Shortcomings of WiFi and cellular

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In what applications would you expect WiFi and cellular to not provide the needed communication performance?

Bluetooth – IEEE 802.15.1

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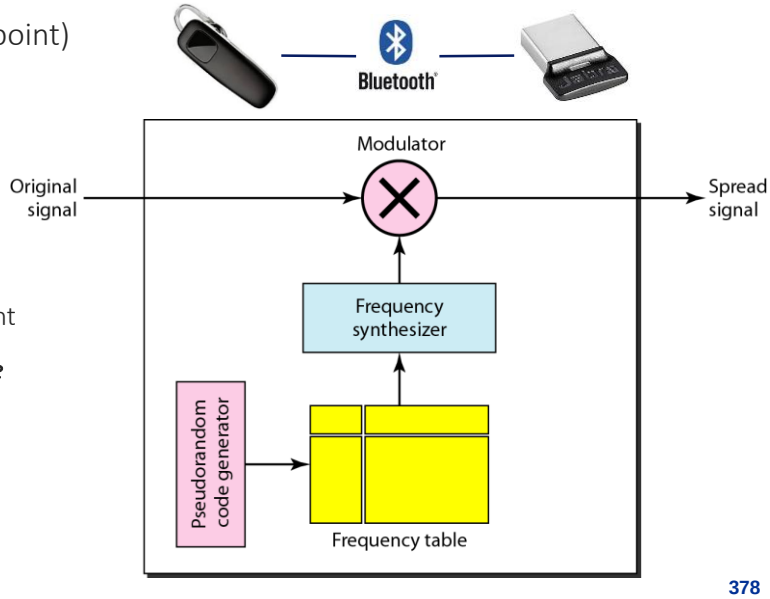
- *Cable replacement* (point to point) technology
- MAC
  - 2.4GHz
  - TDM – 625μs timeslots
  - FDM – 79 channels
  - Frequency hopping spread spectrum (FHSS)
    - Each timeslot on different channel according to a *pseudorandom sequence*



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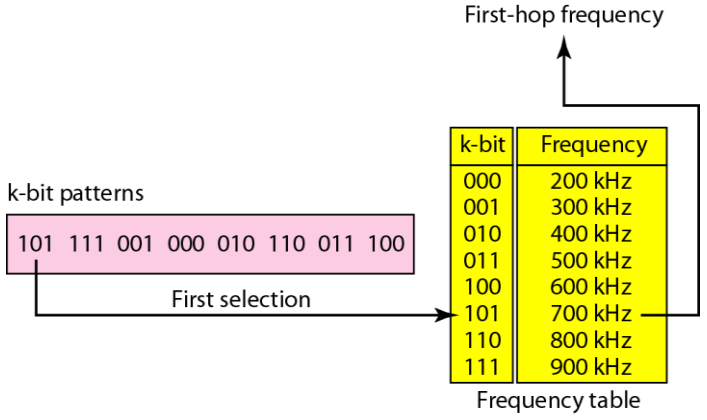

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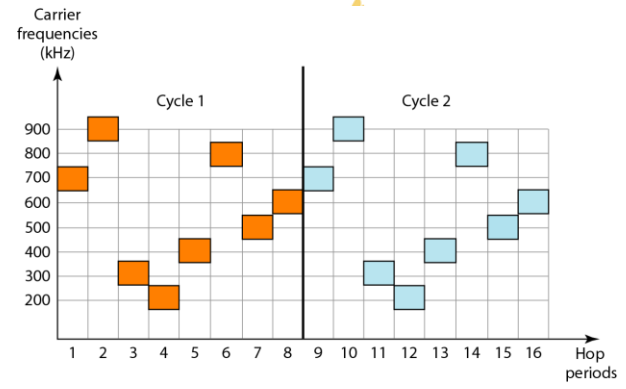
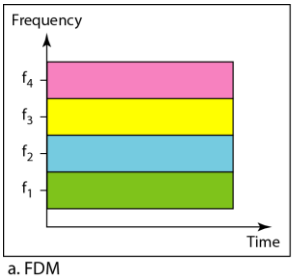
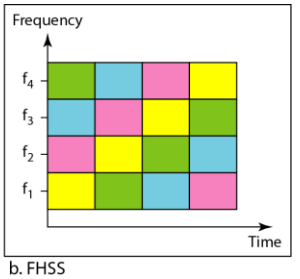




a. FDM



b. FHSS

Bluetooth – IEEE 802.15.1

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- MAC
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  - TDM – 625μs timeslots
  - FDM – 79 channels
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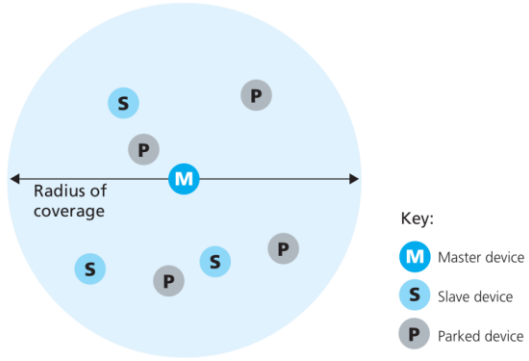
- Performance
  - Version 3 – 25Mbps
  - Version 4 (BLE) - 25Mbps, 200ft
  - Version 5 – 50Mbps, 800ft



- Piconet
  - 1 master
  - 7 active devices (transmit to and from master)
  - 255 parked devices (wait to be active)

Bluetooth

- Has service discovery to learn devices capabilities
  - Knows if the device is a mouse, or a headset

Protocol Name	UUID	Protocol Specification
SDP	0x0001	Bluetooth Core Specification
TCS-BIN	0x0005	Telephony Control Specification / TCS Binary [DEPRECATED]
HIDP	0x0011	Human Interface Device Profile (HID)
AVCTP	0x0017	Audio/Video Control Transport Protocol (AVCTP)
AVDTP	0x0019	Audio/Video Distribution Transport Protocol (AVDTP)

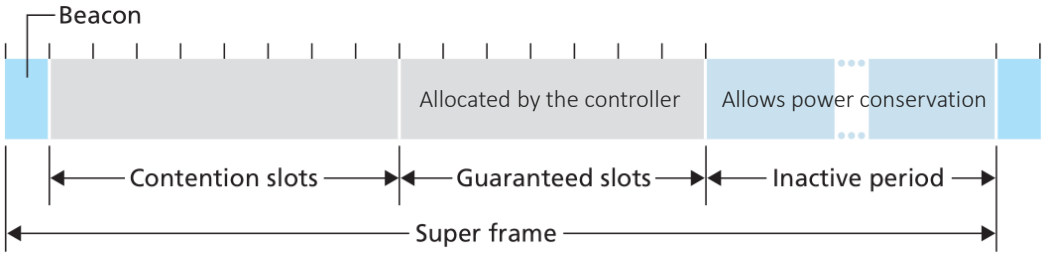
Zigbee

- For low power, low rate, low duty cycle devices
- Support mesh connectivity

Why does that reduce communication power?

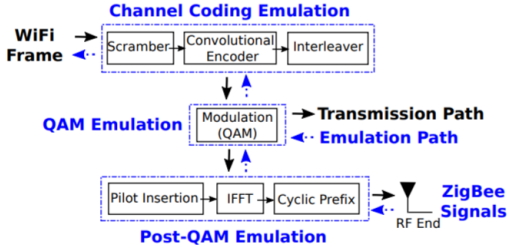
- *Full function* and *reduced function* devices

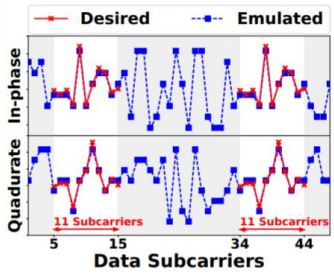
- MAC
  - 20, 40, 100, and 250Kbps channels
  - Beacons and link layer ACKs (like 802.11)
  - CSMA/CA
  - Guaranteed timeslots (like DOCSIS)



WEBee

Emulate Zigbee signals using a WiFi transmitter





Near-Field Communication (NFC)

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- Support interaction between users' smartphones and the physical world (access control, payments, marketing, information exchange)
- Employs electromagnetic induction between two loop antennas
- Full duplex – can check for collisions like Ethernet (CSMA/CD)
- Typical range is 5cm in the ISM band of 13.56 MHz
- Rates between 106 and 424 kbit/s
- Short messages - 96 to 8,192 bytes (ID, credit card info, etc.)

- Three modes
  - NFC card emulation
  - NFC reader/writer
  - NFC peer-to-peer

Long Range (LoRa)

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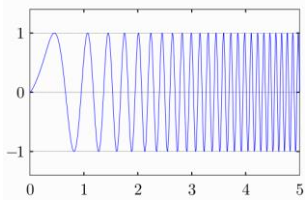
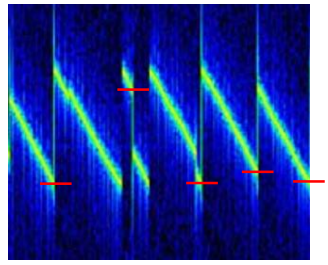
- Chirp spread spectrum (CSS)
  - Enables longer range at expense of lower data rate
  - A chirp is a sinusoidal signal whose frequency increases or decreases over time (often with a polynomial expression for the relationship between time and frequency)
  - Resistant to multipath fading
  - Resistant to the Doppler effect





BEARTOOTH

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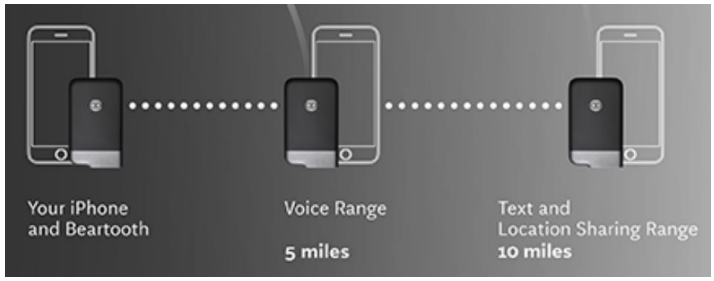

- LoRa Modulation with Frequency Hopping between Beartooths
- Bluetooth 2.0 Connection to Smartphone
- Mesh Networking for Extended Range

Mobility

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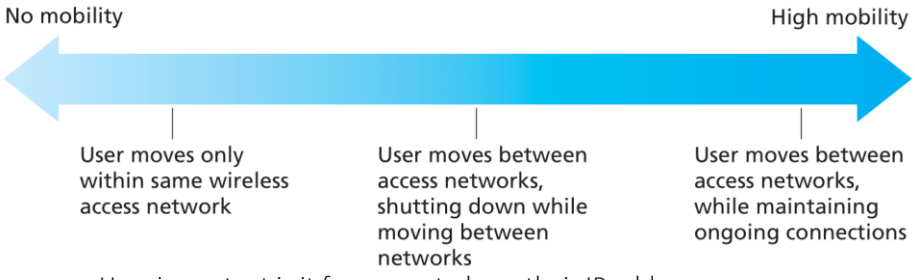
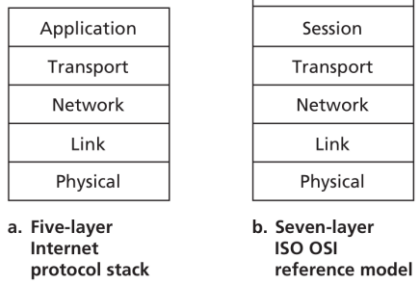


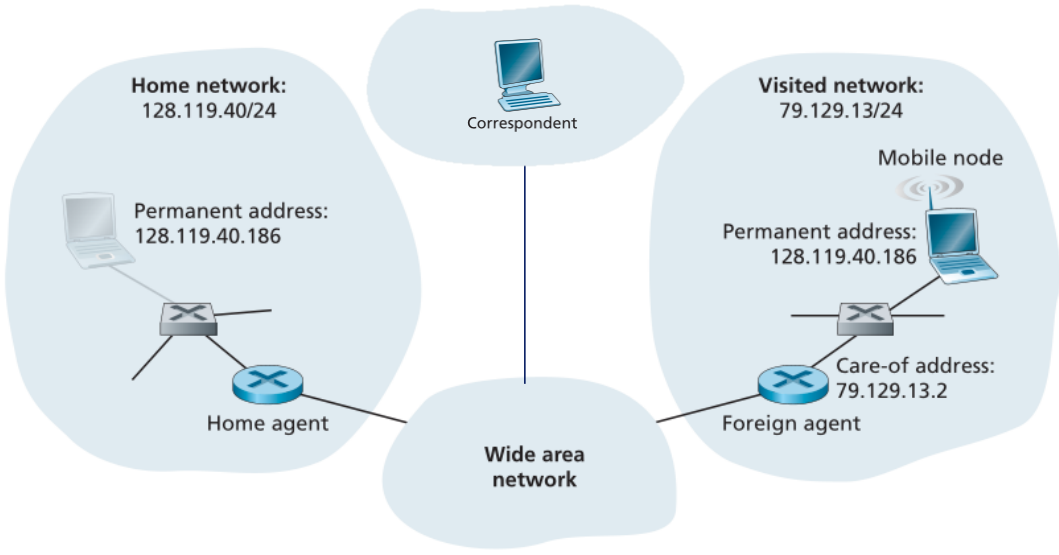
- How important is it for a user to keep their IP address as they move around?
- How could a user maintain a connection to the same application from different locations?

Why keeping your IP as you move around would break the Internet?

- What about a streaming application?
- Analogy: How do you keep getting important mail when you move around during college?



Mobile IP



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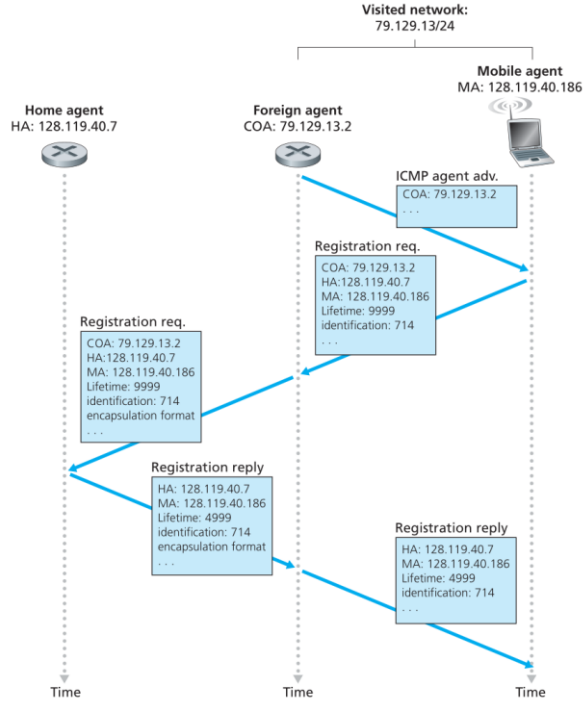
Mobile IP



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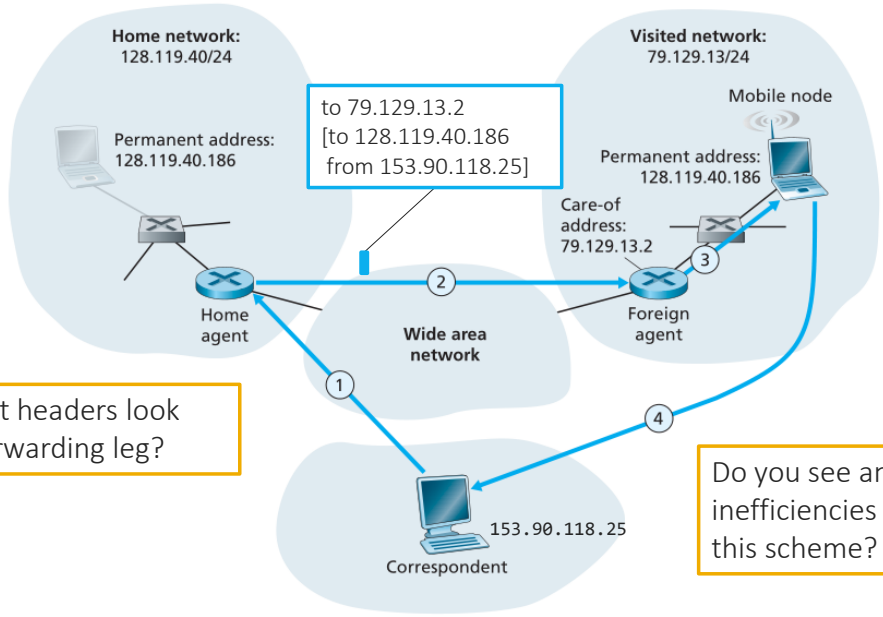
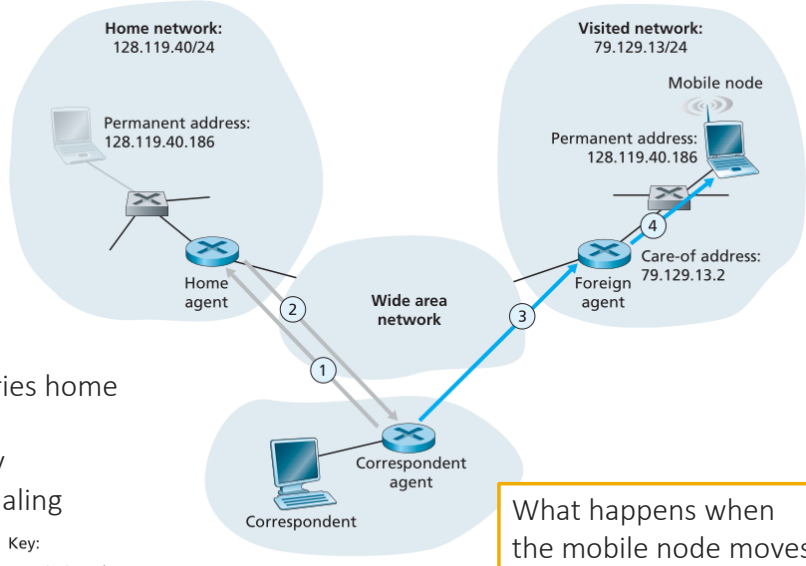
Mobile IP: Indirect routing



What do packet headers look like on each forwarding leg?

Do you see any inefficiencies with this scheme?

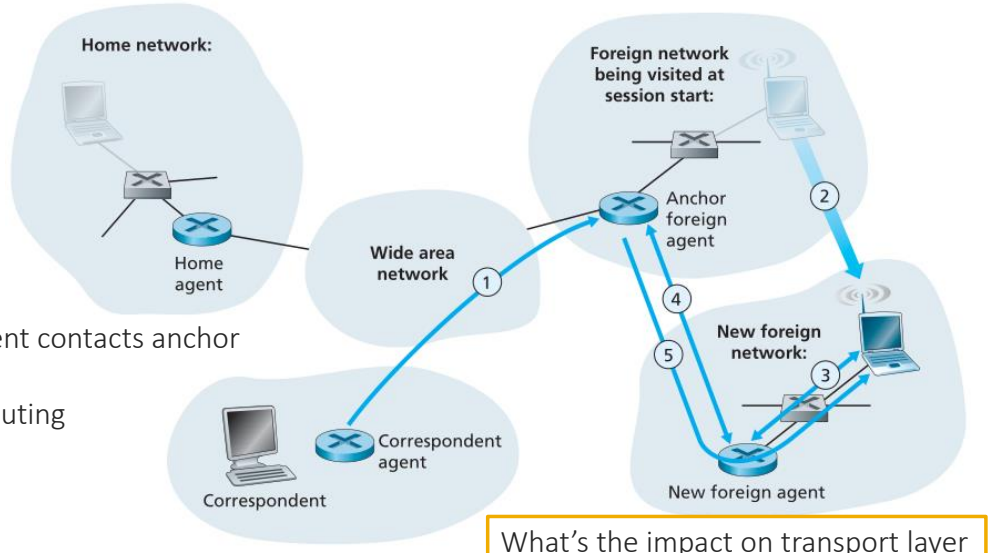
Direct routing in Mobile IP



- Corresponding agent queries home agent for care-of-address
- Packets forwarded directly
- Mobile IP RFCs define signaling

What happens when the mobile node moves to another network?

Mobile handovers in GSM



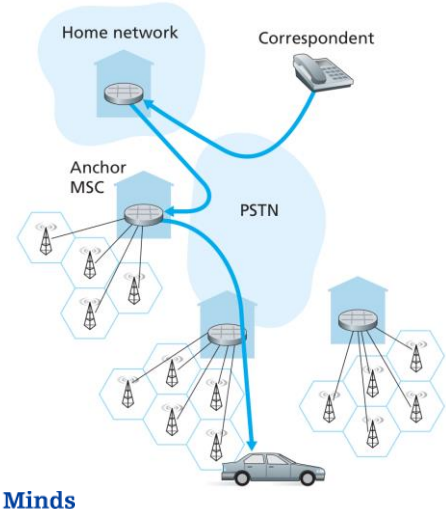
- New foreign agent contacts anchor foreign agent to update direct routing

What's the impact on transport layer performance?

Mobility in Cellular Networks

Definitely need to keep the same number!

MSCs act as anchor foreign agents



Make before break handoff