IEEE 802.11

Outcomes

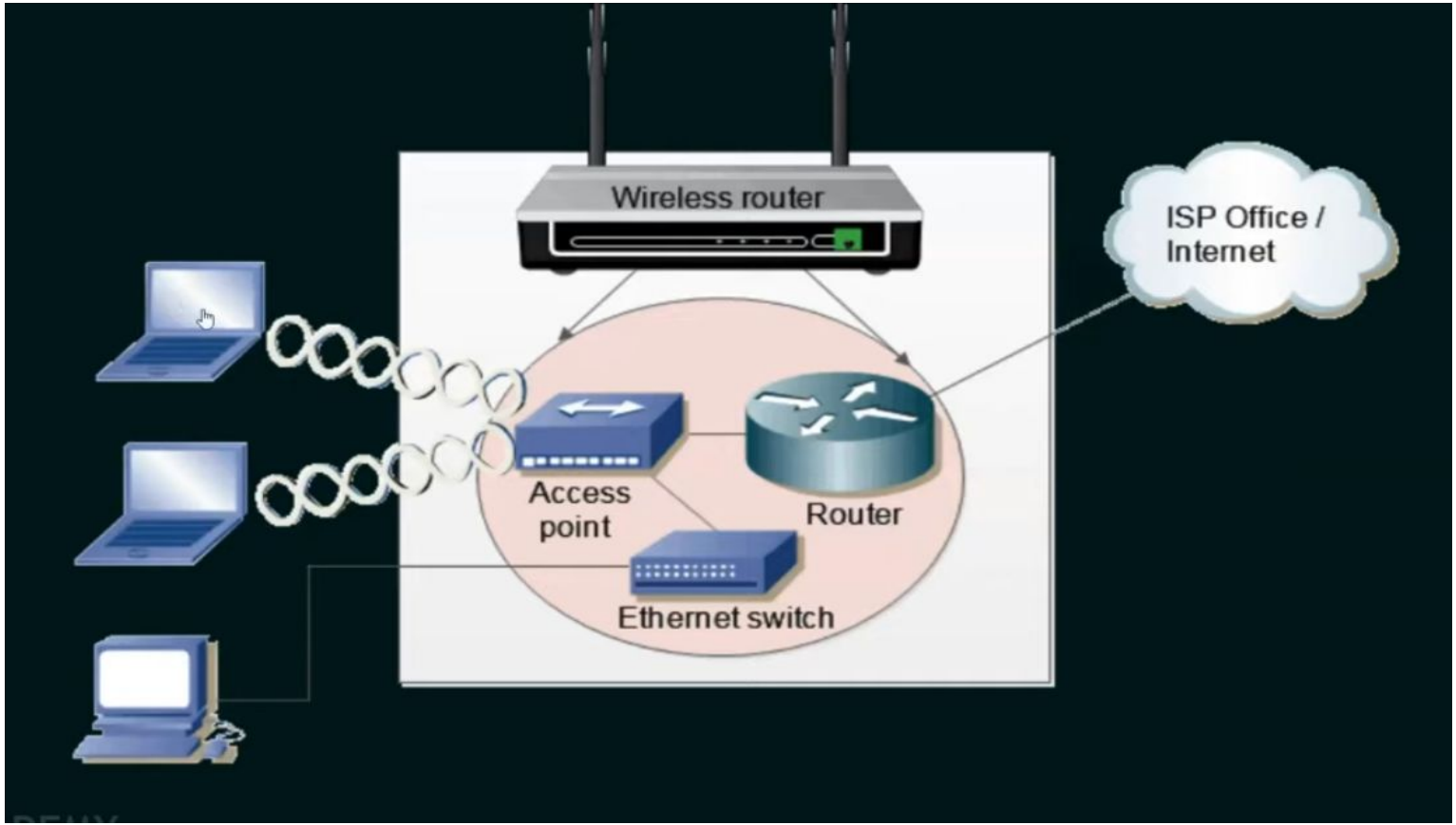
Upon the completion of this session, the learner will be able to

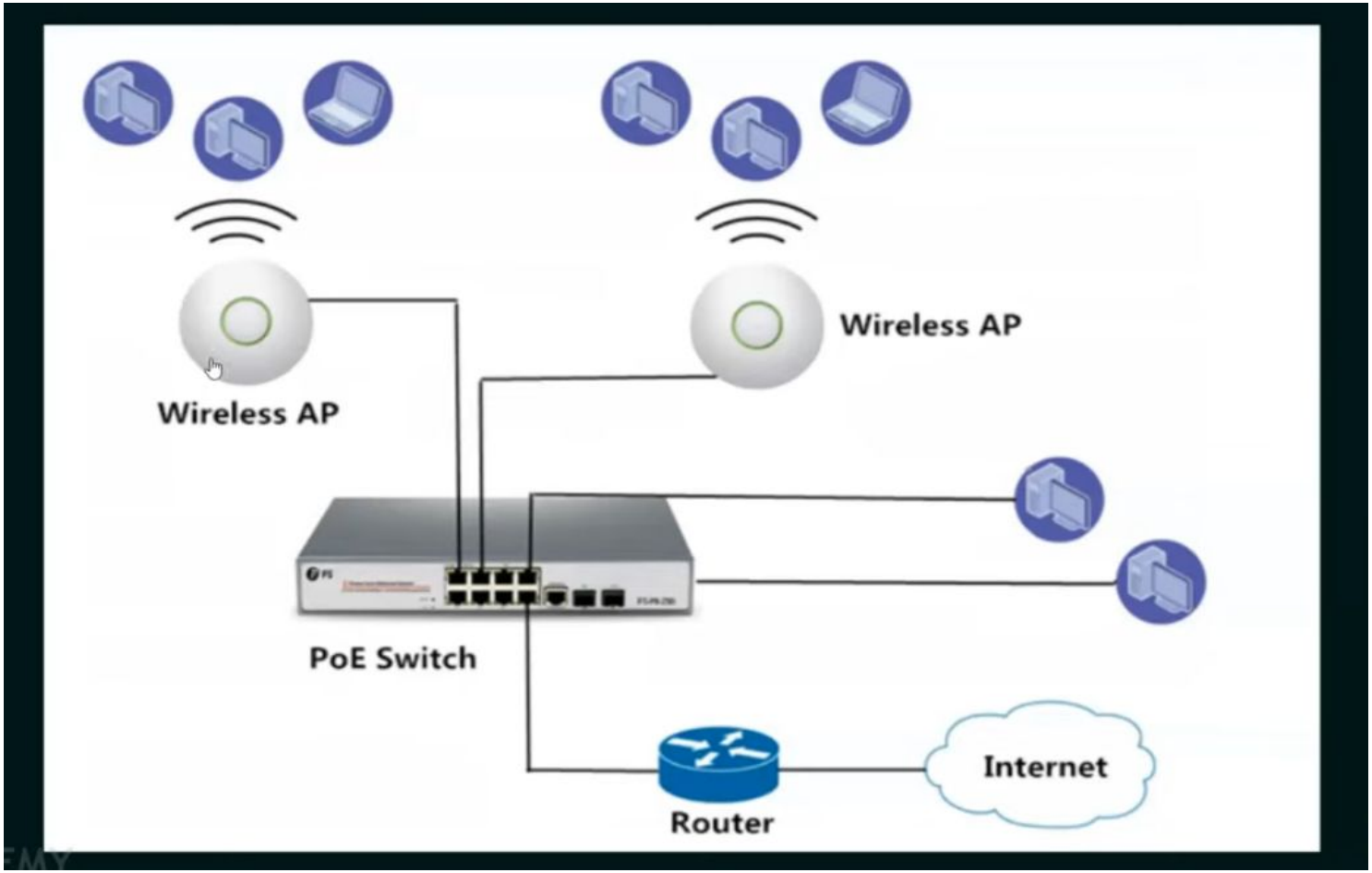
- Know about IEEE 802.11 Wi-Fi.
- Know the access method of Wi-Fi.
- See Wi-Fi adaptors.
- Understand the modes of Wi-Fi.
- Know different Wi-FI protocols.
- Recall the modes of Wi-FI.
- Know about IEEE 802.11 Distribution System.
- Know how APs are connected to DS.
- Understand active and passive scanning


John
Jeni

IEEE 802.11 Wi-Fi

- Also known as Wireless Fidelity(Wi-Fi).
- Like its Ethernet and token ring siblings, 802.11 is designed for use limited geographical area(homes,office buildings,campuses).
- Primary challenge is to mediate access to a shared communication medium-in this case, signals propagating through space.
- 802.11 supports additional features:
    - Power management and
    - Security mechanisms


Wireless router
ISP Office / Internet
Access point
Router
Ethernet switch


Wireless AP
Wireless AP
PoE Switch
Router
Internet

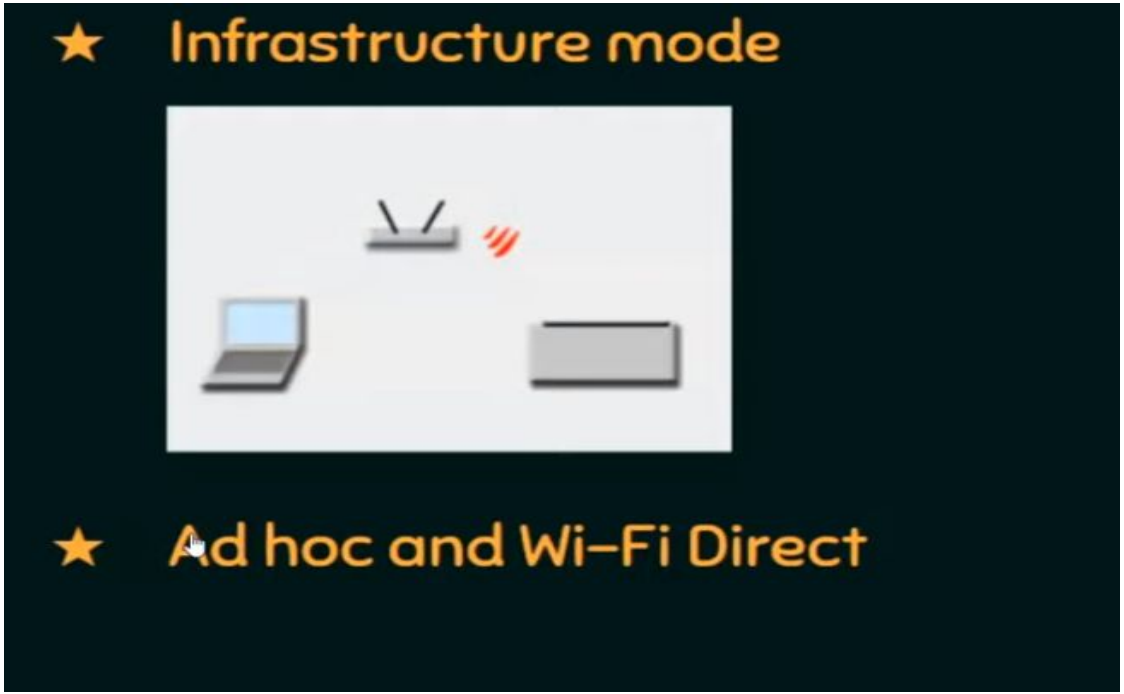
IEEE 802.11 Wi-Fi

802.11 uses 5 GHz Radio Band(High Frequency) which has 23 overlapping channels rather than the 2.4 GHz frequency band which has only three non-overlapping channels.

Access Method of IEEE 802.11 Wi-Fi: CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)

Wi-Fi Adapters

Modes of Wi-Fi:



Different Wi-Fi Protocols

Protocol	Frequency	Channel Width	Maximum data rate (theoretical)
802.11 ax	2.4 or 5GHz	20, 40, 80, 160MHz	2.4 Gbps
802.11 ac wave2	5 GHz	20, 40, 80, 160MHz	1.73 Gbps
802.11 ac wave1	5 GHz	20, 40, 80MHz	866.7 Mbps
802.11n	2.4 or 5 GHz	20, 40MHz	450 Mbps
802.11g	2.4 GHz	20 MHz	54 Mbps
802.11a	5 GHz	20 MHz	54 Mbps
802.11b	2.4 GHz	20 MHz	11 Mbps
Legacy 802.11	2.4 GHz	20 MHz	2 Mbps

The Evolution of IEEE 802.11 Standards

Standard	Year	Frequency Band	Speed	Modulation	Characteristics
802.11	1997	2.4GHz	1-2Mbps	DSSS,FHSS	Base version
802.11b	1999	2.4GHz	11Mbps	DSSS	Oldest, least expensive
802.11a	1999	5 GHz	54Mbps	OFDM	Rarely used
802.11g	2003	2.4 GHz	54Mbps	OFDM	Compatible with 802.11b networks
802.11n	2009	2.4GHz 5 GHz	65-600Mbps	OFDM	- Backward compatible with 802.11a, b, g standards - MIMO (multiple input-multiple output) - Channel bonding: doubles the bandwidth - Frame aggregation : reduces overhead

Which WiFi Standard Has the Furthest Range?

In terms of theoretical distance, 802.11ah would have the furthest range, but it's not commonly used by the average consumer. Out of the most common WiFi networks, **802.11n technology** has the **best range at 230 ft indoors.**

IEEE 802.11 Architecture

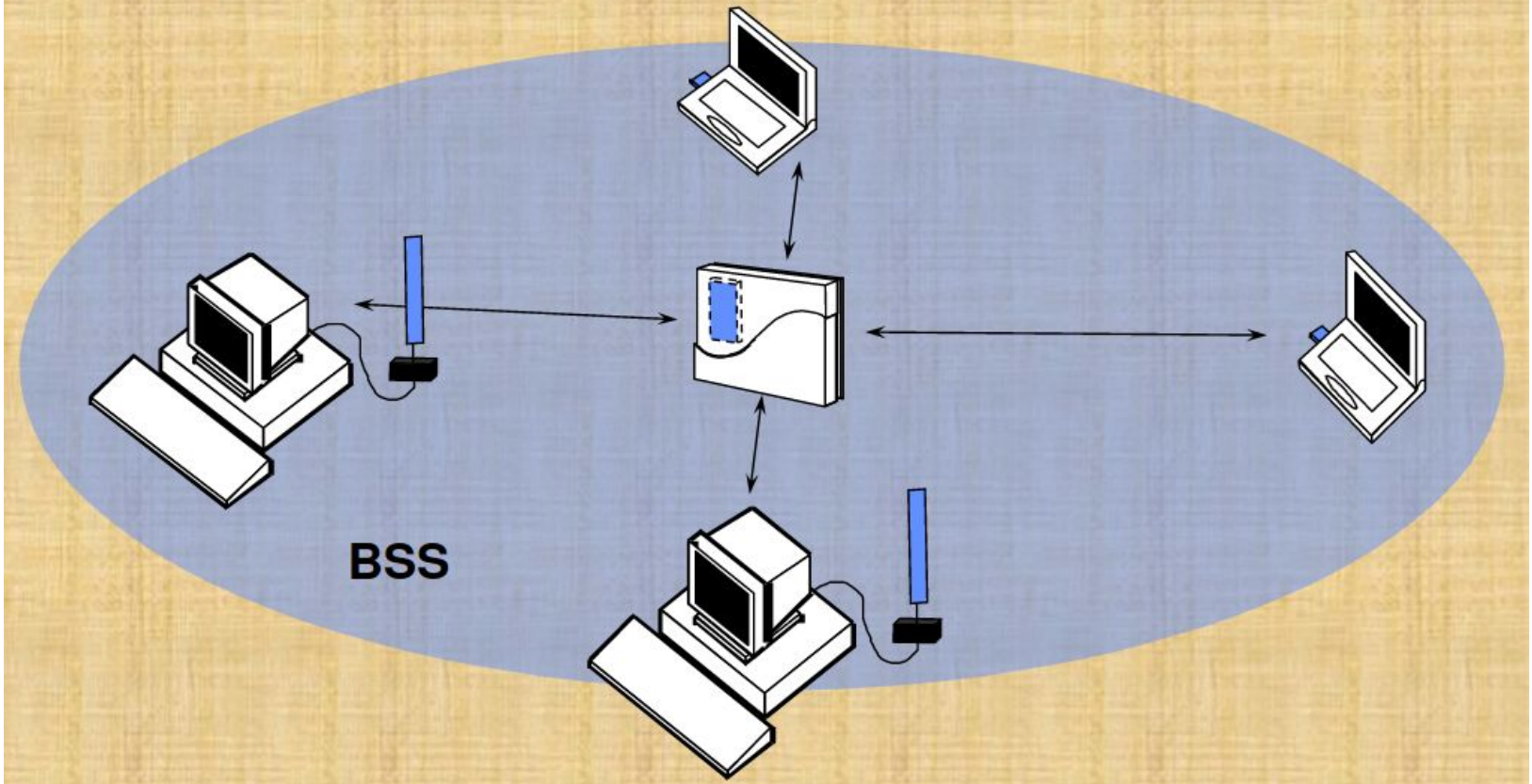
The components of an IEEE 802.11 architecture are as follows −

- **Stations (STA)** − Stations comprises of all devices and equipment that are connected to the wireless LAN. A station can be of two types−
  - Wireless Access Point (WAP) − WAPs or simply access points (AP) are generally wireless routers that form the base stations or access.
  - Client– Clients are workstations, computers, laptops, printers, smartphones, etc.
- Each station has a wireless network interface controller.

Contd…

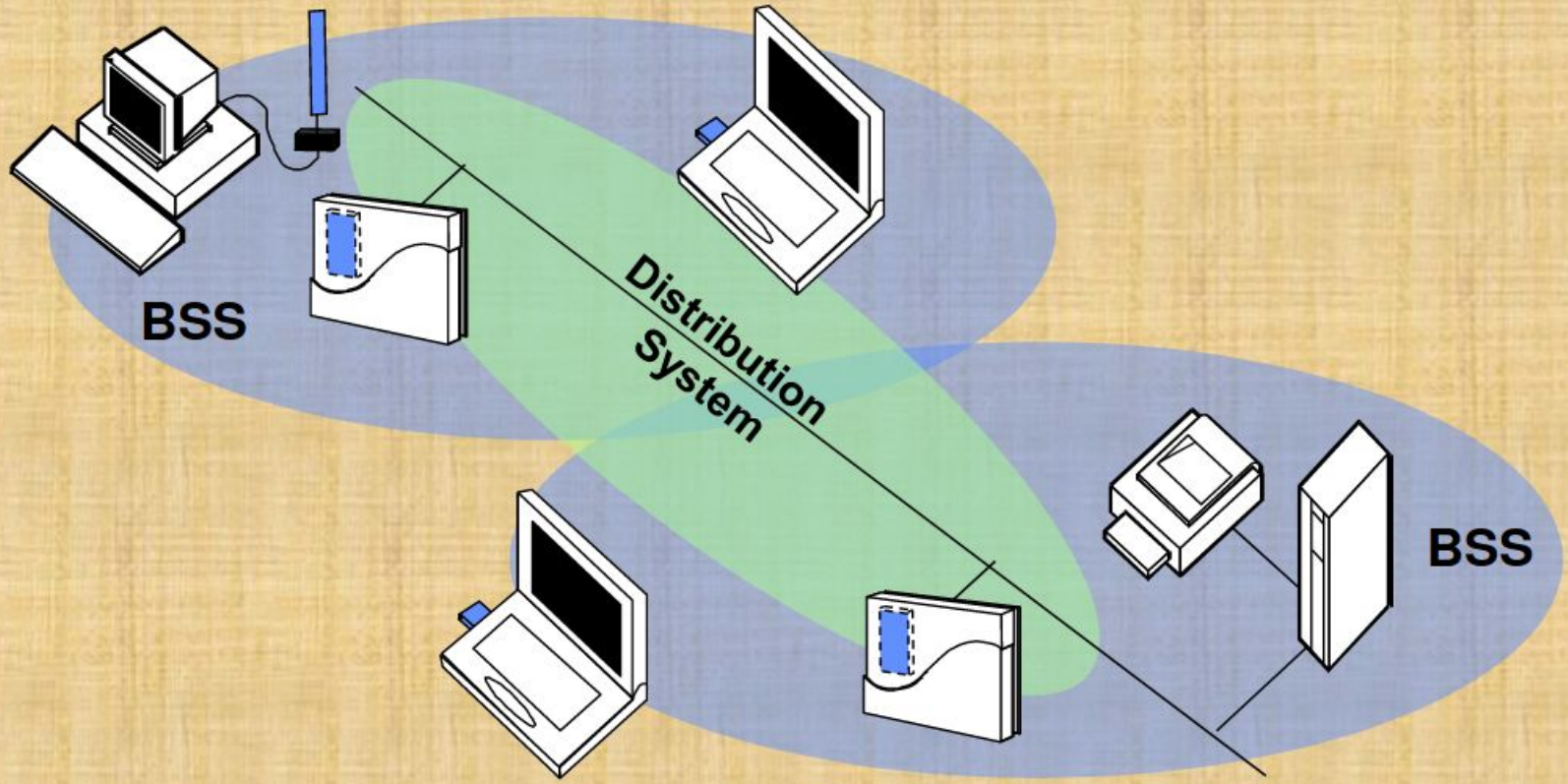
- **Basic Service Set (BSS)** − A basic service set is a group of stations communicating at the physical layer level. BSS can be of two categories depending upon the mode of operation−
  - **Infrastructure BSS** − Here, the devices communicate with other devices through access points.
  - **Independent BSS** − Here, the devices communicate in a peer-to-peer basis in an ad hoc manner.
- **Extended Service Set (ESS)** − It is a set of all connected BSS.
- **Distribution System (DS)** − It connects access points in ESS.

Basic Service Set (BSS)



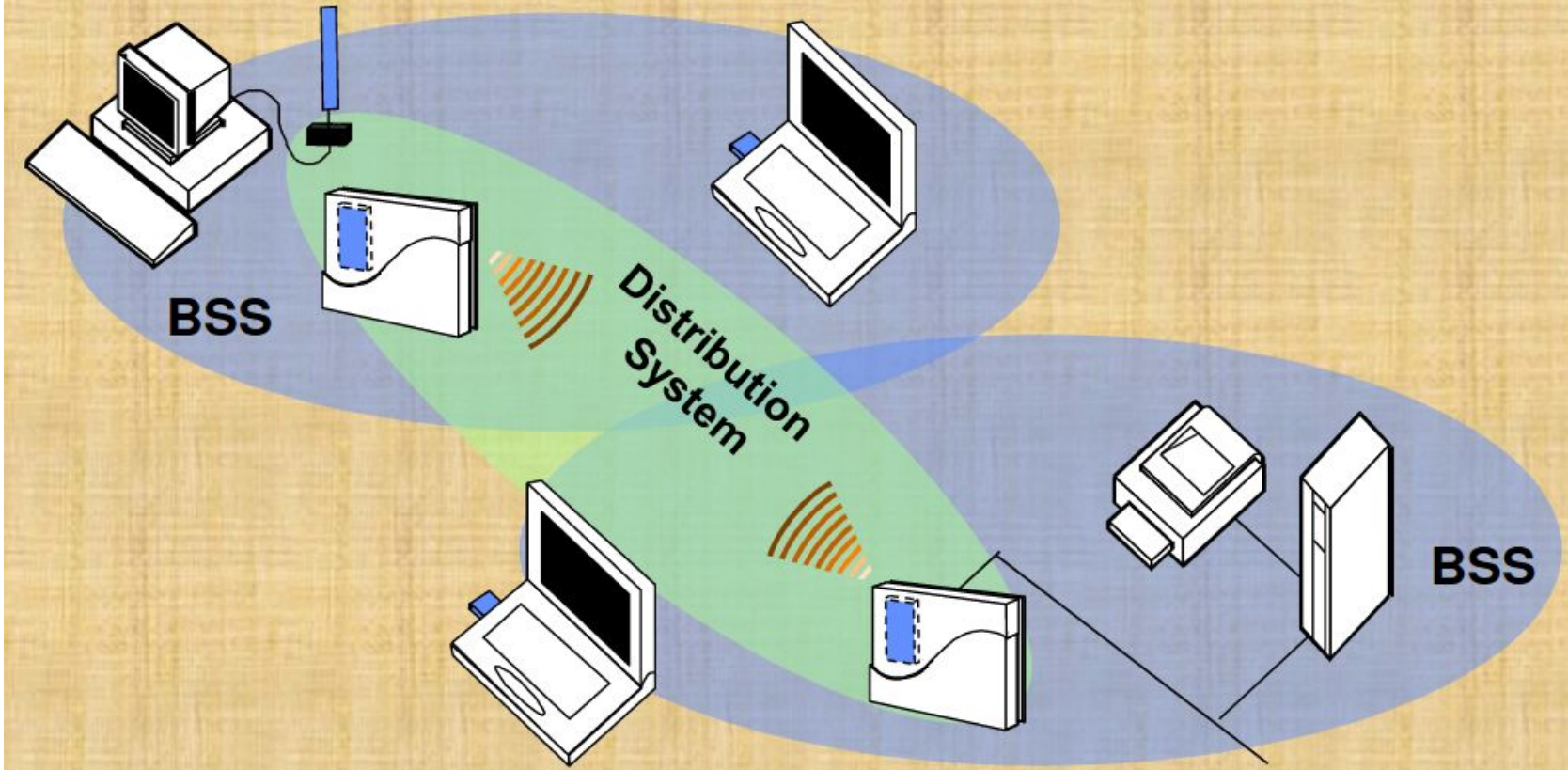
Extended Service Set (ESS)

BSS's with wired Distribution System (DS)

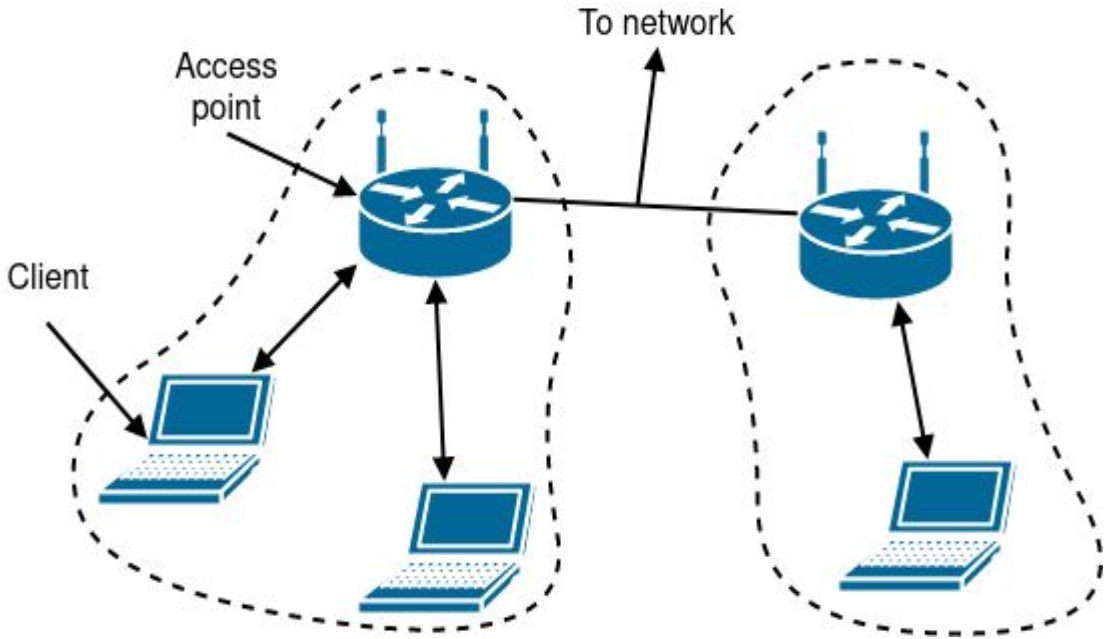


Extended Service Set (ESS)

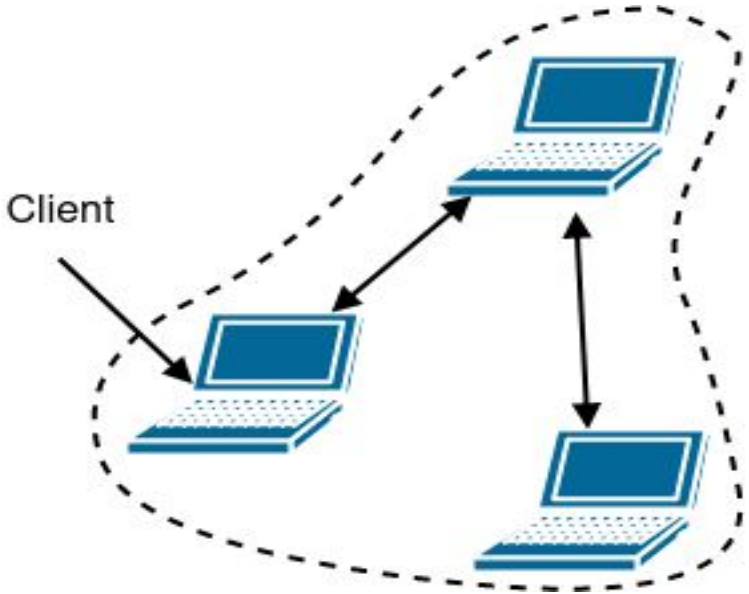
BSS's and wireless Distribution System (DS)

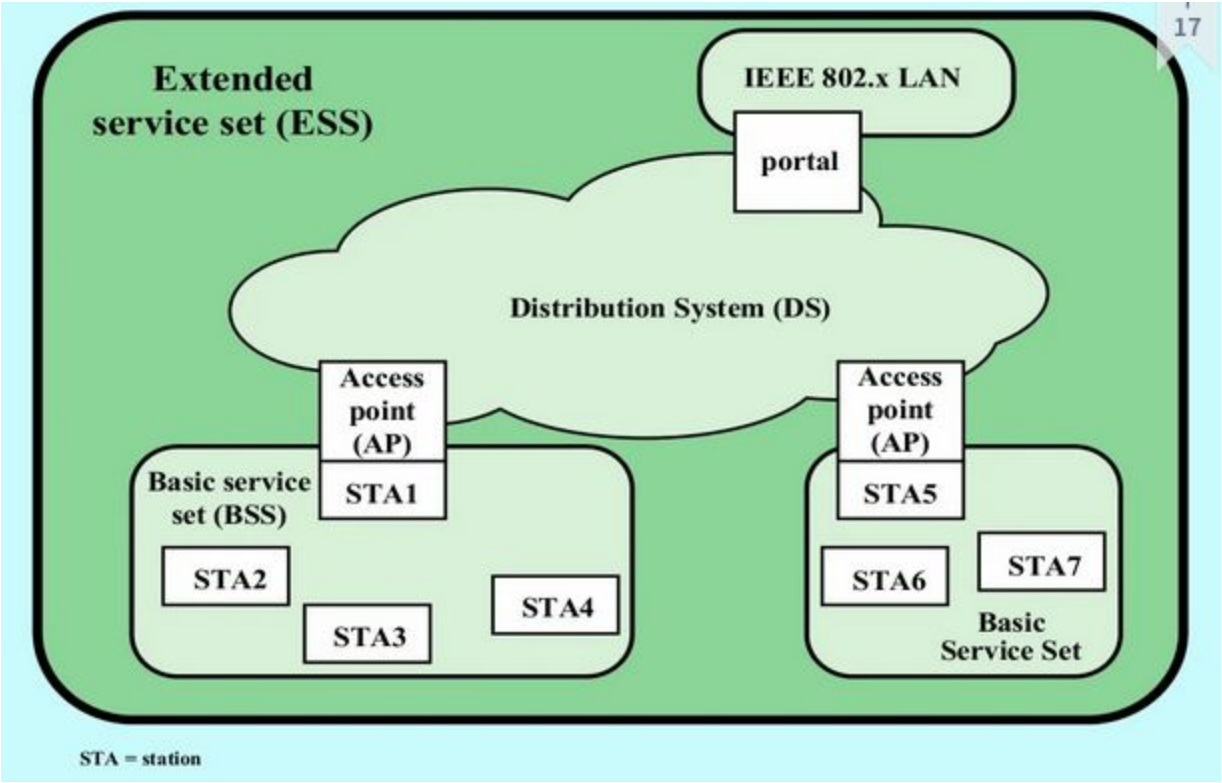


Infrastructure Mode

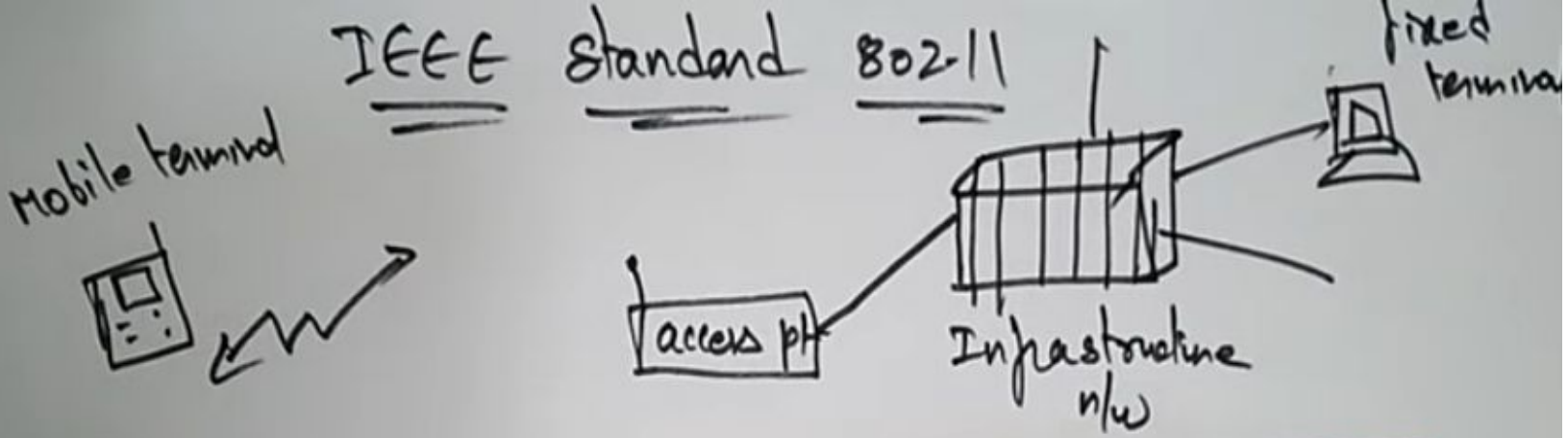


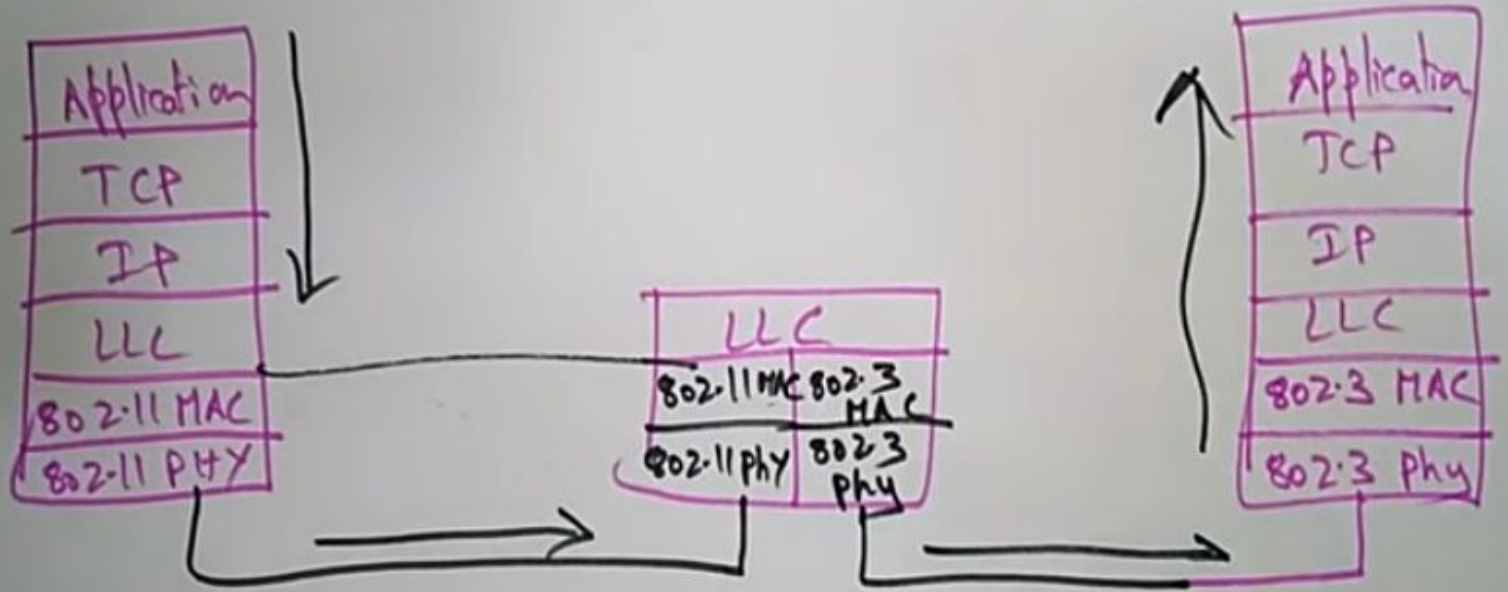
Independent or Ad-Hoc Mode




Extended
service set (ESS)
IEEE 802.x LAN
portal
Distribution System (DS)
Access
point
(AP)
Basic service
set (BSS)
STA1
STA2
STA3
STA4
Access
point
(AP)
STA5
STA6
STA7
Basic
Service Set
STA = station

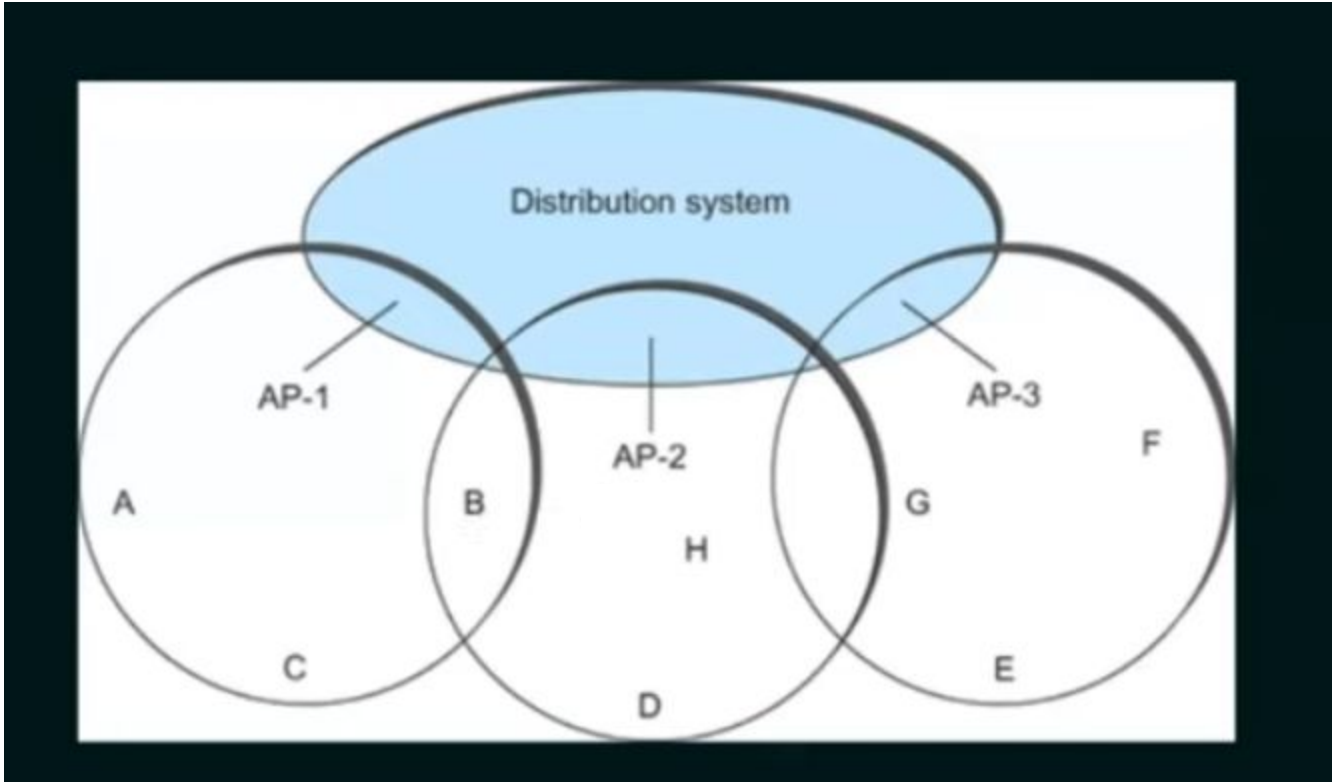
IEEE Standard 802.11





IEEE 802.11 Distribution System

- 802.11 is suitable for an ad-hoc configuration of nodes that may or may not be able to communicate with all other nodes.
- Nodes are free to move around.
- The set of directly reachable nodes may change over time.
- To deal with this **mobility** and **partial connectivity.**
  - 802.11 defines additional structures on a set of nodes.
  - Instead of all nodes being created equal,
    - Some nodes are allowed to roam and some are connected to a wired network infrastructure, they are called **Access Points(AP)** and they are connected to each other by a so-called **distribution system.**

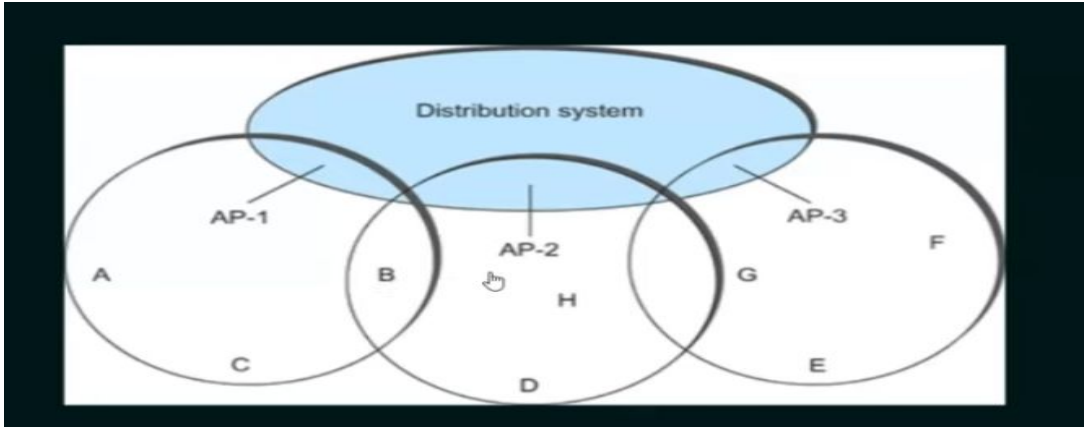

Distribution system
AP-1
AP-2
AP-3
A
B
C
D
E
F
G
H

Access Points connected to a Distribution Network

Following figure illustrates a distribution system that connects three access points, each of which services the nodes in the same region

Each of these regions is analogous to a cell in a cellular phone system with the APIs playing the same role as a base station.

The distribution network runs at layer 2 of the OSI architecture.



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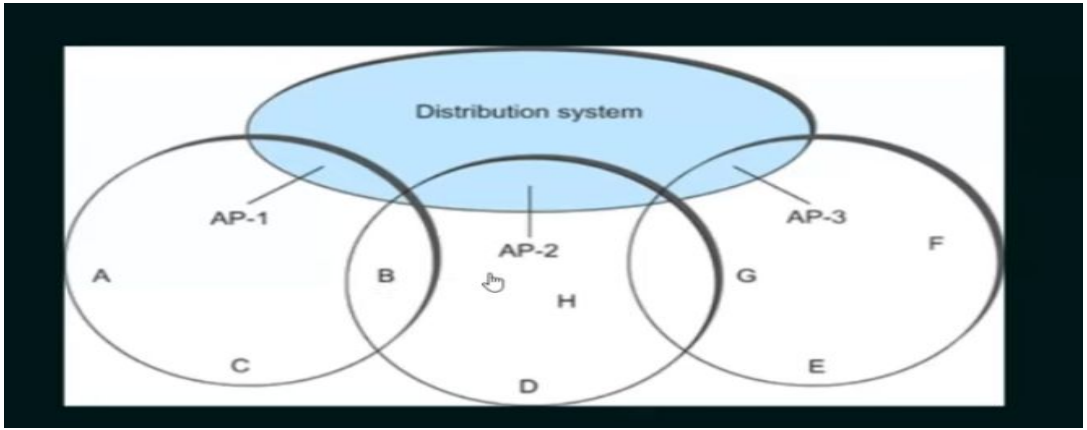
Although two nodes can communicate directly with each other if they are within a range of each other, the idea behind this configuration is

Each nodes associates itself with one access point.

For node A to communicate with node E, A first sends a frame to its AP-1 which forwards the frame across the distribution system to AP-3, which finally transmits the frame to E.

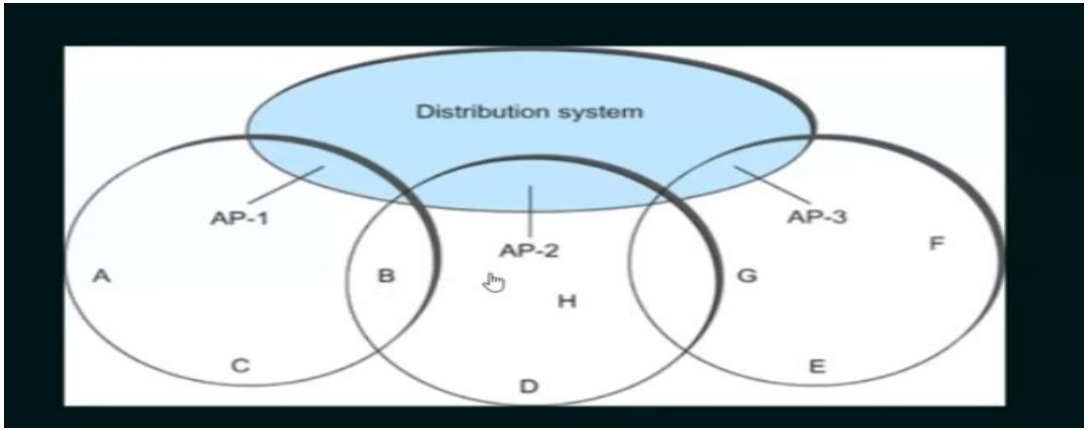
How does the nodes select their AP?

- The technique for selecting an AP is called scanning.
  - The node sends a Probe frame.
  - All APs within range reply with a Probe Response frame.
  - The node selects one of the access points and sends that AP Association Request frame.
  - The AP replies with an Association Response frame.



How does the nodes select their AP?

- A node engages this protocol whenever it joins the network, as well as
- When it becomes unhappy with its current AP?
  - This might happen, for example, because the signal from its current AP has weakened due to the node moving away from it.
  - Whenever a node acquires a new AP, the new AP notifies the old AP of change via the distribution system.

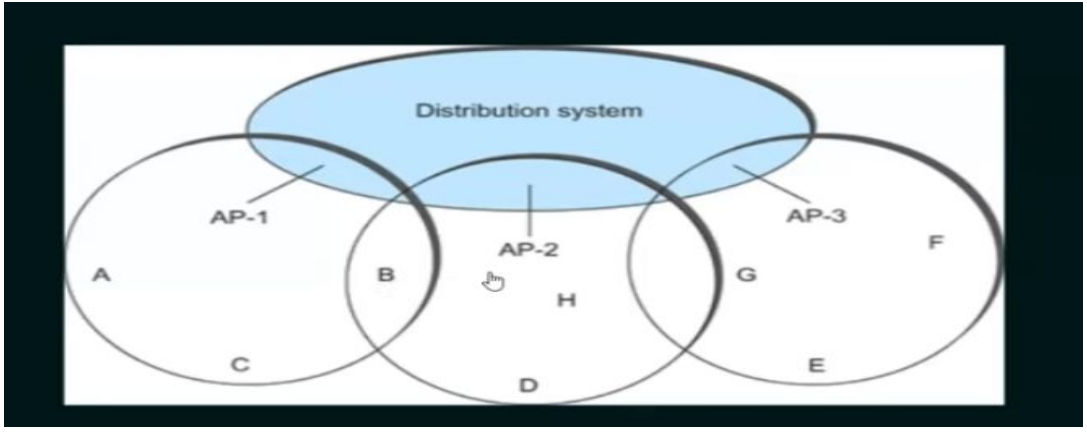


Node Mobility

Consider the situation shown in the following figure when node C moves from the cell serviced by AP-1 to the cell serviced by AP-2.

As it moves, it sends Probe frames, which eventually result in Probe Responses from AP-2.

At some point, C prefers AP-2 over AP-1, and so it associates itself with that access point.This is called active scanning since the node is actively searching for an access point.



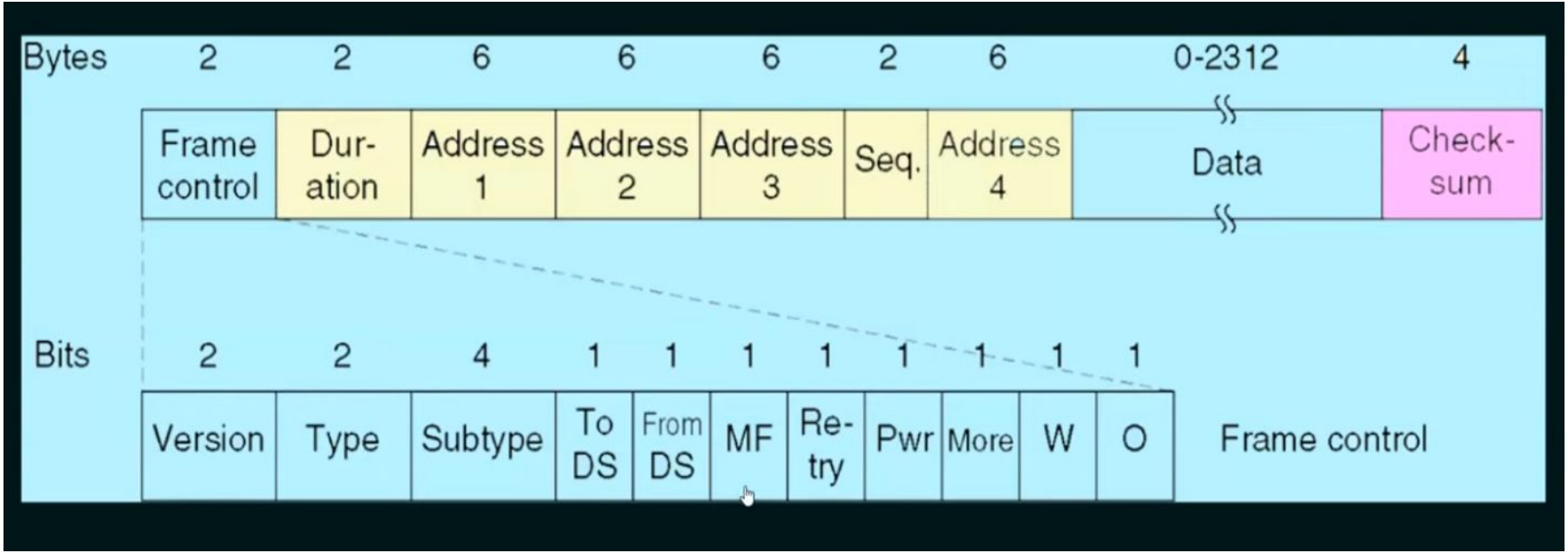
Passive Scanning

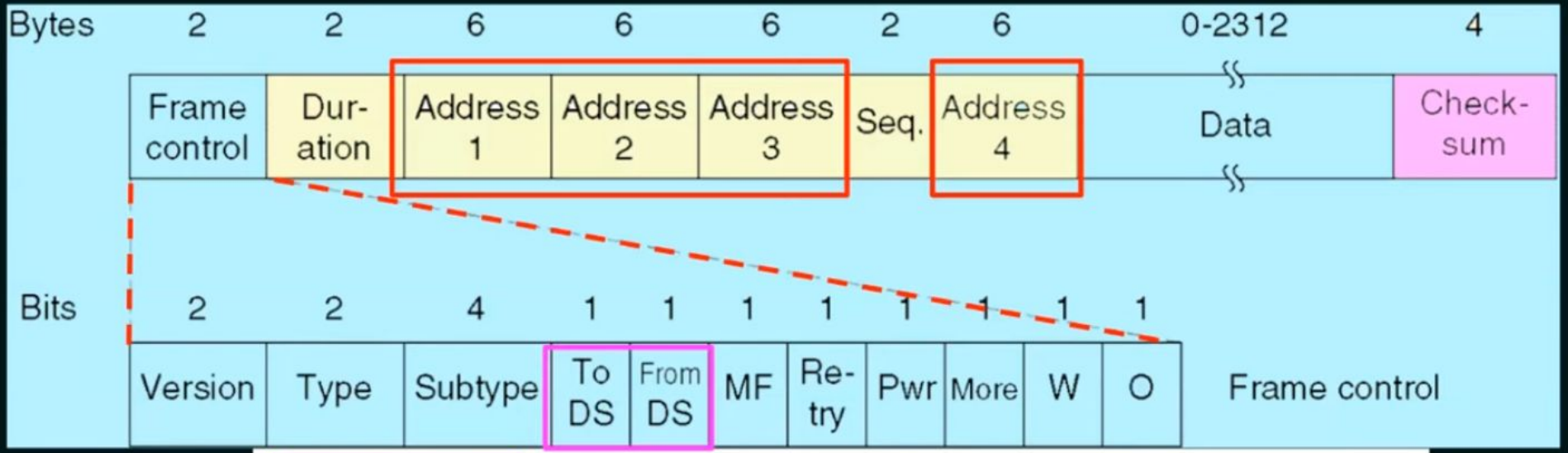
APs also periodically send a Beacon Frame that advertises the capabilities of the access point; these include the transmission rate supported by the AP.

This is called passive scanning.

A node can change to this AP based on the Beacon frame simply by sending it an Association Request frame back to the access point.

IEEE 802.11 Wi-Fi Format





To DS	*From* DS	*Address* 1	*Address* 2	*Address* 3	*Address* 4
0	0	Destination	Source	BSS ID	N/A
0	1	Destination	SendingAP	Source	N/A
1	0	Receiving AP	Source	Destination	N/A
1	1	Receiving AP	SendingAP	Destination	Source

Advantages of IEEE 802.11

- The IEEE 802.11 is easy to installation.
- It has higher frequency range.
- It has efficient coding technique.
- The IEEE 802.11 has reduced wiring expense.
- It is less cost effective.
- Simultaneously use of equipment.
- It use unlicensed part of the radio spectrum.

Disadvantages of IEEE 802.11

- It has traffic disruptions.
- Network security and the maintenance needed to stay secured.
- It is required periodic maintenance.
- Data transmitted over radio waves can be captured by any Wi-Fi ready devices in the area.
- Communication isn't secure and may be accessed by unauthorized users
- Frame spoofing.
- Session hijacking.
- Due to Low security as attackers can get access to the transmitted data.

Applications

IEEE 802.11 is used in most home and office networks **to allow laptops, printers, smartphones, and other devices to communicate with each other and access the Internet without connecting wires**.