Introduction to Management Information Systems

Wireless Networks & Mobility

Telecommunications and Networks

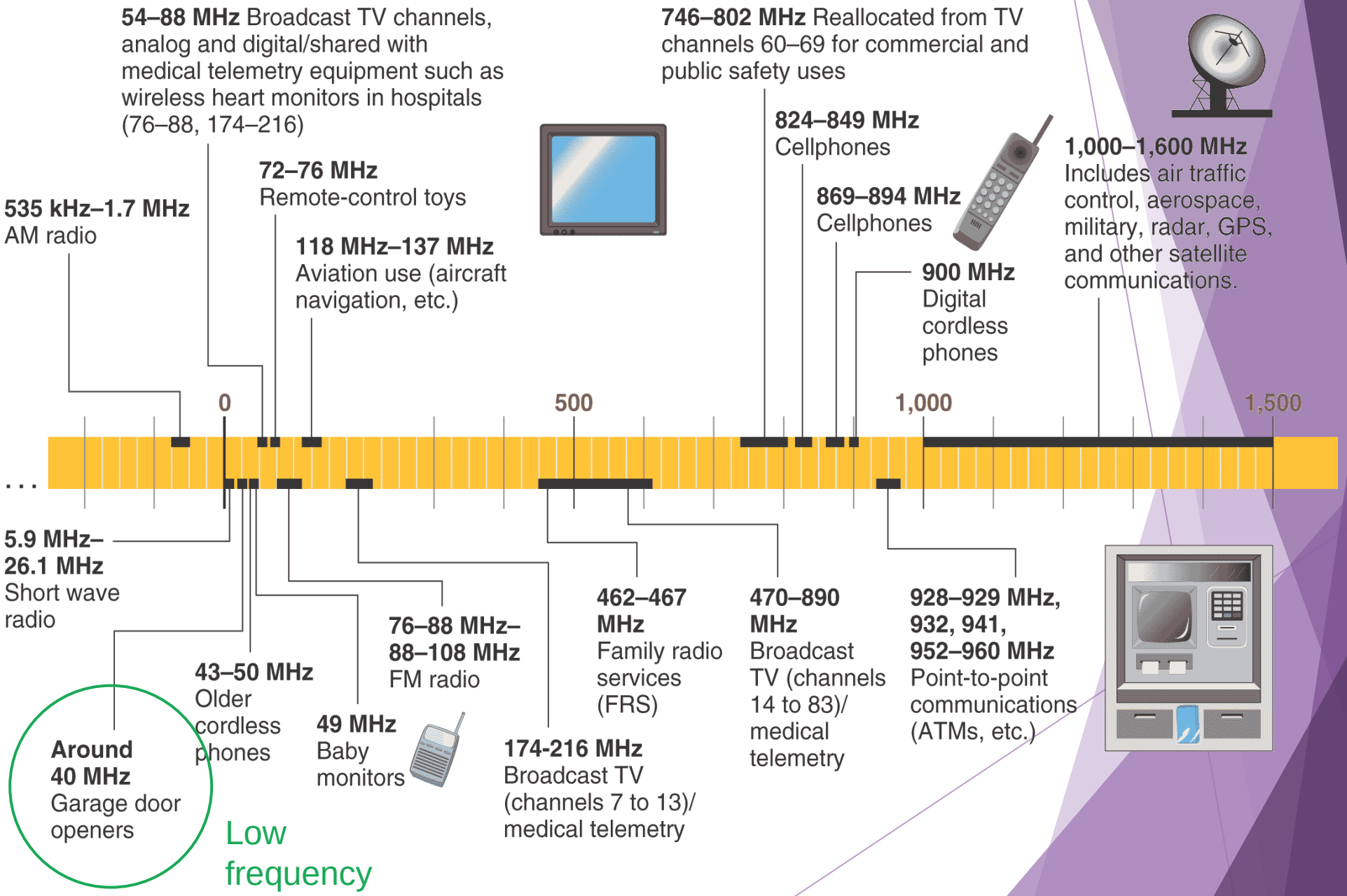
Learning objectives

- explain the basic components and terminology of wireless and mobile networks;
- explain how mobile networks work;
- identify the benefits of wireless computer networks;

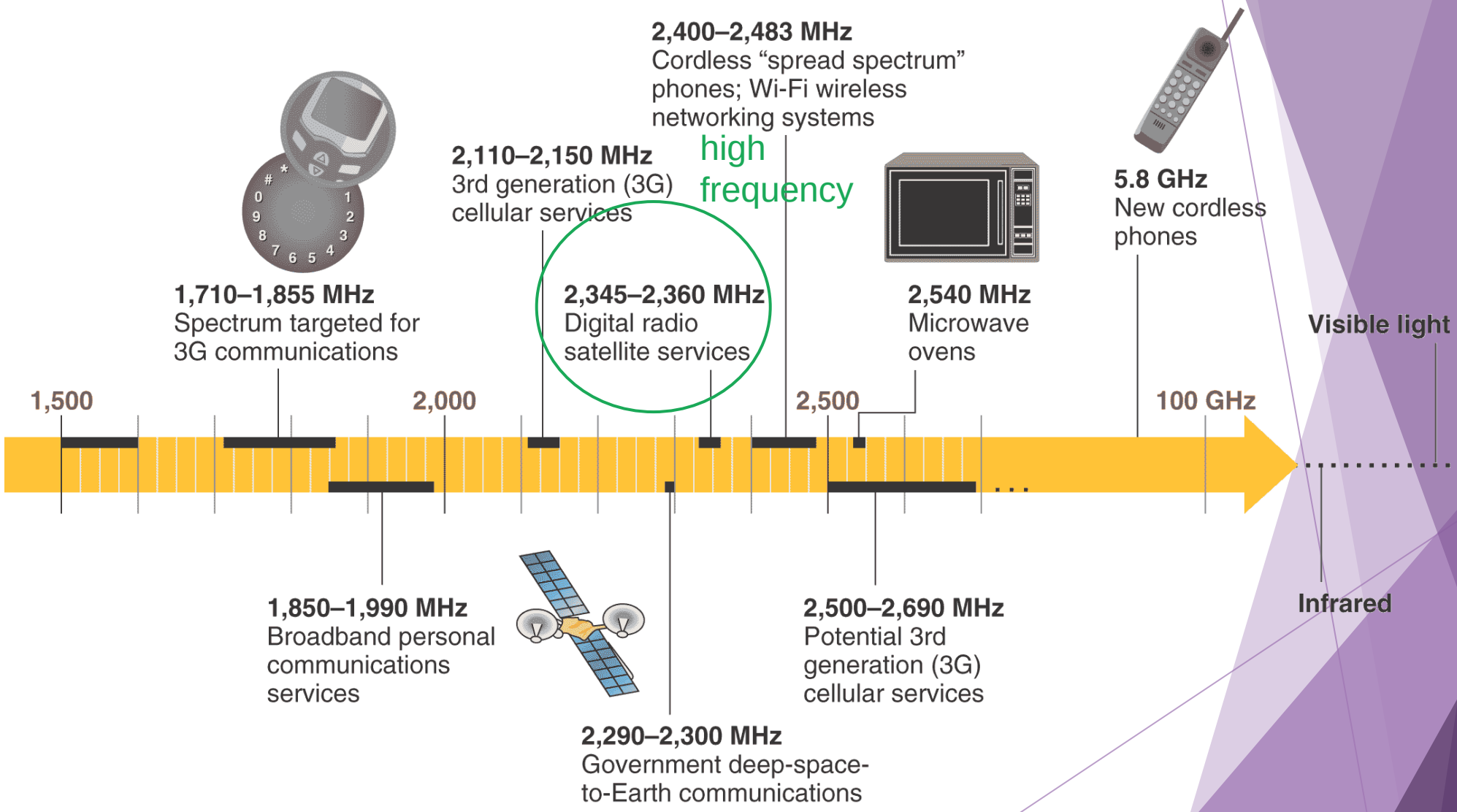
Wireless Communications

- Electromagnetic spectrum of radiation is the basis of all telecommunications signal
- Part of this spectrum is the Radio-frequency spectrum that we use for radio communication
- Fields of electrical energy & magnetic energy that carry most communication signals
- Electromagnetic waves vary in frequency
  - Number of times a wave repeats or makes a cycle (per second)

The radio-frequency spectrum



The radio-frequency spectrum



Wireless Transmission

Transfer Rates for Various Types of Wireless Transmission Media

Medium		Maximum Transfer Transmission Rate
Infrared		115 Kbps to 4 Mbps
Broadcast radio	• Bluetooth	1 Mbps to 2 Mbps
	• HomeRF	1.6 Mbps to 10 Mbps
	• 802.11b	11 Mbps
	• 802.11a	54 Mbps
	• 802.11g	54 Mbps
	• 802.11n	108 Mbps
	• UWB	110 Mbps to 480 Mbps
Cellular radio	• 2G	9.6 Kbps to 19.2 Kbps
	• 3G	144 Kbps to 2.4 Mbps
	• 4G	Up to 15 Mbps
Microwave radio		150 Mbps
Communications satellite		1 Gbps

Wireless Communications

Infrared Transmission

- infrared light
- line-of-sight
- low frequencies – can’t see
- TV remote control

Broadcast Radio

- AM/FM
- Sends data over long distances
- using a transmitter and a receiver
- Broadband TV, CB radio, barcode readers

Wireless Communications

Cellular radio

- phones

Microwave Radio

- high frequency radio waves (2.4 gigahertz)
- line-of-sight transmitters and receivers
- Satellite & ground communications
- Telephone systems use dish microwave transmission
- Short-range - bluetooth

Communications Satellites

transmitting a signal from ground station to a satellite

GEO – geostationary earth orbit

- Always above equator, 35K km up

MEO – medium earth orbit

- 8-15K km up

LEO – low earth orbit

- less signal delay, 1.5K km up or less

GPS

- global positioning system (GPS)
- a navigation system
- consists of one or more earth-based receivers
- that accept and analyze signals sent by satellites
- to determine the GPS receiver's geographic location

Built into many mobile devices

Available as a handheld device

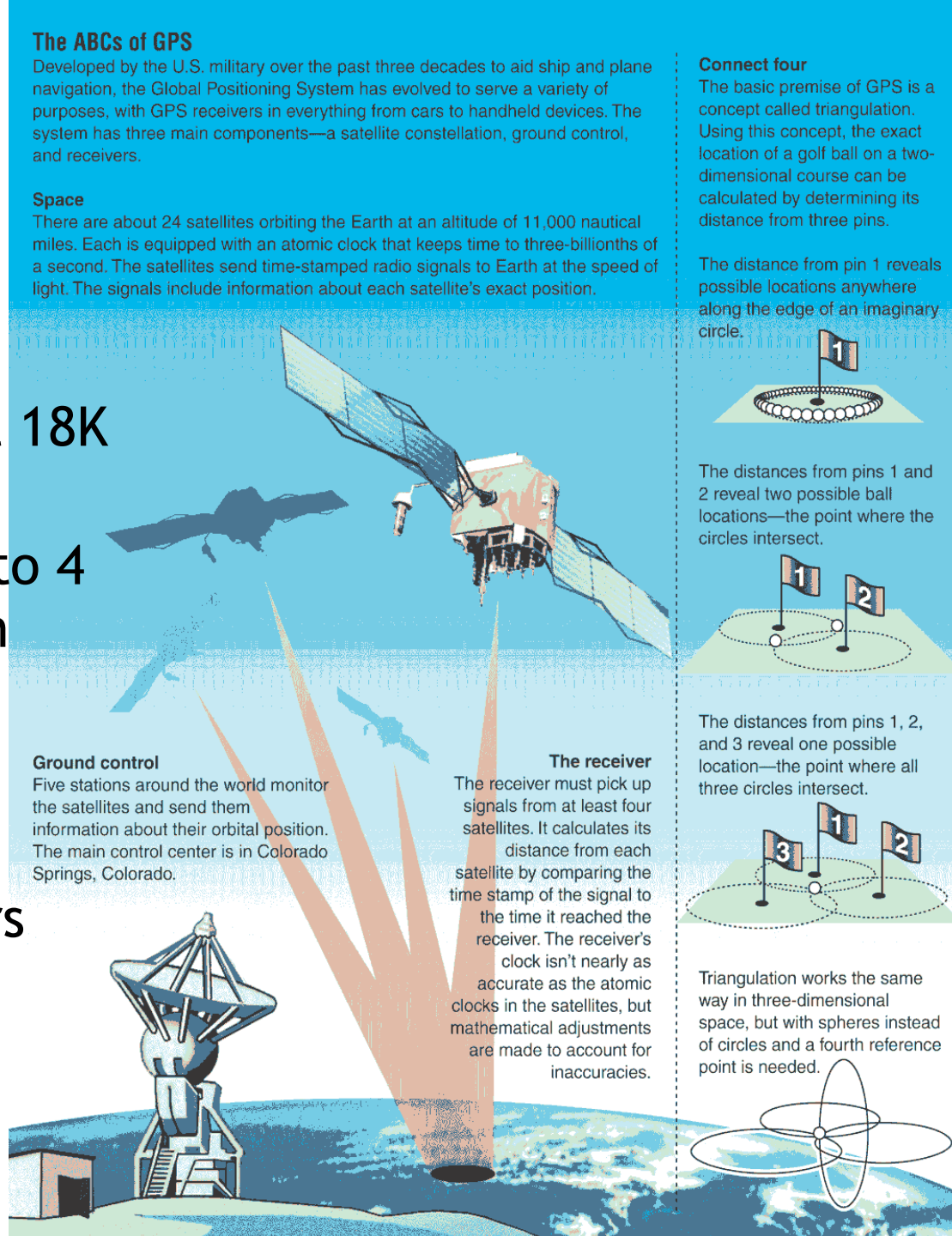
Available with new vehicles

Global Positioning System

MEO satellites

- continuously transmit timed radio signals
- Each satellite circles earth twice each day at 18K km up
- GPS receivers pick up transmissions from up to 4 satellites and pinpoint the receiver's location

- Accurate within 15 metres, with a norm of 3 metres accuracy
- GPS receivers contain map files to guide users



Wi-Fi

based on the 802.11 standard

referred to as wireless Ethernet

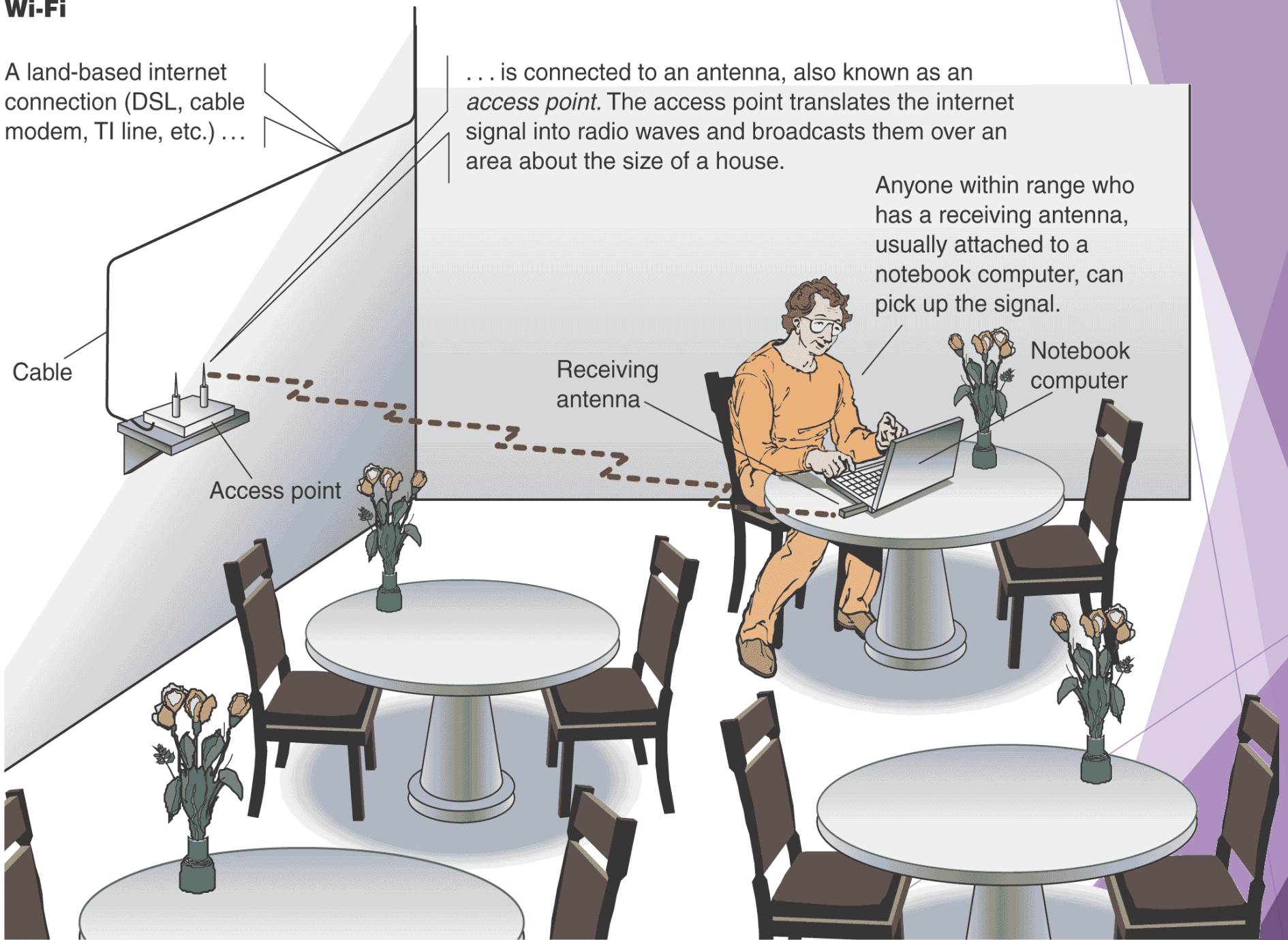
802.11 Series of Standards

Standard	Transfer Rates
802.11	1 or 2 Mbps
802.11a	Up to 54 Mbps
802.11b	Up to 11 Mbps
802.11g	54 Mbps and higher
802.11n	108 Mbps and higher

Access point

- a central communications device
- allows devices to transfer data wirelessly
- among themselves or to a wired network

Wi-Fi


A land-based internet connection (DSL, cable modem, TI line, etc.) . . .
. . . is connected to an antenna, also known as an *access point.* The access point translates the internet signal into radio waves and broadcasts them over an area about the size of a house.
Anyone within range who has a receiving antenna, usually attached to a notebook computer, can pick up the signal.
Cable
Access point
Receiving antenna
Notebook computer

Short-range Wireless

- **Local Area Networks**
  - Range 50 – 150 feet
  - Wi-Fi (802.11) type networks
- **Personal Area Networks**
  - Range 30 – 32 feet
  - Bluetooth, wireless USB
- **Home Automation Networks**
  - Range 100 – 250 feet

Short-range Wireless

Bluetooth

- defines how two Bluetooth devices use short-range radio waves to transmit data

UWB (ultra-wideband)

- how two UWB devices use short-range radio waves to communicate at high speeds

IrDA

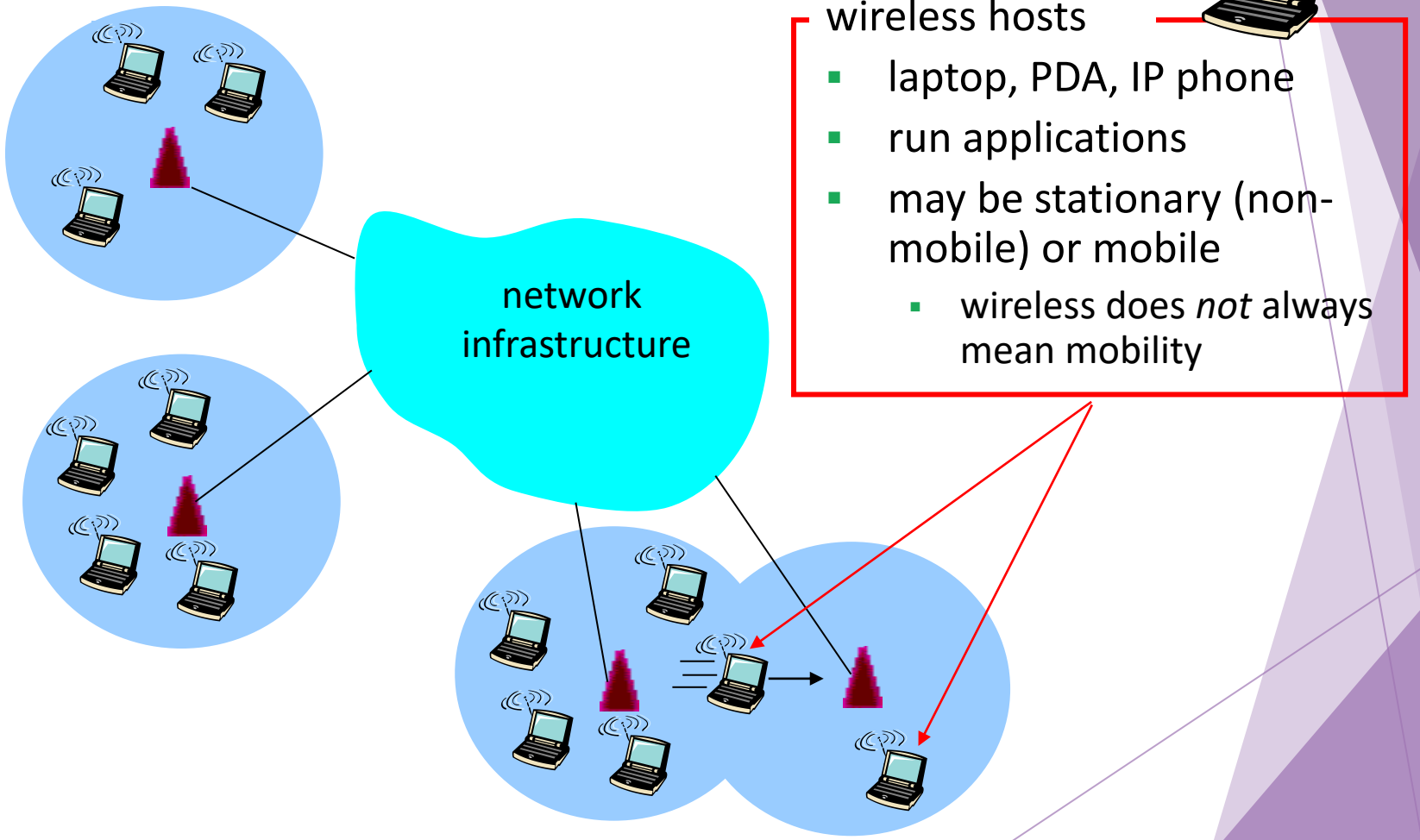
- transmits data wirelessly via infrared (IR) light waves

RFID

- uses radio signals to communicate with a tag placed in or attached to an object, animal, or person

How does a mobile / wireless network, work?

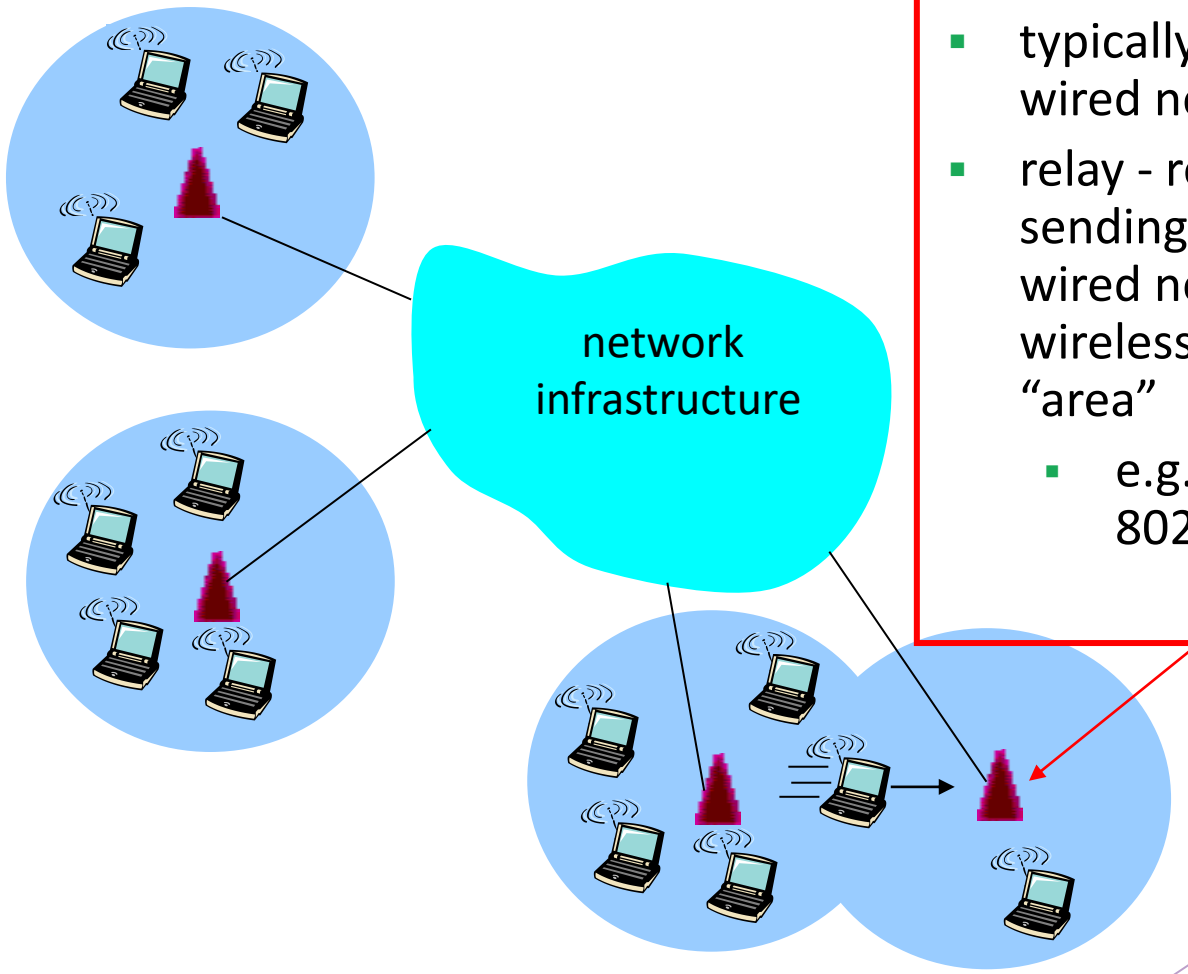
Elements of a wireless network



wireless hosts

- laptop, PDA, IP phone
- run applications
- may be stationary (non-mobile) or mobile
  - wireless does *not* always mean mobility

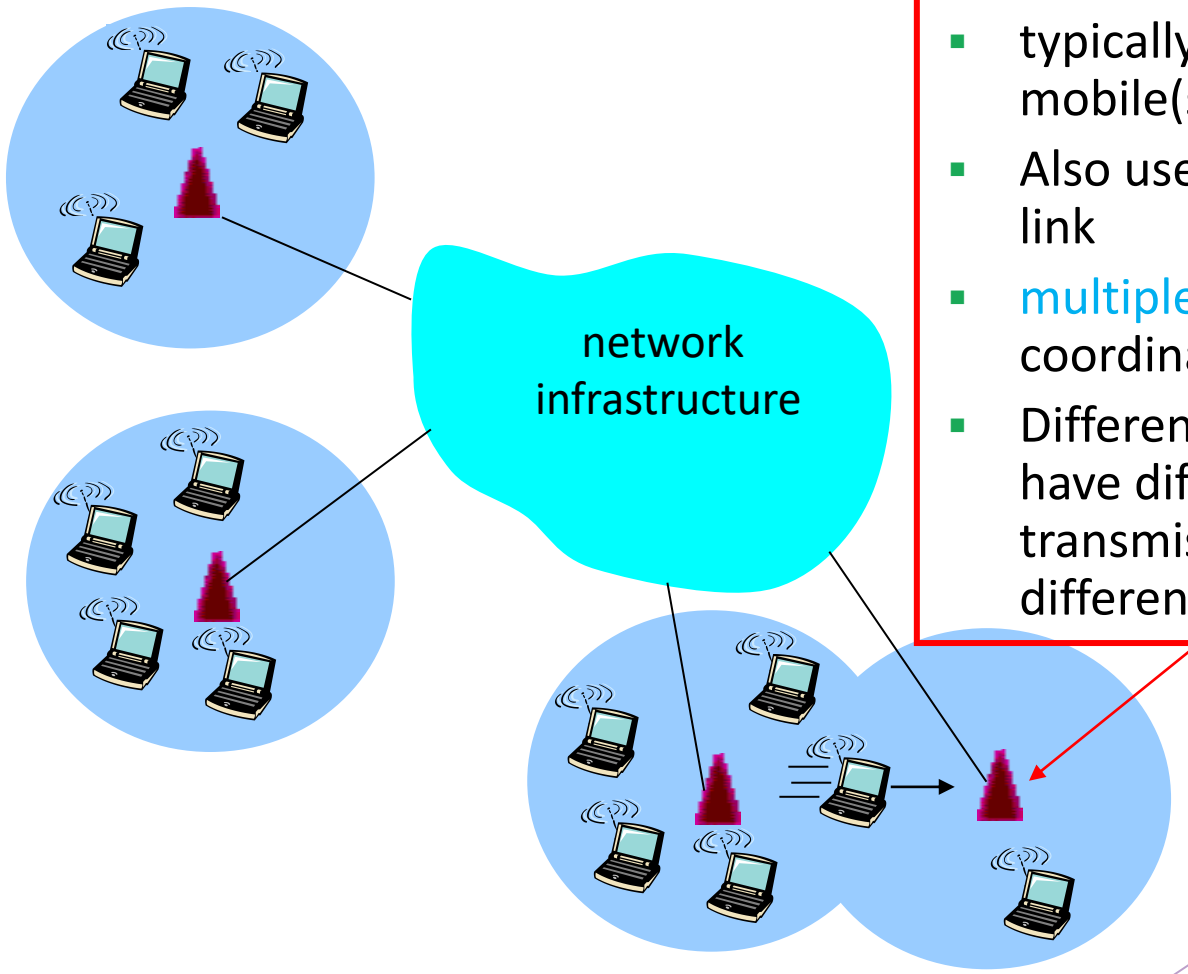
Elements of a wireless network



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

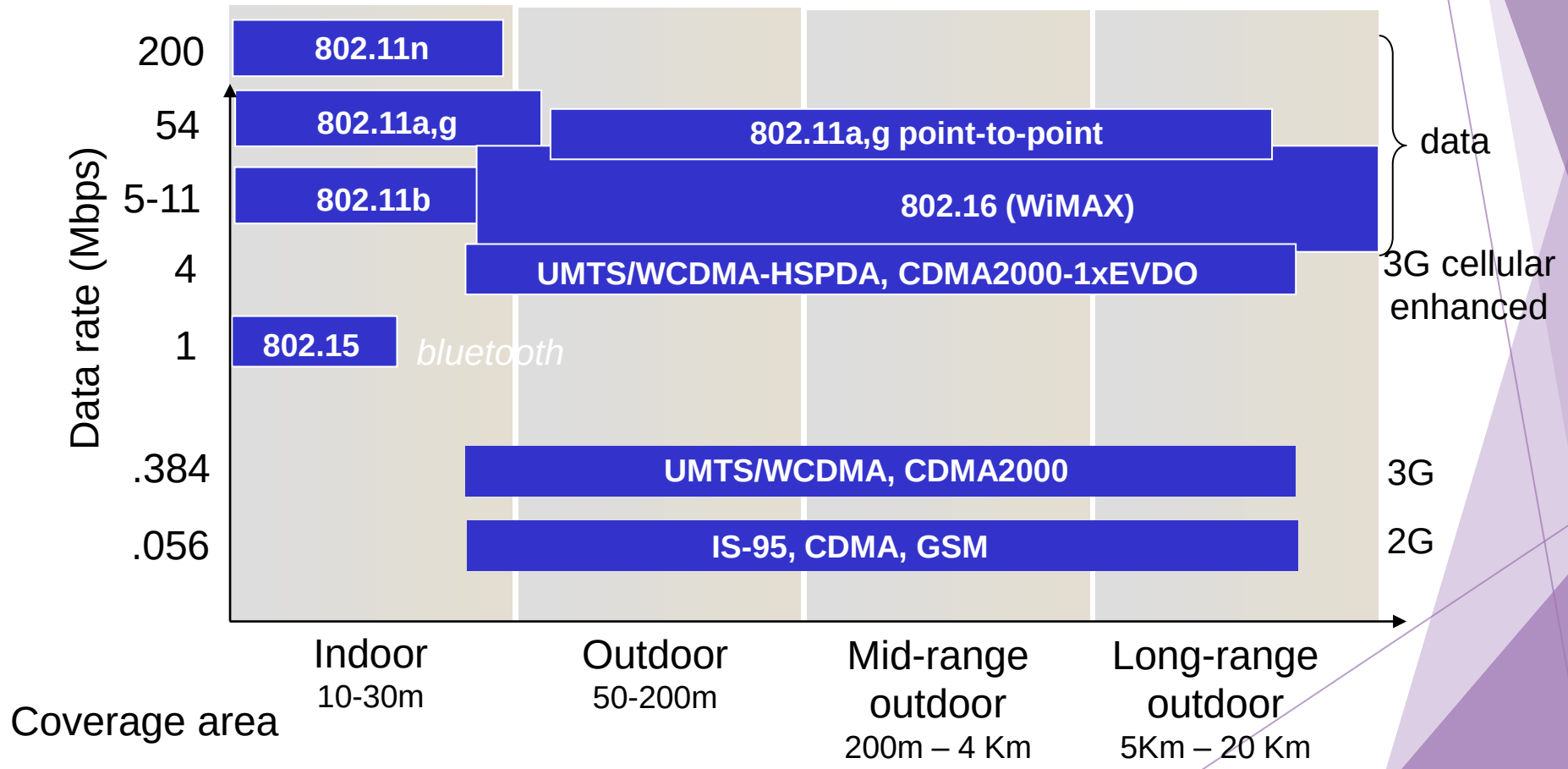
- typically used to connect mobile(s) to base station
- Also used as backbone link
- multiple access protocol coordinates link access
- Different technologies have different transmission rates over different distances

Wireless and Mobile Networks

Wireless communications links

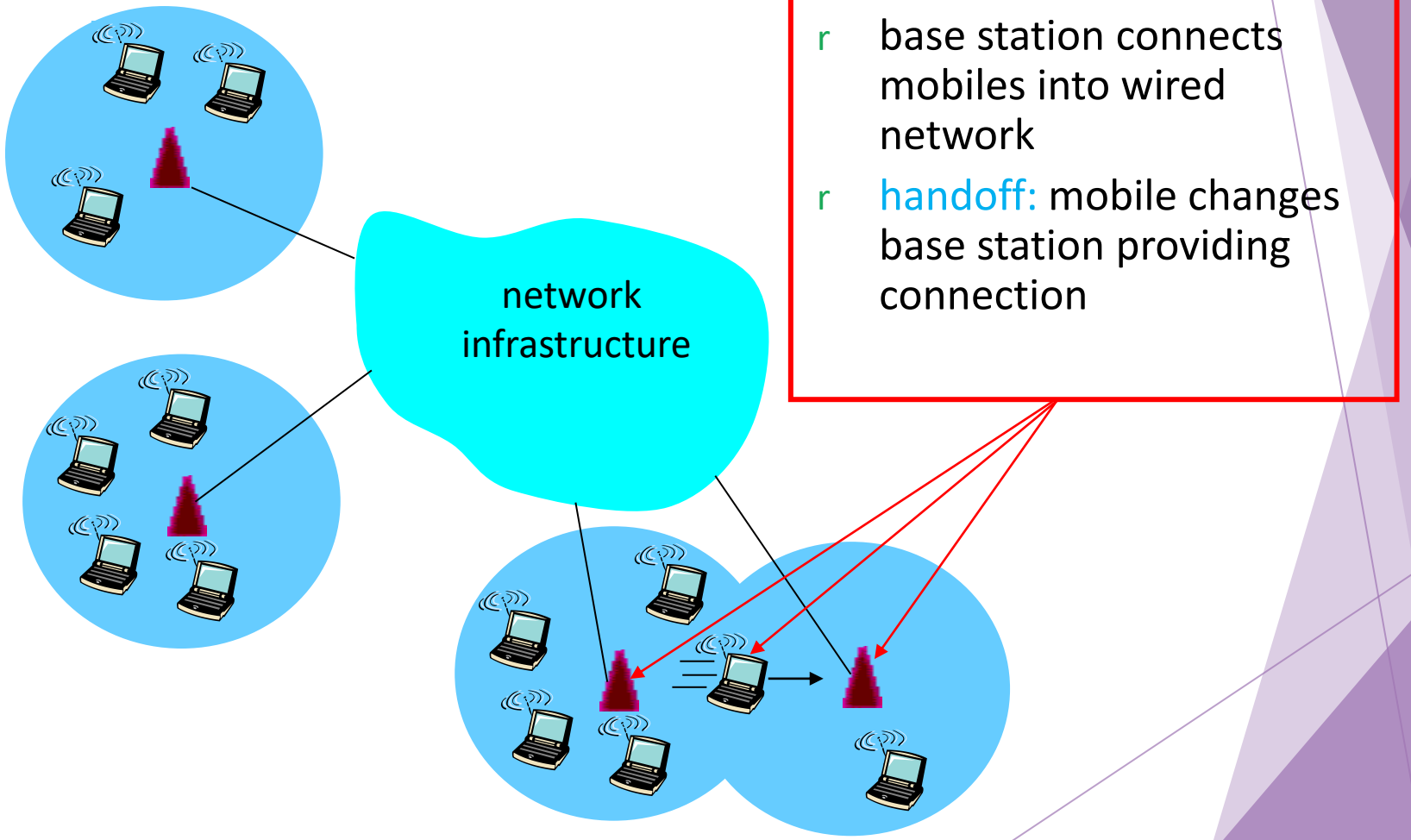
- Different wireless links technologies have
  - different transmission rates, and
  - can transmit over different distances

Characteristics of selected wireless link standards



Values can differ with distance, conditions and number of users

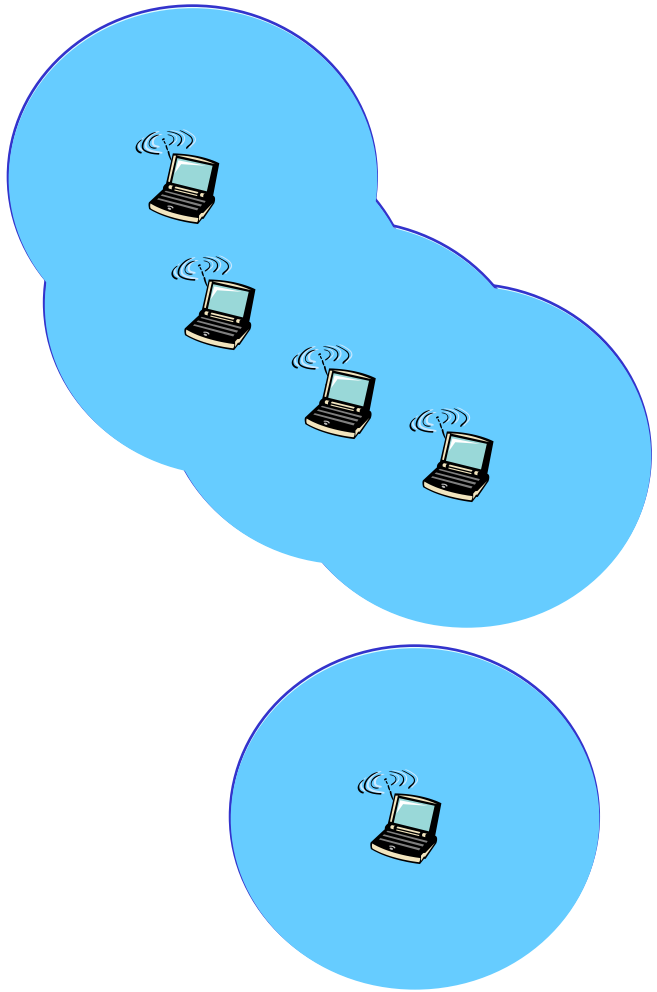
Elements of a wireless network



infrastructure mode

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

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

Code Division Multiple Access (CDMA)

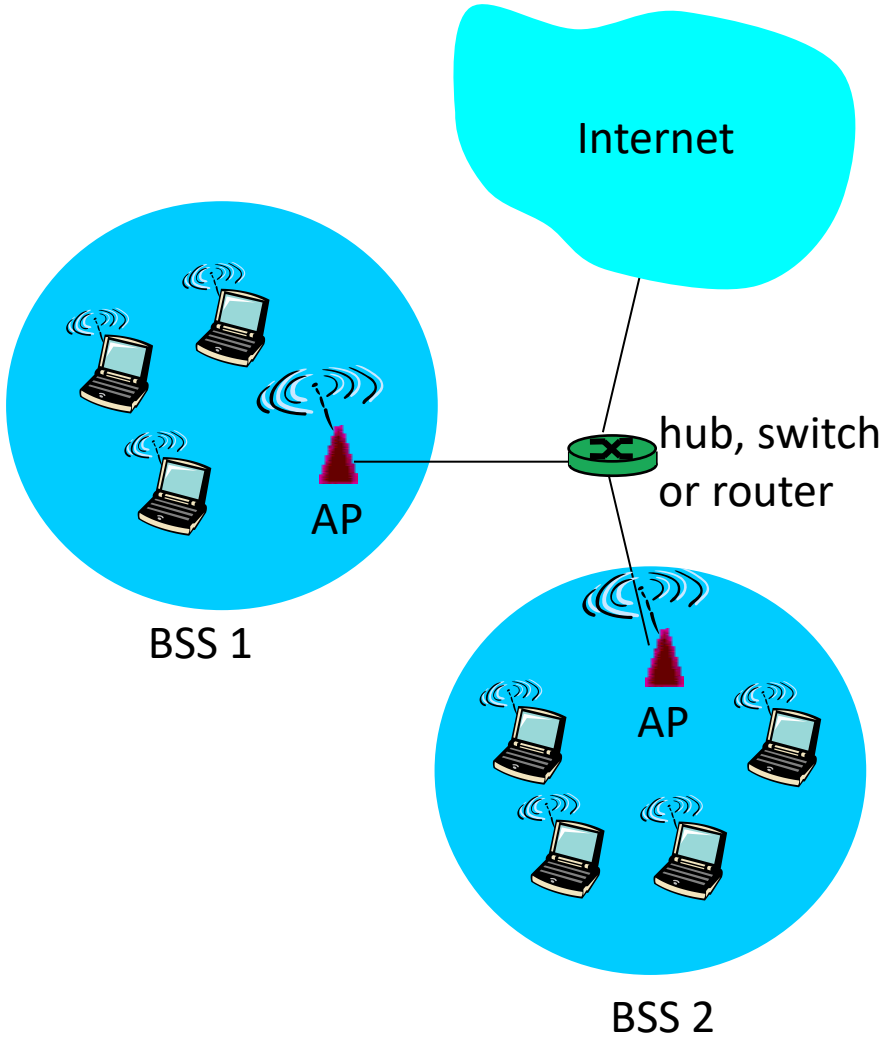
Analogy:

- Cocktail party
- Many people talking
- Multiple languages
- Understand one language
- Filter unknown

- Each node has a code
- The code is a sequence of bits (called a chipping sequence)
- Multiple the code with the data
- Receiving node knows the code & deciphers the message

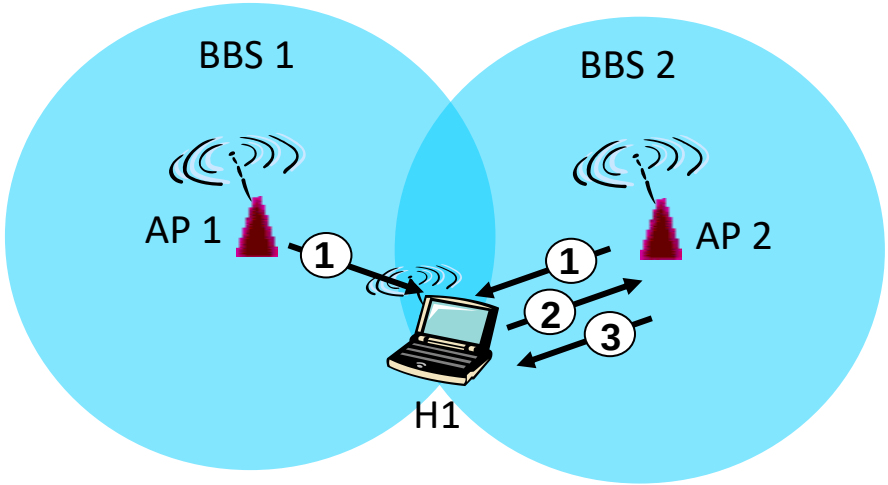
802.11 wireless LANs

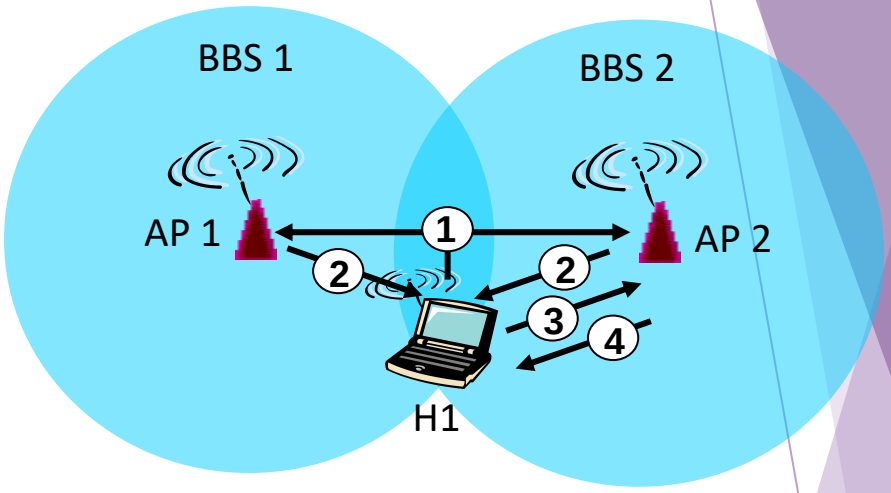
802.11 LAN architecture



- 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

802.11: passive/active scanning





Passive Scanning:

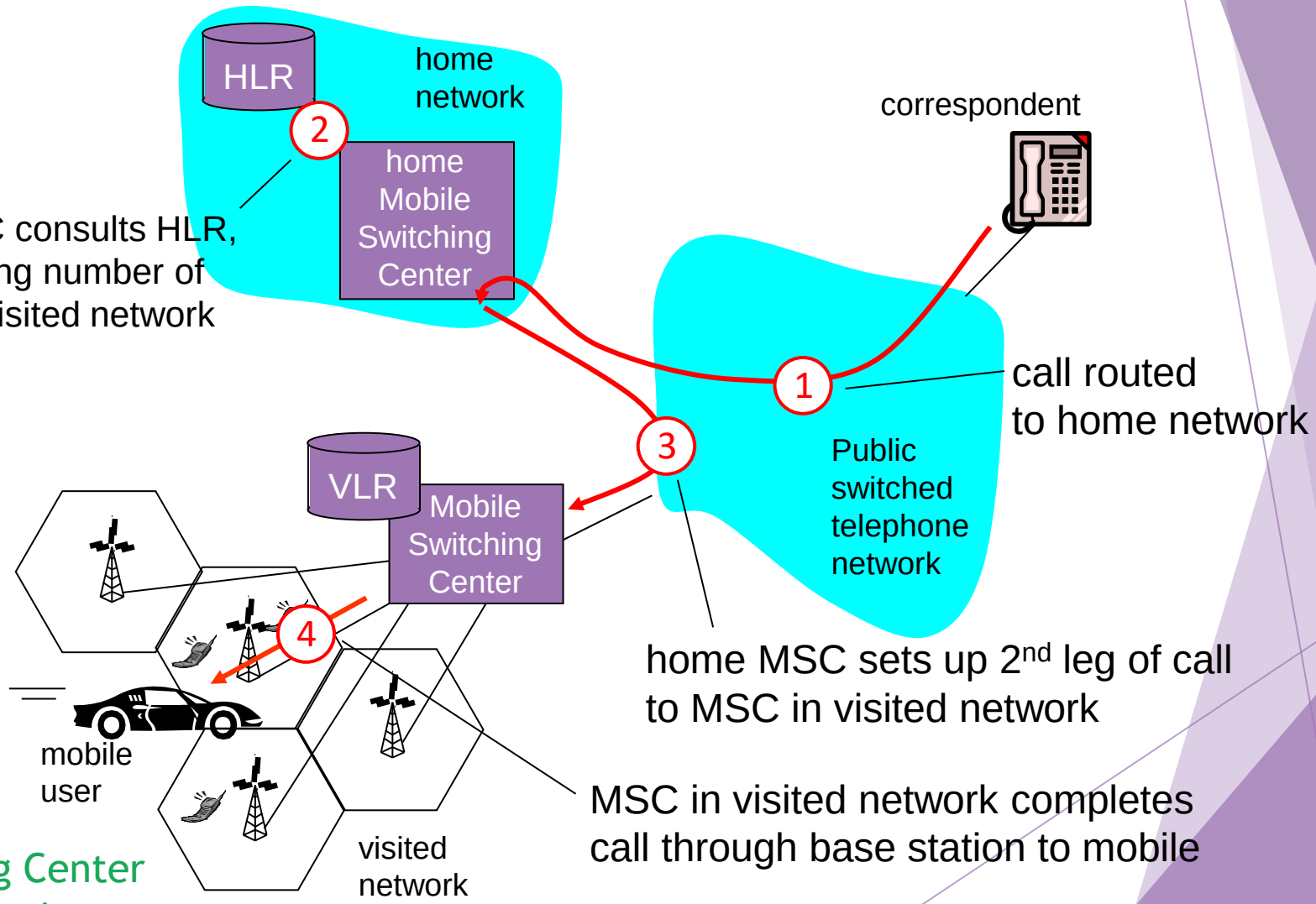
(1) beacon frames sent from APs
(2) association Request frame sent: H1 to selected AP
(3) association Response frame sent: H1 to selected AP

Active Scanning:

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

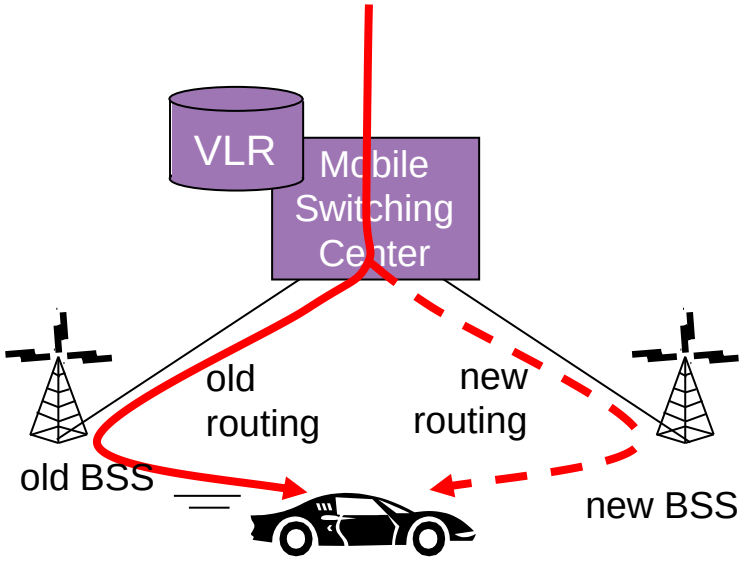
mobility

Global System for Mobile Communications (GSM)
indirect routing to mobile



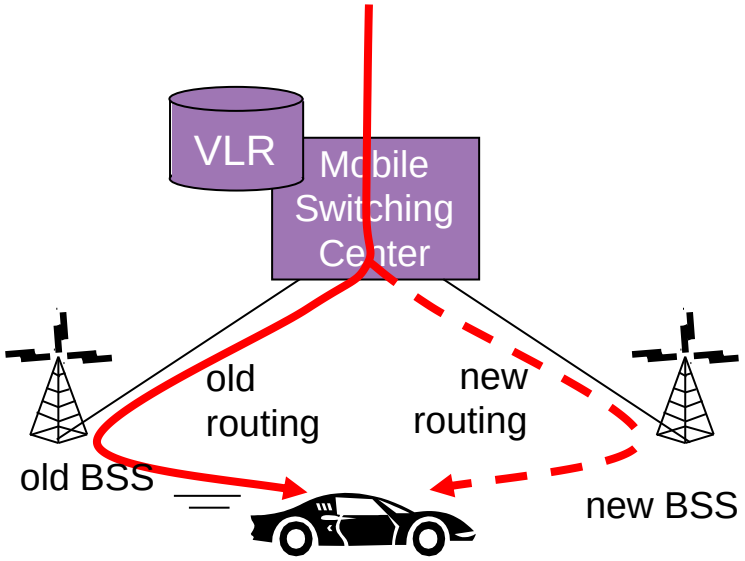
MSC = Mobile Switching Center
HLR = Home location register
VLR = Visiting location register

GSM: handoff with common MSC



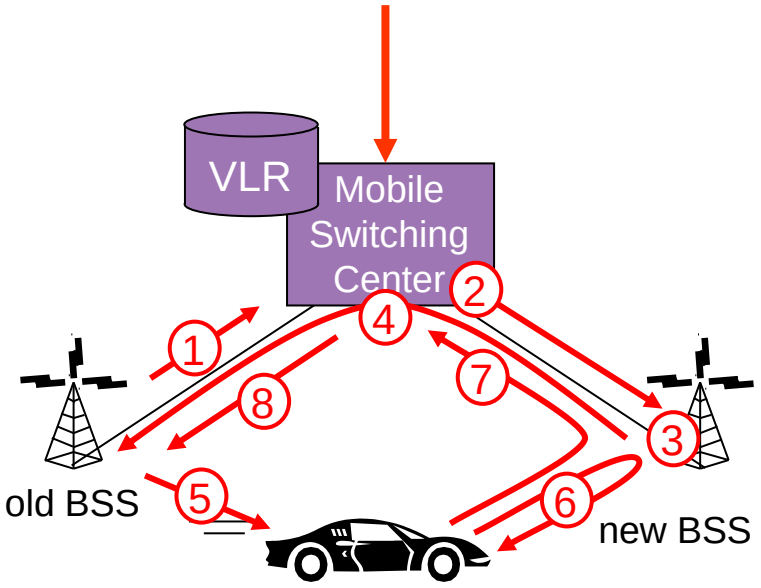
- Handoff goal: route call via new base station (without interruption)
- initiated by old BSS

GSM: handoff with common MSC



- reasons for handoff:
  - stronger signal to/from new BSS (continuing connectivity, less battery drain)
  - load balance: free up channel in current BSS
  - GSM doesn't mandate why to perform handoff (policy), only how (mechanism)

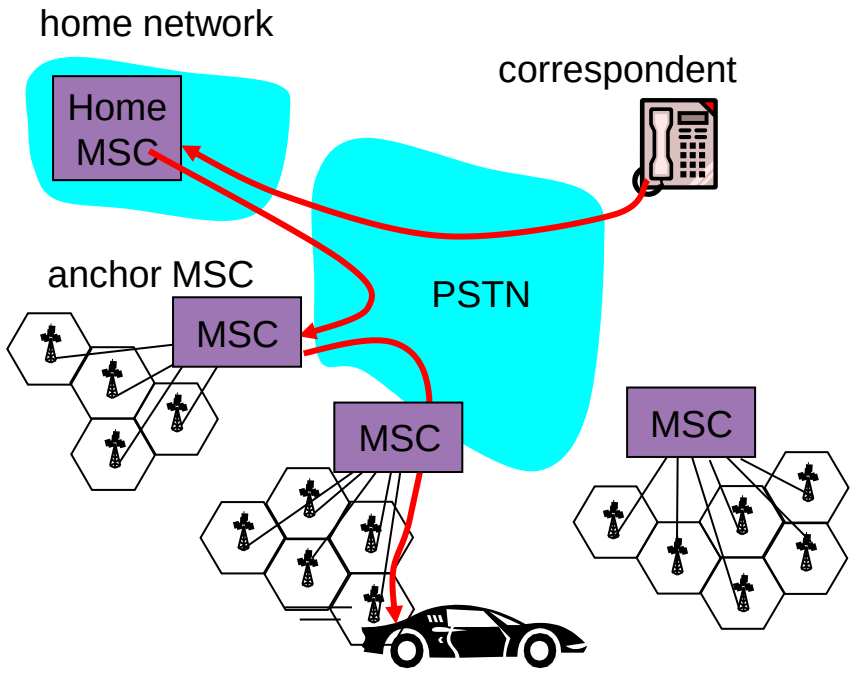
GSM: handoff with common MSC



1. old BSS informs MSC of impending handoff, provides list of 1+ new BSSs
2. MSC sets up path (allocates resources) to new BSS
3. new BSS allocates radio channel for use by mobile
4. new BSS signals MSC, old BSS: ready
5. old BSS tells mobile: perform handoff to new BSS
6. mobile, new BSS signal to activate new channel
7. mobile signals via new BSS to MSC: handoff complete. MSC reroutes call

8 MSC-old-BSS resources released

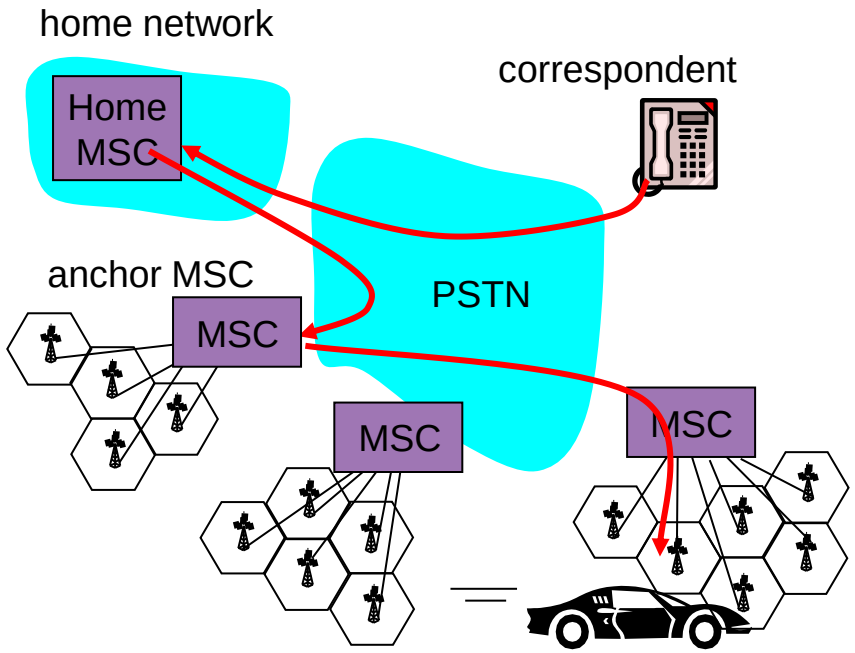
GSM: handoff between MSCs



(a) before handoff

- anchor MSC: first MSC visited during cal
  - call remains routed through anchor MSC
- new MSCs add on to end of MSC chain as mobile moves to new MSC
- IS-41 allows optional path minimization step to shorten multi-MSC chain

GSM: handoff between MSCs



(b) after handoff

- anchor MSC*:* first MSC visited during cal
  - call remains routed through anchor MSC
- new MSCs add on to end of MSC chain as mobile moves to new MSC
- IS-41 allows optional path minimization step to shorten multi-MSC chain

Thank you!

any questions?