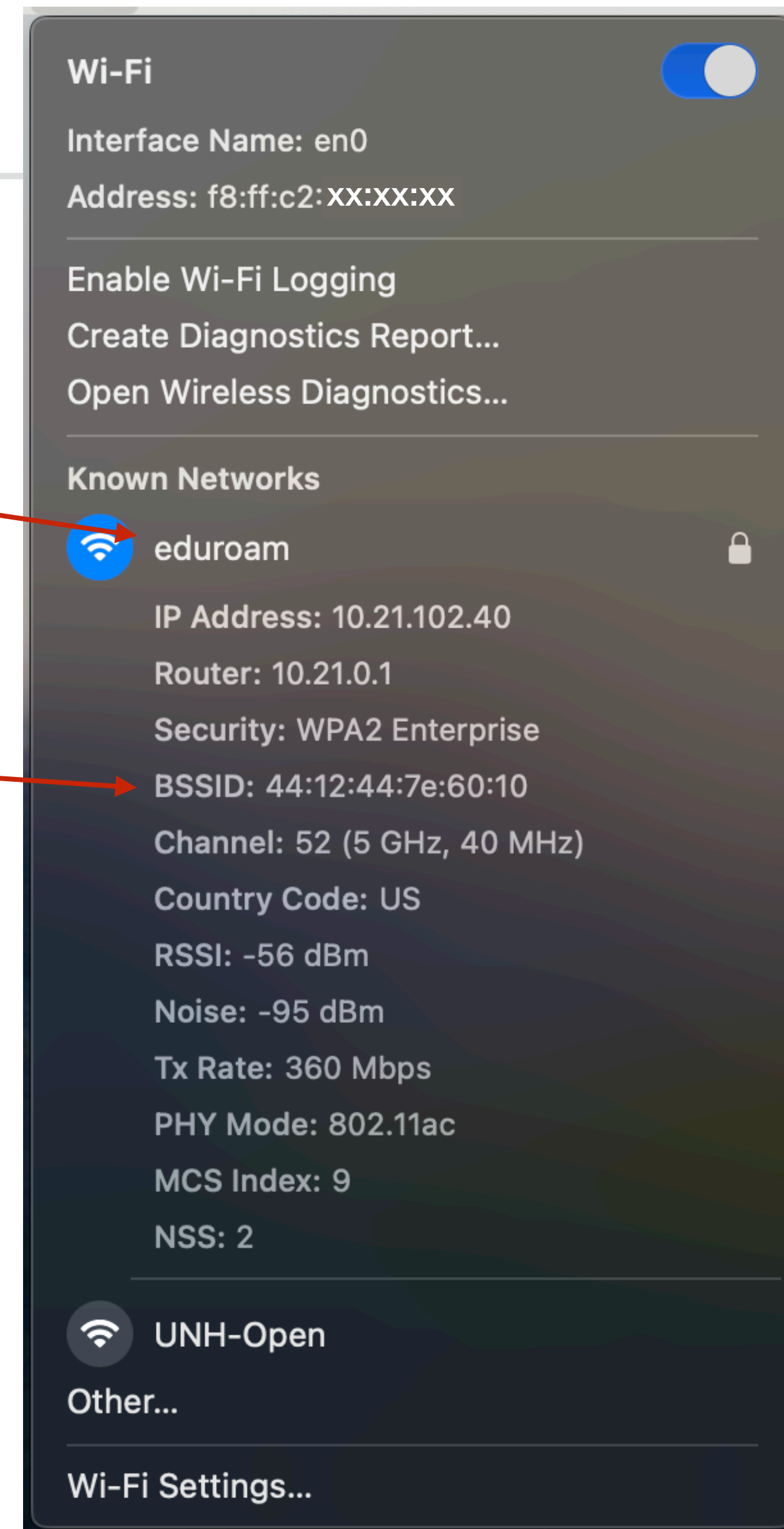
SSID vs BSSID

► SSID

- string identifier of a WLAN

► BSSID

- MAC of a specific access point on the WLAN



WiFi Addresses

Table 4-2. Use of the address fields in data frames

Function	ToDS	FromDS	Address 1 (receiver)	Address 2 (transmitter)	Address 3	Address 4
IBSS	0	0	DA	SA	BSSID	Not used
To AP (infra.)	1	0	BSSID	SA	DA	Not used
From AP (infra.)	0	1	DA	BSSID	SA	Not used
WDS (bridge)	1	1	RA	TA	DA	SA

Table and image source: Matthew S. Gast, 802.11 Wireless Networks: The Definitive Guide, 2nd Edition, <https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html>

