

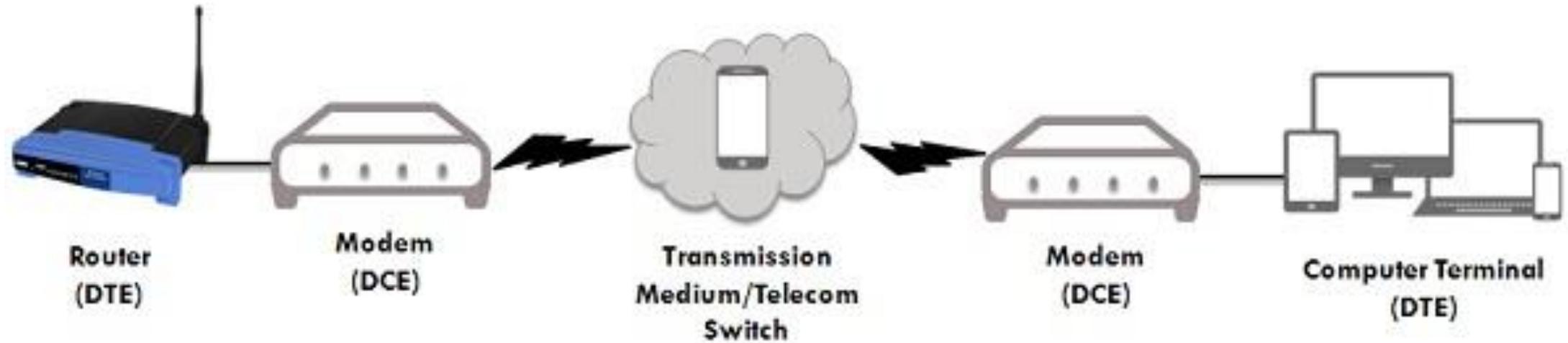


Badji Mokhtar University Annaba
Electronics Department

Level 3: Telecommunication
Module: Telecommunication systems and networks

Lecture : Telecommunications networks

Contact:
seifallah.nasri@univ-annaba.org



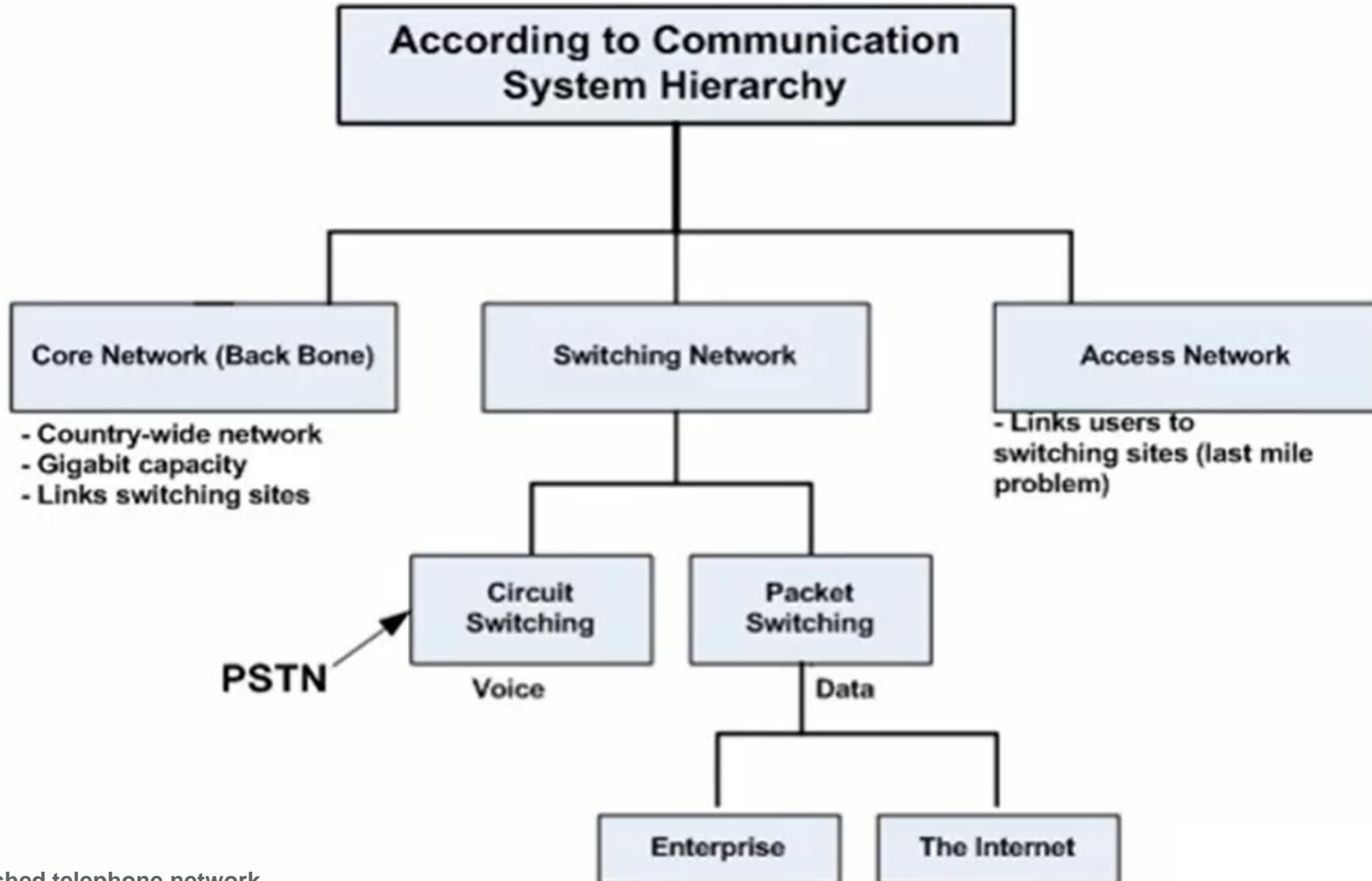
(Data Terminal Equipment)
ETTD (équipement terminal de traitement de données)

(Data Control Equipment)
ETCD (équipement terminal de circuit de données).

Telecommunication

- Telecommunication deals with the service of providing communications at a distance
- A large business with huge investments
 - Serves a large population with different needs
 - Relies on highly skilled technical personnel
- May be private or open to public access
The latter are government-owned telephone companies, or private corporations, that sell their services publicly

Telecommunication Systems: Classification



Wireless and Mobile Networks: context

- more wireless (mobile) phone subscribers than fixed (wired) phone subscribers (10-to-1 in 2019)!
- more mobile-broadband-connected devices than fixed-broadband-connected devices (5-1 in 2019)!
 - 4G/5G cellular networks now embracing Internet protocol stack, including SDN
- two important (but different) challenges
 - **wireless**: communication over wireless link
 - **mobility**: handling the mobile user who changes point of attachment to network

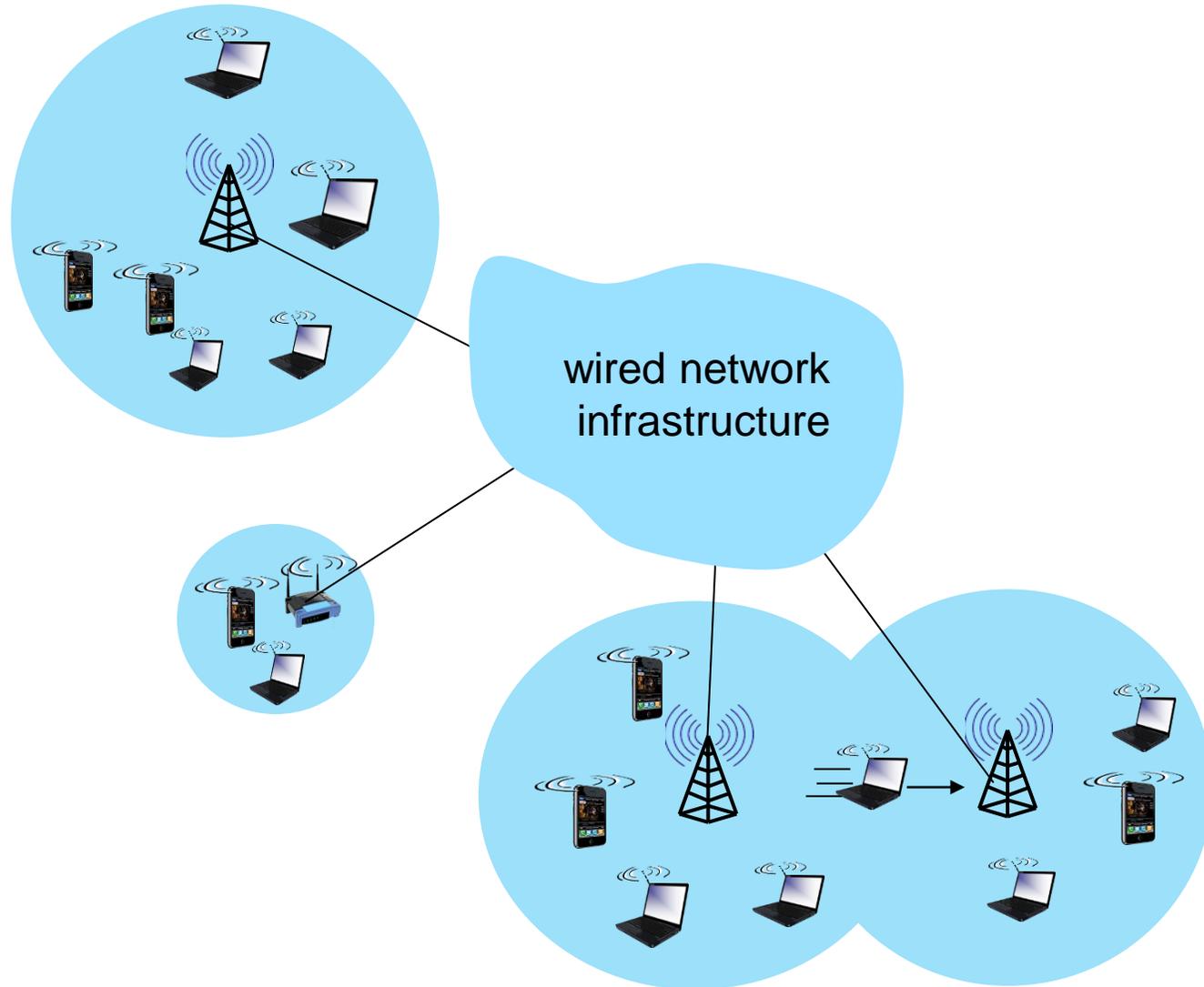
Wireless

- Wireless Links and network characteristics
- WiFi: 802.11 wireless LANs
- Cellular networks: 4G and 5G

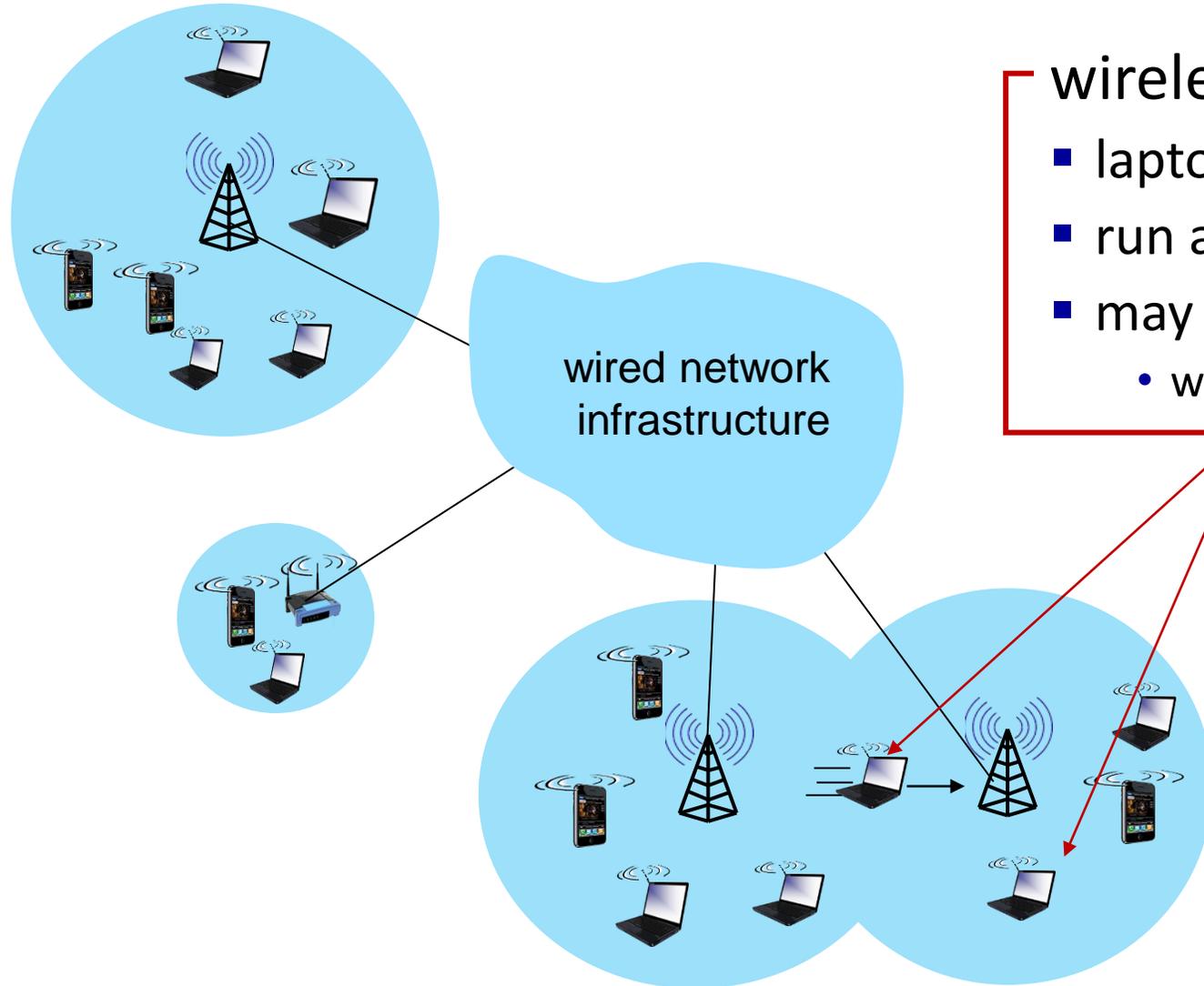
Mobility

- Mobility management: principles
- Mobility management: practice
 - 4G/5G networks
 - Mobile IP
- Mobility: impact on higher-layer protocols

Elements of a wireless network



Elements of a wireless network

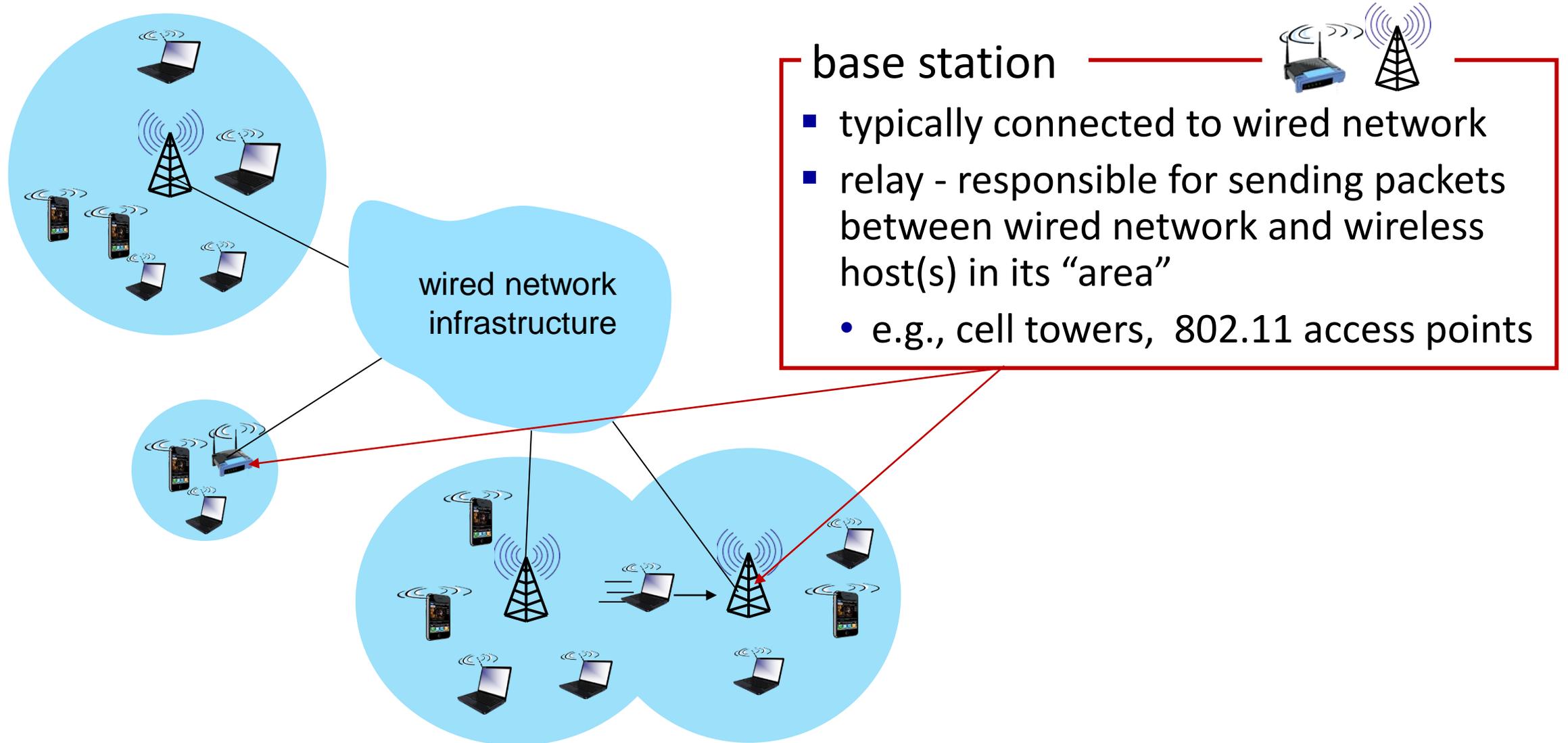


wireless hosts

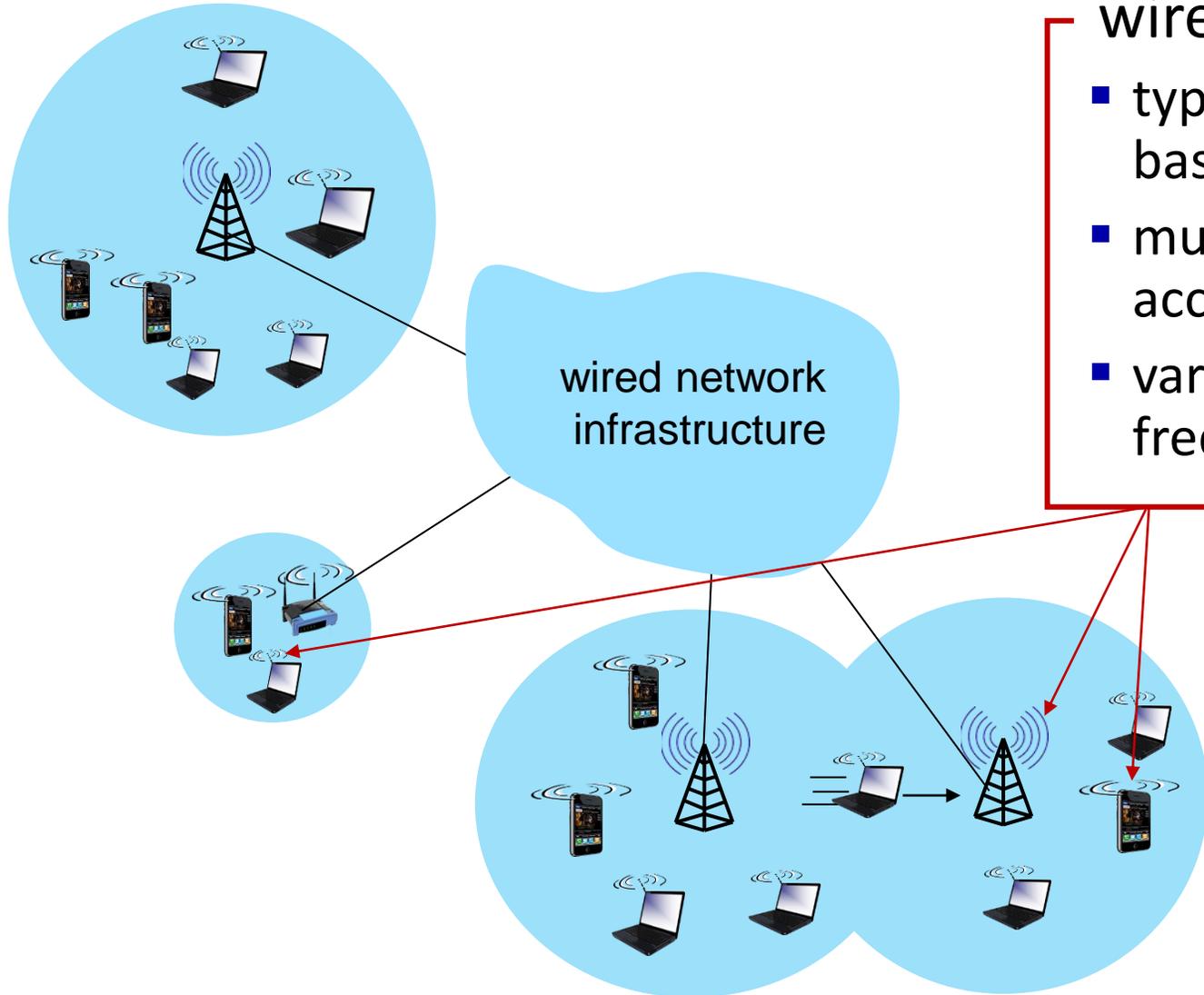
- laptop, smartphone, IoT
- run applications
- may be stationary (non-mobile) or mobile
 - wireless does *not* always mean mobility!



Elements of a wireless network



Elements of a wireless network

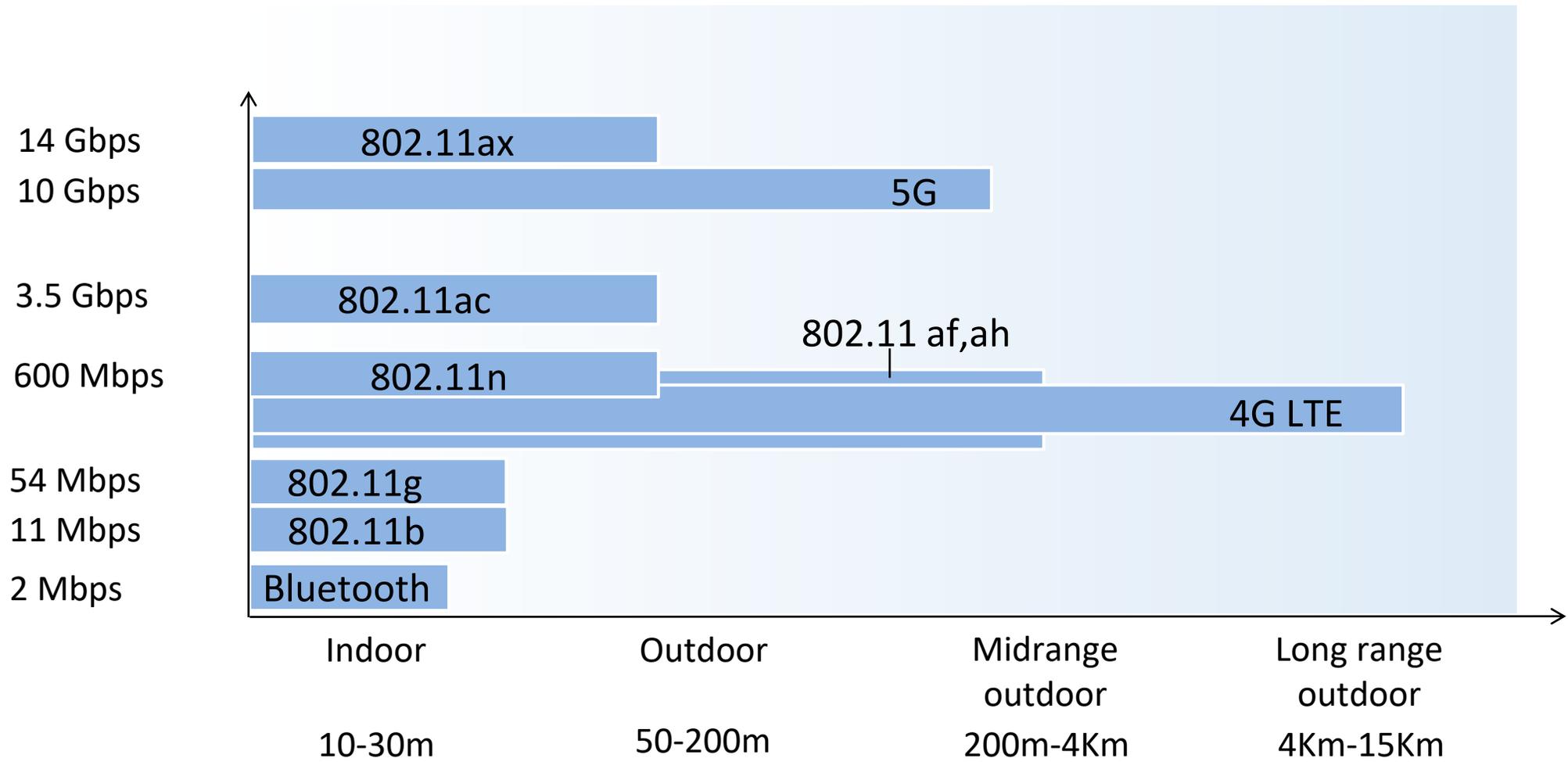


wireless link

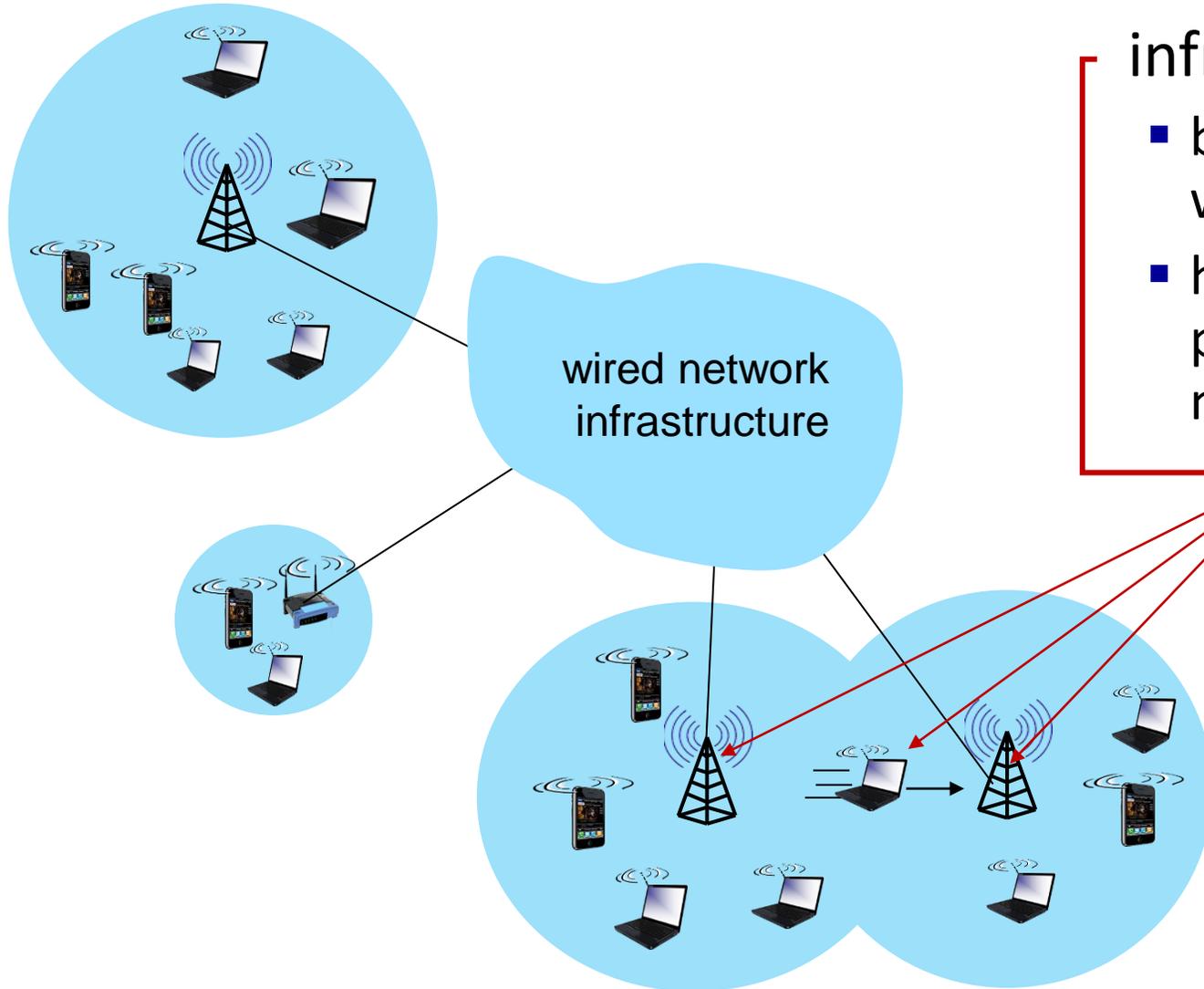


- typically used to connect mobile(s) to base station, also used as backbone link
- multiple access protocol coordinates link access
- various transmission rates and distances, frequency bands

Characteristics of selected wireless links



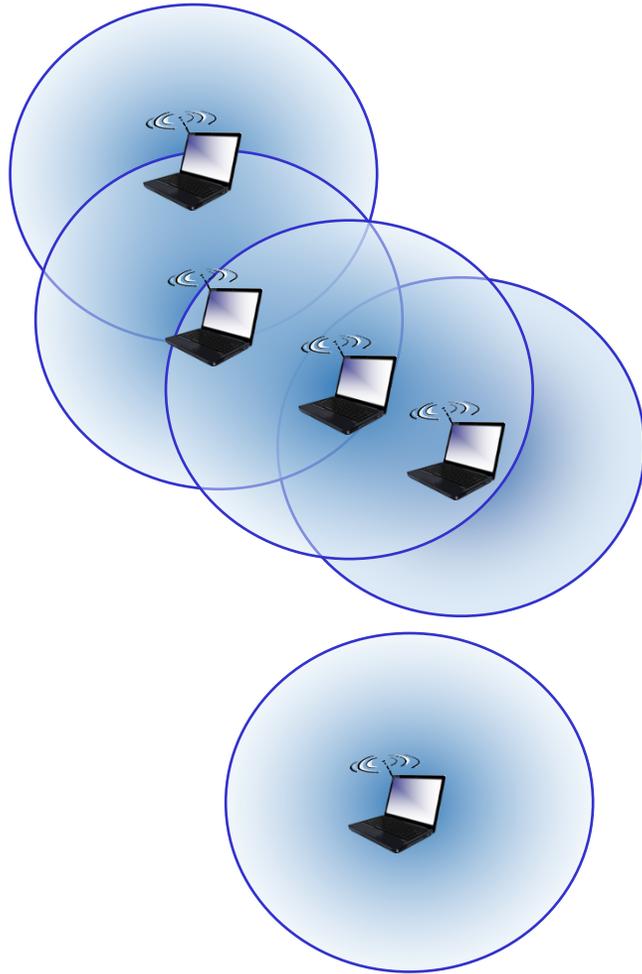
Elements of a wireless network



infrastructure mode

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

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

Wireless network taxonomy

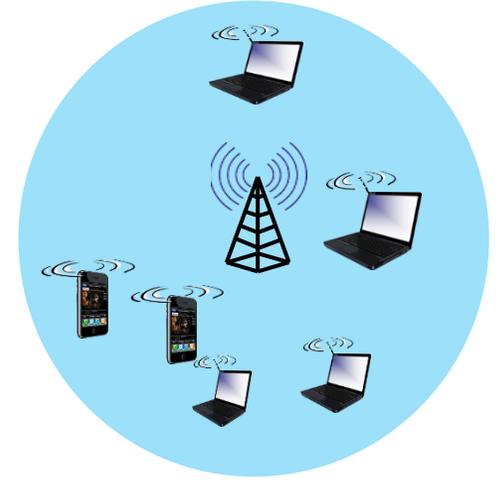
	single hop	multiple hops
infrastructure (e.g., APs)	host connects to base station (WiFi, cellular) which connects to larger Internet	host may have to relay through several wireless nodes to connect to larger Internet: <i>mesh net</i>
<i>no infrastructure</i>	no base station, no connection to larger Internet (Bluetooth, ad hoc nets)	no base station, no connection to larger Internet. May have to relay to reach other a given wireless node MANET, VANET

Wireless link characteristics (1)

important differences from wired link

- **decreased signal strength:** radio signal attenuates as it propagates through matter (path loss)
- **interference from other sources:** wireless network frequencies (e.g., 2.4 GHz) shared by many devices (e.g., WiFi, cellular, motors): interference
- **multipath propagation:** radio signal reflects off objects ground, arriving at destination at slightly different times

.... make communication across (even a point to point) wireless link much more “difficult”



IEEE 802.11 Wireless LAN

IEEE 802.11 standard	Year	Max data rate	Range	Frequency
802.11b	1999	11 Mbps	30 m	2.4 Ghz
802.11g	2003	54 Mbps	30m	2.4 Ghz
802.11n (WiFi 4)	2009	600	70m	2.4, 5 Ghz
802.11ac (WiFi 5)	2013	3.47Gpbs	70m	5 Ghz
802.11ax (WiFi 6)	2020 (exp.)	14 Gbps	70m	2.4, 5 Ghz
802.11af	2014	35 – 560 Mbps	1 Km	unused TV bands (54-790 MHz)
802.11ah	2017	347Mbps	1 Km	900 Mhz