WIRELESS LOCAL AREA NETWORKS (LANS)

ECE 422 – DATA COMMUNICATION & COMPUTER NETWORKS

Tuesday, 14 April 2026

WHERE ARE WE IN THE SYLLABUS…

Course Content:

Introduction: Overview of Data Communications and Networking.

Physical Layer: Analog and Digital, Analog Signals, Digital Signals, Analog versus Digital, Data Rate Limits, Transmission Impairment, More about signals.

Digital Transmission: Line coding, Block coding, Sampling, Transmission mode.

Analog Transmission: Modulation of Digital Data; Telephone modems, modulation of Analog signals.

Multiplexing: FDM, WDM, TDM.

Transmission Media: Guided Media, Unguided media (wireless).

Data Link Layer: Error Detection and correction - Types of Errors, Detection, Error Correction; Data Link Control and Protocols-Flow and Error Control, Stop-and-wait ARQ. Go-Back-N ARQ, Selective Repeat ARQ, HDLC. Point-to-Point Access- Point–to-Point Protocol (PPP), PPP Stack, Multiple Access Random Access, Controlled Access, Channelization.

Network Layer: Host to Host Delivery: Internetworking, addressing and Routing Network Layer Protocols: ARP, IPV4, ICMP, IPV6 and ICMPV6

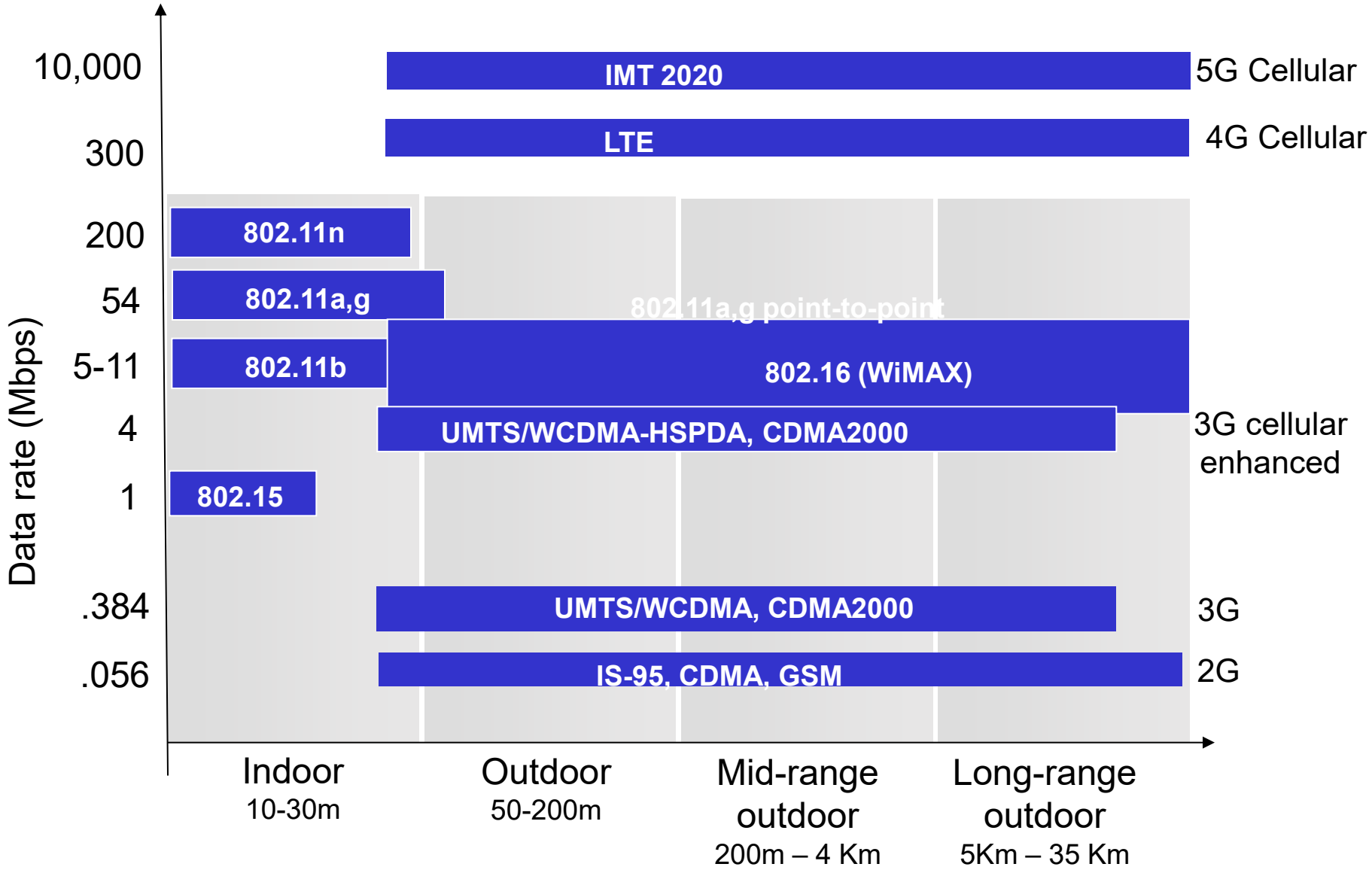
Transport Layer: Process to Process Delivery: UDP; TCP congestion control and Quality of service.

Application Layer: Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP) and file transfer (FTP) HTTP and WWW.

Local area Network: Ethernet - Traditional Ethernet, Fast Ethernet, Gigabit Ethernet; Token bus, token ring; Wireless LANs - IEEE 802.11, Bluetooth virtual circuits: Frame Relay and ATM.

Industrial Communication and Control Networks: Transmission methods, Network topology, Contemporary networks – Profibus, Controller Area Network (CAN), DeviceNet, CANopen, Actuator Sensor Interface (AS-1),Industrial Ethernet.

WIRELESS STANDARDS



IEEE 802.11
WiFi and its variants

IEEE 802.15
Wireless Personal Area Network (WPAN)/Blue Tooth, Zigbee.

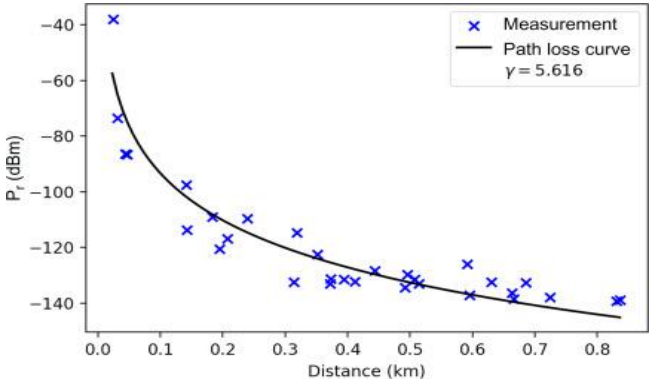
IEEE 802.16
Worldwide Interoperability Microwave Exchange (WiMax)

WIRELESS NETWORK TAXONOMY

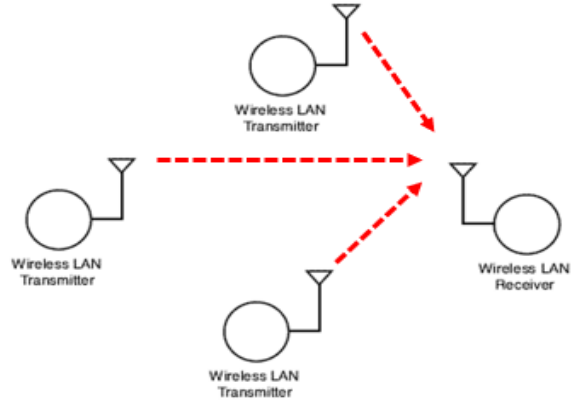
	SINGLE HOP	MULTIPLE HOPS	
INFRASTRUCTURE NETWORK	• Host connects to base station which connects to distant stations. **Examples:** WiFi, WiMAX, cellular.	• Host relays through several wireless nodes to connect to distant stations **Examples:** Internet and cellular wireless communication	
INFRASTRUCTURELESS NETWORK	• No base station • Host connects to a local node directly. **Examples:** Bluetooth, ZigBee when used as cable replacement to a computer.	• No base station, • Host relays through other similar nodes to connect to distant nodes. **Examples:** Bluetooth, ZigBee when used in sensor networks/ad hoc networks	

FACTORS AFFECTING WIRELESS COMMUNICATION

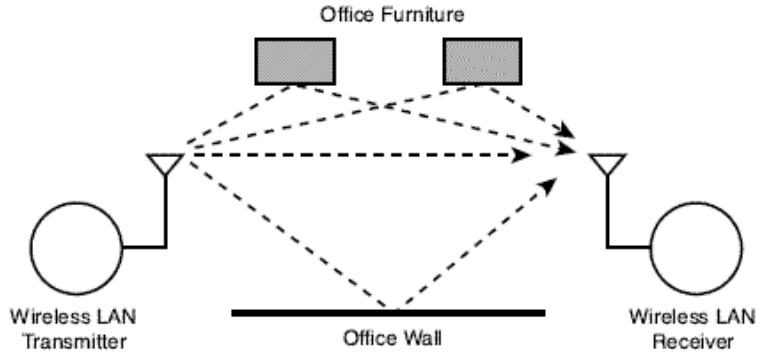
1. **Path Loss:** radio signal attenuates as it propagates through space



2. **Interference from other sources:** standardized wireless network frequencies (e.g., 2.4 GHz) shared by other devices (e.g., phone); devices (motors) interfere as well.

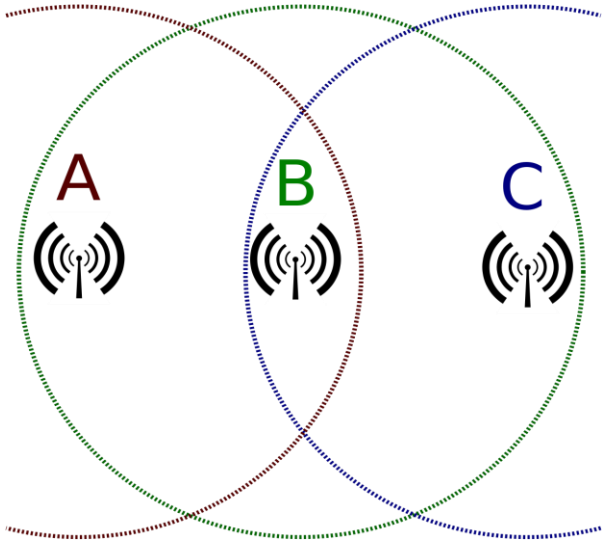


3. **Multipath propagation:** radio signal reflects off objects ground, arriving at destination at slightly different times.



HIDDEN TERMINAL PROBLEM

1. A station on a wireless LAN may not be able to transmit or receive from all other stations because of path loss, interference and/or multipath propagation.
2. In wired LANs, e.g. Ethernet, when one station sends a frame, all other stations receive it. The absence of this property in wireless LANs causes a variety of complications.
3. The problem of a wireless station not being able to detect a potential competitor for the medium because the competitor transmission losses is called the *hidden terminal problem.*

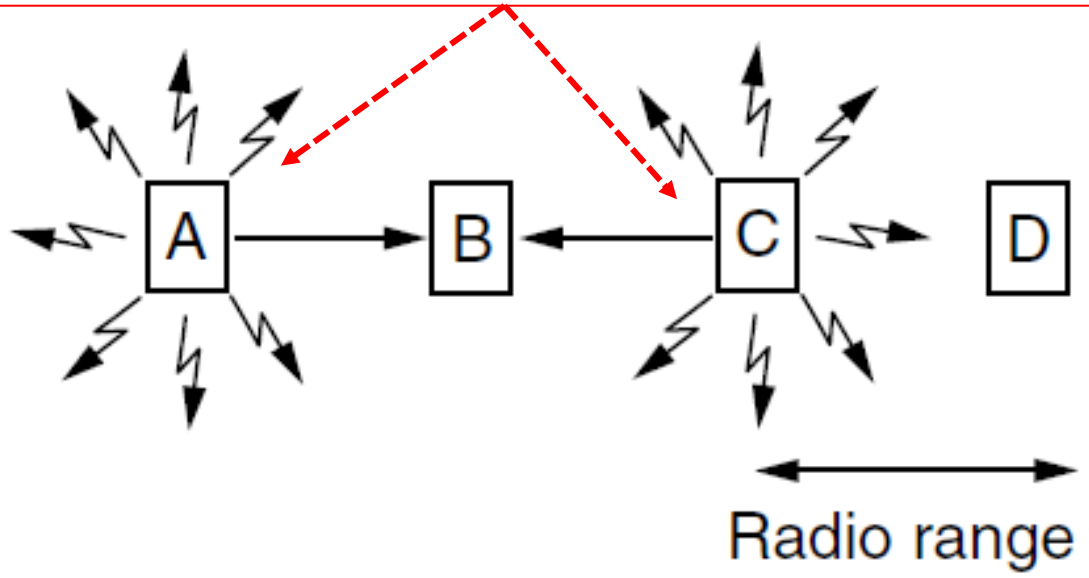


HIDDEN TERMINAL PROBLEM IN WIRELESS LANS

Hidden terminals are senders that cannot sense each other but nonetheless their transmissions collide at intended receiver

A and C are hidden terminals when sending to B

Because **C** cannot sense transmissions from **A**, it could start transmitting to **B** hence causing a collision.

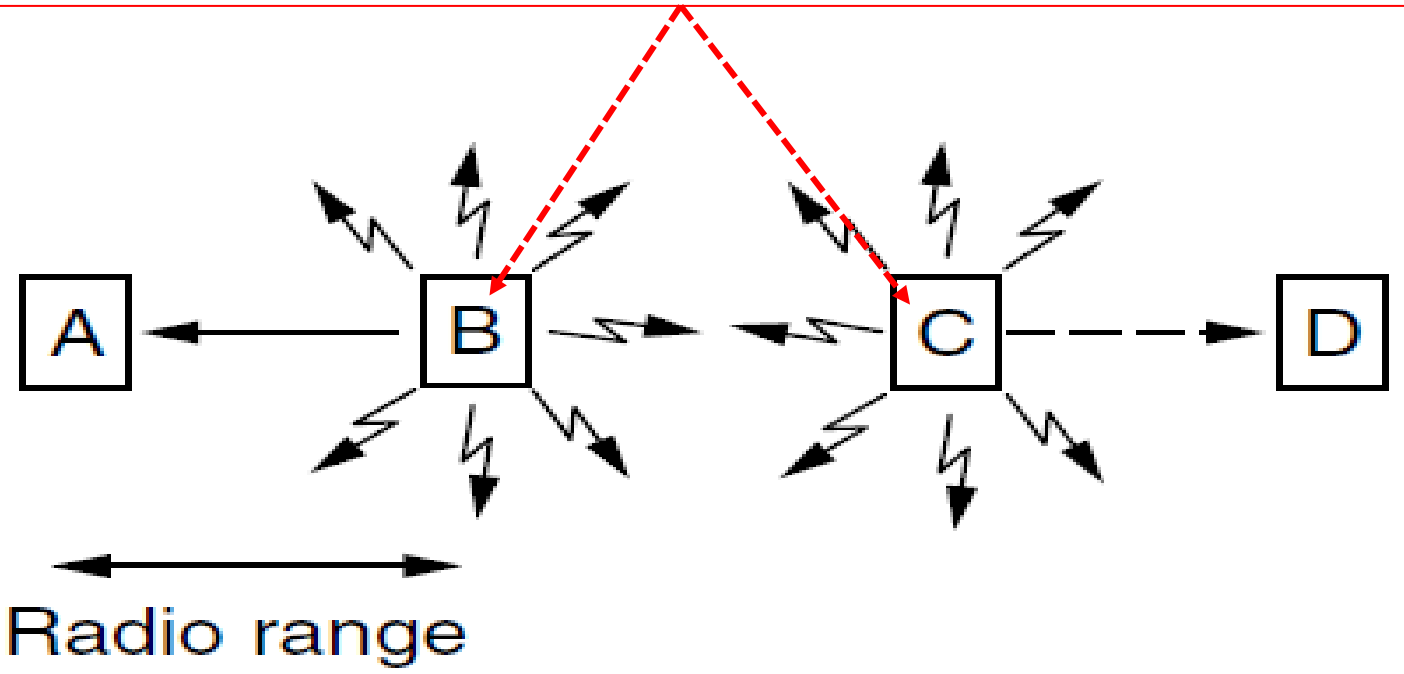


WIRELESS LANS– EXPOSED TERMINAL PROBLEM

Exposed terminal Problem arises in wireless communications when terminals that could communicate to each other are restrained from doing so because they are exposed to transmisssions from other terminals.

C is an exposed terminal to signals from B.

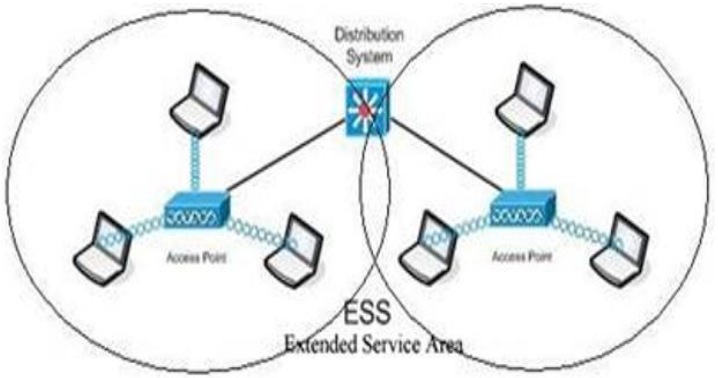
C could transmit safely to **D**, but because it is exposed to transmissions from B, it is restrained from transmitting.



IEEE 802.11 (WiFi)

1. **IEEE 802.11** is a wireless LAN specification which covers the physical and data link layers.

2. The standard defines two kinds of services, i.e
   1. **Basic Service Set (BSS)** made of stationary or mobile wireless stations and an optional central base station, known as the access point (AP).
   2. **The Extended Service Set (ESS)** made up of two or more BSSs with APs.
   3. The BSSs are connected through a *distribution system,* which is usually a wired LAN.

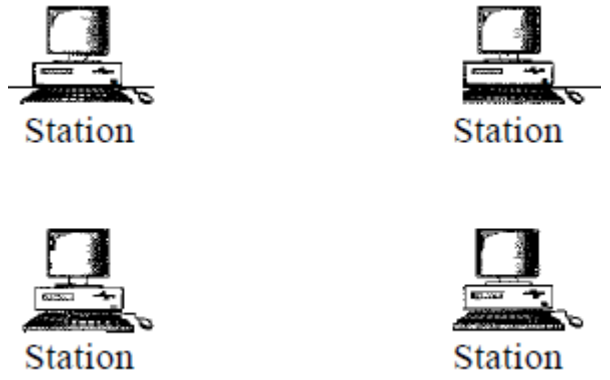


BASIC SERVICE SET

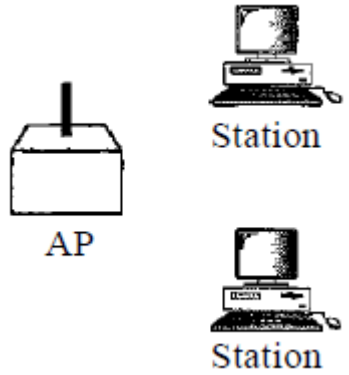
1. **Basic Service Set (BSS)** as the building block of a wireless LAN.

2. **BSS** without an Access Point (AP) is a stand-alone network and cannot send data to other BSSs. It is called an **Ad Hoc Network**.

3. **BSS** with an Access Point is sometimes referred to as an **infrastructure network**.



(a) Ad hoc network (no Access Point

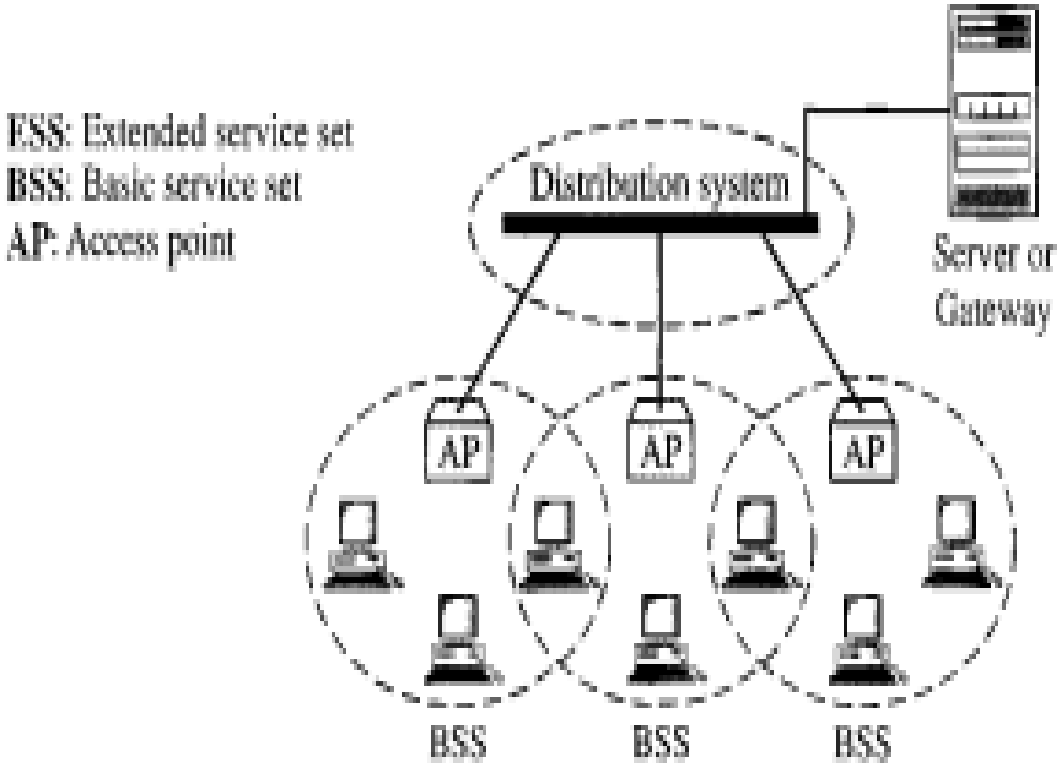


(b) Infrastructure Network

EXTENDED SERVICE SET

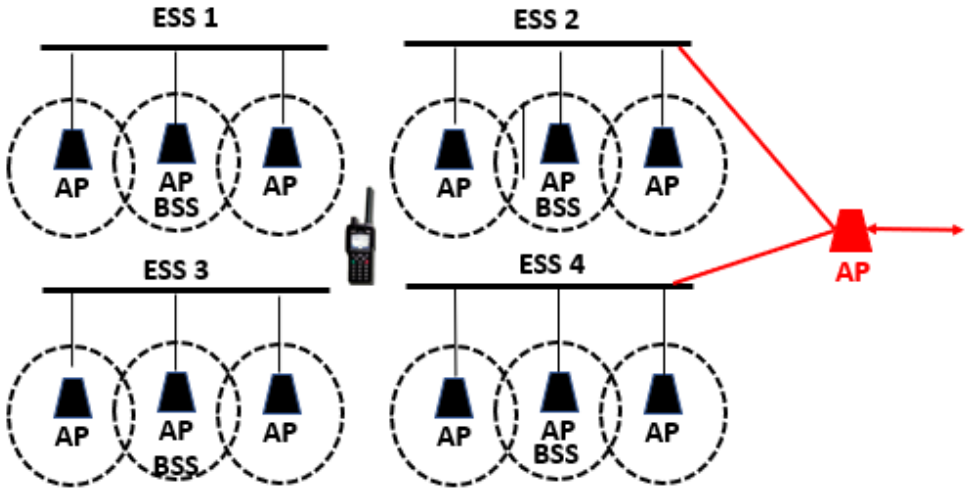
1. **Extended Service Set (ESS)** is made up of two or more BSSs with APs which are connected through a distribution system (usually wired LAN).

2. Extended Service Set uses two types of stations, i.e **mobile (inside the BSS)** and **stationary (Wired LAN).**



IEEE 802.11 STATION TYPES

1. IEEE 802.11 defines three types of stations based on their mobility in a wireless LAN, i.e
   a) **no-transition** which is either stationary or moving but only inside a BSS.
   b) **BSS transition** which can move from one BSS to another, but the movement is confined inside one ESS.
   c) **ESS-transition** mobility which can move from one ESS to another



WHAT IS BLUETOOTH?

1. **Bluetooth** is a global, RF-based (S-BAND - ISM band: 2.4GHz), short-range, connectivity technology & solution for portable, personal devices
   a) it is not just a radio
   b) create piconets on-the-fly (appr. 1Mbps)
      - piconets may overlap in time and space for high aggregate bandwidth
2. Bluetooth protocol operates at 2.4GHz in the same unlicensed ISM frequency band where RF protocols like ZigBee and WiFi.
3. The Bluetooth specification comprises:
   a) a hardware and software protocol specification
   b) usage case scenario profiles and interoperability requirements

BLUETOOTH ARCHITECTURE / 01

Communication

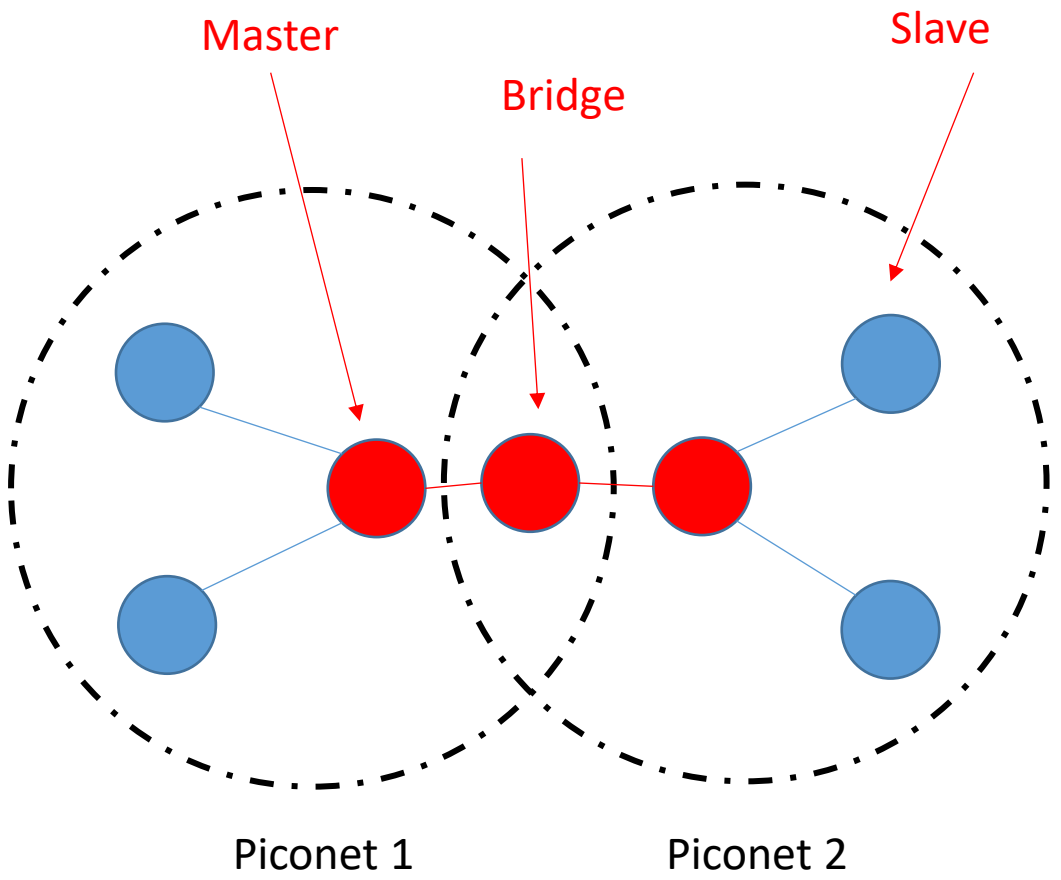
- Bluetooth communication occurs between a master and a slave station. A slave can only connect to one master.
- Bluetooth radios are symmetric in that the same device may operate as a master and also the slave.

Piconets

- Two or more radio devices together form **ad-hoc** networks called piconets.
- All units within a piconet share the same channel.
- Each piconet has one master device and one or more slaves. There may be up to seven active slaves at a time within a piconet.
- A device may be a master in one piconet and a slave in another or a slave in more than one piconet.

Scatternet

- Multiple piconets with overlapping coverage areas form a scatternet.



(a) Scatternet

BLUETOOTH ARCHITECTURE / 02

Radio designation

- Connected radios can be master or slave
- Radios are symmetric (same radio can be master or slave)

Piconet

- Master can connect to 7 simultaneous or 200+ inactive (parked) slaves per piconet
- Each piconet has maximum channel capacity of 1 Mbps.
- Unique hopping pattern/ID

Scatternet

- High capacity system
- Minimal impact with up to 10 piconets within range