Introduction to Wireless LAN

Wireless LAN

- **WLAN**: Data transmission system designed to provide location-independent network access between computing devices using radio frequencies.
- Usually implemented as the final link between existing wired network.
- Has been the popular technology to be implemented due to:
  - Increased used of laptops and handheld devices
  - Rapid advances in WLAN data rate
  - Drops in WLAN device prices

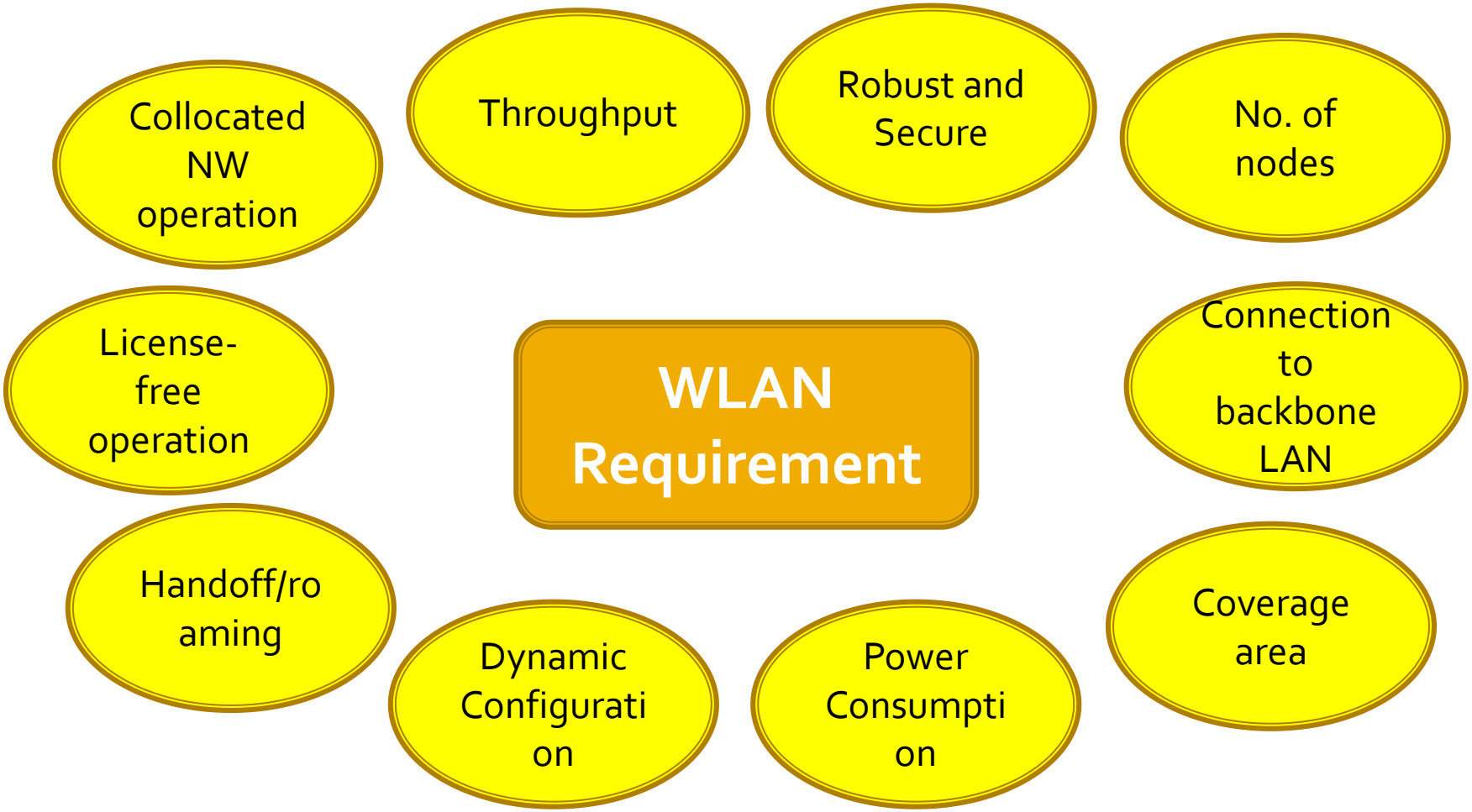
Wireless LAN

- WLANs provide network access by broadcasting a signal across a wireless radio frequency (RF) carrier.
- The transmitter prefaces its transmissions with a service set identifier (SSID).
- A receiving station can be within range of a number of transmitters. The receiver uses the SSID to filter through the received signals and locate the one it wants to listen to

Why Wireless LAN?

- **High Mobility**: users can connect to existing networks and are then allowed to roam freely
- **High Flexibility**: WLAN can be deployed in a very short time anytime, anywhere.
- **Low Cost:** Since not much devices is needed to setup a WLAN, a lot of cost can be reduced, e.g: no cabling cost to each client is needed.

Wireless LAN Requirements



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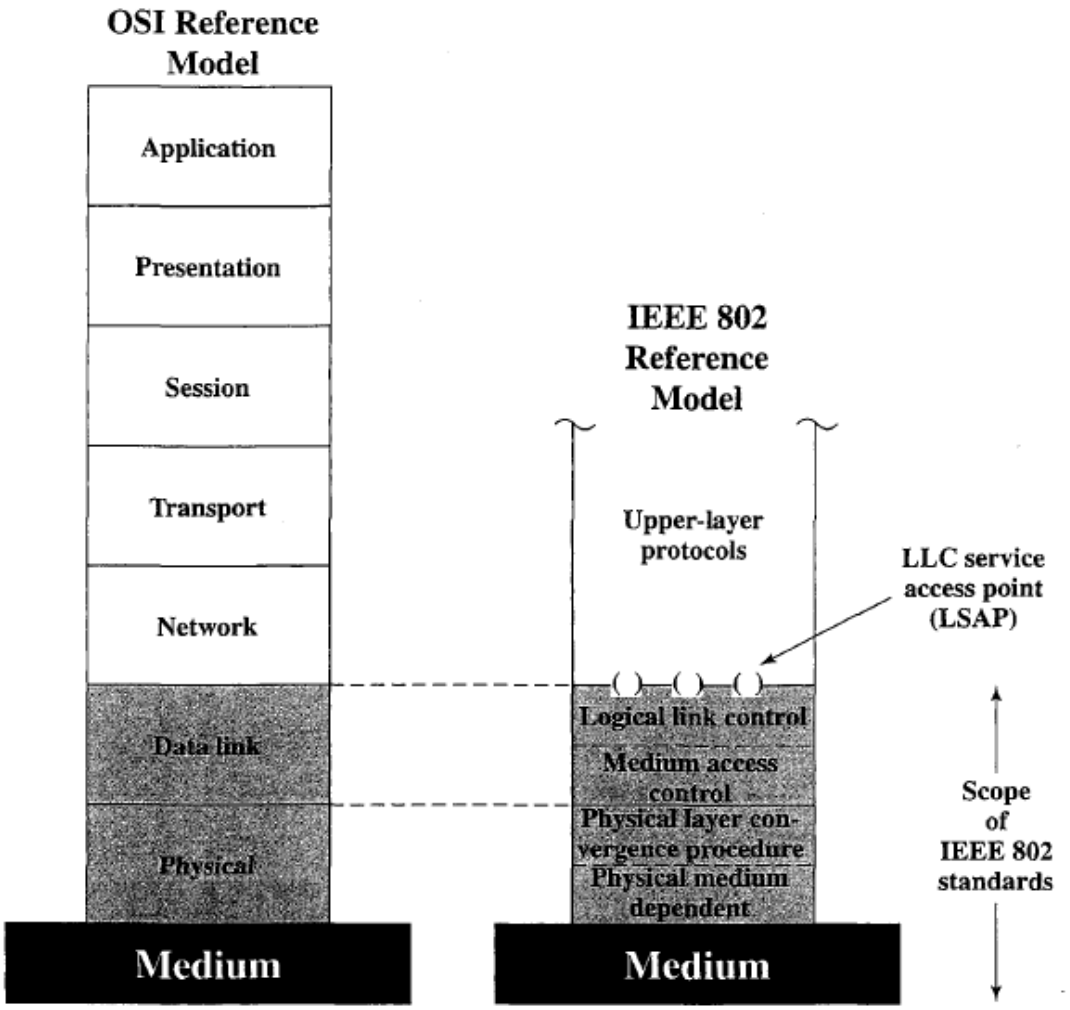
IEEE 802.11 WLAN STANDARD

- IEEE formed a group in 1990 to establish a wireless LAN standard.
- WiFi – 802.11b

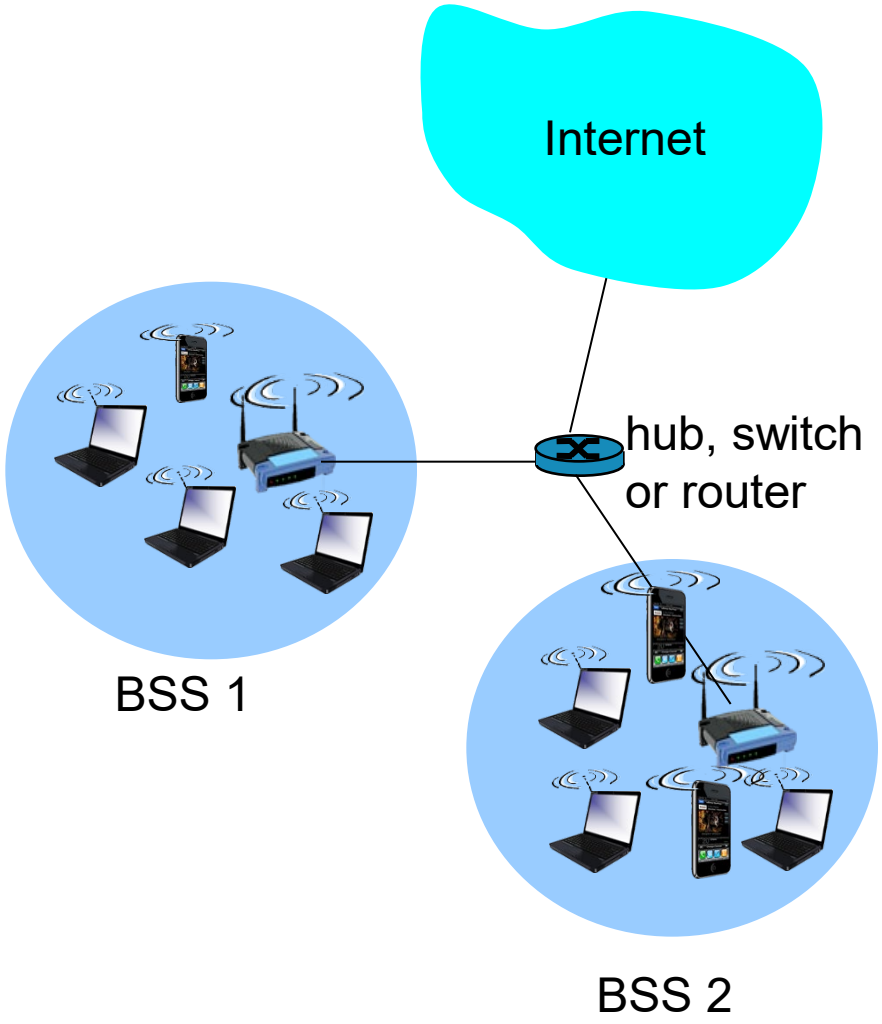
Key Standards	Max Rate	Spectrum (U.S.)	Year
802.11	2 Mbps	2.4 GHz	1997
802.11a	54 Mbps	5 GHz	1999
802.11b	11 Mbps	2.4 GHz	1999
802.11g	54 Mbps	2.4 GHz	2003

IEEE 802.11 Protocol Layer vs OSI Model



- Physical Medium Dependent Sublayer
- Physical layer convergence procedure
- Medium Access Control
- Logical Link Control

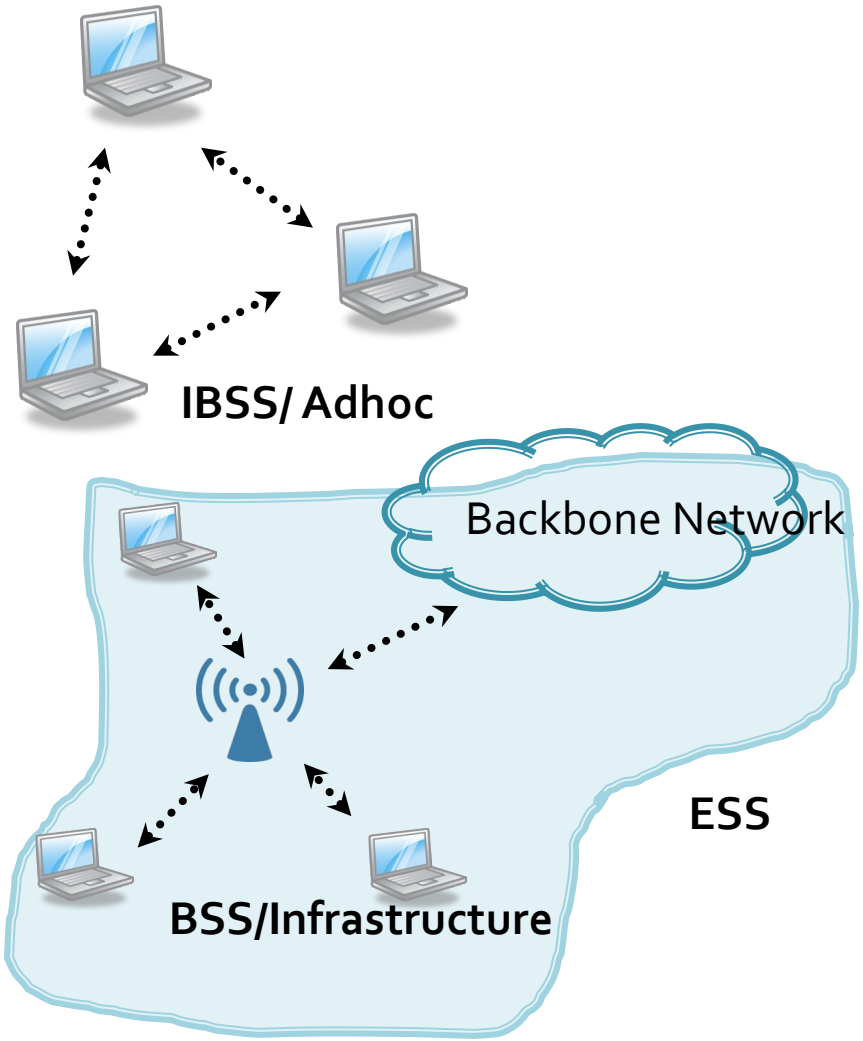
802.11 LAN architecture



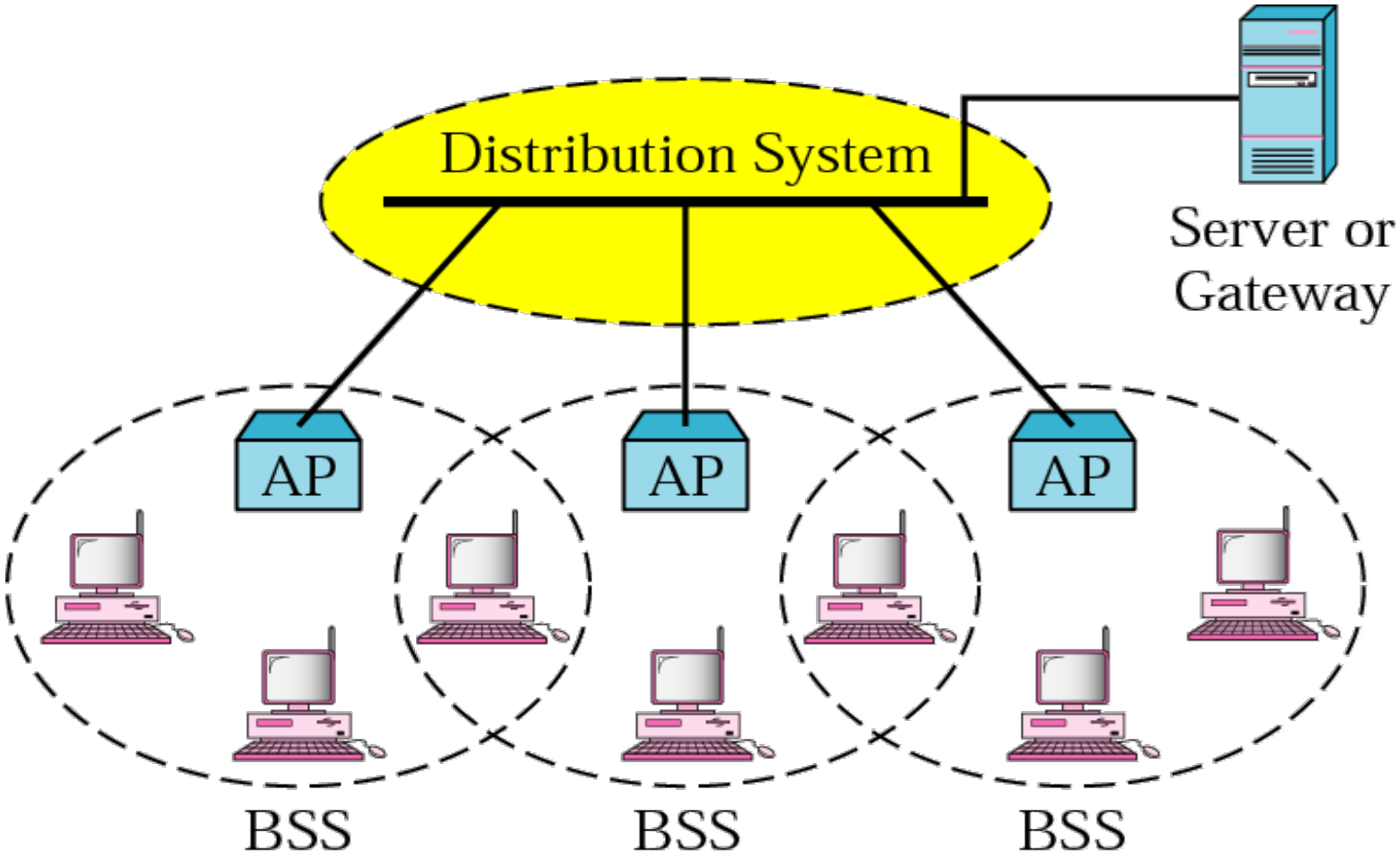
- Two basic equipment in IEEE 802.11
  - Wireless terminal/ Mobile Station (MS) : An IEEE 802.11 enabled device
  - Access Point (AP): Base Station
- Basic Service Set (BSS) (aka "cell") in infrastructure mode contains:
  - wireless hosts
  - access point (AP): base station
  - ad hoc mode: hosts only

802.11 LAN architecture: 3 Topologies

- Independent Basic Service Set (IBBS)
  - MS communicate directly with each other
  - Must be within direct communication range
  - IBSS are composed of a small number of stations set up for a specific purpose and for a short period of time.
- Basic Service Set (BSS)
  - Distinguished by the use of an AP .
  - APs are used for all communications in infrastructure networks, including communication between mobile nodes in the same service area
- Extended Service Set (ESS)
  - Created by chaining BSSs together with a backbone network.
  - APs in an ESS are given the same service set identifier (SSID), which serves as a network "name" for the users.

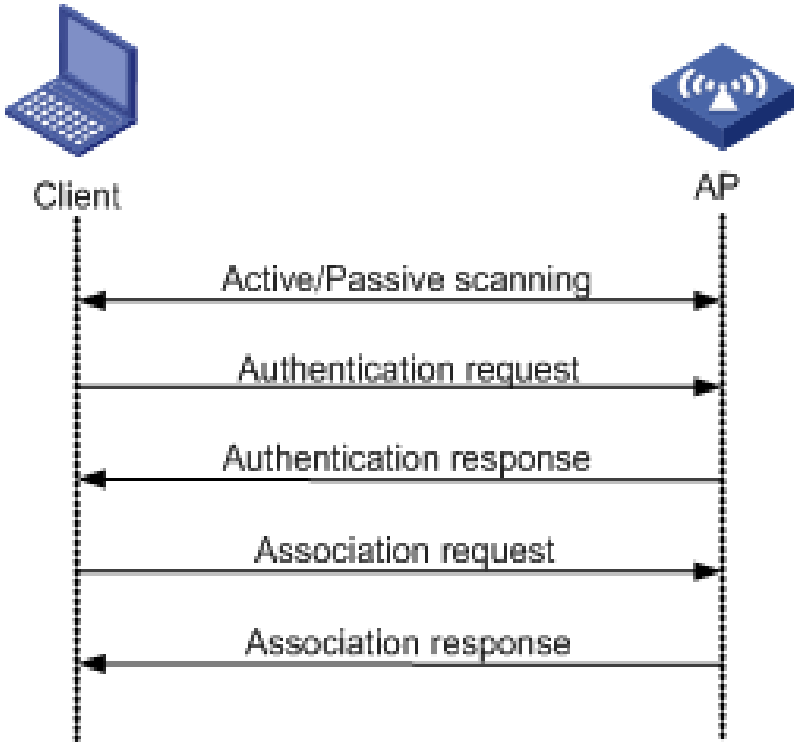


Extended Service Set (ESS)



Wireless Client Access

- Scanning
- Authentication
- Association



Scanning Process

Scanning - to determine a suitable AP to which the client may need to use

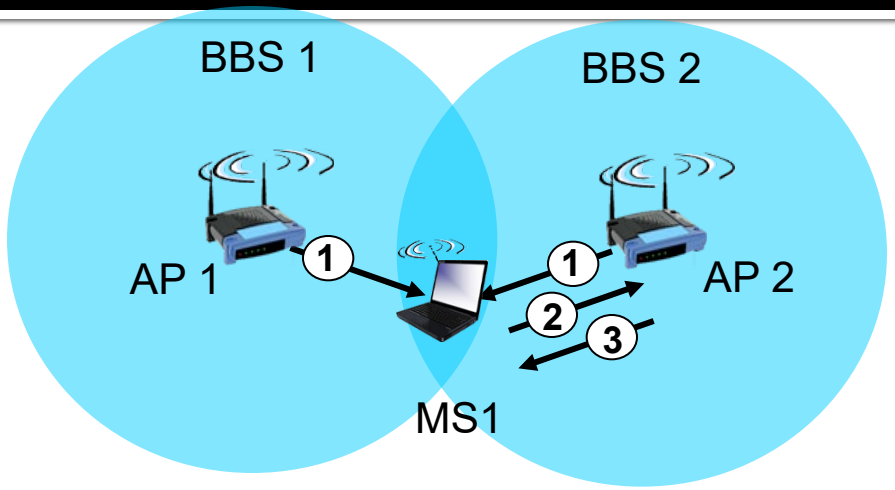
Passive Scanning

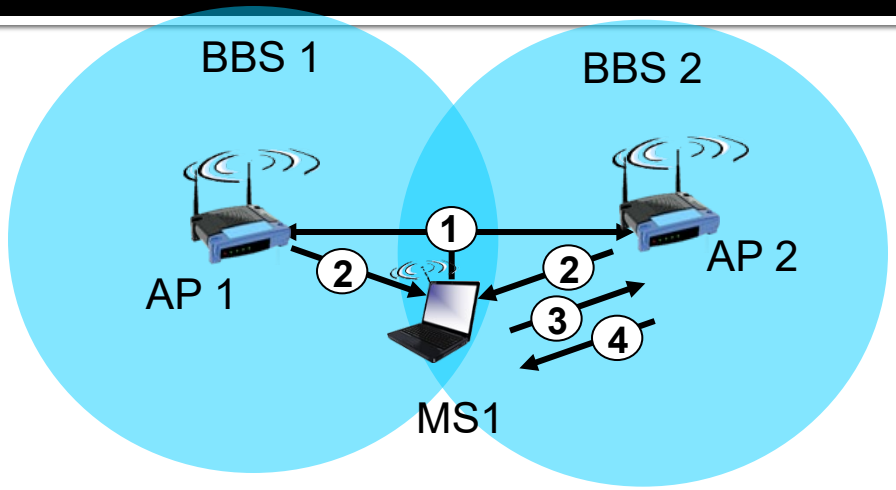
- MS listens on each channel for beacons sent periodically by an AP
- Beacon frame contains a lot of information the client needs: availability, capability, compatibility

Active Scanning

- Mobile Station (MS) transmits a probe request and listens for a probe response from an AP
- Probe frame contains information of what the client wants: data rate, compatibility, capability

802.11: passive/active scanning





passive scanning:

(1) beacon frames sent from APs
(2) association Request frame sent: MS1 to selected AP
(3) association Response frame sent from selected AP to MS1

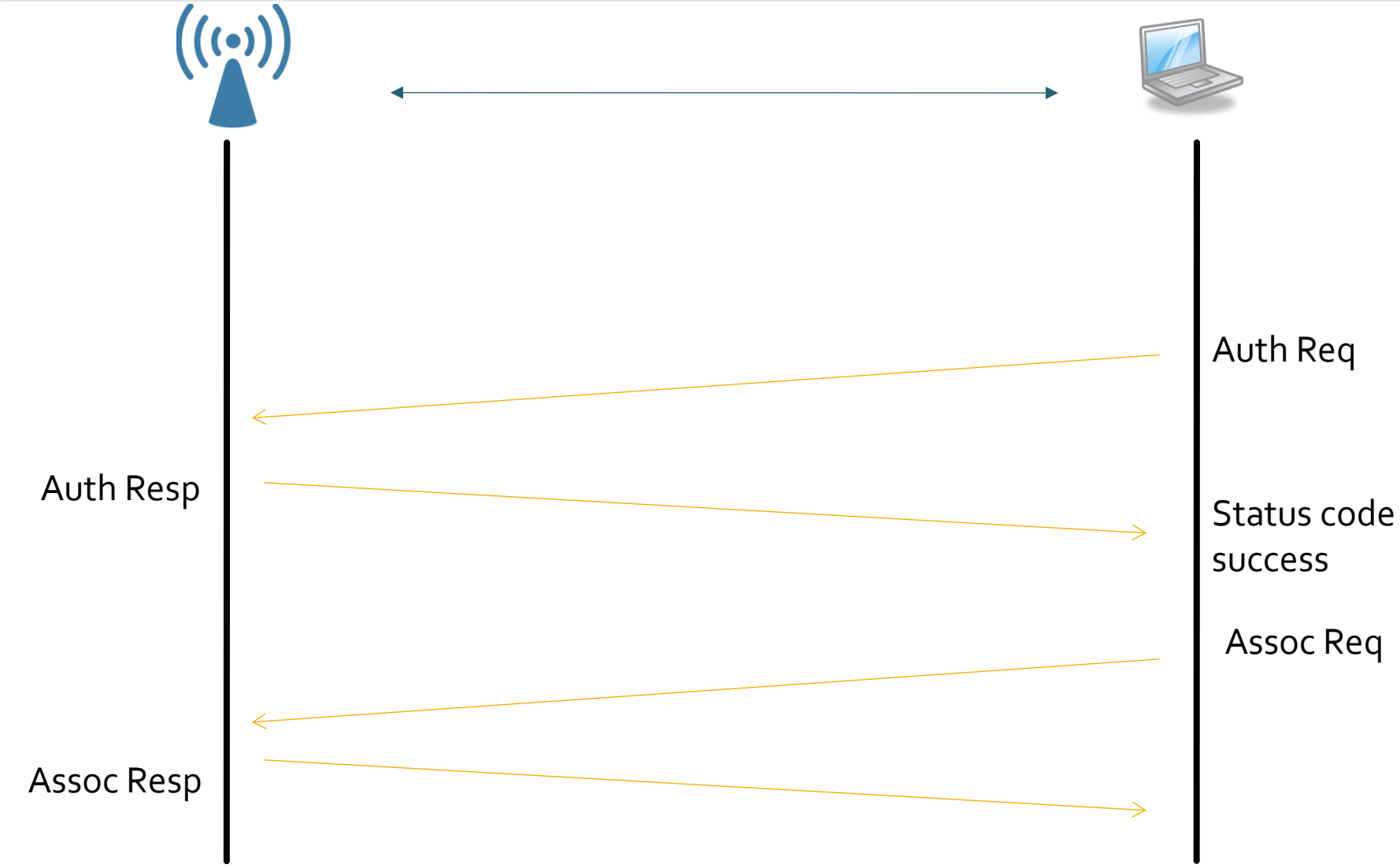
active scanning:

(1) Probe Request frame broadcast from MS1
(2) Probe Response frames sent from APs
(3) Association Request frame sent: MS1 to selected AP
(4) Association Response frame sent from selected AP to MS1

Authentication and Association

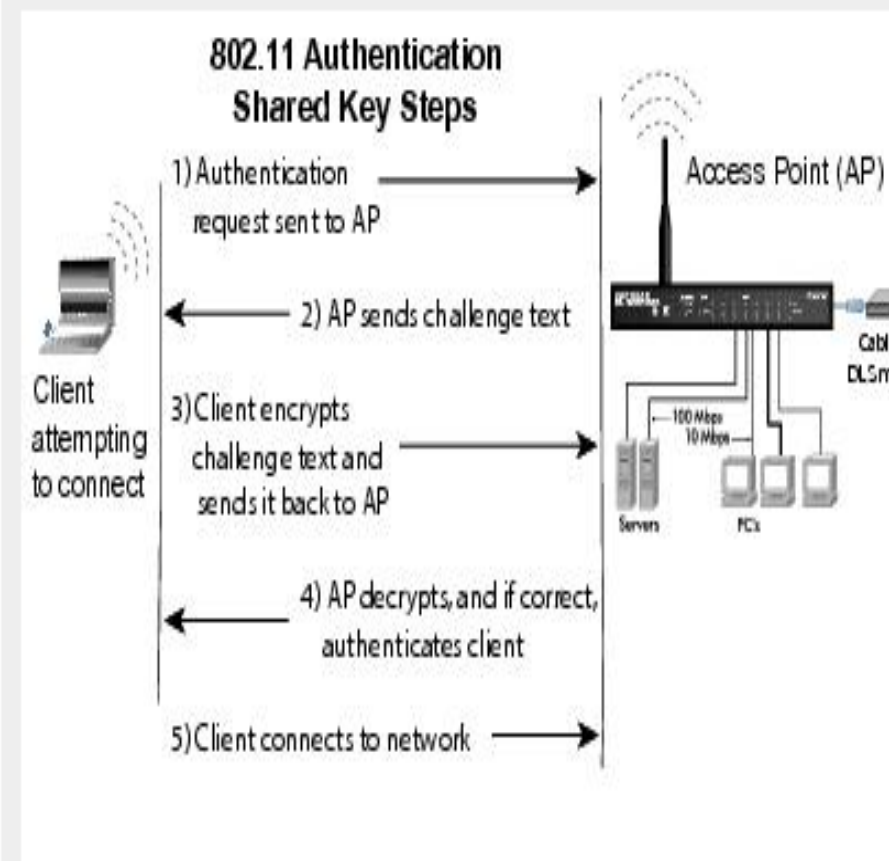
- Before connecting to a network, a MS must identify itself before it can send its frame.
- Establish its identity: Authentication
- Only AP authenticates mobile stations, not vice versa.
- MS MUST be authenticated before it can associate.
  - Open Systems Authentication
  - Shared Key Authentication
- Once authentication is complete, mobile devices can associate with an AP/router to gain full access to the network. Association allows the AP/router to record each mobile device so that frames are properly delivered. A station can only associate with one AP/router at a time.

Open System Authentication



Shared Key Authentication

1. MS sends an authentication request AP.
2. AP sends challenge text to the MS. MS uses its configured 64-bit or 128-bit default key to encrypt the challenge text, and it sends the encrypted text to the AP.
3. The AP decrypts the encrypted text using its configured WEP key that corresponds to the MS's default key.
4. The AP compares the decrypted text with the original challenge text. If the decrypted text matches the original challenge text, then the access point and the MS shares the same WEP key, and the access point authenticates the MS
5. The MS connects to the network.



Evolution of High Speed Networks

- IEEE 802.11b
  - September 1999
  - Added two higher speeds, 5.5Mbps and 11 Mbps.
  - Physical Layer Convergence Procedure (PLCP) based on DSSS
  - Uses ISM band of 2.4GHz RF

Evolution of High Speed Networks

- 802.11b Advantages
  - Higher data transfer rate compared to 802.11
  - Became the standard of Wi-Fi, accepted worldwide
- 802.11b Disadvantages
  - ISM band is crowded, subject to interference from other networking technologies: 802.15, cordless phone
  - No means for prioritized transmissions (QoS).

Evolution of High Speed Networks

- IEEE 802.11a
  - 1999 but existed in the market in 2001 due to high cost of developing devices.
  - Maximum speed of 54Mbps but supports 108, 48, 36, 24, 18, 12, 9, and 6 Mbps (108 is not an official speed).
  - Uses the U-NII 5.0GHz RF

Evolution of High Speed Networks

- 802.11a Advantages
  - No subject to interference of 2.4GHz network devices.
  - Allows 23 simultaneous channels to operate compared to 802.11b (3 channels only)
- 802.11a Disadvantages
  - Not compatible to 802.11b
  - Network area is smaller
  - No support for QoS

9.0 Evolution of High Speed Networks (cont.)

- IEEE 802.11g
  - Approved in 2003
  - Objective is compatibility with 802.11b but with higher data transfer rates
  - Maximum speed of 54Mbps
  - Uses the ISM 2.4GHz RF

Evolution of High Speed Networks

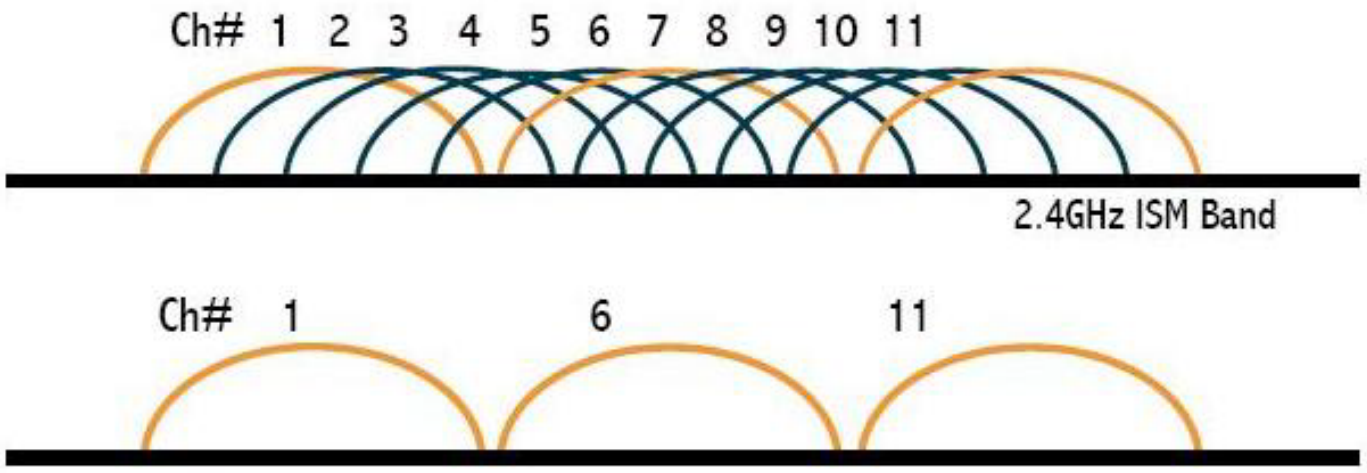
- 802.11g Advantages
  - Compatibility with 802.11b
  - High data transfer rates as in 802.11a
  - Bigger network coverage compared to 802.11a
- 802.11g Disadvantages
  - ISM band is crowded, subject to interference from other networking technologies: Bluetooth, cordless phone
  - No means for prioritized transmissions (QoS).

IEEE 802.11 Radio

	802.11	802.11a	802.11b	802.11g		802.11n
Ratified	1997	1999	1999	2003		Not Ratified
Frequency Band	2.4 GHz	5 GHz	2.4GHz	2.4GHz		2.4GHz
No. of Channels	3	Up to 23	3	3		varies
Transmission	IR, FHSS, DSSS	OFDM	DSSS	DSSS	OFDM	DSSS. CCK, OFDM
Data rates (Mbps)	1,2	6,9,12,18, 24,36,48, 54	1,2,5.5, 11	1,2,5.5, 11	6,9,12,18, 24,36, 48,54	100+

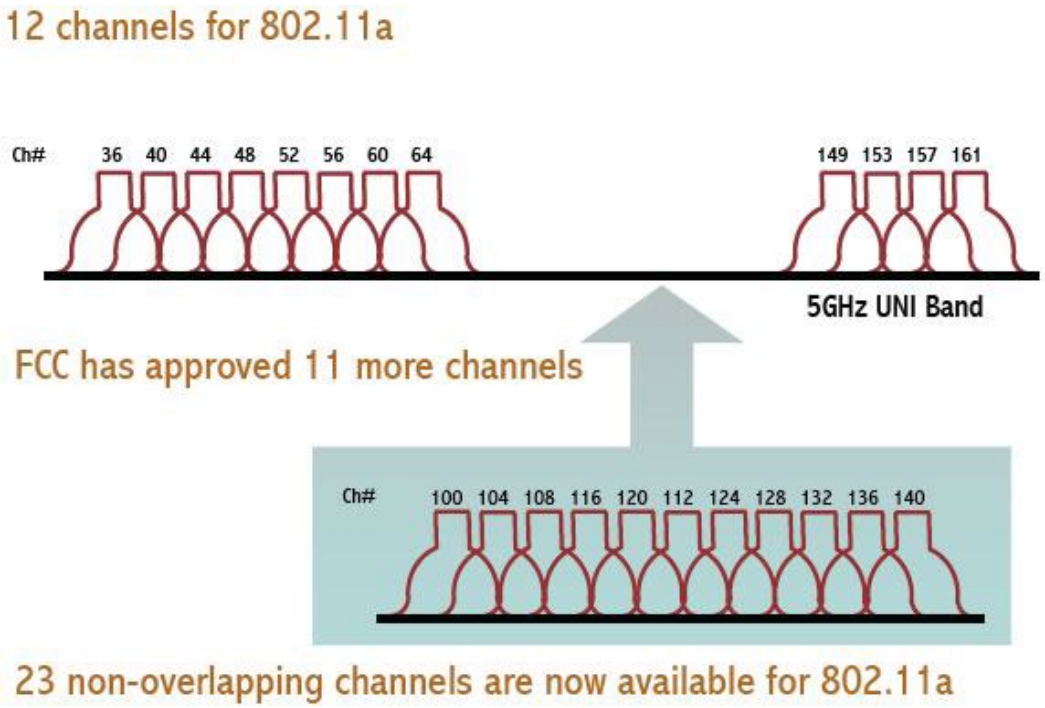
IEEE 802.11b/ g Wireless Spectrum

- 2.4 GHz Industrial Scientific and Medical (ISM) band
  - 2.40 GHz to 2.4835 GHz
  - Allows for 11 channels (US) to 13 channels (EU)



IEEE 802.11a Wireless Spectrum

- 5 GHz ISM band
  - 5.725GHz to 5.875 GHz
  - Allows for 23 channels



Factors Affecting Wireless LAN Performance

- Intel and IBM suggested six factors affecting wireless LAN performance:
  - Interference
    - Likely to occur in the 2.4GHz RF environment
    - Interference from devices using the same RF: Bluetooth, microwave oven, cordless phones.
    - Will significantly lower the Signal to Noise Ratio (SNR)
    - Signal/Noise (SNR)

Factors Affecting Wireless LAN Performance

- Antenna
  - Determines the amount of radio frequency energy being transmitted or received and the direction of the wave being directed.
  - the attributes of the antenna are the antenna gain, diversity and cable length
- Scattering and Multipath Fading
  - refers to the signal being scattered and goes indirectly towards the intended receiver through multipath routes.
  - Increases time difference of the client receiving parts of packets

Factors Affecting Wireless LAN Performance (cont.)

- System Design
  - Comprises of three subcategories:
    - Transmit power : More power to transmit data, the better performance
    - Turn-around time: Time for client to switch modes between transmitting and receiving
    - Receiver sensitivity: Minimum receiver power threshold
- Network Loads
  - Amount of users and traffic mix
  - In traffic mix, some applications may demand for higher bandwidth

Factors Affecting Wireless LAN Performance (cont.)

- Location Factors
  - Distance between the AP and the clients
  - The farther the distance between the two devices, the lower the performance will be
  - Performance may be affected by the orientation of clients, depending on the location and distance of antenna and AP