COMPUTER NETWORKS

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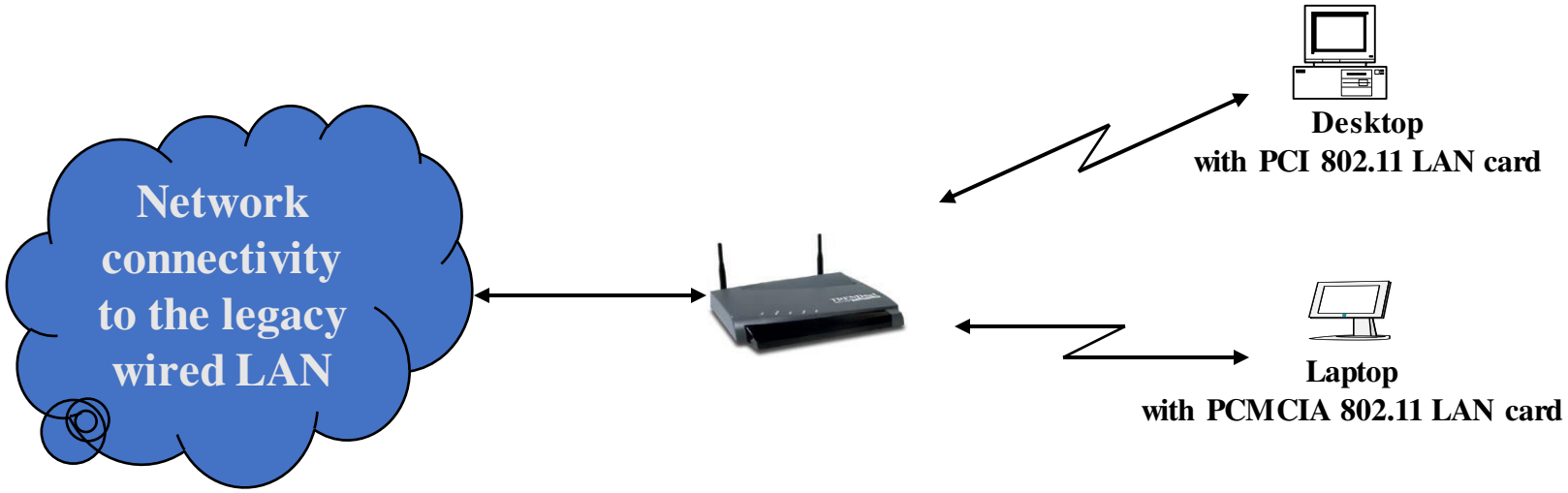
Unit – 5 Link Layer and LAN Roadmap

- Introduction
- Error detection, correction
- Multiple access protocols
- LANs
  - Addressing, ARP
  - Ethernet
  - Switches
- A day in the life of a web request
- Physical layer
  - Purpose, Signals to Packets
  - Analog Vs Digital Signals
  - Transmission Media
- Wireless LANs: IEEE 802.11

Class 55 : IEEE 802.11- Wireless LAN : Learning Objectives

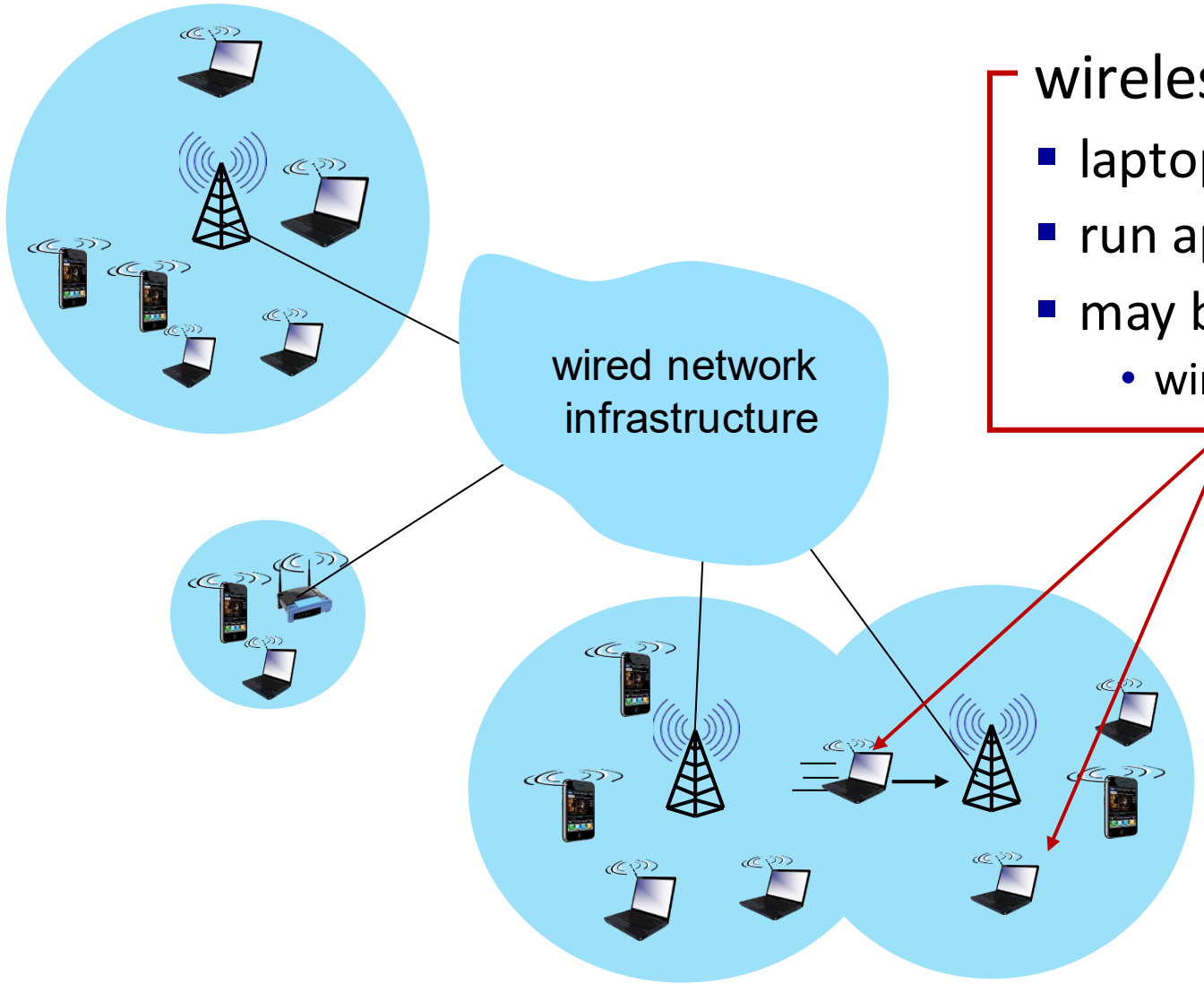
- Why, What- Wireless LAN
- 802.11 Architecture

Wireless LAN



- Provides network connectivity over wireless media
- An Access Point (AP) is installed to act as Bridge between Wireless and Wired Network
- The AP is connected to wired network and is equipped with antennae to provide wireless connectivity

Elements of a Wireless Network



wireless hosts

- laptop, smartphone, IoT
- run applications
- may be stationary (non-mobile) or mobile
  - wireless does *not* always mean mobility!

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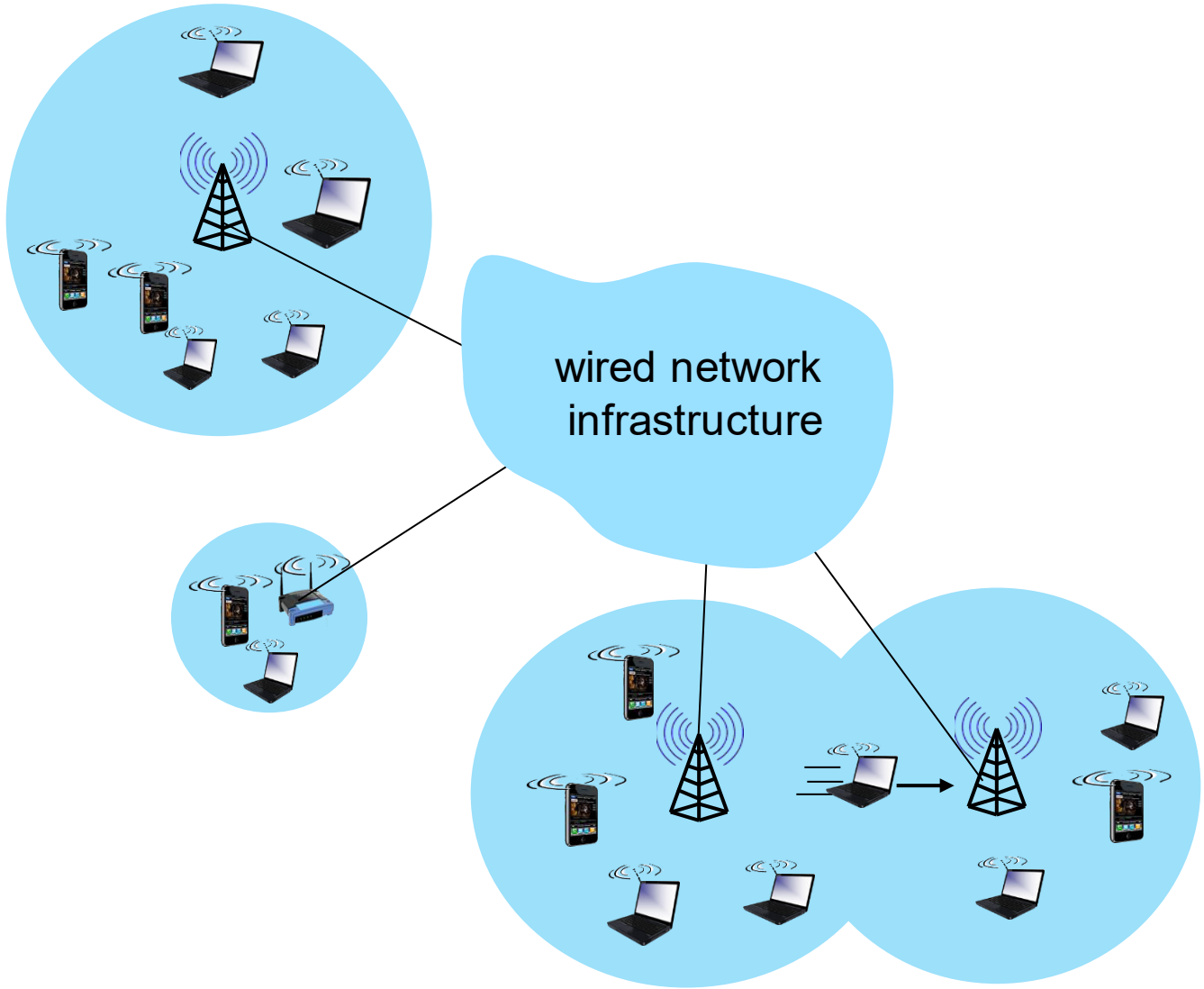
Elements of a Wireless Network



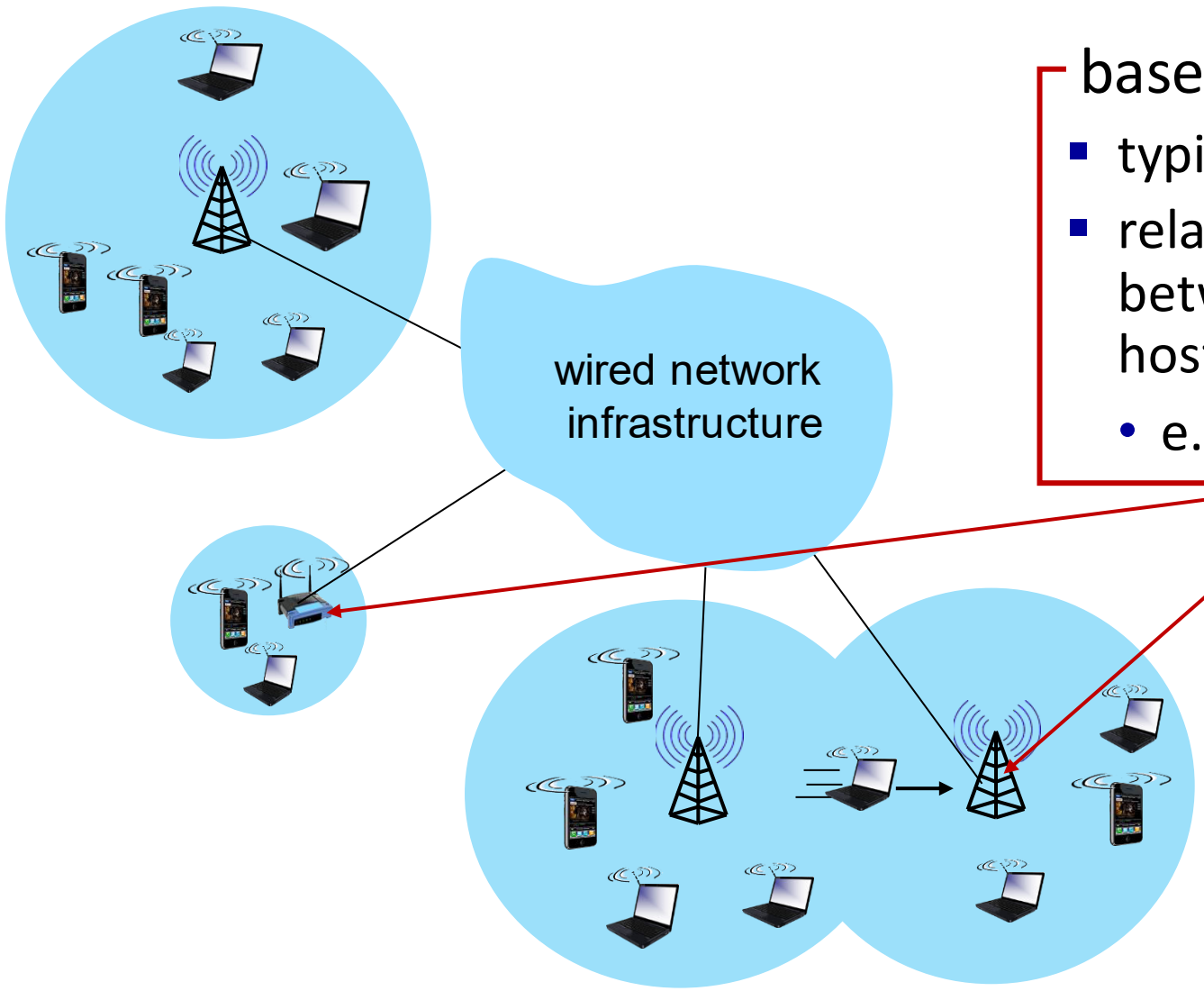
IEEE 802.11- Wireless LAN

IEEE 802.11 defines

- MAC protocol and
- Physical medium specification

for wireless LANs

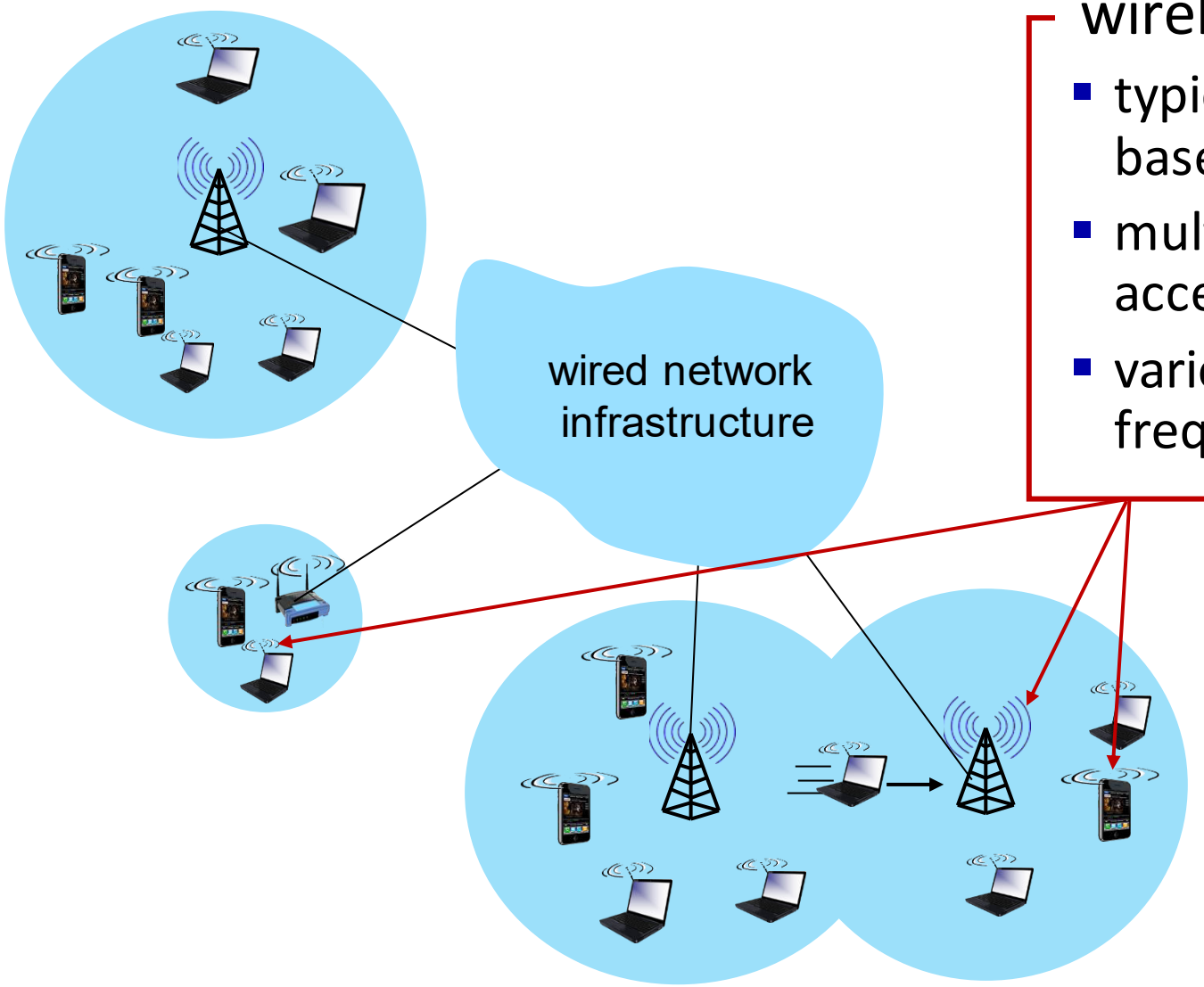
Elements of a Wireless Network



base station

- typically connected to wired network
- relay - responsible for sending packets between wired network and wireless host(s) in its "area"
  - e.g., **cell towers**, **802.11 access points**

Elements of a Wireless Network



wireless link

- typically used to connect mobile(s) to base station, also used as backbone link
- multiple access protocol coordinates link access
- various transmission rates and distances, frequency bands

IEEE 802.11- Terminology

Access point (AP)	Any entity that has station functionality and provides access to the distribution system via the wireless medium for associated stations
Basic service set (BSS)	A set of stations controlled by a single coordination function.
Coordination function	The logical function that determines when a station operating within a BSS is permitted to transmit and may be able to receive PDUs.
Distribution System (DS)	A system used to interconnect a set of BSSs and integrated LANs to create an ESS.
Extended service set (ESS)	A set of one or more interconnected BSSs and integrated LANs that appear as a single BSS to the LLC layer at any station associated with one of these BSSs.
MAC protocol data unit (MPDU)	The unit of data exchanged between two peer MAC entites using the services of the physical layer.
MAC service data unit (MSDU)	Information that is delivered as a unit between MAC users.
Station	Any device that contains an IEEE 802.11 conformant MAC and physical layer.

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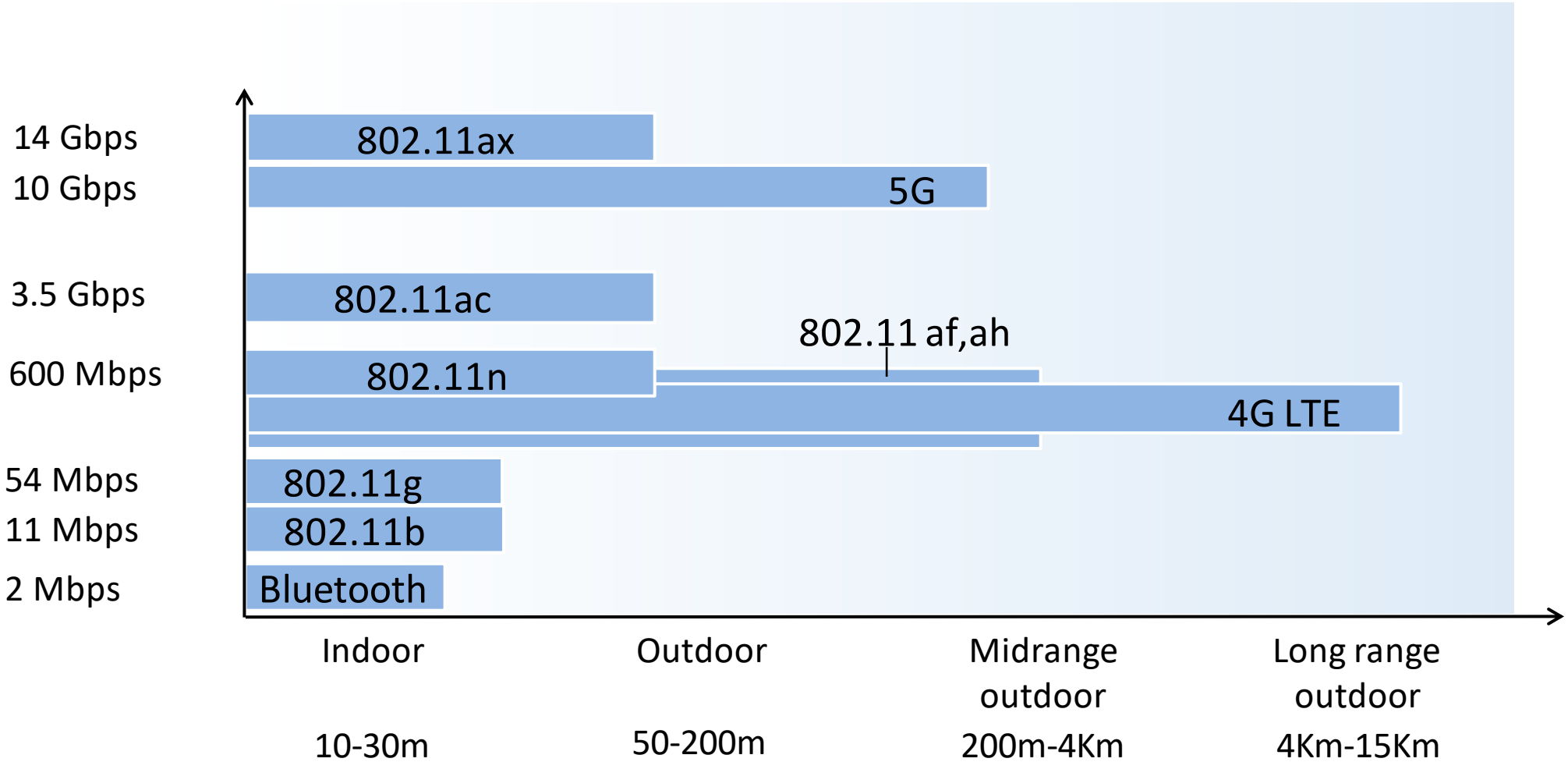
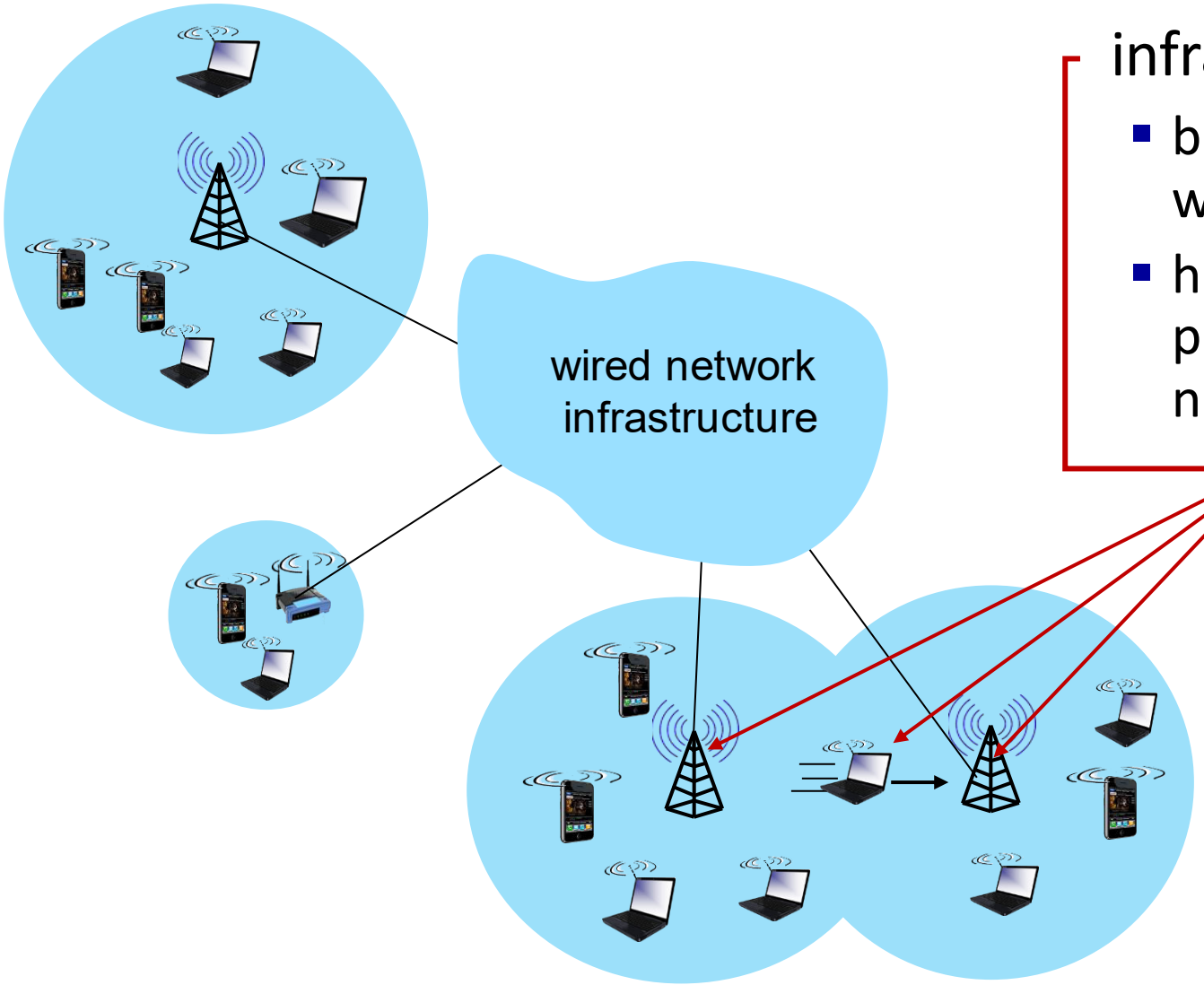
Characteristics of Selected Wireless Links



2 Key Areas:

Coverage area & Link rate

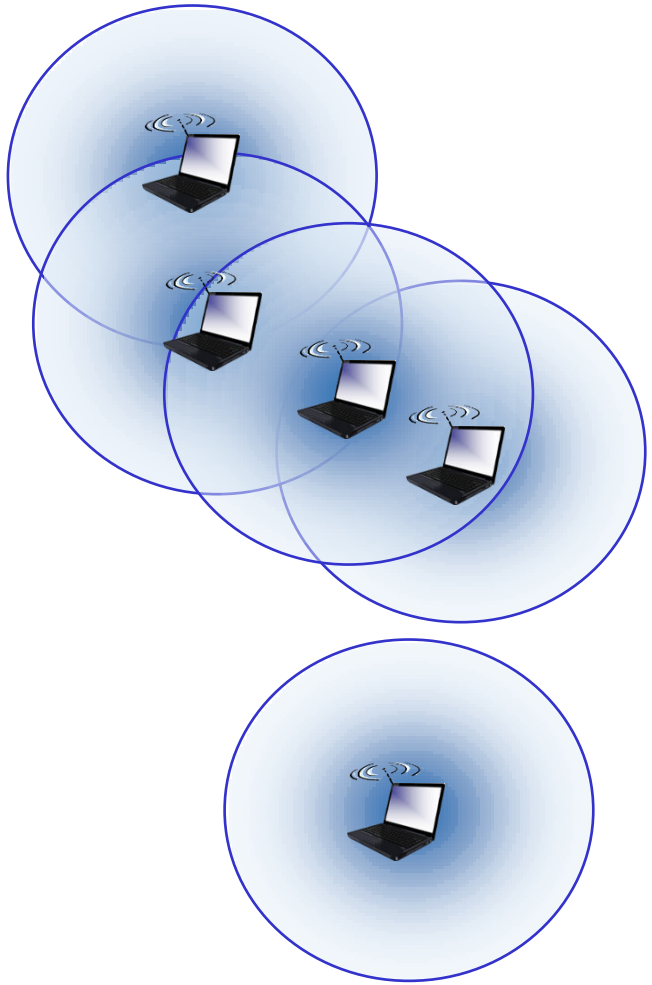
Wireless Network



infrastructure mode

- base station connects mobiles into wired network
- handoff: mobile changes base station providing connection into wired network

Wireless Network



ad hoc mode

- no base stations
- nodes can only transmit to other nodes within link coverage
- nodes organize themselves into a network: routing, address assignment, DNS-like name translation, and more.

Wireless network taxonomy

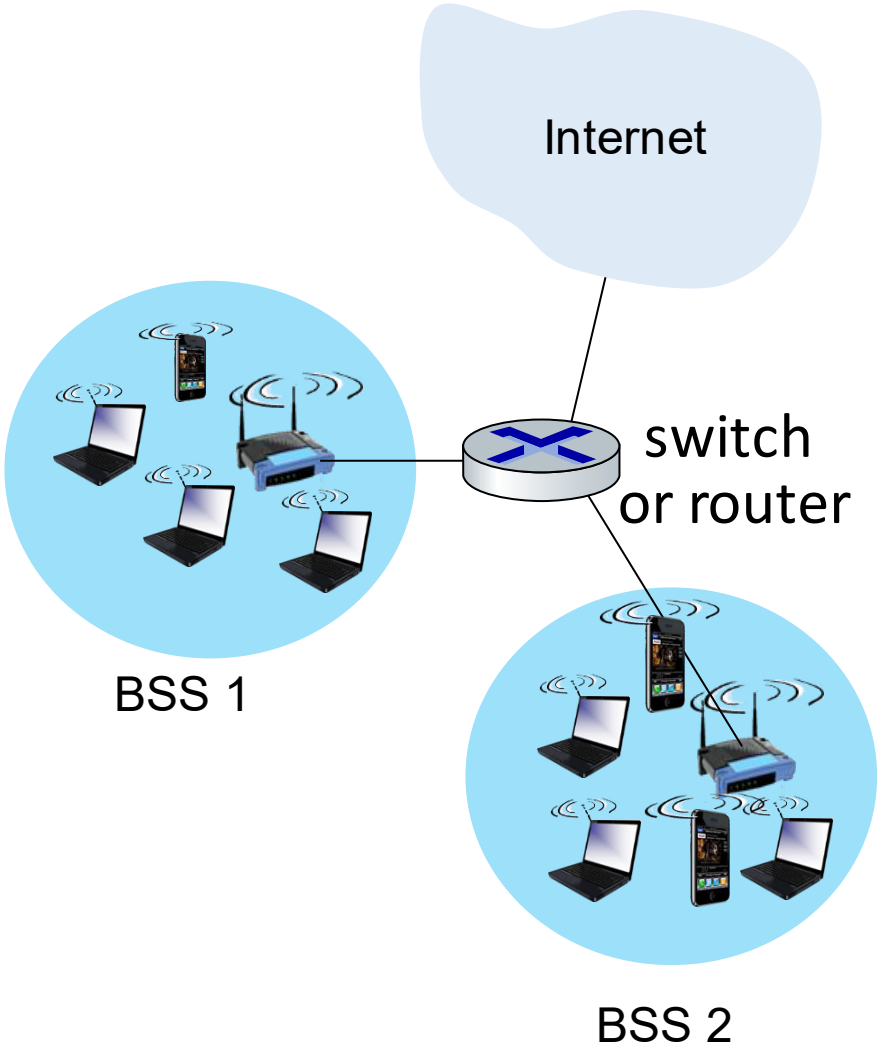
	single hop	multiple hops
infrastructure (e.g., APs)	host connects to base station (WiFi, cellular) which connects to larger Internet. **Eg: 4G LTE**	host may have to relay through several wireless nodes to connect to larger Internet: ***mesh net***
infrastructure less	no base station, no connection to larger Internet. eg: **Bluetooth, ad hoc nets**	no base station, no connection to larger Internet. May have to relay to reach other. **eg: MANET, VANET**

IEEE 802.11 Wireless LAN (WiFi)

IEEE 802.11 standard	Year	Max data rate	Range	Frequency
802.11b	1999	11 Mbps	30 m	2.4 Ghz
802.11g	2003	54 Mbps	30m	2.4 Ghz
802.11n (WiFi 4)	2009	600	70m	2.4, 5 Ghz
802.11ac (WiFi 5)	2013	3.47Gpbs	70m	5 Ghz
802.11ax (WiFi 6)	2020 (exp.)	14 Gbps	70m	2.4, 5 Ghz
802.11af	2014	35 – 560 Mbps	1 Km	unused TV bands (54-790 MHz)
802.11ah	2017	347Mbps	1 Km	900 Mhz

- all use CSMA/CA for multiple access, and have base-station and ad-hoc network versions

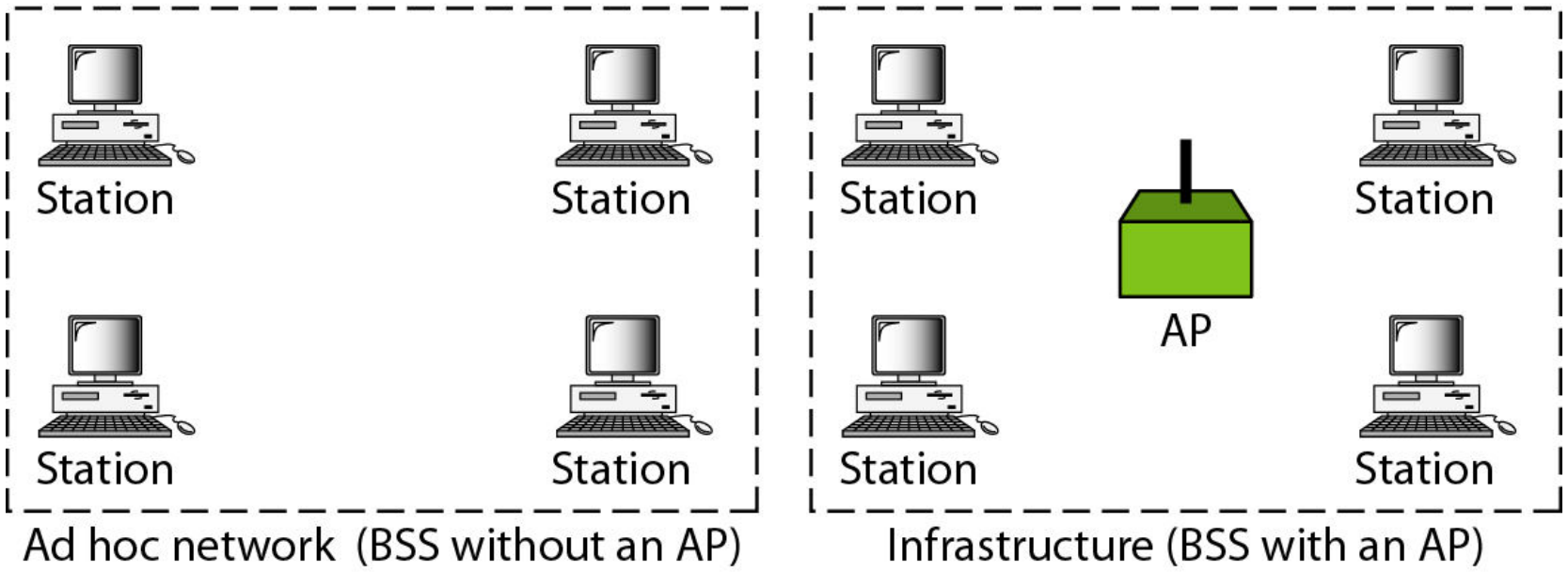
The 802.11 LAN architecture



- wireless host communicates with base station
  - base station = access point (AP)
- Basic Service Set (BSS) (aka “cell”) in infrastructure mode contains:
  - wireless hosts
  - access point (AP): base station
  - ad hoc mode: hosts only

Basic Service Set

BSS: Basic service set
AP: Access point



May be isolated or connect to backbone distribution system (DS) through access point (AP)

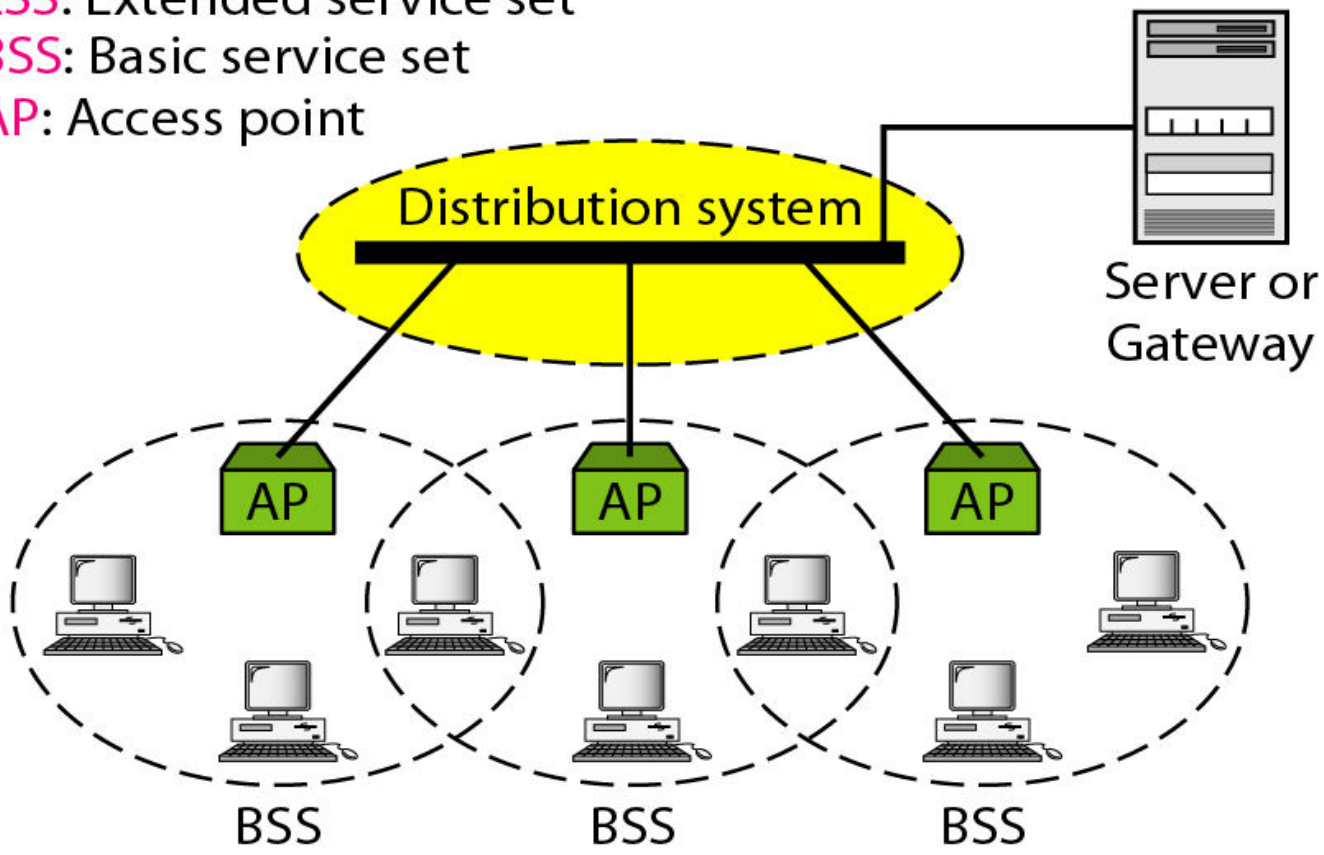
- AP functions as bridge

BSS- Smallest building block

- Number of stations
- Same MAC protocol
- Competing for access to same shared wireless medium

Extended Service Set

ESS: Extended service set
BSS: Basic service set
AP: Access point



An Access Point (AP) broadcasts SSID (service set identifier) roughly every 100 ms and at 1 Mbps (to accommodate the slowest client)

802.11: Channels, Association

- spectrum divided into channels at different frequencies
  - AP assigns **Service Set ID (SSID)**
  - AP admin chooses frequency for AP (**2.4 GHz to 2.4835 GHz**)
  - interference possible: channel can be same as that chosen by neighboring AP! – **WiFi Jungle**

- arriving host: must associate with an AP
  - scans channels, listening for *beacon frames* containing AP's name (SSID) and MAC address
  - selects AP to associate with
  - then may perform authentication
  - then typically run DHCP to get IP address in AP's subnet

BSS

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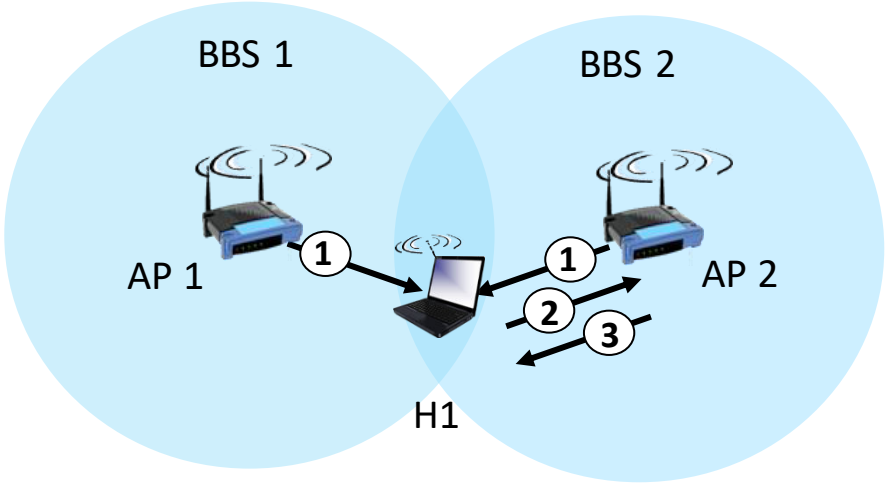
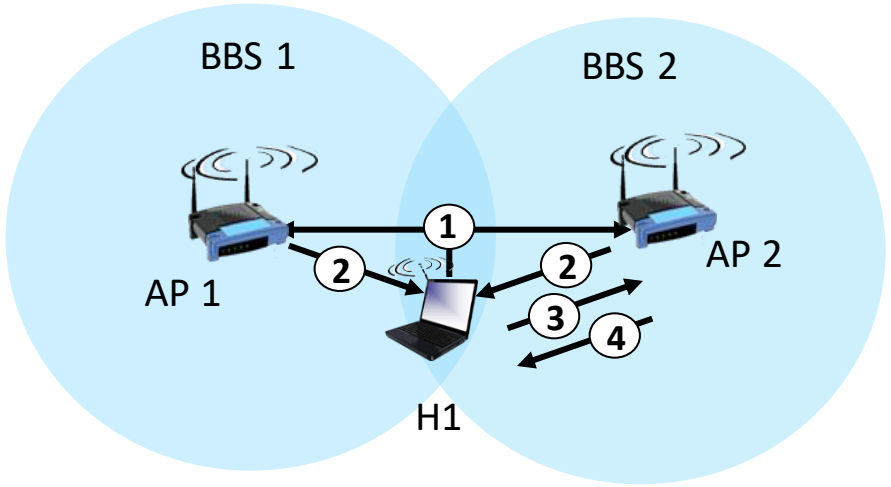
802.11 active/passive scanning





passive scanning:

(1) beacon frames sent from APs
(2) association Request frame sent: H1 to selected AP
(3) association Response frame sent from selected AP to H1

active scanning:

(1) Probe Request frame broadcast from H1
(2) Probe Response frames sent from APs
(3) Association Request frame sent: H1 to selected AP
(4) Association Response frame sent from selected AP to H1

Thank You
For Your Attention

THANK YOU

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