ITMC412

Introduction
Personal Area Networks
PAN

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- 20 test
- 30 HWs and Qs
- 50 Final

PAN Definition

- A Network for communicating between devices close to one's person.
- Range is typically a few meters
- < 10 m

The main characteristics of a WPAN are:

- Low cost,
- Low power,
- Short-range,
- Small networks.

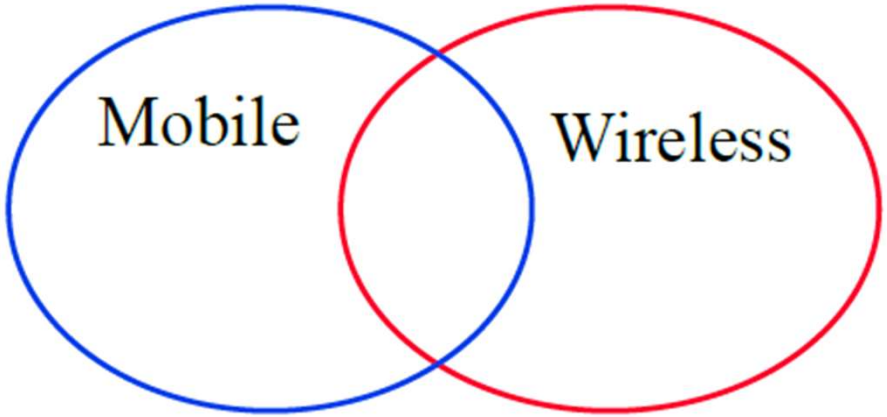
Wireless personal area networks differ from wireless local area networks at the interaction, packet format, type of devices, network build-out timeframe, relative cost, and general network architecture. The Wireless personal area network concerns highly mobile devices; it is cheaper and consumes less power.

Area Network

- Personal Area Network
- Short Range Networks
- Home Networks
- M2M Networks
- Body Area Network BAN

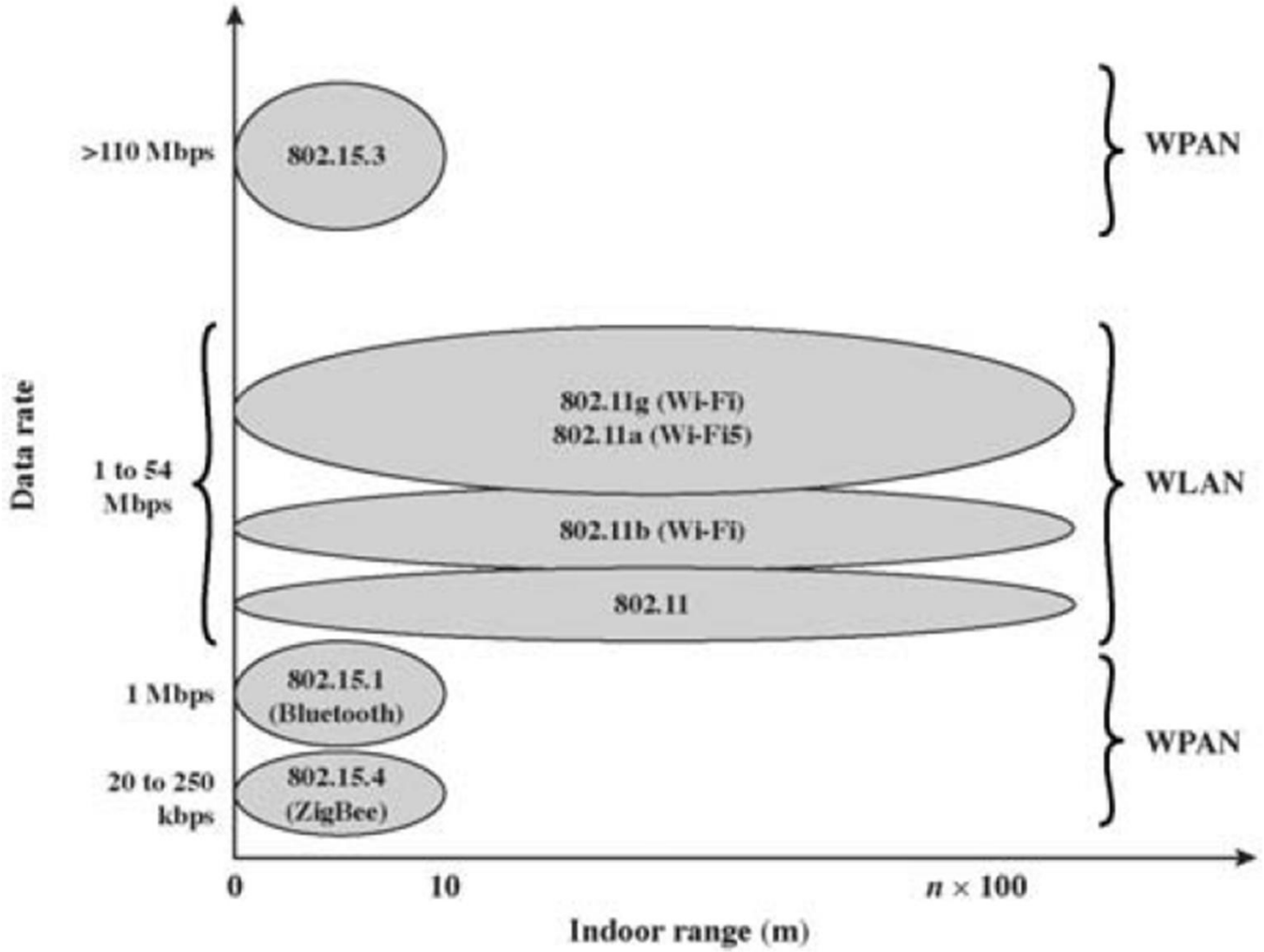
Home Network Areas

Standard	Area	Rate	Energy-constrained	Typical applications	Data Type
Zigbee	Personal area	Low	Yes	Automatic control	Sensors, monitoring, smart grid
Bluetooth	Personal area	Low	Yes	Music sharing	Voice, low-rate data, music
UWB	Personal area	High	No	Video, file sharing	Video, high-rate data, files
802.15.6	Body area	Low	Yes	Healthcare	Biomedical data
WiFi	Local area	High	No	Home thermostats, water metering	VoIP, data, video
Femtocell	Local area	High	No	Cellular phones	VoIP, data, video

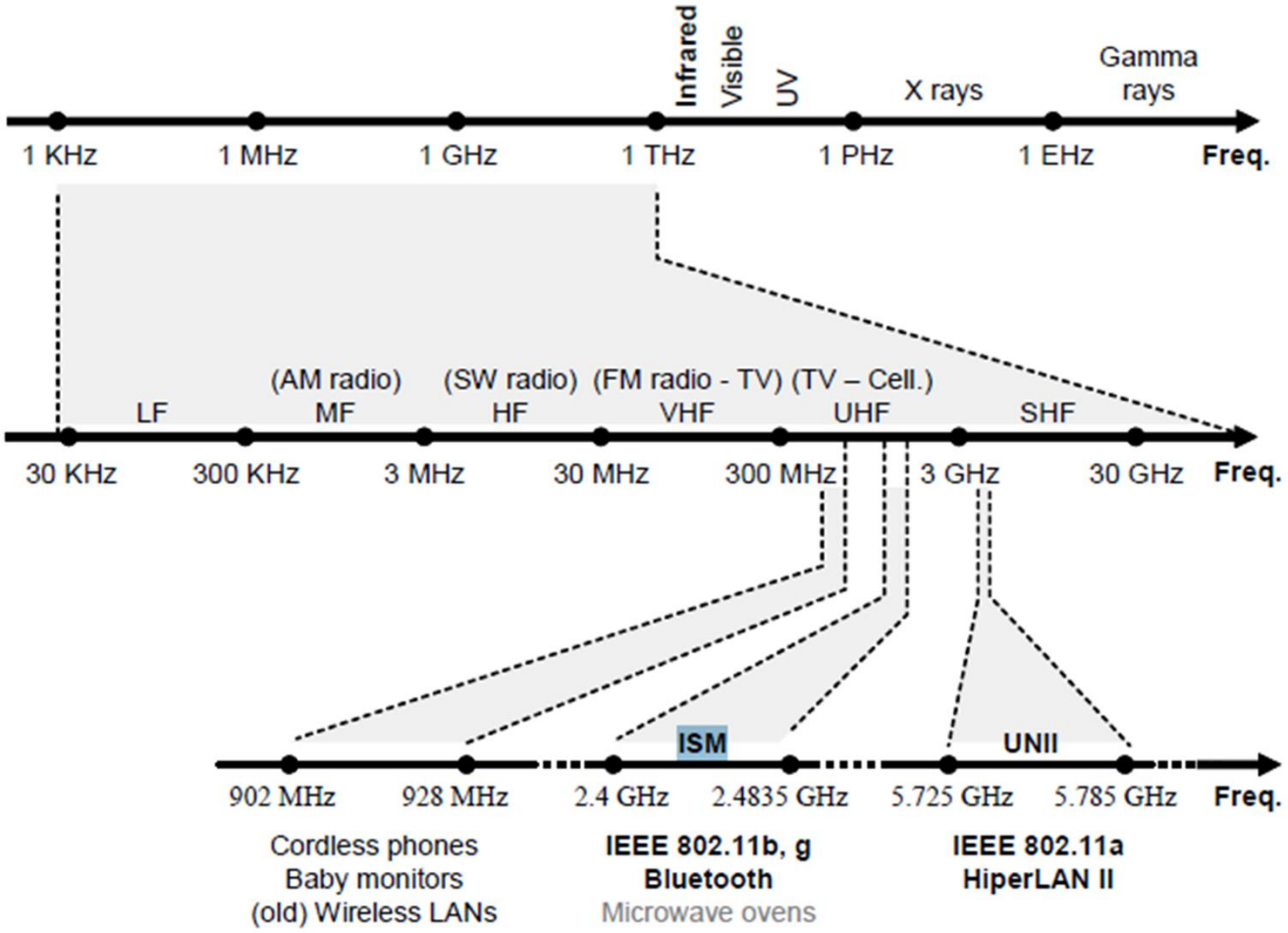


- Mobile vs Stationary
- Wireless vs Wired
- Wireless ⇒ media sharing issues
- Mobile ⇒ networking, addressing issues

Transmission Rate vs Range



Frequency Band



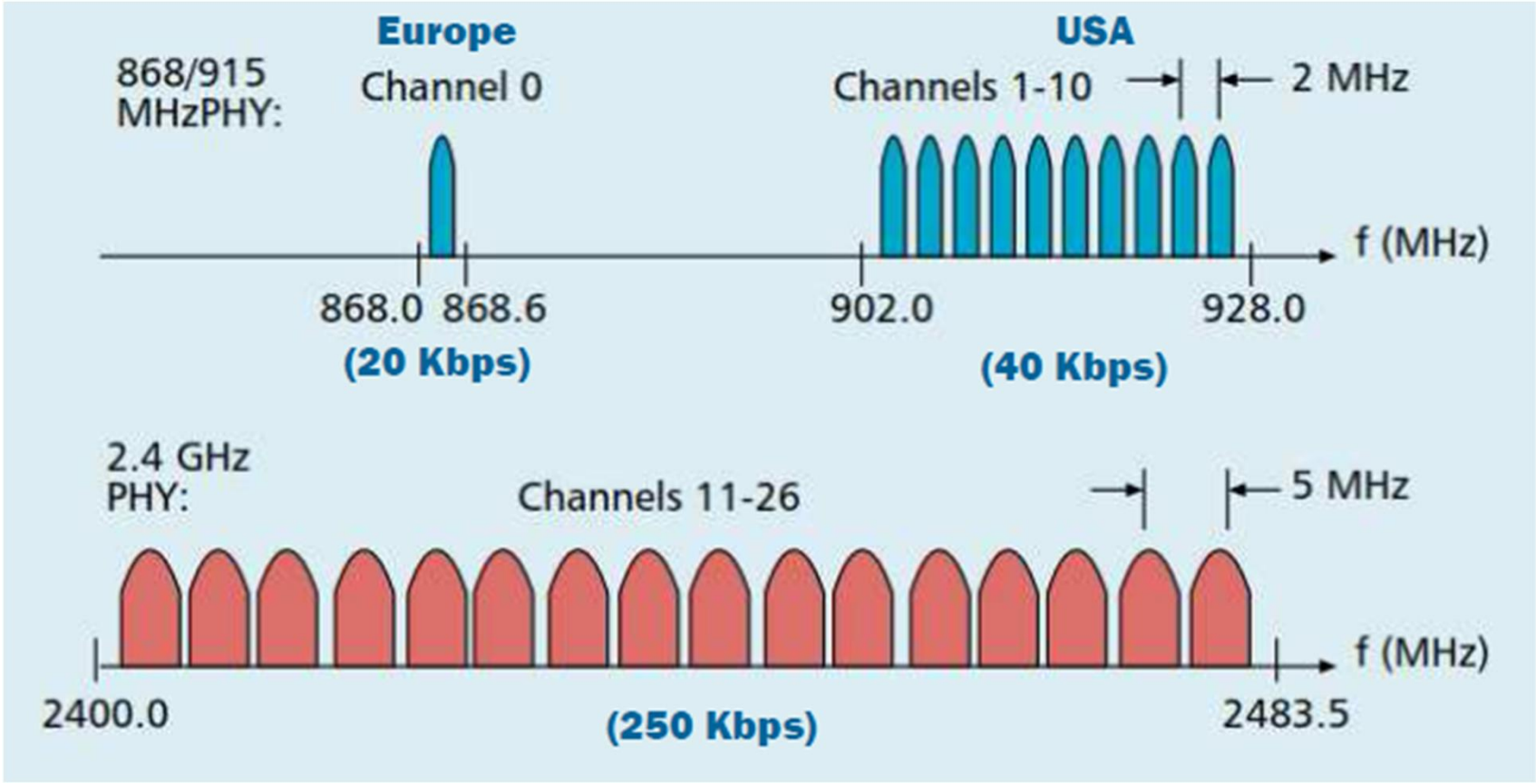
The electromagnetic spectrum allocation. ISM = Industry, Science & Medicine, UNII = Unlicensed National Information Infrastructure.

Unlicensed Band

Unlicensed spectrum location in the United States.

Unlicensed Bands	Spectrum
ISM: Industry, Science and Medicine 902-928 MHz, 2.4-2.4835 GHz & 5.725-5.85 GHz	234.5 MHz
UPCS: Unlicensed PCS Asynchronous: 1910-1920, 2390-2400 MHz Isochronous: 1920-1930 MHz	 20 MHz 10 MHz
UNII: Unlicensed National Information Infrastructure UNII (5.15-5.25 GHz) UNII (5.25-5.35 GHz) UNII (5.525-5.825 GHz)	 100 MHz 100 MHz 100 MHz
Millimeter Wave (59-64 GHz)	5 GHz

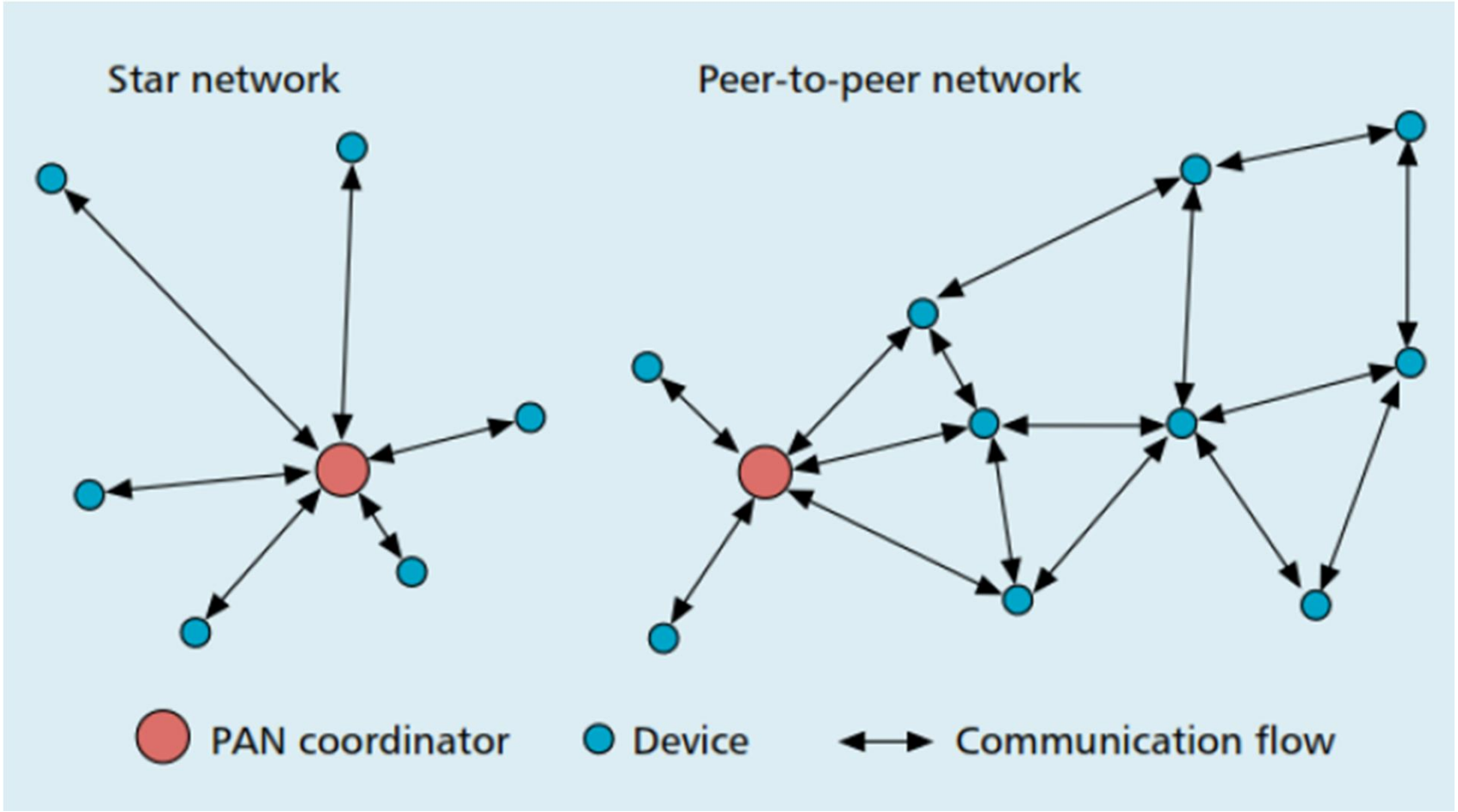
802.15.4 System Bands and Channels



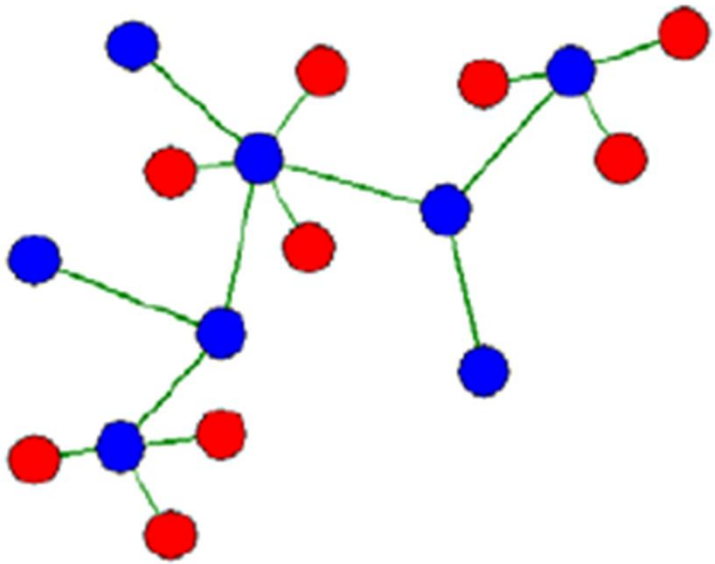
Networks

- Network: a set of electronic devices (nodes) connected by communication links.
- Node: Host, Router, end-device, intermediate-device.
- Link: physical communication medium
- Protocol: a set of rules that govern data communications.
- Standards: are agreed-upon rules and protocols between manufacturers of technology.
- Topology: the geometric representation of the relationship of all the nodes and links. Ring, Star, Bus, Mesh Topologies.
- Physical and Logical topology.
- Network Creteria: Performance, Reliability, and Security.

PAN Topologies



Combined Topology



Clustered stars - for example, cluster nodes exist between rooms of a hotel and each room has a star network for control.

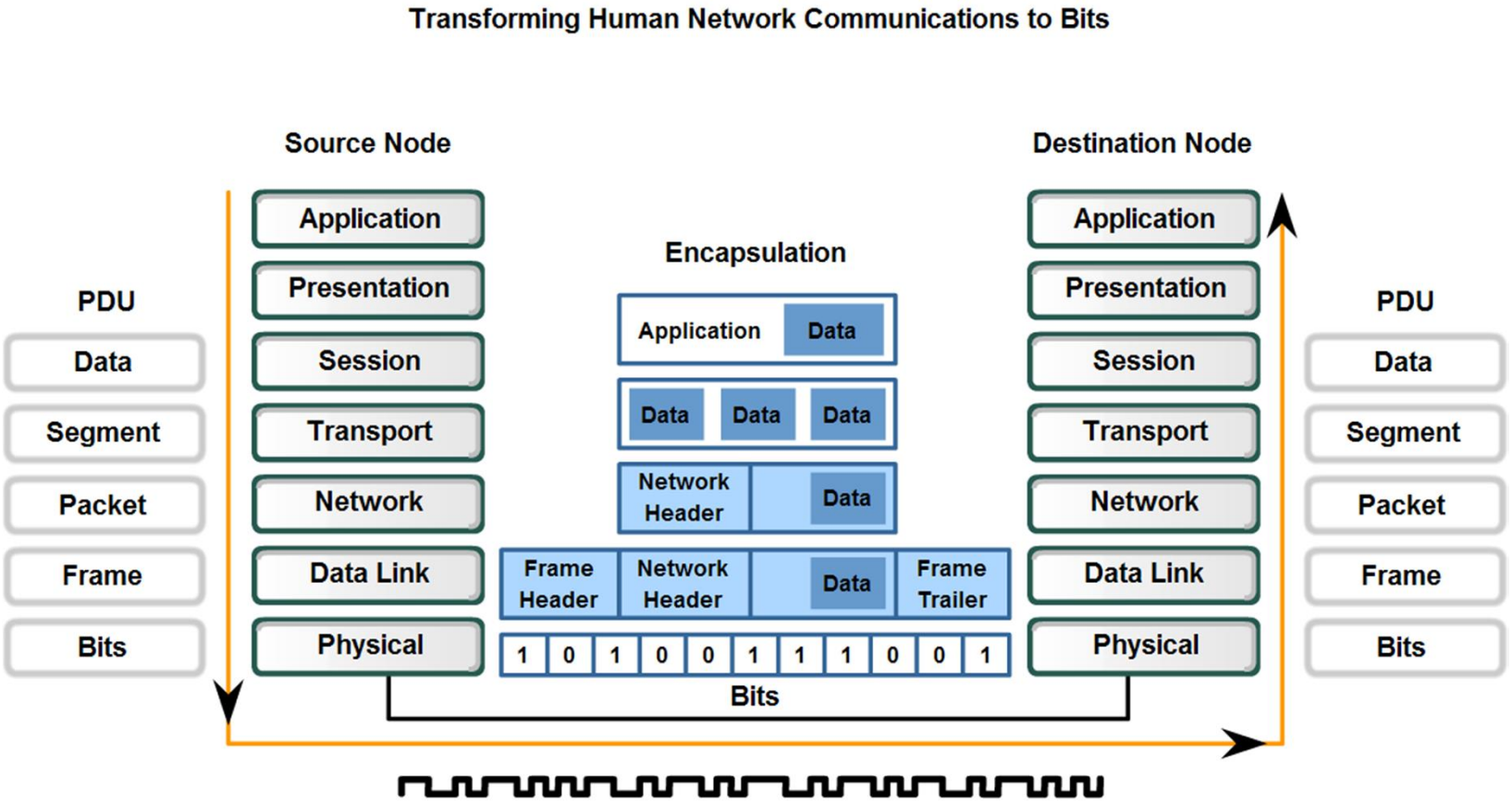
Full function device

Reduced function device

Communications flow

Protocols & Services

Describe the role of bits in representing a frame as it is transported across the local media.



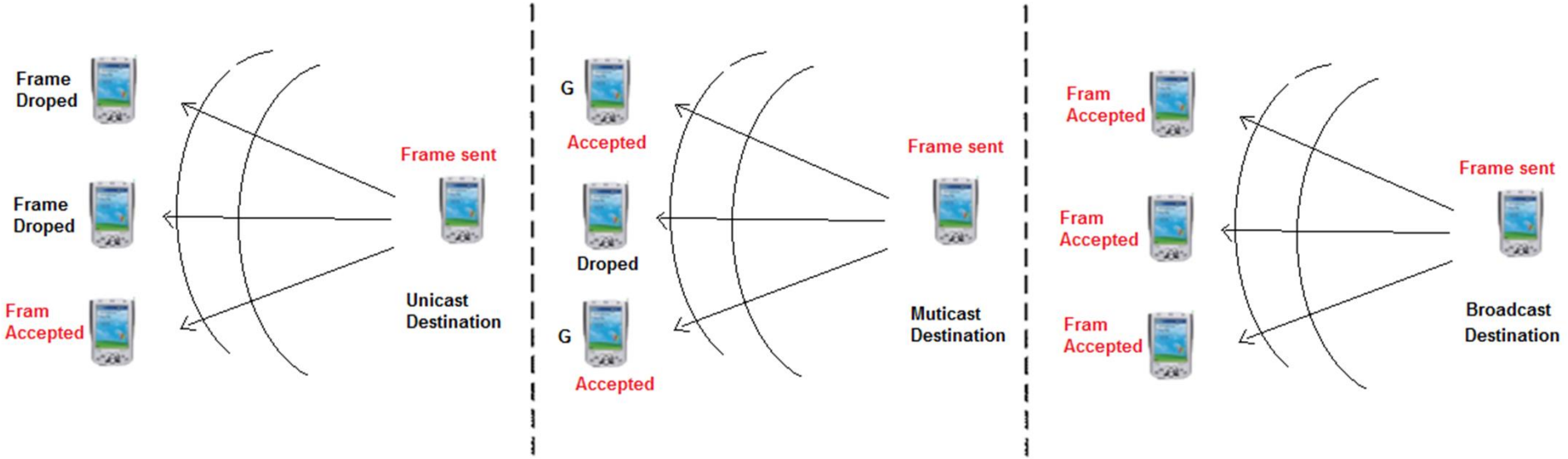
Addresses

- Link address of a device, also known as *MAC address, which is a physical address for a* given *network interface card (NIC), also known as network adaptor.*
- Network address of a device, also known as *IP address, which is a logical address.*

Address Type

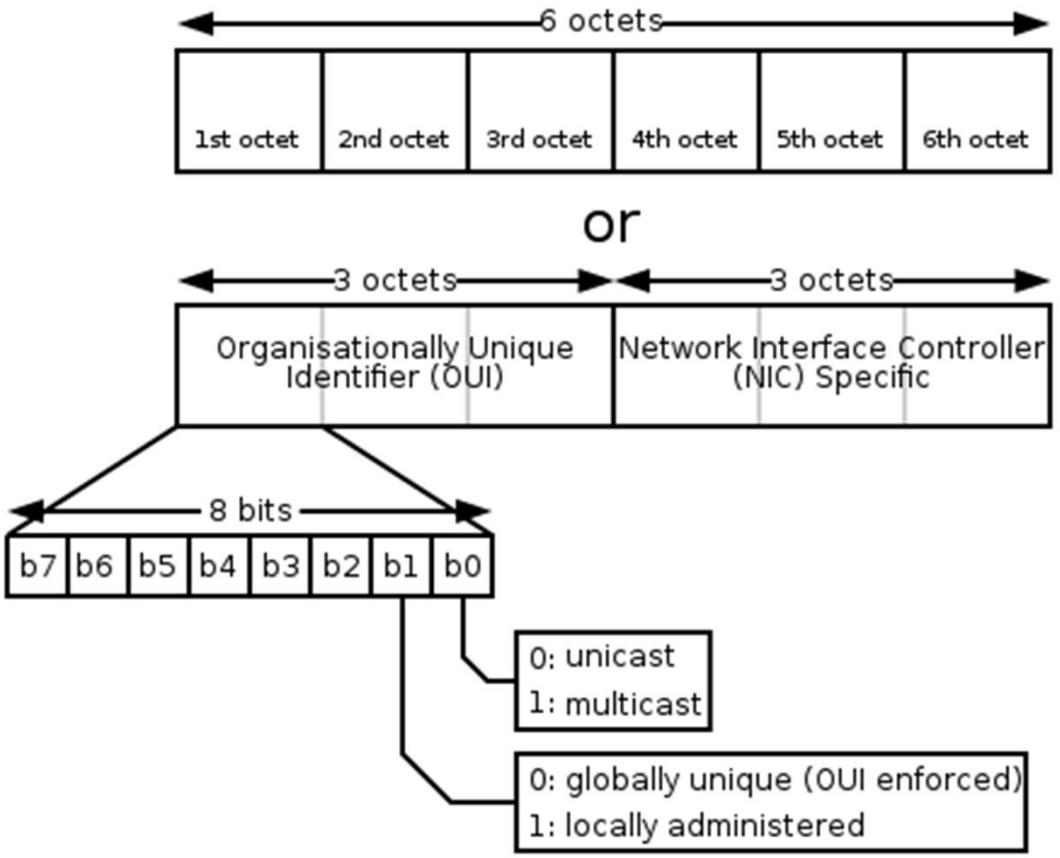
- Broadcast Address
- Unicast Address
- Multicast Address

Data Network Communication using Address-types

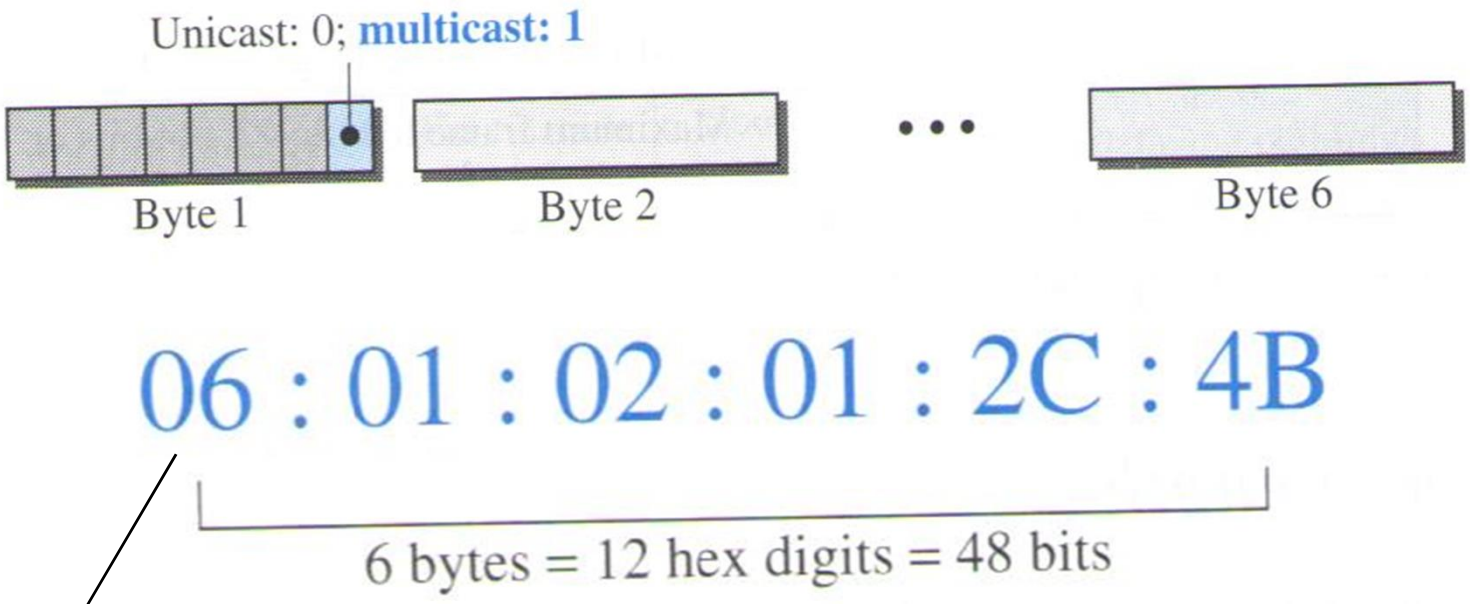


MAC address

- 48-bit address used to identify each device



MAC Address Type



unicast

0000 011**0**: 0000 0001: 0000 0010: 0000 0001: 0010 1100:0100 1011

Broadcast:

FF:FF:FF:FF:FF:FF

Example

Define the type of the following destination addresses:

a. 4A:30:10:21:10:1A
b. 47:20:1B:2E:08:EE
c. FF:FF:FF:FF:FF:FF

Solution

To find the type of the address, we need to look at the second hexadecimal digit from the left. If it is even, the address is unicast. If it is odd, the address is multicast. If all digits are F's, the address is broadcast. Therefore, we have the following:

a. This is a unicast address because A in binary is 1010 (even).
b. This is a multicast address because 7 in binary is 0111 (odd).
c. This is a broadcast address because all digits are F's.

The way the addresses are sent out on line is different from the way they are written in hexadecimal notation. The transmission is left-to-right, byte by byte; however, for each byte, the least significant bit is sent first and the most significant bit is sent last. This means that the bit that defines an address as unicast or multicast arrives first at the receiver.

Example

Show how the address 47:20:1B:2E:08:EE is sent out on line.

Solution

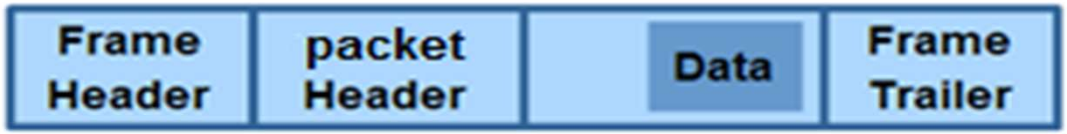
The address is sent left-to-right, byte by byte; for each byte, it is sent right-to-left, bit by bit, as shown below:

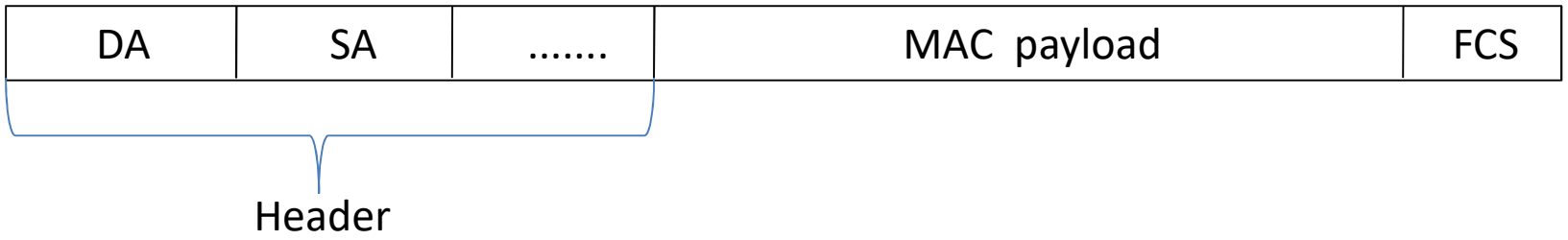
11100010 00000100 11011000 01110100 00010000 01110111

Frame

Encapsulates data while frame header contain:

- Destination Address (DA)
- Source Address (SA)





Network Performance

- Latency (E2E delay)
- Throughput
- Goodput
- Capacity and link bandwidth
- Load

Delay and Throughput

- Transmission Time (TT) = frame_size /tran_bit rate
- Propagation Time (PT)= distance/light_speed
- End_to_end Delay= TT + PT
- Throughput= frame_size/E2E_delay

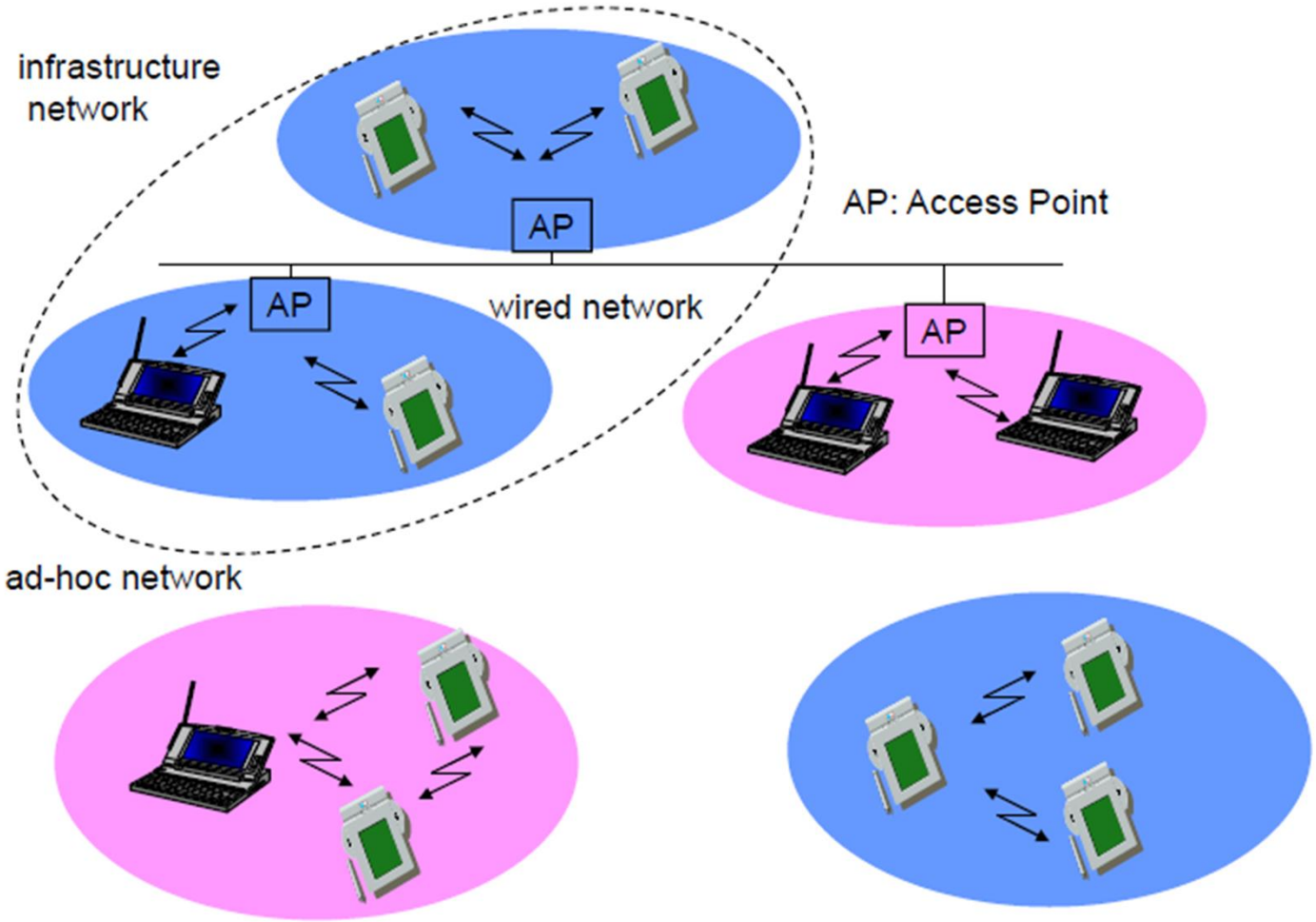
System Architecture

- Infrastructure System (Fixed network resource, and Access Points)

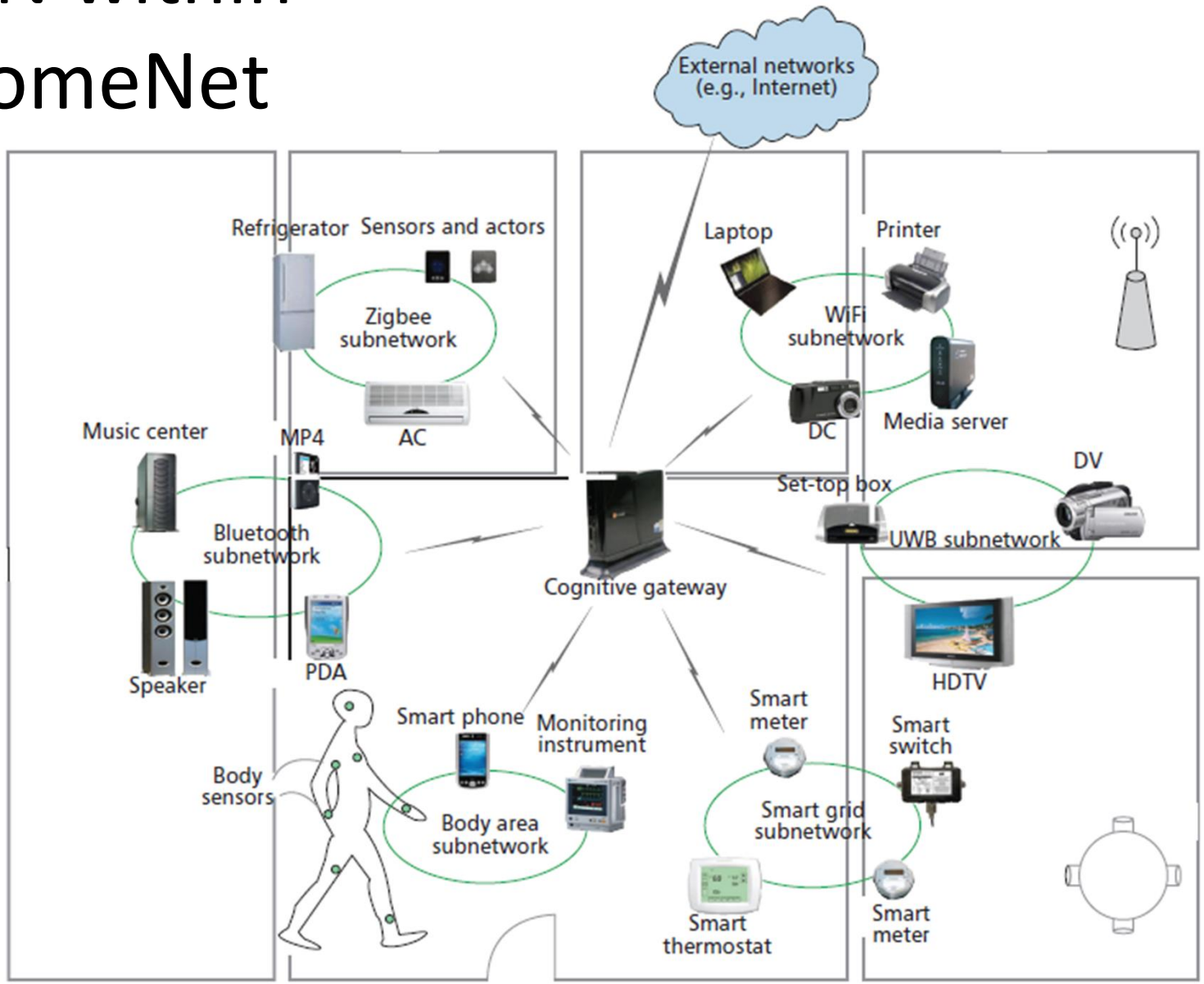
  Ex: WLAN, WPAN

- Ad Hoc System (Infrastructure-less)

  Ex: MANET, WSN

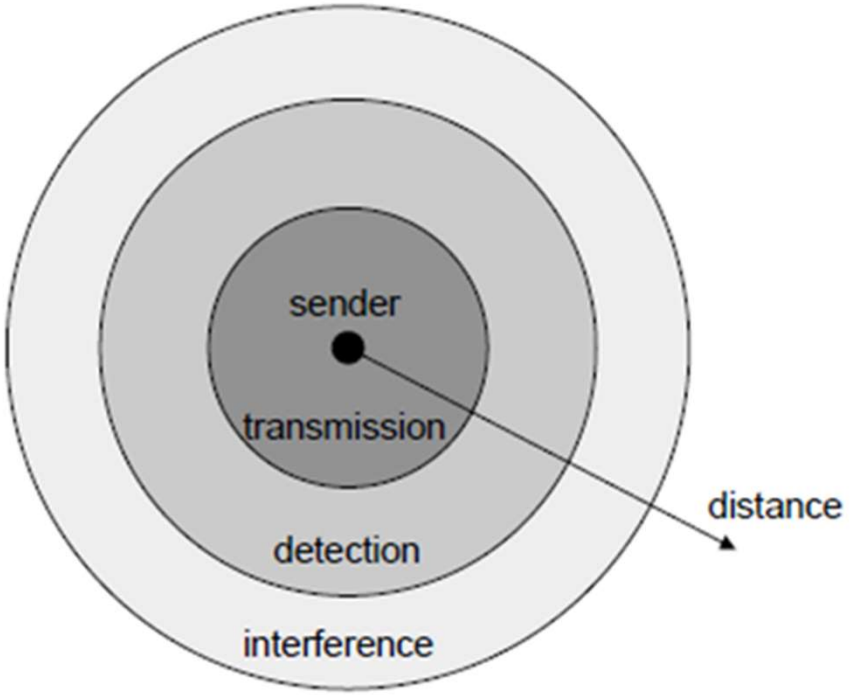

infrastructure
network
AP
AP: Access Point
AP
wired network
AP
ad-hoc network

PAN within HomeNet

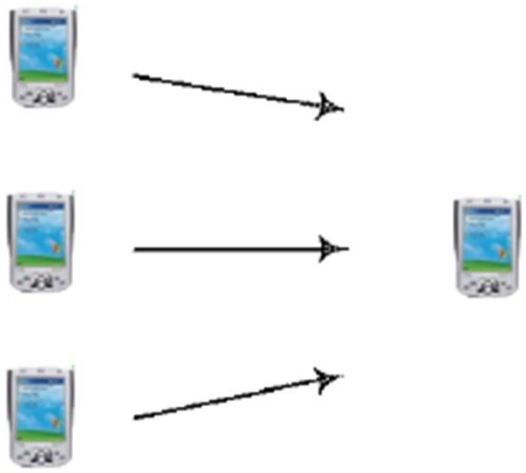


Signal Propagation Range (distance)

- Transmission Range
  - Possible communication
  - Low error rate and high quality
- Detection Range
  - Possible detection of signal and type
  - No communication possible
- Interference Range
  - Signal not detected
  - Signal adds to noise

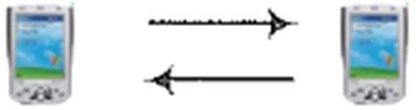


Multiple Access and Duplex



تعدد النفاذ

Multiple Access



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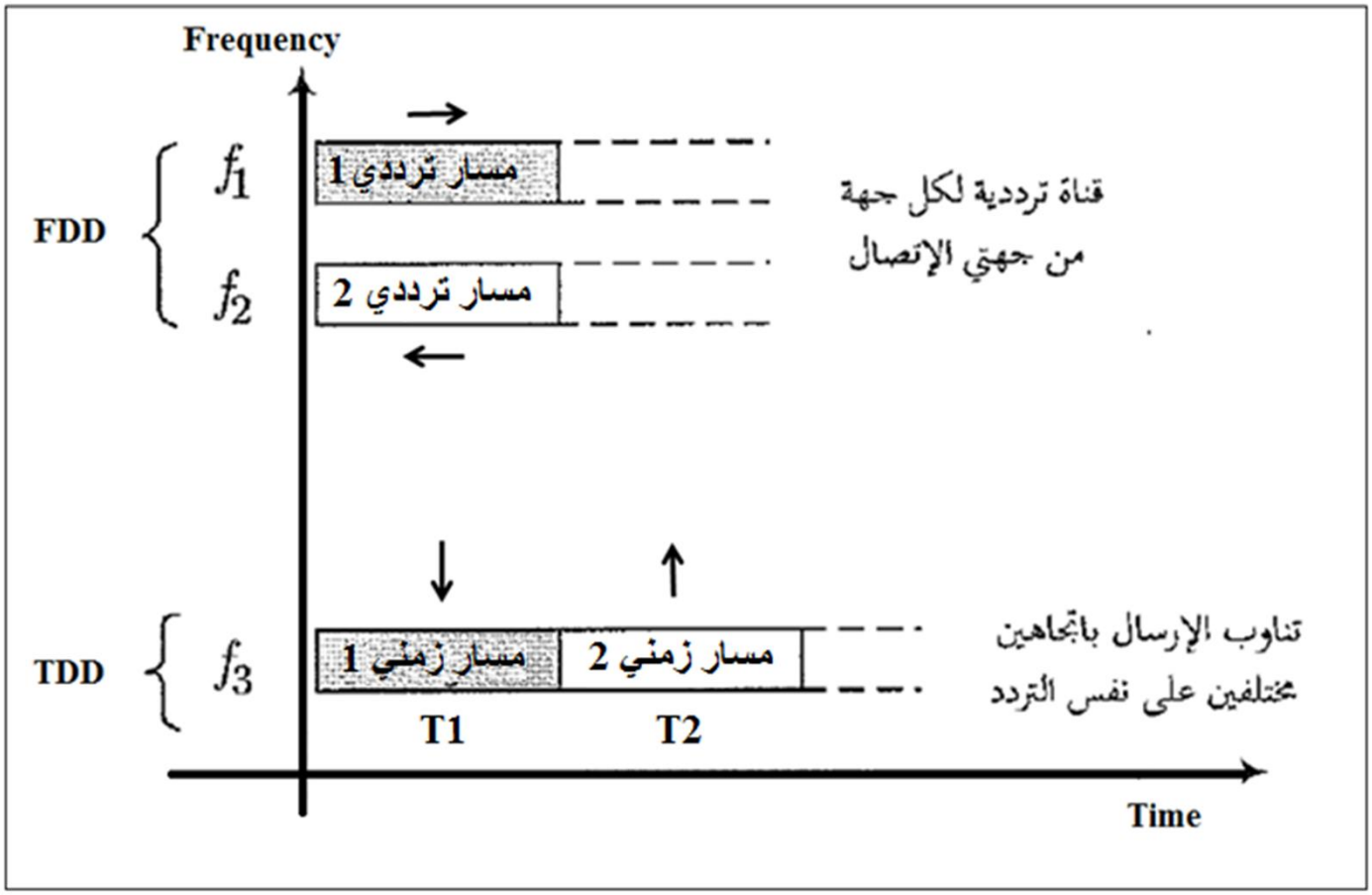
Duplex Flow

Duplex Methods



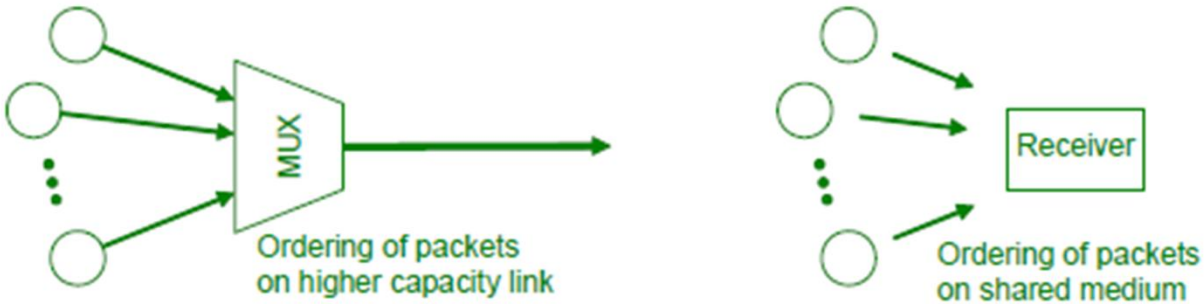
Frequency Division Duplex (FDD)

Time Division Duplex (TTD)

Differences between MA and MUX

MULTIACCESS vs. MULTIPLEXING

♦ Related to multiple access (MA) is *multiplexing* since in both cases multiple sources share a common medium. The difference is that in multiplexing the packets from different sources are scheduled by the multiplexor in serial order, thus assuring that there is no contention between different sources. (The contending packets are simply forced to wait for their turn.) In MA, there is no single physical device that gathers packets before marching them on the shared medium, so the contention problem must be solved.



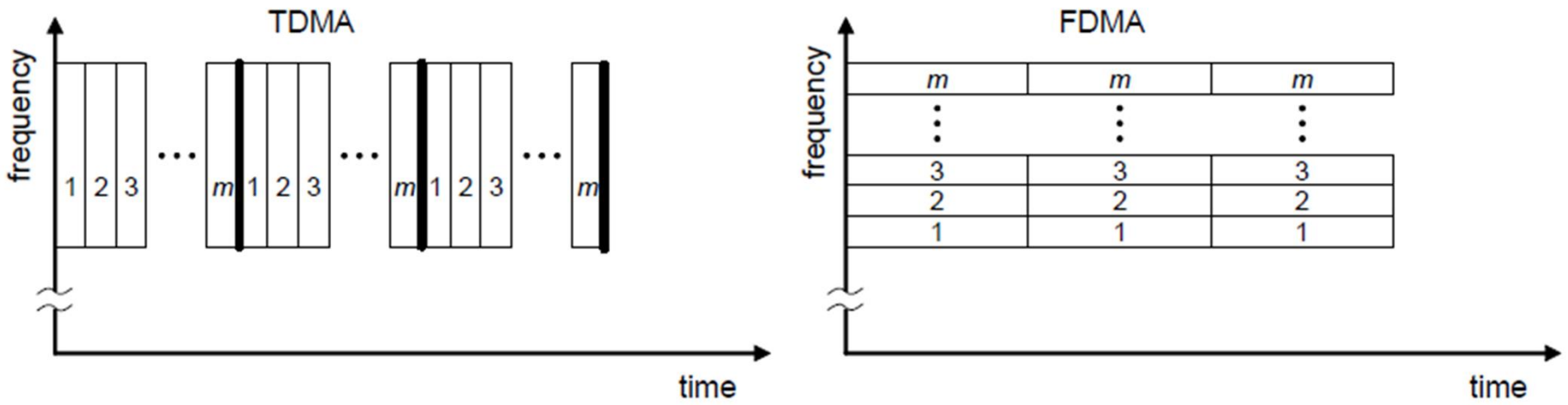
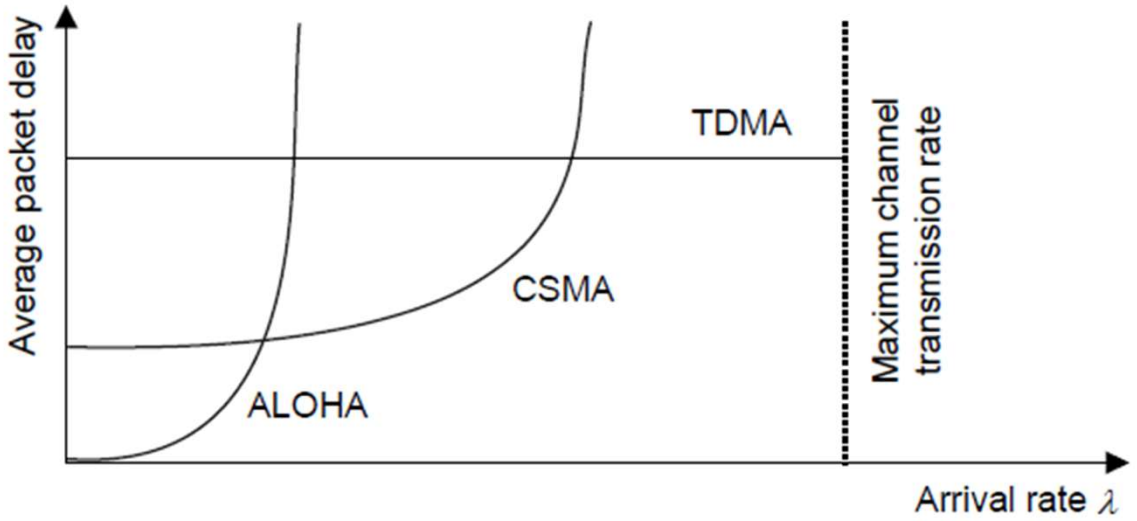


Figure 3-2. Static or deterministic multiaccess schemes. A wideband channel capacity is divided into *m* channels and each channel is assigned to a different station. In TDMA, a station periodically gets hold of the wideband channel capacity for one time unit, whereas in FDMA the station gets continuous hold of a narrowband subchannel of the capacity 1/*m*.


Average packet delay
TDMA
CSMA
ALOHA
Maximum channel transmission rate
Arrival rate λ

Quiz -1

Q4- a) Define the type of the WPAN physical addresses, and show how address is sent :

- 5B:AA:23:44:22:34
- 68:9D:22:6F:77:46
- 11:11:11:11:11:11

b) the address 43:7B:6D:DE:20:00 has been shown as the source address in a WPAN frame. The receiver has discarded the frame, Why?