

CS 725/825 & IT 725

Lecture 25

**Link Layer**

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December 4, 2024

# IEEE 802.11 (WiFi)

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- ▶ 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

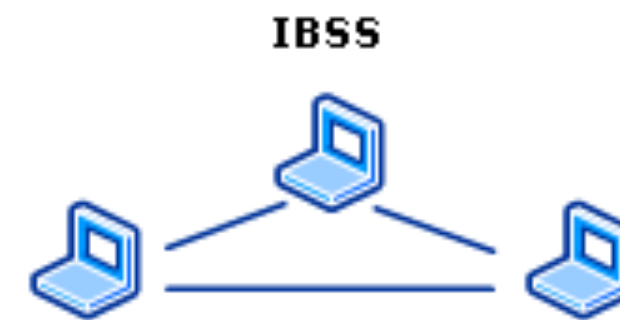
(\*) Early versions (a, b, and g) omitted

# IEEE 802.11 (WiFi)

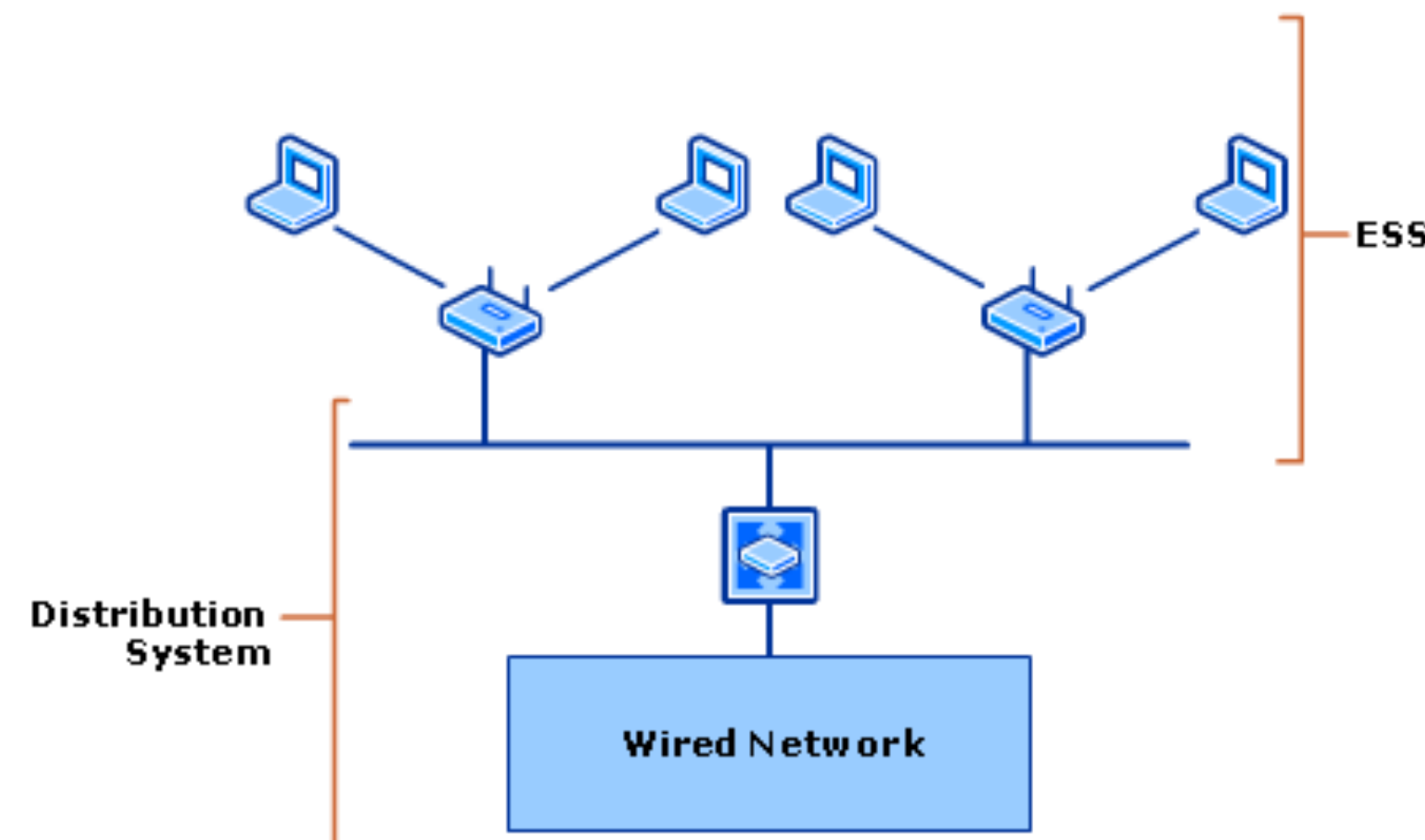
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► Modes of operation:

– 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)

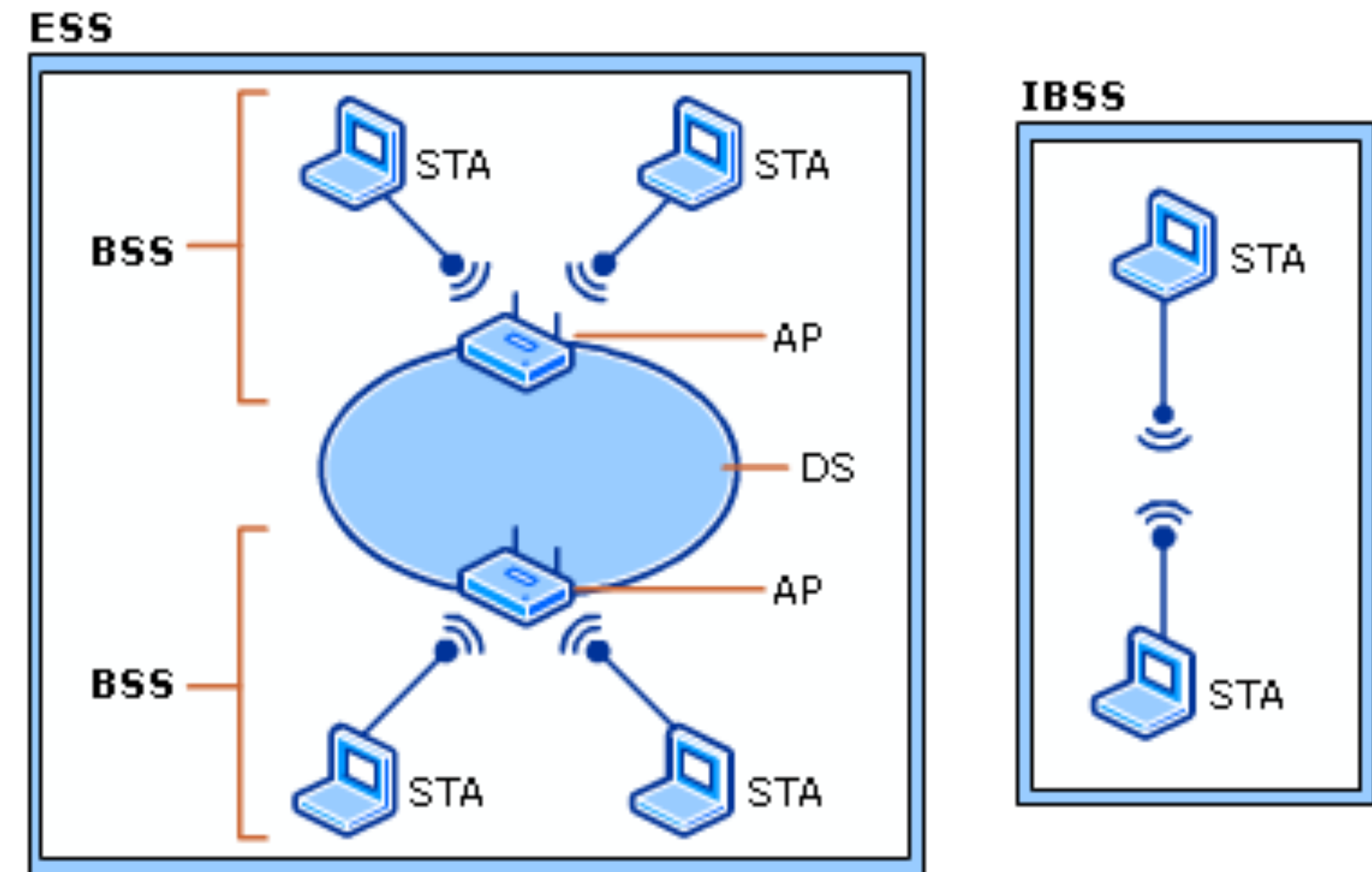
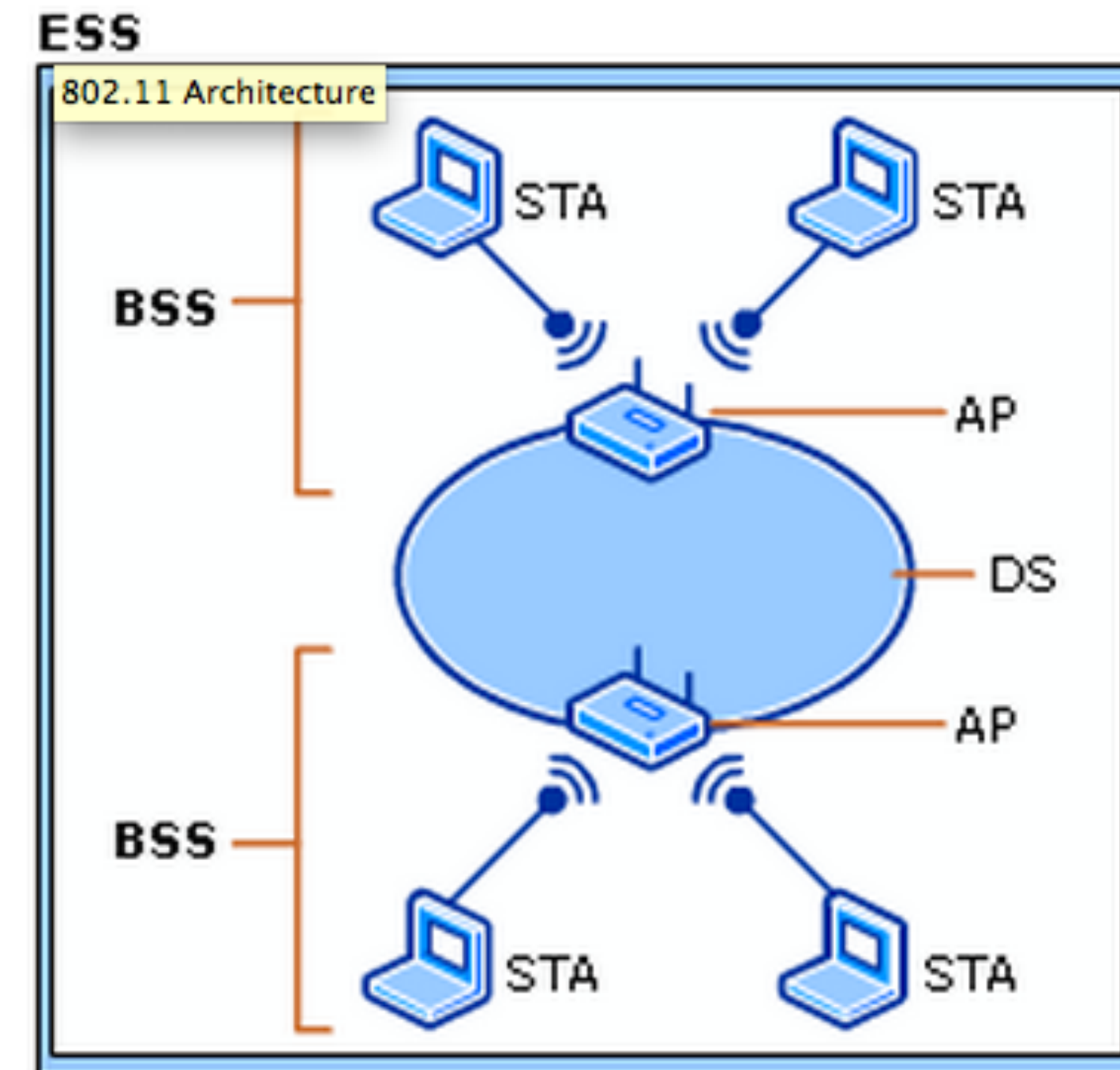
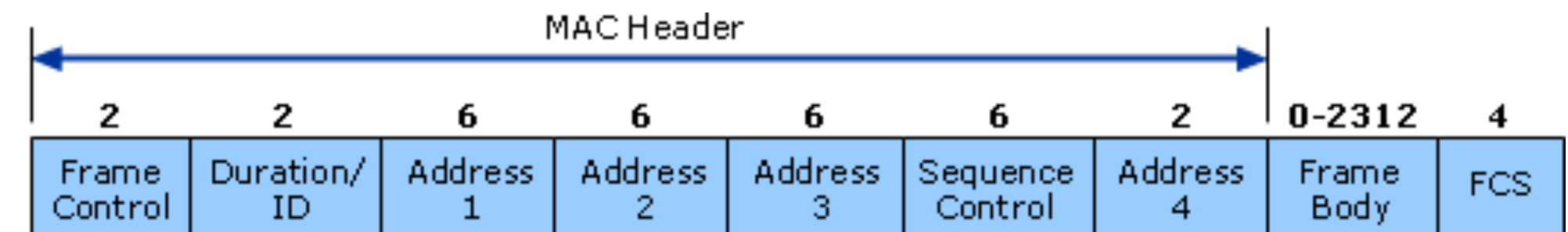


Image source: <http://technet.microsoft.com/en-us/library/cc757419.aspx>

# 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



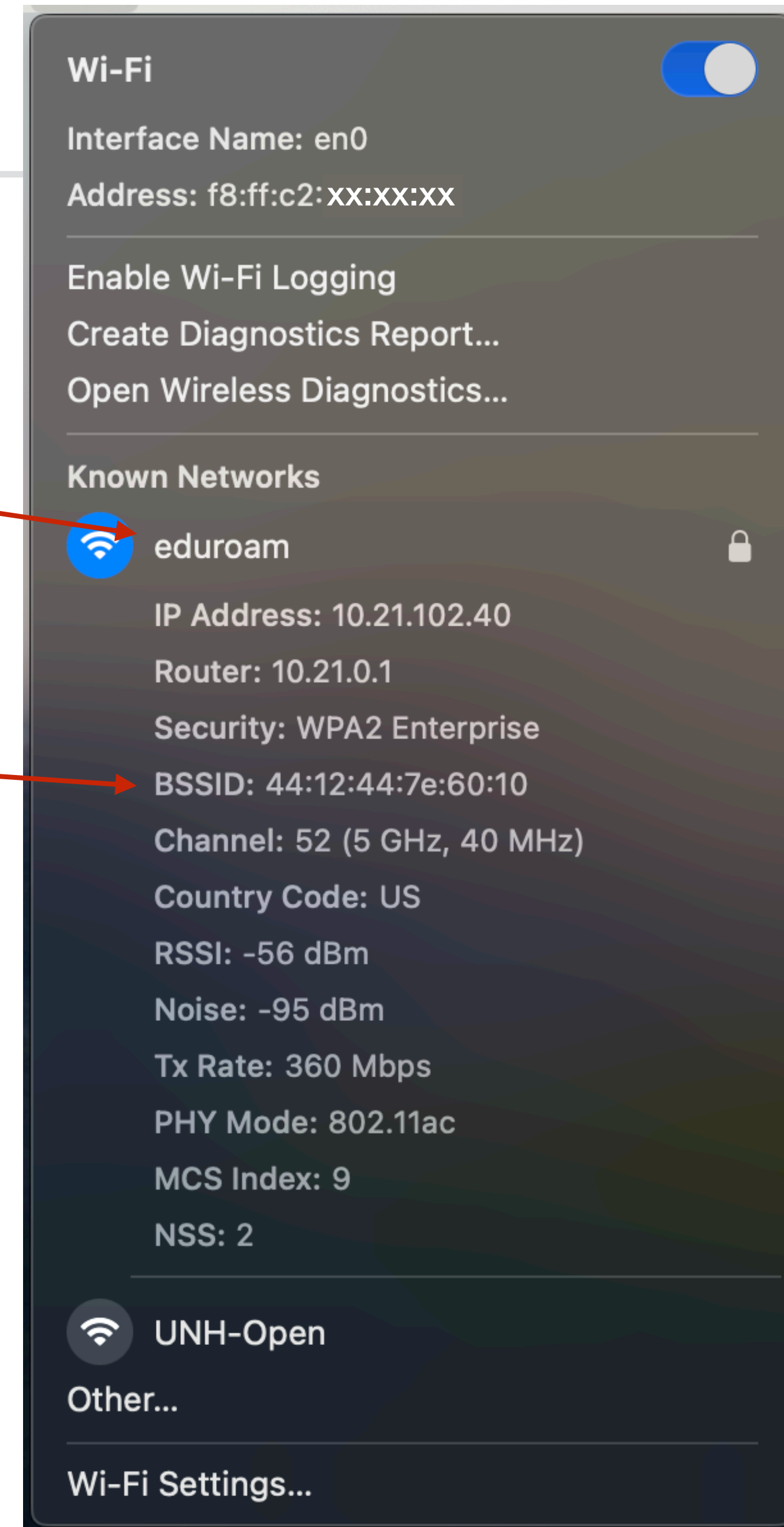
# SSID vs BSSID

## ▶ SSID

- string identifier of a WLAN

## ▶ BSSID

- MAC of a specific access point on the WLAN

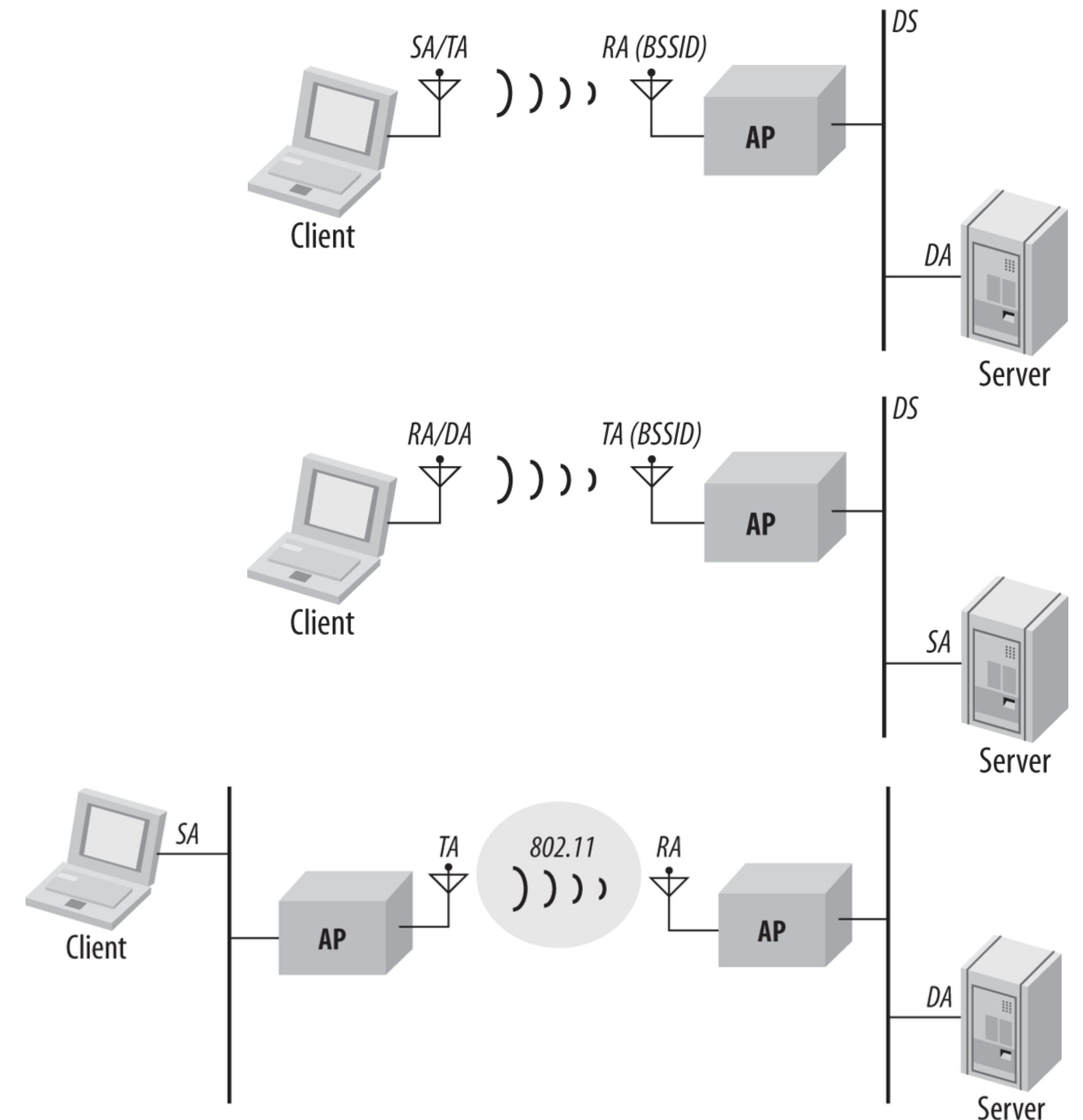


# WiFi Addresses

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>



# Multicasting

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- ▶ **Media** delivery
  - IPTV
- ▶ **Data** distribution
  - streamed data (e.g., stock market)
  - multicasted files (file distribution in CDNs)
- ▶ **Management and discovery**
  - Bonjour, mDNS
  - “All routers” multicast address



# Multicasting

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- ▶ Delivery to multiple destinations...
  - potentially from multiple sources
- ▶ Objective
  - reduce the number of link transitions
- ▶ Alternative approaches
  - repeated unicast
  - flood and filter
- ▶ L2 and L3 multicast

# Multicast Considerations

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- ▶ Reliable vs unreliable
- ▶ Static vs dynamic group membership
  - membership churn
- ▶ Permanent vs transient multicast groups
  - group churn
- ▶ Sparse vs dense groups
- ▶ Concentrated vs distributed members
- ▶ Amount of data

# Multicast Addressing

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## ▶ In general

- list of destinations, multicast group id, “implicit”, ...

## ▶ In practice

- IPv4: 224.0.0.0 to 239.255.255.255, i.e., IP addresses starting with (1110)<sub>2</sub>; remaining 28 bits\* form the multicast group id
- IPv6: FF::, anything starting with 8 ones; remaining 120 bits\* form the multicast group id
- MAC
  - IPv4 01:00:5E:00:00:00 to 01:00:5E:7F:FF:FF, multicast group id is 23 bits
  - IPv6 33:33:00:00:00:00 to 33:33:FF:FF:FF:FF, multicast group id is 32 bits

\* It is a bit more complicated but for now it is close enough

# Two Problems

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- ▶ L3 and L2 multicast

