Wireless Networks

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- Wireless and Mobile Networks: Context
  - More wireless (mobile) phone subscribers than fixed (wired) phone subscribers (10-to-1 in 2029)
  - 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 Hosts
  - Laptop, smartphone, IoT device, etc.
  - Run applications
  - May be stationary (non-mobile) or mobile
    - Wireless does not always mean mobility
- Base Station
  - Key element that connects the wireless network to wired networks through the backbone link
  - Relay — responsible for sending packets between wired networks and wireless host(s) in its "area"
    - For examples, cell towers, IEEE 802.11, access points
- Network Infrastructure

  - Larger network with which a wireless host may wish to communicate
  - Backbone link: connects base station to network infrastructure

- Infrastructure Mode
  - Each node is associated to the base station
  - Base station connects wireless hosts into the wired network
  - Handoff or handover: mobile node changes base station providing connection into wired network (without losing connectivity)

- Operating Modes of a Wireless Network
  - Ad Hoc Mode
    * No base stations
    * No larger network infrastructure to connect
    * Nodes can only transmit to other nodes within link coverage
    * Nodes organize themselves into a network: route among themselves
    * Development of protocols is challenging

- Wireless Link Characteristics
  - Decreased signal strength: radio signal attenuates as it propagates through matter (path loss)
  - Interference from other sources: some wireless network frequencies (like 2.4 GHz) are shared by many devices (like WiFi, Bluetooth, garage openers, motors, etc), which cause interference
  - Multipath propagation: radio signal reflects off objects and ground, arriving at destination may create different copies of the signal at slightly different times (multipath fading)
  - Moreover, nodes in the wireless link (broadcast link) do not receive the same signal

- WiFi: IEEE 802.11 Wireless LAN
  - Many different 802.11 Standards:
    * Link layer and physical layer
    * Most of the IEEE 802.11 standards have infrastructure mode and ad hoc mode network versions
    * Common MAC protocol
    * Common frame format
    * All offer connectionless reliable service with positive ACK and stop and wait at the link layer

* Different data rates
* All (but one) operate in unlicensed spectrum → ISM bands (Industrial, Scientific, and Medical bands)
    - Open frequency bands for non-exclusive usage (no license required)