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Introduction

- A wireless communication network is
  - A computer network that uses a wireless connection between network nodes.
  - A method to connect telecommunications networks, and business installations or to connect between various equipment locations, to avoid the costly process of introducing cables.

- Examples of wireless communication networks include
  - Cellular networks,
  - Wireless local area networks (WLANs),
  - Wireless ad-hoc networks,
  - Wireless sensor networks,
  - Vehicular communication networks,
  - Satellite communication networks.

Wired Communication Network Infrastructure

- User equipment in wired networks is referred to as fixed communication terminals due to limited mobility.

- In the early days, user equipment such as land-line telephones and desktop computers are directly connected to a network switch or a network router through physical network cables.

- In modern data centers and cloud computing centers, the servers are also hard wired to switches or routers. The core network consists of many switches and routers that are interconnected with physical medium, such as copper wire, Ethernet cable, fiber optics, etc.
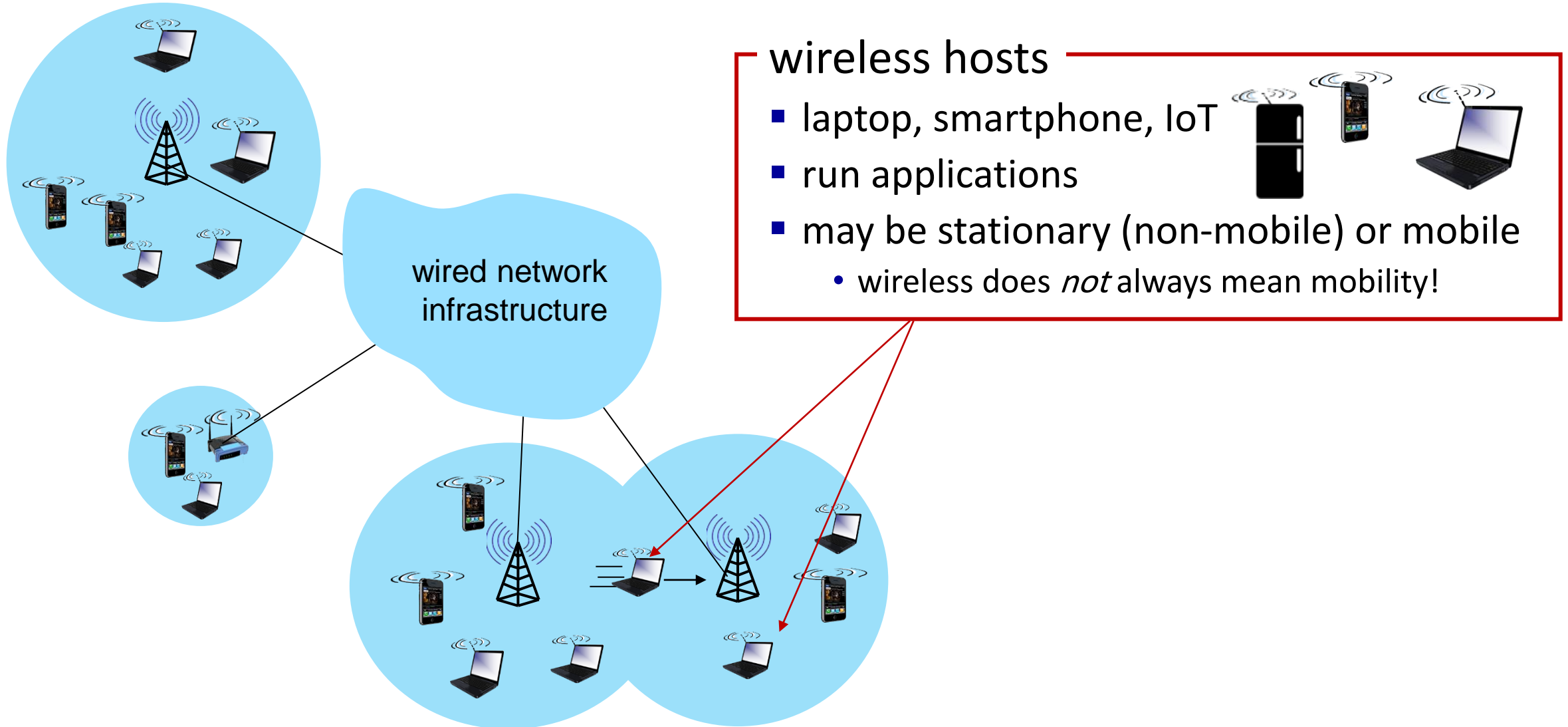
Elements of a wired network

Network Switch

Fixed Communication Terminal

Local Area Network

Network Router

Fixed Communication Terminal
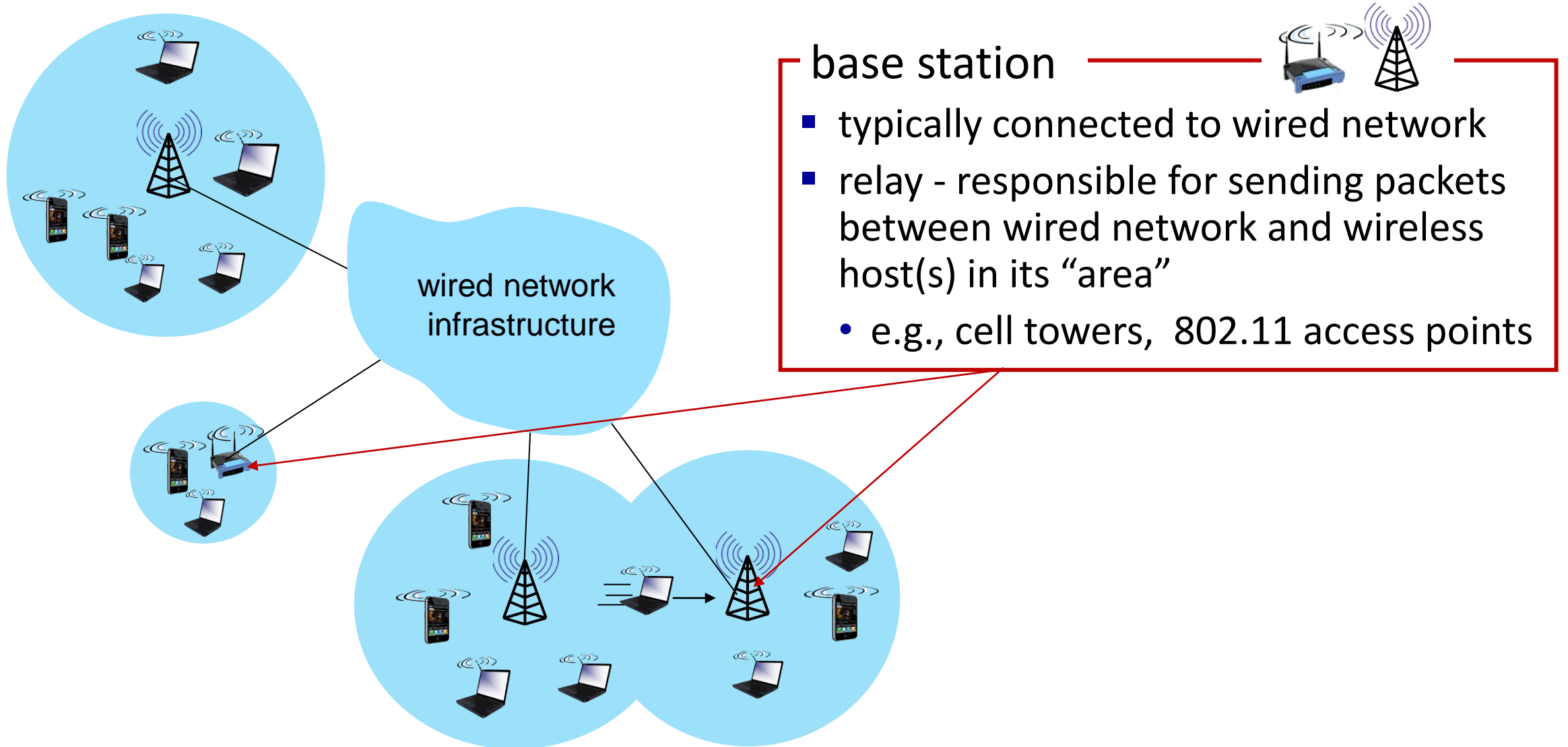
Network

wired network infrastructure
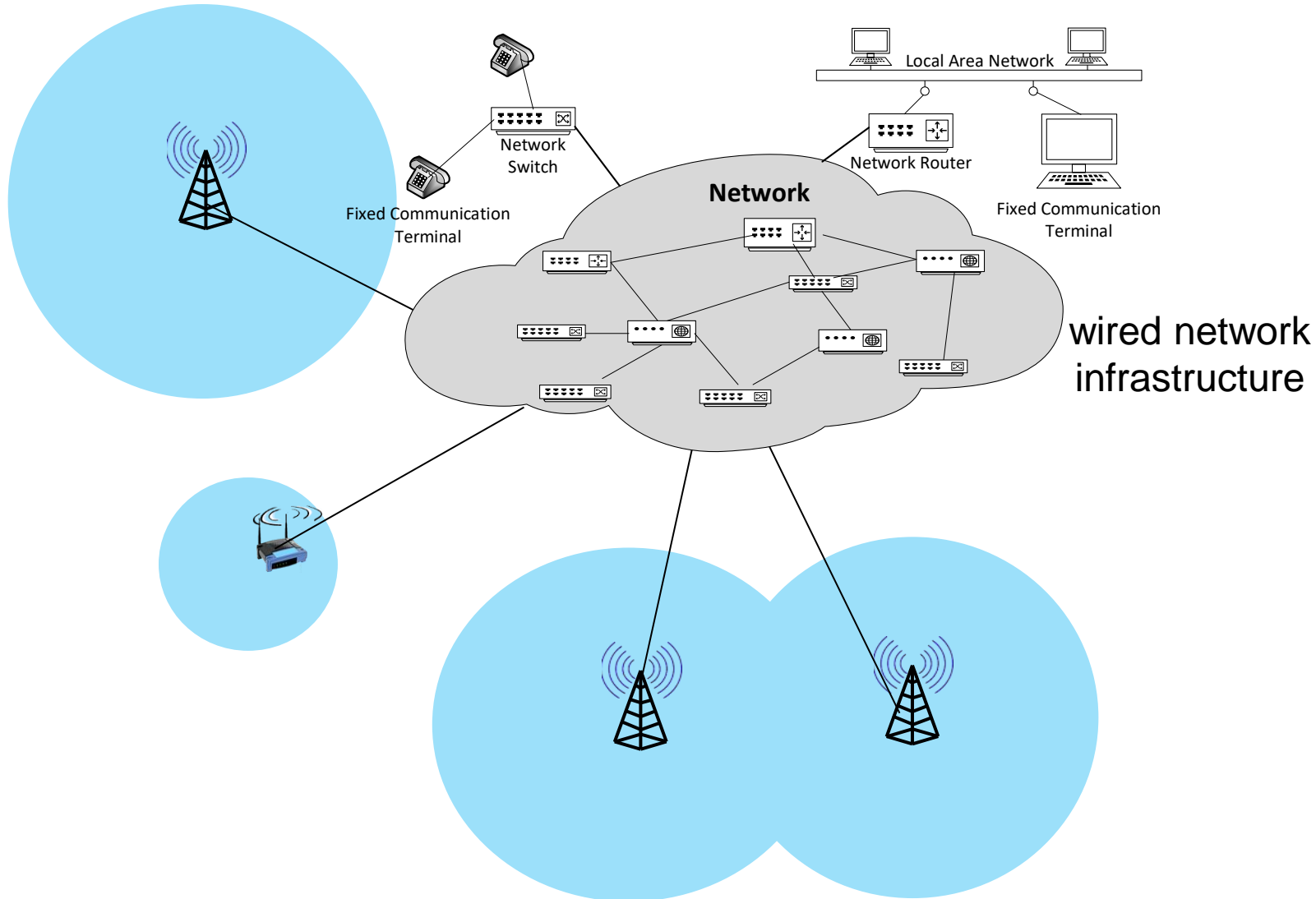
Wireless Communication Network Infrastructure

- Most wireless communication systems only deploy wireless components at the edge of the communication infrastructure

- The core network in a general wireless communication infrastructure is a wired network.

- The wireless access is provided with extra components and resources to the core network infrastructure.
  - Wireless transceivers: base stations, access point (AP), mobile stations (MSs), etc.
  - Management entities: mobility management, power management, radio resource management, security management, etc.
  - Spectrum: radio frequency bands for data transmission and possible air interface.
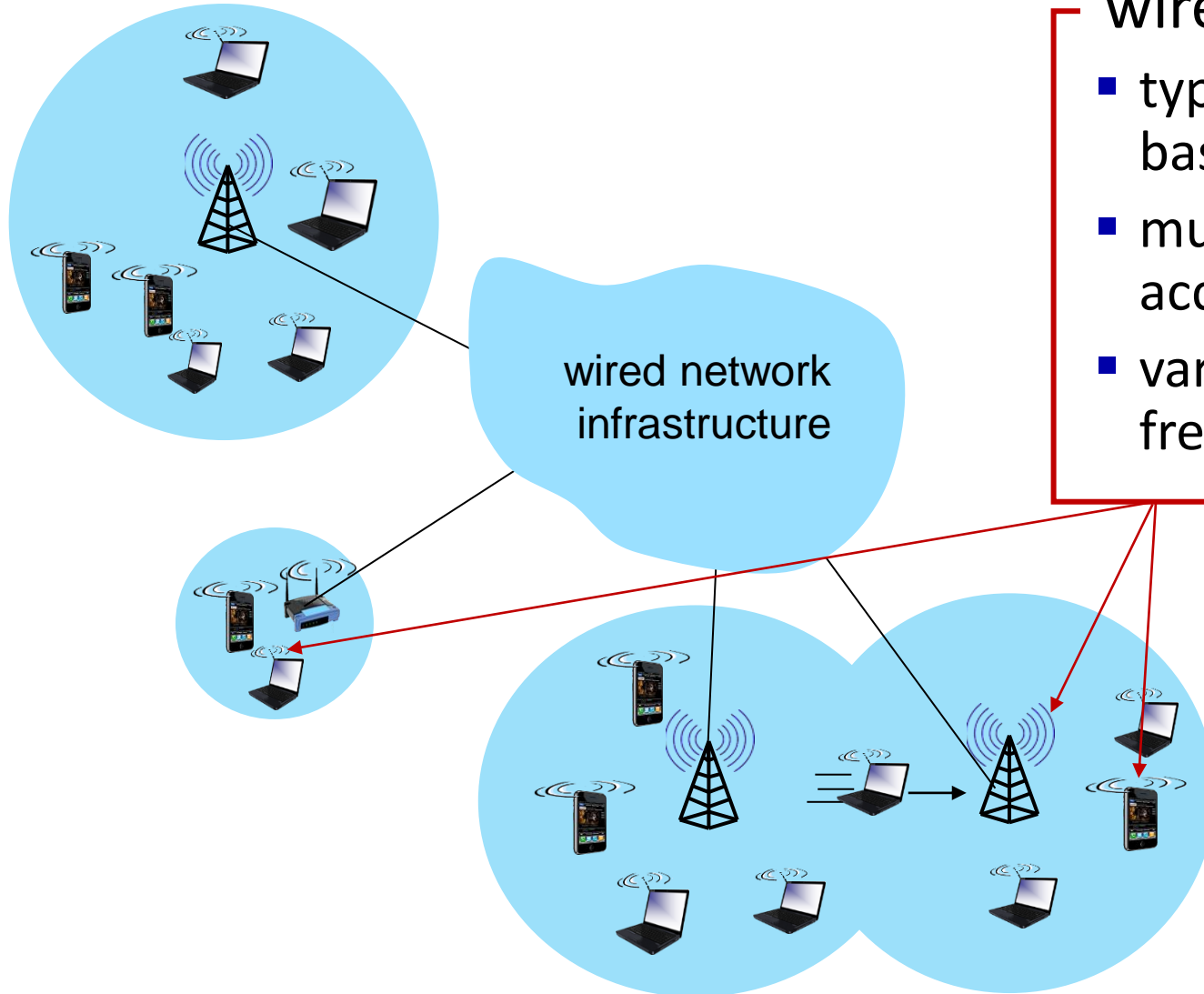 - Deployment: spectrum reuse in communications, wireless network design, etc.

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!

wired network infrastructure

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

wired network infrastructure
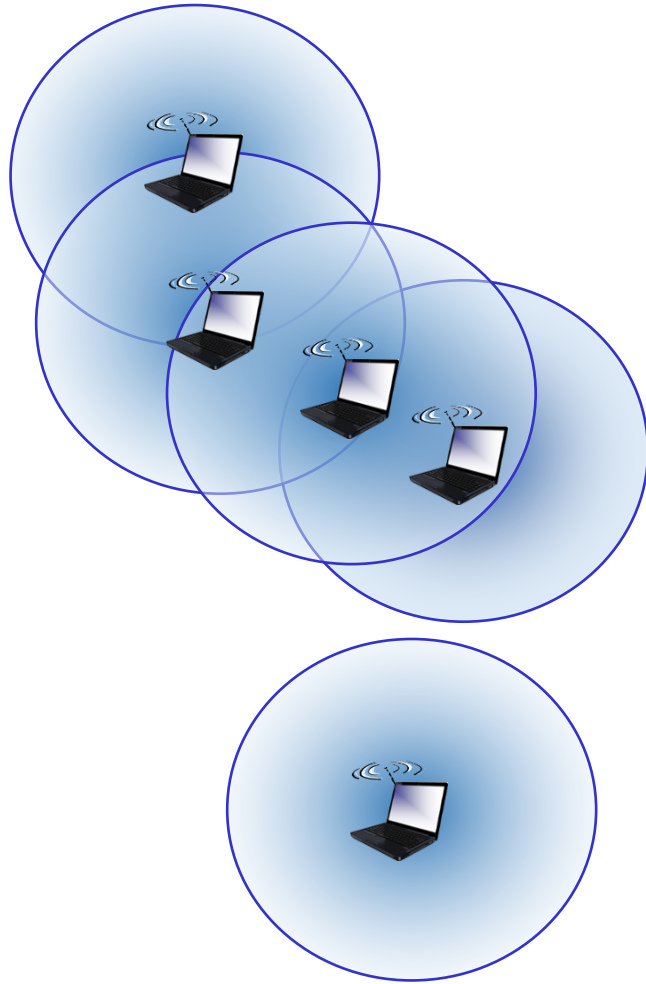
Elements of a wireless network

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

wired network infrastructure
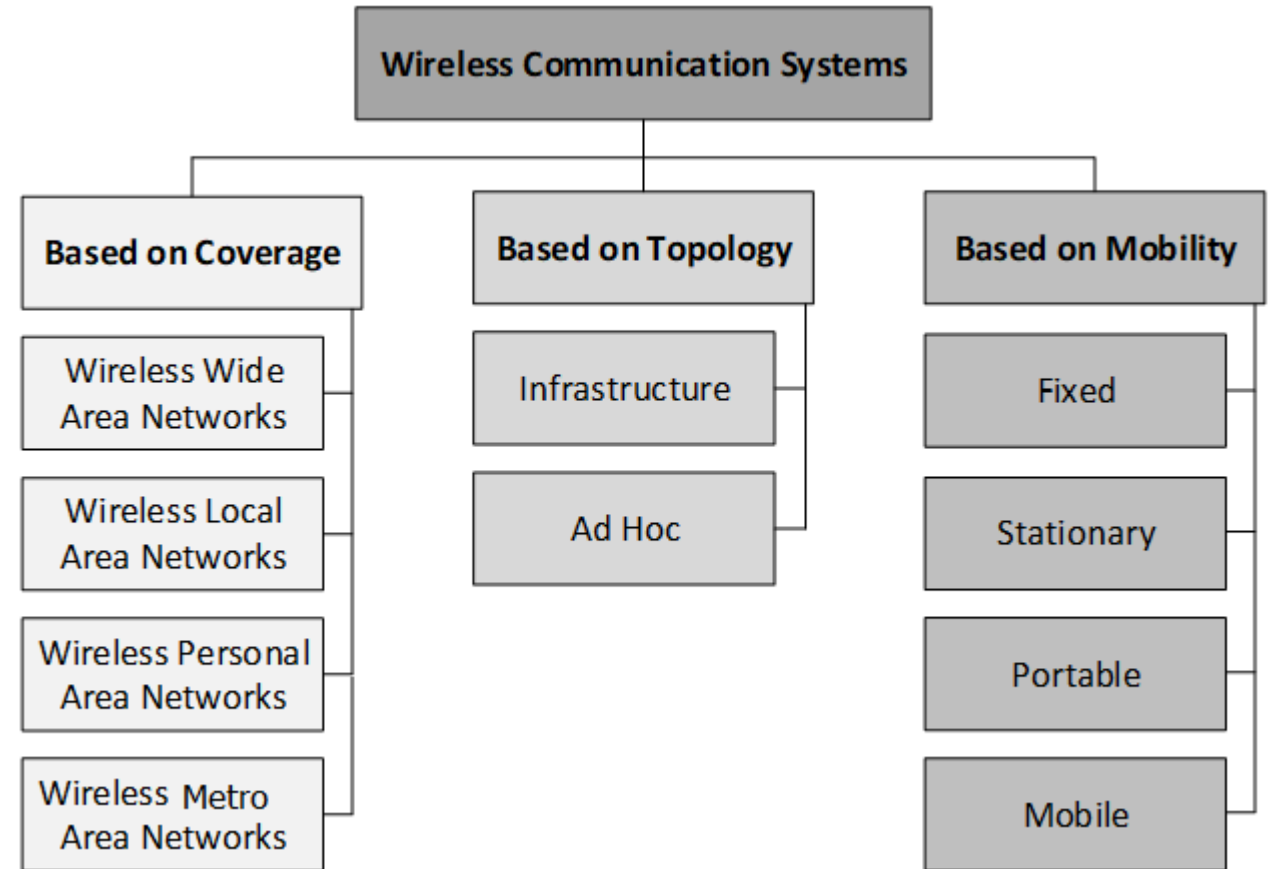
Elements of a wireless network

ad hoc mode

- no base stations
- nodes can only transmit to other nodes within link coverage
- nodes organize themselves into a network: route among themselves

Classification of Wireless Communication Systems

- Wireless communication systems can be classified in several ways, based on coverage, topology, or mobility,

Classification Based on Coverage

|	Wireless PAN (WPAN)	Wireless LAN (WLAN)	Wireless MAN (WMAN)	Wireless WAN (WWAN)
TYPE OF NETWORK	Personal area network	Local area network	Metropolitan area network	Wide area network
GOAL	Transmit signals between devices in limited areas, typically 10 meters	Provide internet access within a building or limited outdoor area	Provide access outside office and home networks, typically regional	Provide access outside the range of WLANs and WMANs
CONNECTIVITY	Bluetooth, Zigbee and infrared	IEEE 802.11 WIFI	IEEE 802.16 WiMax	LTE
RANGE	10 M	100 M	10 KM	35 KM
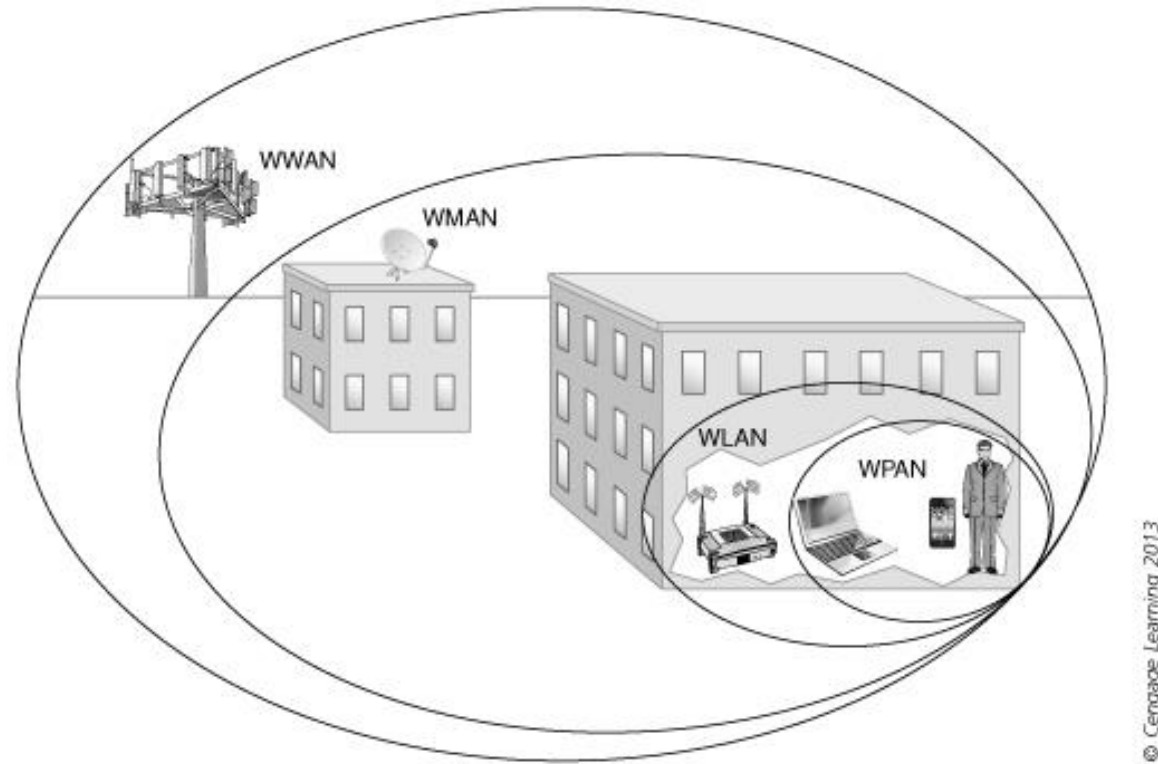
Figure 1-8 Coverage areas of wireless networks

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Wireless Personal Area Networks

- A WPAN can be used for communications among the personal devices themselves.

- A WPAN usually has an ad-hoc topology. Master–slave mode and mesh mode are the two types of ad-hoc networks that can be applied for WPANs.

  - A master–slave ad-hoc network consists of a master node and multiple slave nodes. The master node defines a cell or piconet. The slave nodes within the piconet connect to the master device.

  - Some WPANs apply mesh mode, where nodes are interconnected with wireless links without forming a specific cell or piconet

Master and Slave Ad-Hoc Mode

Slave

Slave
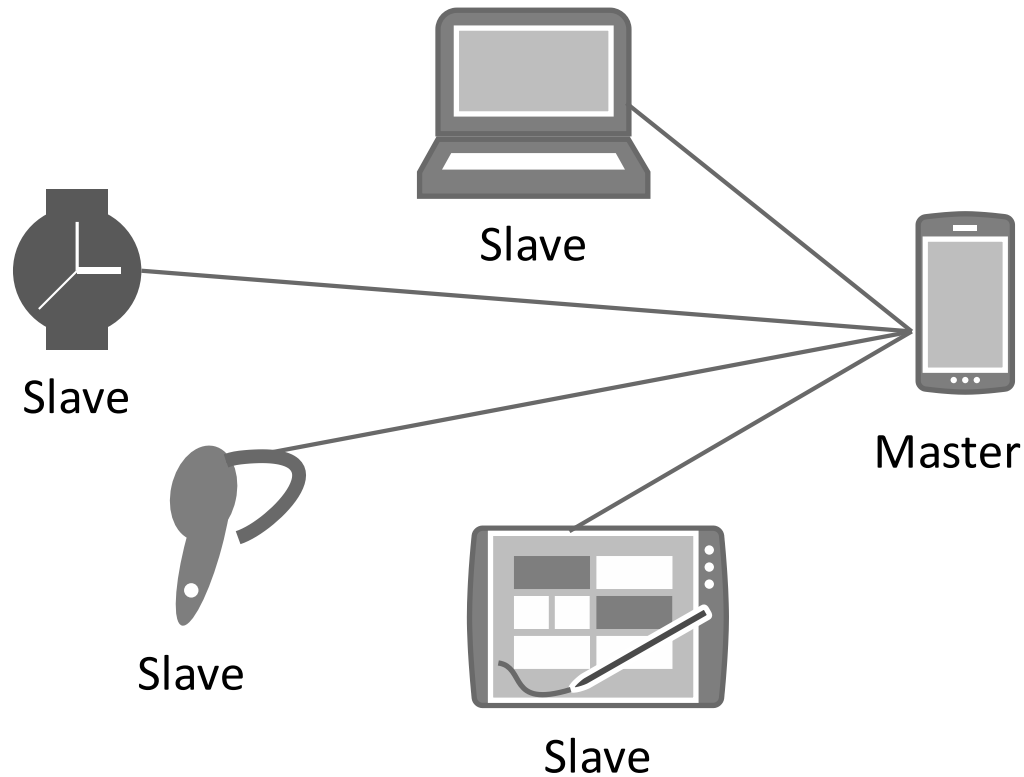
Master

Slave

Slave

Master and slave ad-hoc mode
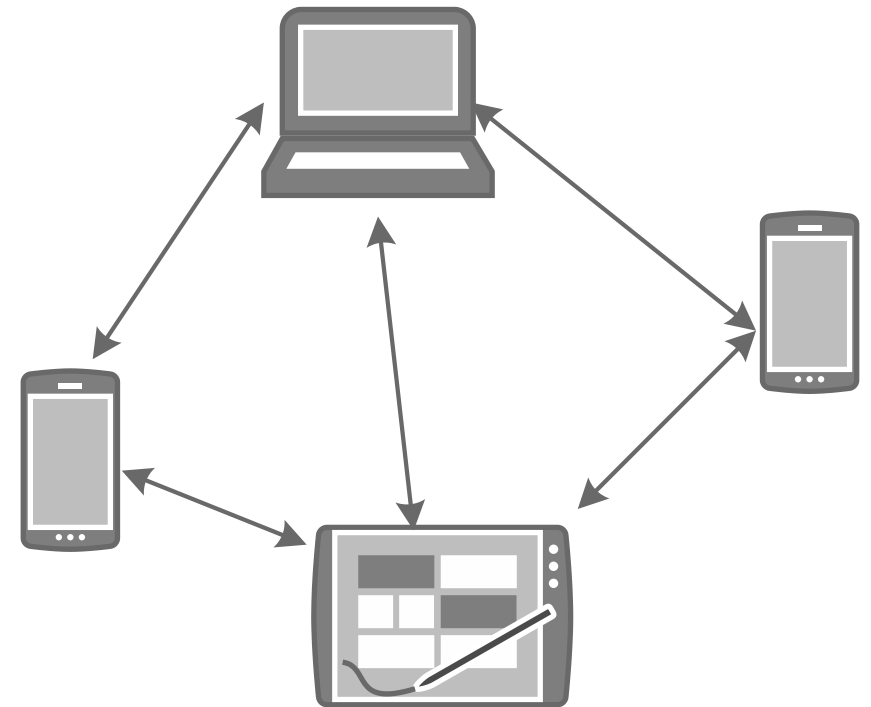
Mesh mode

Wireless Local Area Networks

- WLANs are infrastructure based wireless communication systems. They are normally built on top of a wired local area network (LAN).

- One of the typical WLAN settings is a home Wi-Fi, which forms one basic service set (BSS) that includes one AP and multiple user devices.

- The AP may have extra Ethernet ports to support wired access from servers, desktops, and other devices.

- A WLAN may have extended service set (ESS) that supports multiple BSSs, similar to a traditional Ethernet based LAN.

- All APs are interconnected, in most cases through wired connection.

- A user may be within the radio coverage of multiple APs, each user can connect to one BSS only at a time.
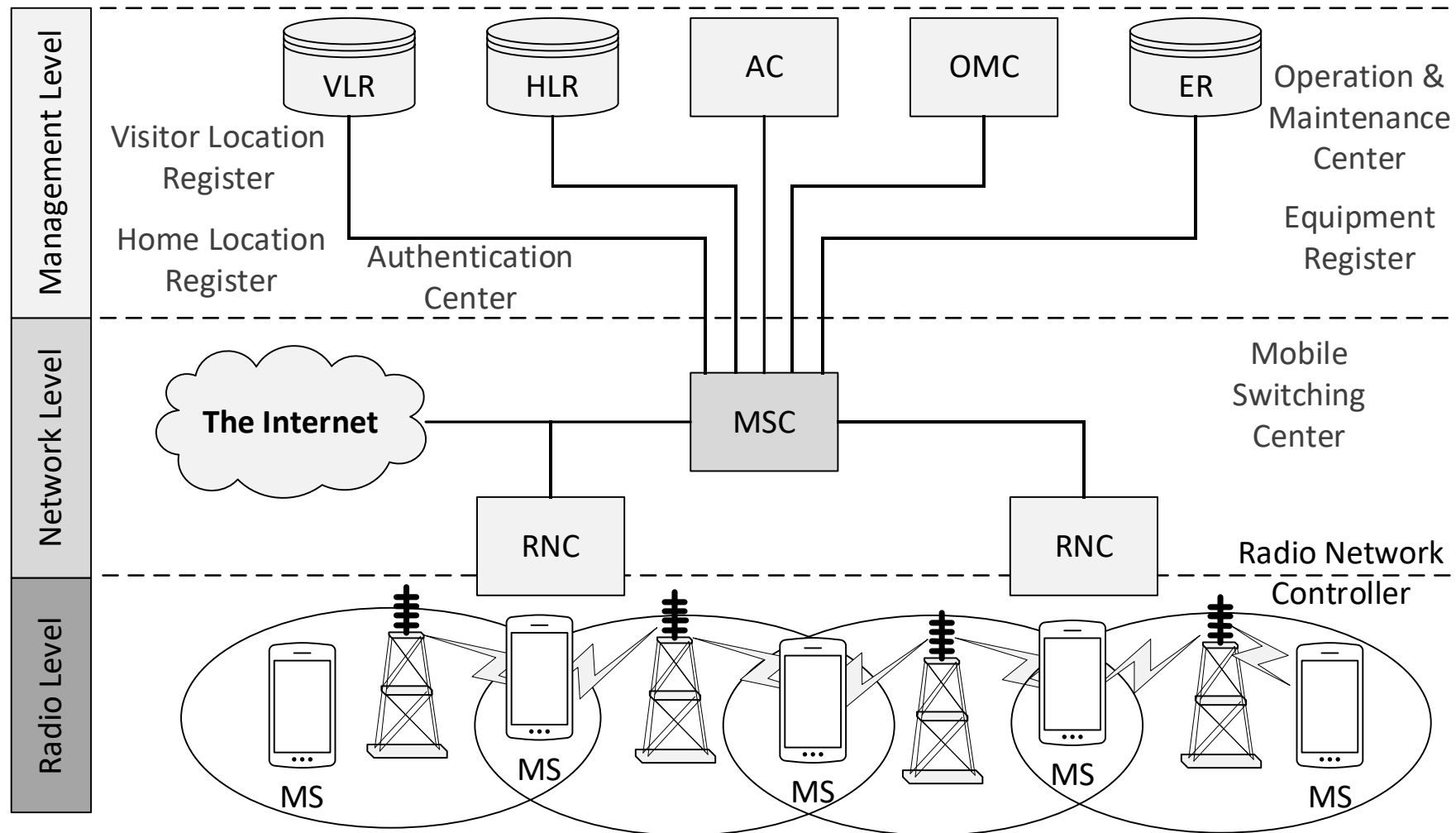
Architecture of WLAN

Extended Service Set (ESS)

The Internet

AP1

AP2

Basic Service Set (BSS)

16
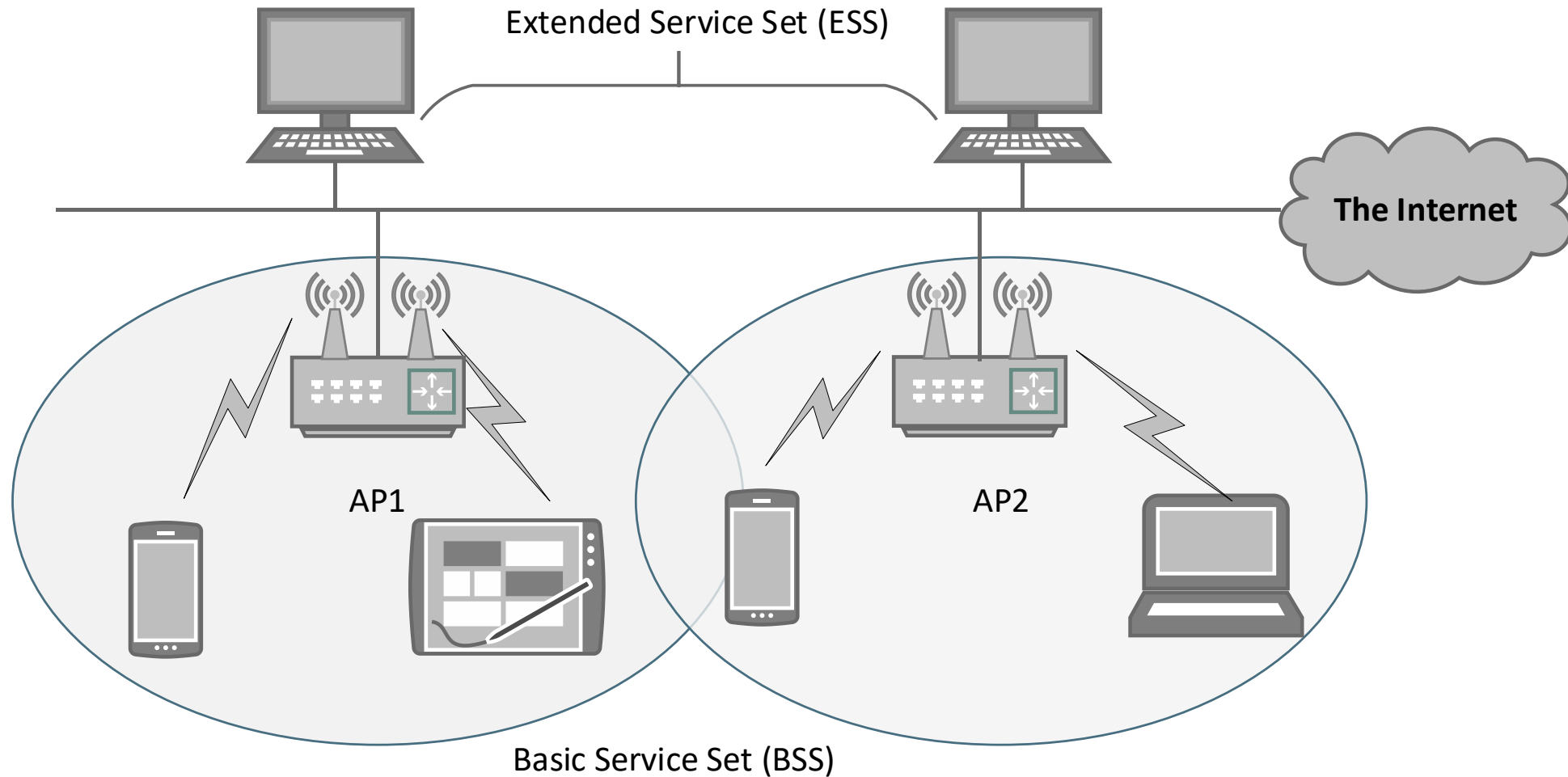
Wireless Wide Area Networks

- WWAN has the largest service coverage in all wireless communication systems.

- A general architecture of WWANs has different components at the radio level, the network level, and the management level.

- **The radio level** provides wireless access to user equipment, or mobile stations (MSs), which can be a mobile phone, a smart watch, a vehicle, etc. MSs access to WWAN through points of access in the infrastructure. Point of access is the physical radio transceiver. It creates the air interface and communications with MSs. Points of access could be base stations, base transceiver subsystem, mobile data base station, AP, NodeB, eNodeB, etc., depending on the wireless technology it is deployed.

- **The network level** is the backbone infrastructure that connects all switches and routers in the network. A radio network controller (RNC) bridges the radio level and the network level. RNC provides spectrum and power management to base stations, as well as other issues in wireless access. A mobile switching center (MSC) in the network level is a mobile data intermediate system that bridges the network level and the management level in cellular communication systems. MSC manages mobility of devices and keeps track of the location of MSs. MSC also ensures security by using the authentication center and equipment register in the management level to prevent fraudulent devices from using the network.

- **The management level** performs administrative operations of network service providers, such as accounting and billing. In a cellular communication system, the management level includes visitor location register, home location register, authentication center, operation and maintenance center, and equipment register.

Architecture of WWANs

Summary

- An introduction on
  - general communication network architectures and
  - wireless communication architectures.