Wireless & Mobile Computing

First Semester 3rd Class

2025/2024

Introduction

- There are now a larger number of mobile phone subscriptions than there are people on our planet.
- The many advantages of cell phones are evident to all—anywhere, anytime, untethered access to the
- global telephone network via a highly portable lightweight device.
- More recently, smartphones, tablets, and laptops have become wirelessly connected to the Internet via a cellular or WiFi network.

- We start a discussion of mobile users, wireless links, and networks, and their relationship to the larger typically wired) networks to which they connect.
- We'll draw a distinction between the challenges posed by the *wireless* nature of the communication links in such networks, and by the *mobility* that these wireless links enable.

Introduction

- We can identify the following elements in a wireless network:
- *Wireless hosts.* As in the case of wired networks, hosts are the end-system devices that run applications. A **wireless host** might be a smartphone, tablet, or laptop, or it could be an Internet of Things (IoT) device such as a sensor, appliance, automobile, or any other of the myriad devices being connected to the Internet. The hosts themselves may or may not be mobile.
- *Wireless links*. A host connects to a base station or to another wireless host through a **wireless communication link**.
- Different wireless link technologies have different transmission rates and can transmit over different distances
- Transmission rates: the speed at which devices can transmit data, which is limited by their available and configured data rate.
- Transmission speed: Devices can only transmit at data rates less than or equal to their available and configured data rate. This limits the available data transmission rate if the channel can offer more than the device data rate.

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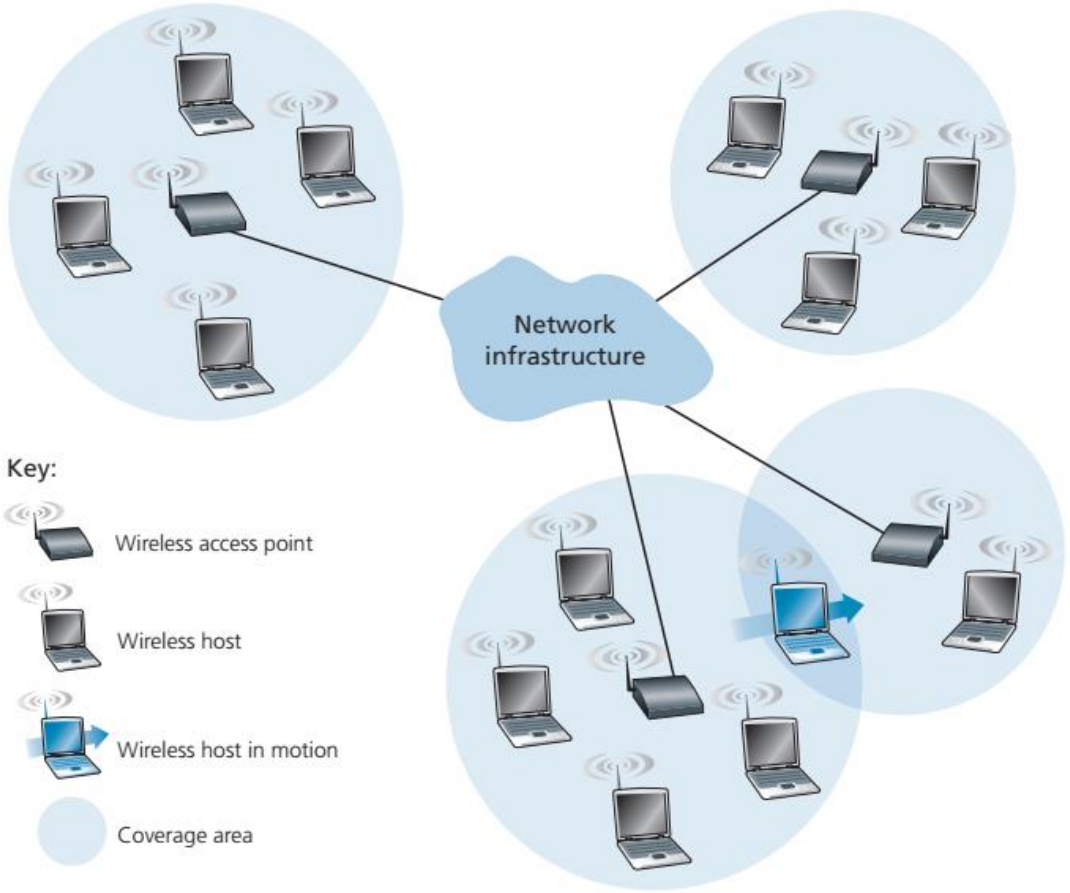
- A 'Wireless Channel' is defined as a communication channel where information is transmitted through electromagnetic waves in open space. It is commonly used in systems like 4G cellular and WiFi for mobile communications.
- Transmission power: Transmission power is affected by propagation distance and usually, it is greater than the receiving power.
- Battery life: The overall network lifetime depends on the lifetime of all devices within the network. Energy is consumed when transmitting, thus energy consumption during a communication process is proportional to the transmission power. Energy can be saved by transmitting at a higher bit rate to minimize the number of retransmissions.

Introduction



The base station is connected to the larger network (e.g., the Internet, corporate or home network), thus functioning as a link-layer relay between the wireless host and the rest of the world with which the host communicates.

Hosts associated with a base station are often referred to as operating in **infrastructure mode**, since all traditional network services (e.g., address assignment and routing) are provided by the network to which a host is connected via the base station.

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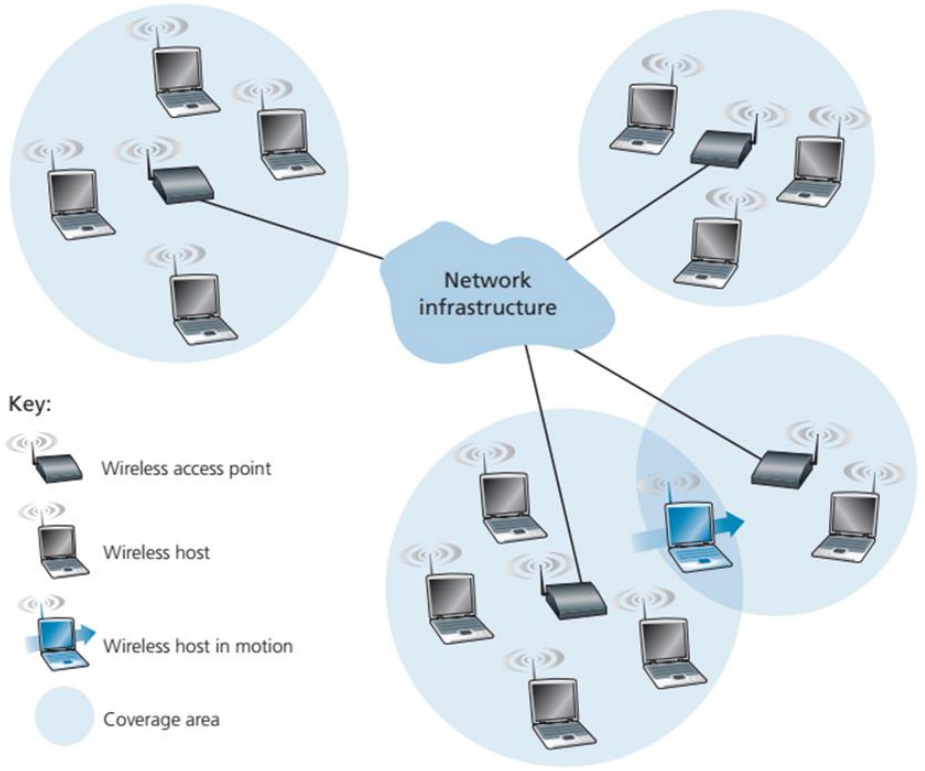
- In ad hoc networks, wireless hosts have no such infrastructure with which to connect. In the absence of such infrastructure, the hosts themselves must provide for services such as routing, address assignment, DNS-like name translation, and more.



Introduction

- Base station:
- The base station is a key part of the wireless network infrastructure.
- A base station is responsible for sending and receiving data (e.g., packets) to and from a wireless host that is associated with that base station.
- A base station will often be responsible for coordinating the transmission of multiple wireless hosts with which it is associated.
- When we say a wireless host is “associated” with a base station,

1. The host is within the wireless communication distance of the base station,
2. and the host uses that base station to relay data between it (the host) and the larger network.

- **Cell towers** in cellular networks and **access points** in 802.11 wireless LANs are examples of base stations.

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- When a mobile host moves beyond the range of one base station and into the range of another, it will change its point of attachment into the larger network (i.e., change the base station with which it is associated)—a process referred to as handoff or handover.
- Such mobility raises many challenging questions.
- If a host can move, how does one find the mobile host's current location in the network so that data can be forwarded to that mobile host?
- How is addressing performed, given that a host can be in one of many possible locations?
- If the host moves during a TCP connection or phone call, how is data routed so that the connection continues uninterrupted?
- These and many (many!) other questions make wireless and mobile networking an area of exciting networking research.

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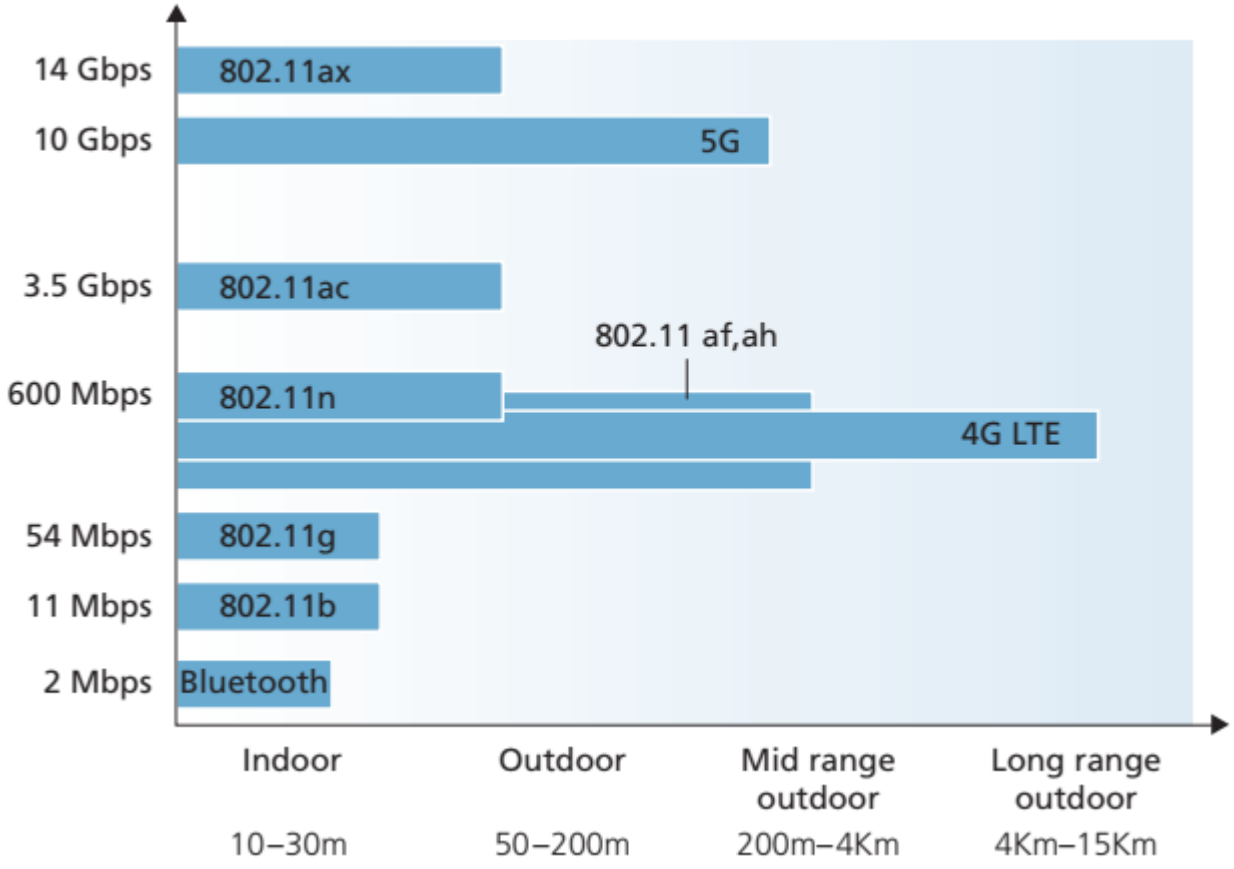

Introduction

- Network infrastructure. This is the larger network with which a wireless host may wish to communicate.
- We can classify wireless networks according to two criteria:
- *(i)* whether a packet in the wireless network crosses exactly *one wireless hop or multiple wireless hops*, and *(ii)* whether there is *infrastructure* such as a base station in the network:

1. *Single-hop, infrastructure-based.* These networks have a base station that is connected to a larger wired network (e.g., the Internet). Furthermore, all communication is between this base station and a wireless host over a single wireless hop.
2. *Single-hop, infrastructure-less.* In these networks, there is no base station that is connected to a wireless network. However, one of the nodes in this single-hop network may coordinate the transmissions of the other nodes. Bluetooth networks (that connect small wireless devices such as keyboards, speakers, and headsets).
3. *Multi-hop, infrastructure-based.* In these networks, a base station is present that is wired to the larger network. However, some wireless nodes may have to relay their communication through other wireless nodes in order to communicate via the base station. Some wireless sensor networks and so-called **wireless mesh networks.**

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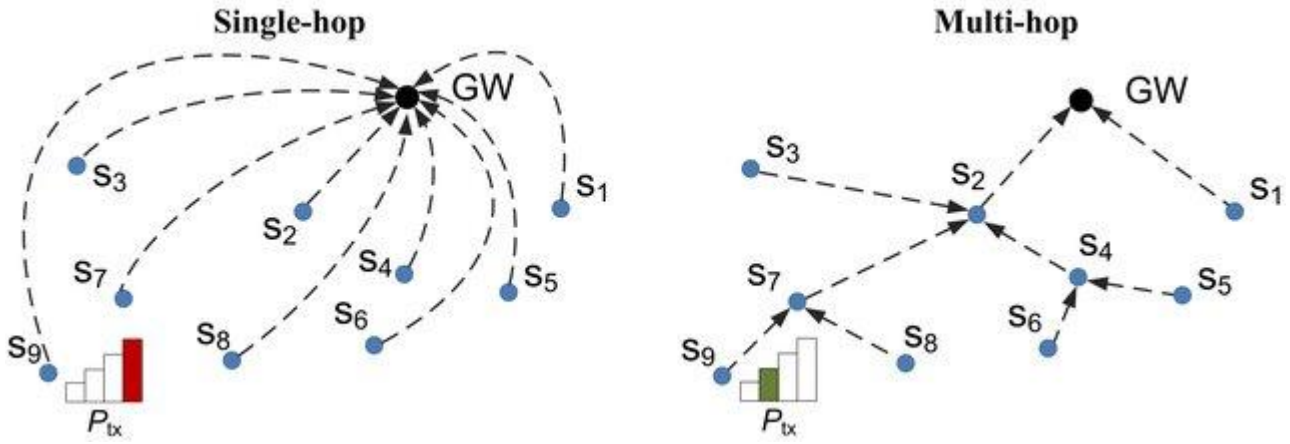
- *Multi-hop, infrastructure-less.* There is no base station in these networks, and nodes may have to relay messages among several other nodes in order to reach a destination. Nodes may also be mobile, with connectivity changing among nodes—a class of networks known as mobile ad hoc networks (MANETs).
- If the mobile nodes are vehicles, the network is a vehicular ad hoc network (VANET).



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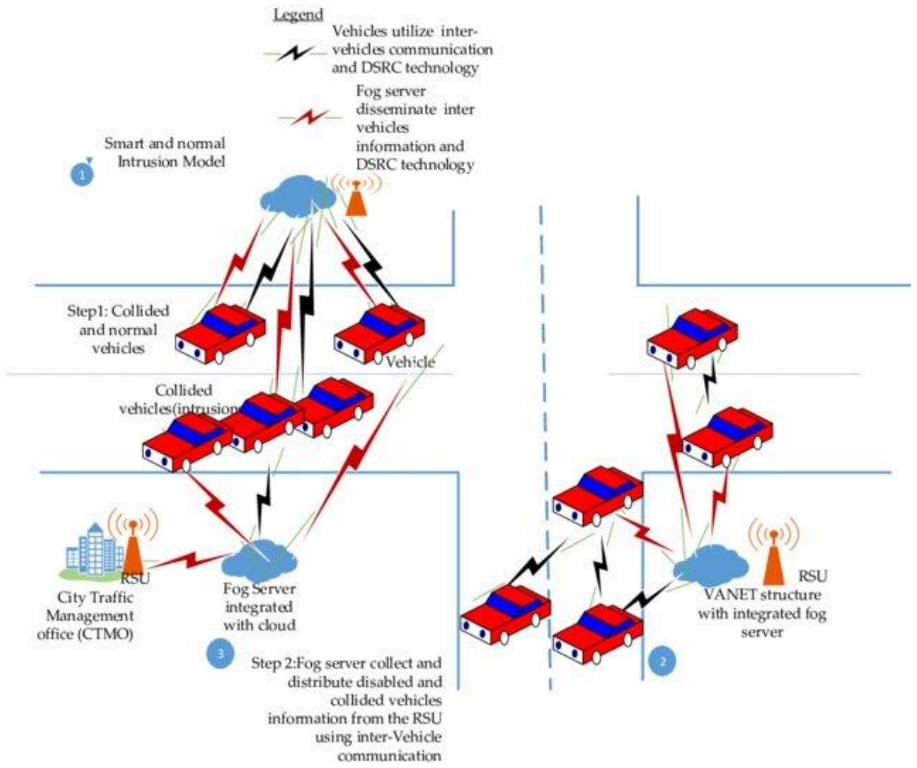
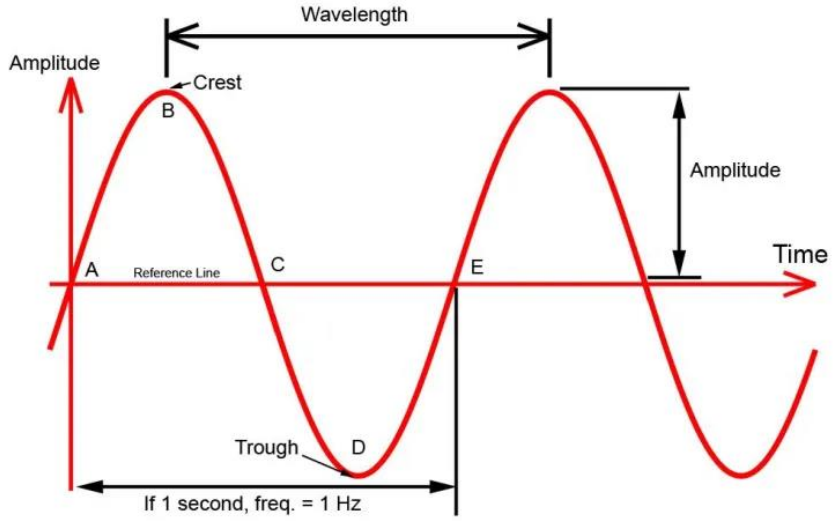


Introduction

- Frequency is the number of occurrences of a repeating event per unit of time.
- Every network connection has a data rate, which describes the rate at which bits are transferred across a network, and bandwidth, which refers to the number of bits per second that a link can send or receive.

if a current completes one cycle in one second, its speed is one Hertz (Hz). If the current complete 60 cycles in one second, the frequency is 60Hz. A computer's clock speed is often measured in gigahertz (GHz) and megahertz (MHz).



Introduction

- Difference between Bandwidth and Frequency
- Frequency indicates the number of complete cycles that appear in unit time.
- Bandwidth is the total quantities of data transmit in a unit of time.
- This frequency band is known as the bandwidth.
- Bandwidth is frequency range within a given band that is typically used for signal transmission.
- Signal bandwidth refers to the frequency range that makes up a specific signal.

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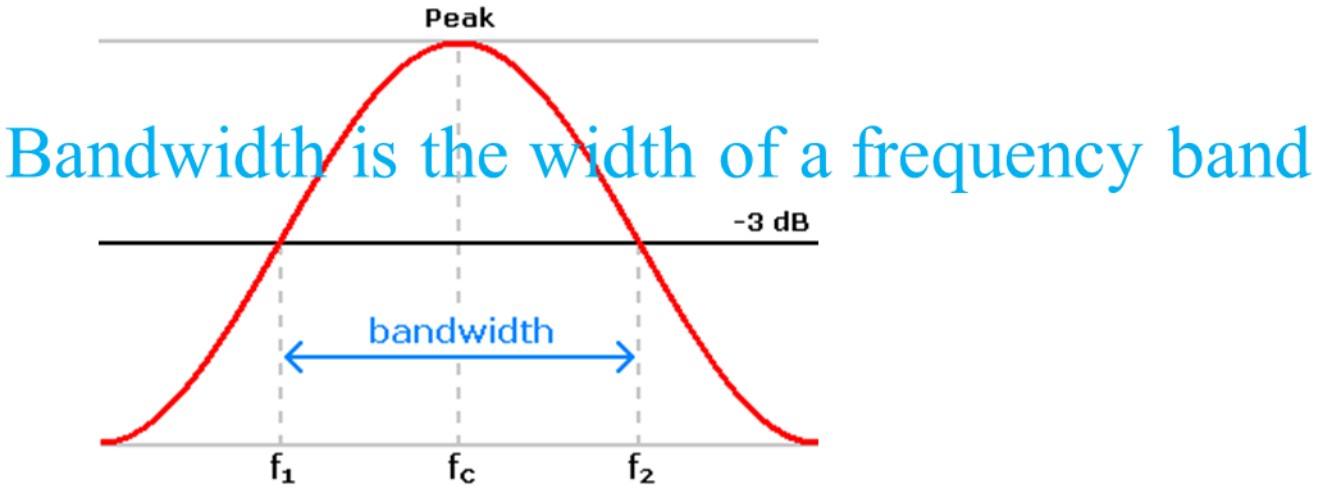
- Assume two points on the frequency scale are f1 and f2, and the bandwidth is provided by f2 - f1 in Hertz or Hz.
- B = [f(max) - f(min)] bits/sec



Introduction

- The wavelength of a wave describes how long the wave is.
- The distance from the "crest" (top) of one wave to the crest of the next wave is the wavelength.
- Alternately, we can measure from the "trough" (bottom) of one wave to the trough of the next wave and get the same value for the wavelength.
- The phase velocity of a wave is the rate at which the wave propagates in any medium. This is the velocity at which the phase of any one frequency component of the wave travels.

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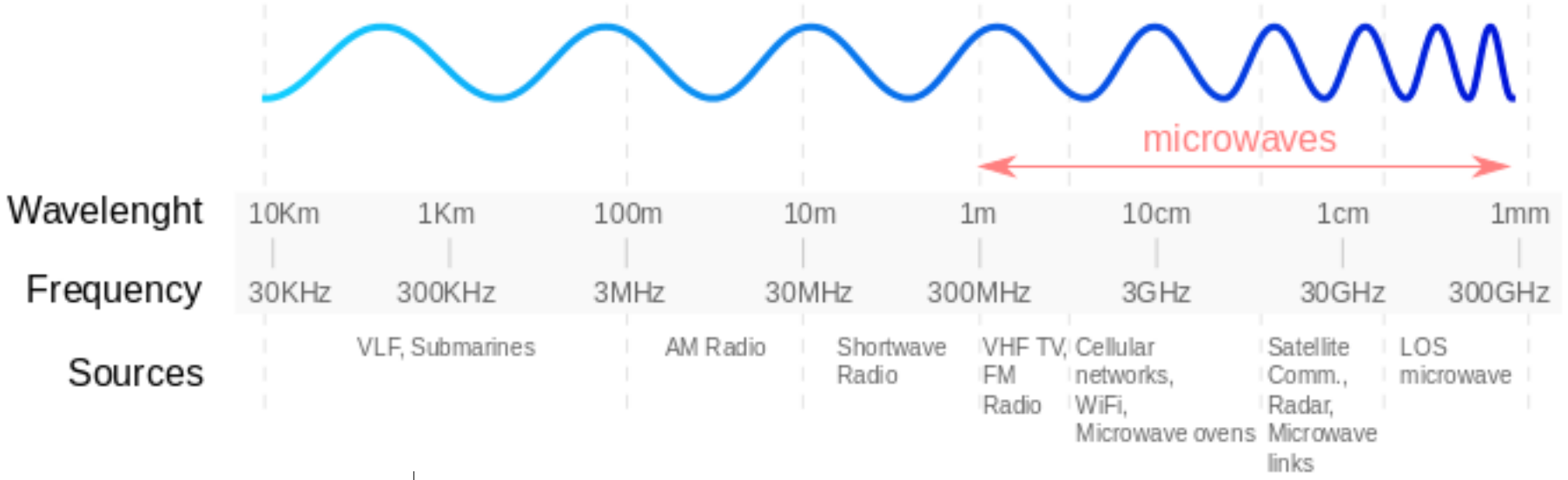
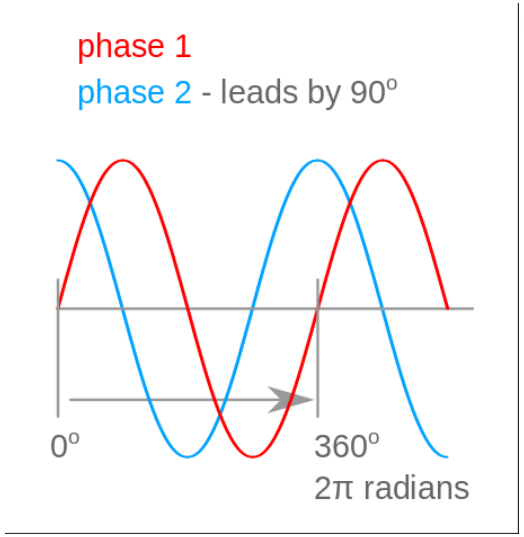
- Phase is the same frequency, same cycle, same wavelength, but are 2 or more wave forms not exactly aligned together.
- The amplitude is the power or intensity of the signal.
- The frequency is how often the signal repeated itself.
- And the phase describes where in the cycle the waveform is with respect to time.
- Data rate is closer to bandwidth which is commonly referred to as the transmission speed, or the number of bits per second transferred across a network.

Introduction





Introduction

- Benefits of Wireless: A *Wireless LAN (WLAN)* is a type of wireless network that is commonly used in homes, offices, and campus environments.
- Networks must support people who are on the move.
- People connect using computers, laptops, tablets, and smart phones.
- There are many network infrastructures that provide network access, such as wired LANs, service provider networks, and cell phone networks.
- But it’s the WLAN that makes mobility possible within the home and business environments.
- In businesses with a wireless infrastructure in place, there can be a cost savings anytime equipment changes, or when relocating an employee within a building, reorganizing equipment or a lab, or moving to temporary locations or project sites.

Introduction

- Types of Wireless Networks:
- Wireless networks are based on the Institute of Electrical and Electronics Engineers (IEEE) standards (*is an American 501 professional association for electronics engineering, electrical engineering, and other related disciplines*) and can be classified broadly into four main types:
- WPAN, Wireless Personal-Area Networks
- WLAN,
- WMAN, and
- WWAN.

Wireless Personal-Area Networks (WPAN): Uses low-powered transmitters for a short-range network, usually 20 to 30 ft. (6 to 9meters). Bluetooth and ZigBee based devices are commonly used in WPANs. WPANs are based on the 802.15 standard and a 2.4-GHz radio frequency.