Wireless Data Networking and Mobile Computing

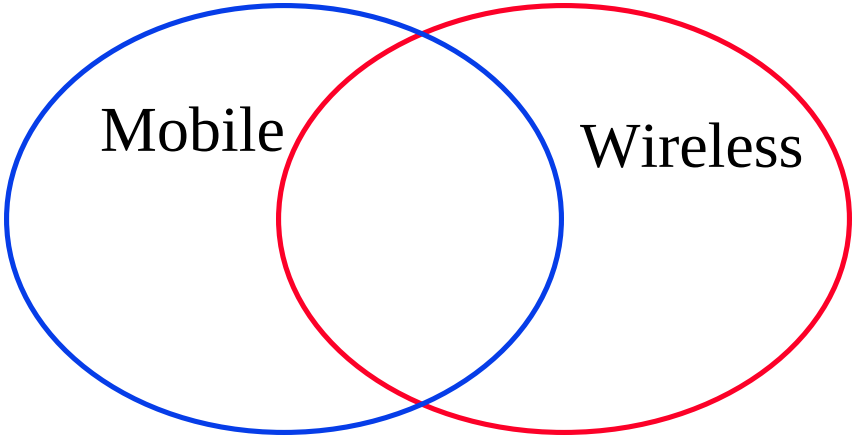
Raj Jain

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

- Wireless local area networks: Spread spectrum
- Wireless wide area networks: CDPD and Metricom
- Wireless LAN standards: IEEE 802.11
- Mobile IP

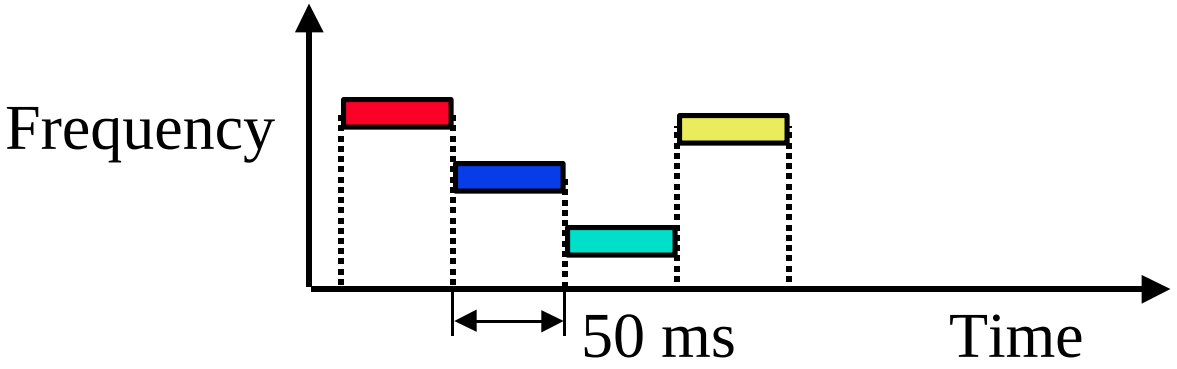
Note: wireless phone services and standards not covered.

Mobile vs Wireless



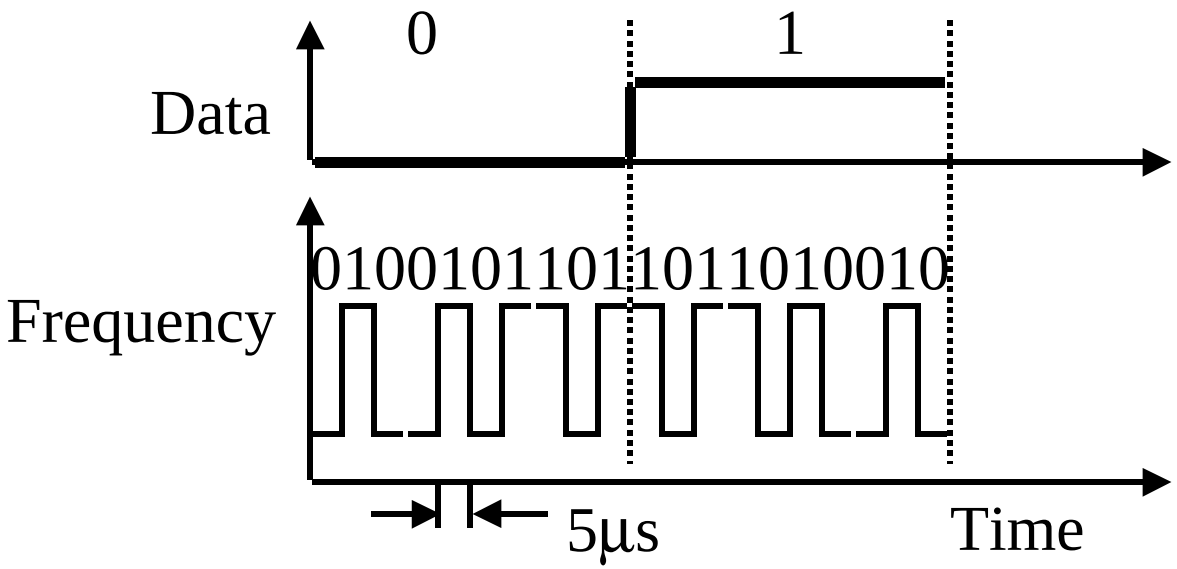
- Mobile vs Stationary
- Wireless vs Wired
- Wireless ⇒ media sharing issues
- Mobile ⇒ routing, addressing issues

Frequency Hopping Spread Spectrum



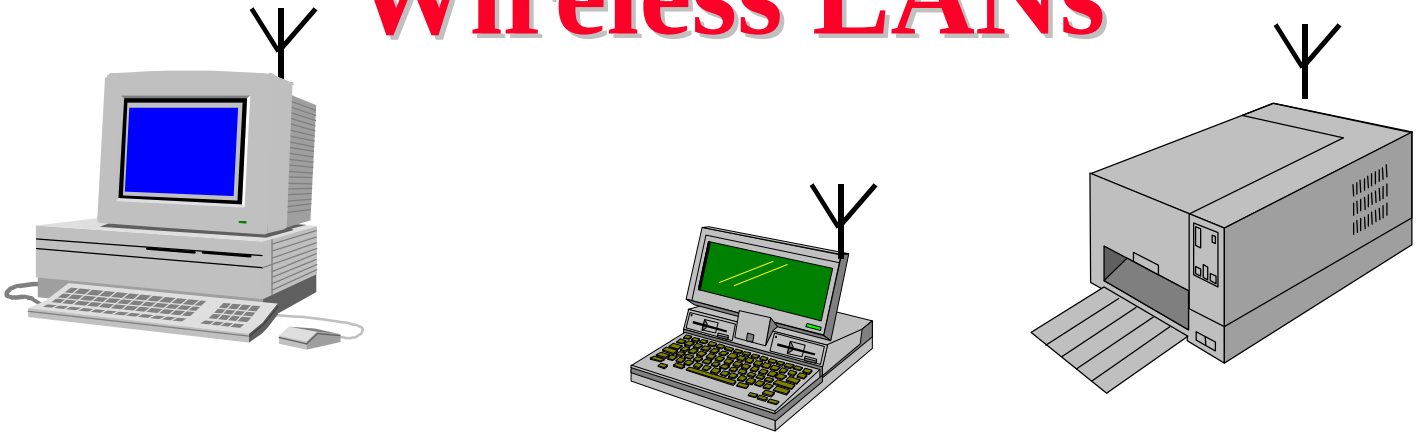
- Pseudo-random frequency hopping
- Spreads the power over a wide spectrum
  $\Rightarrow$ Spread Spectrum
- Developed initially for military
- Patented by actress Hedy Lamarr
- Narrowband interference can't jam

Direct-Sequence Spread Spectrum

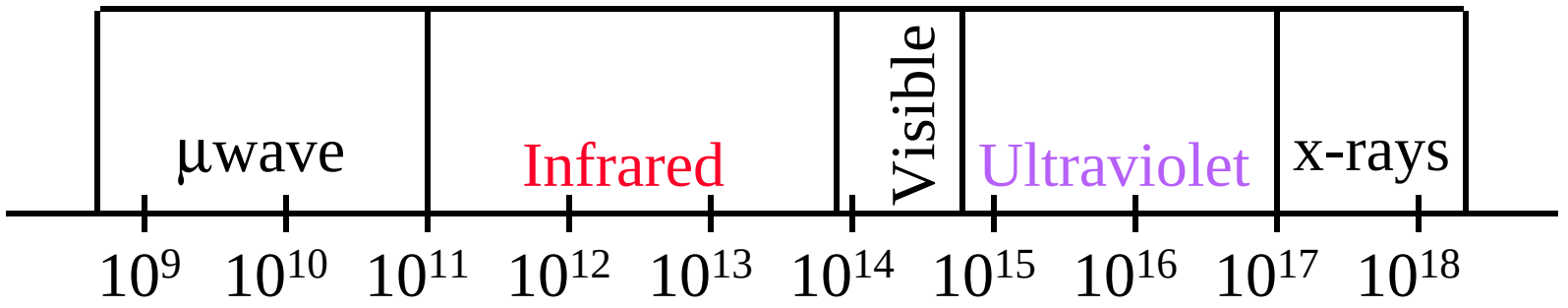


- Spreading factor = Code bits/data bit
  10-100 commercial (Min 10 by FCC), 10,000 for military
- Signal bandwidth >10 X data bandwidth
- Code sequence synchronization
- Correlation between codes
  ⇒ Interference ⇒ Orthogonal codes

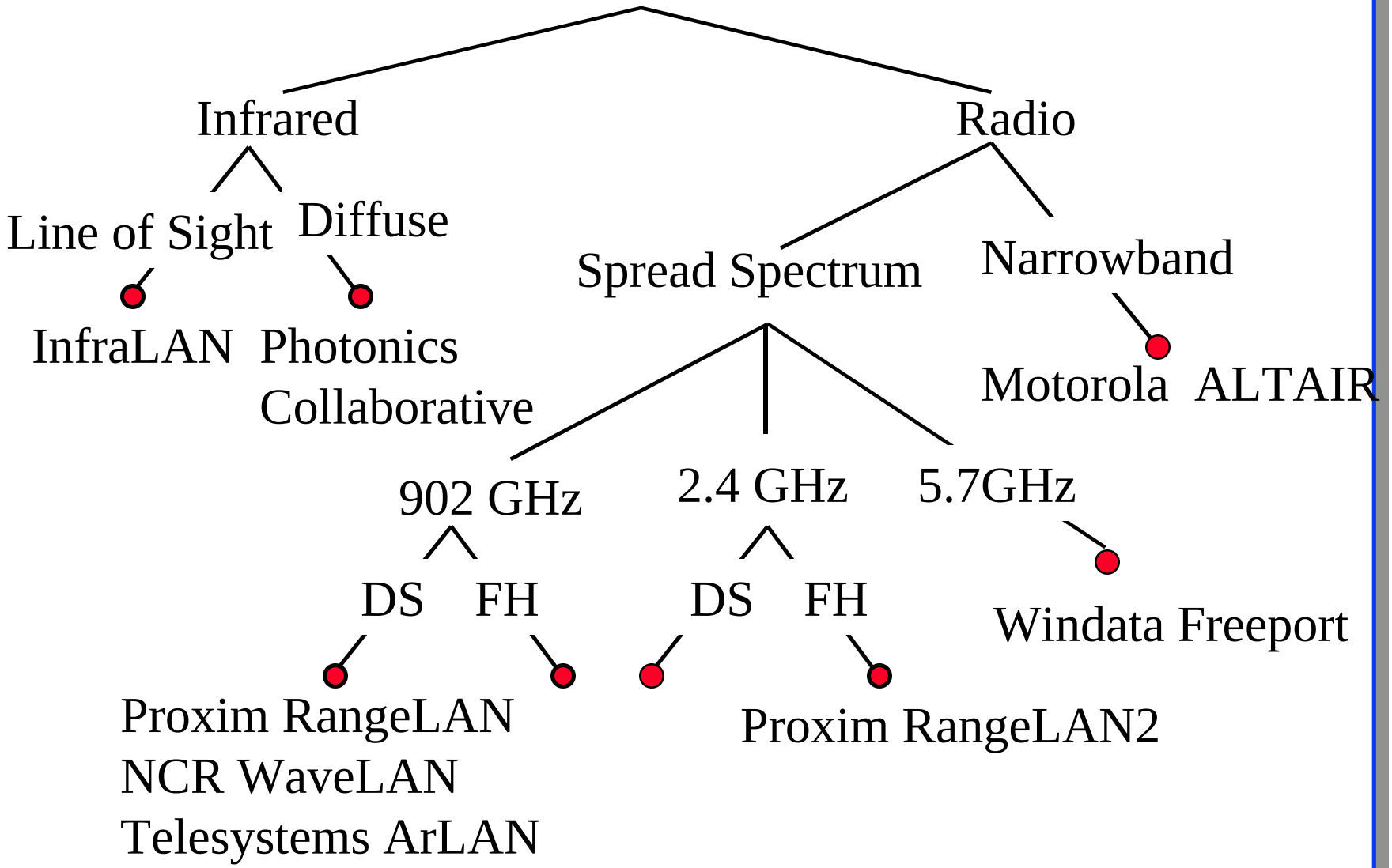
Wireless LANs



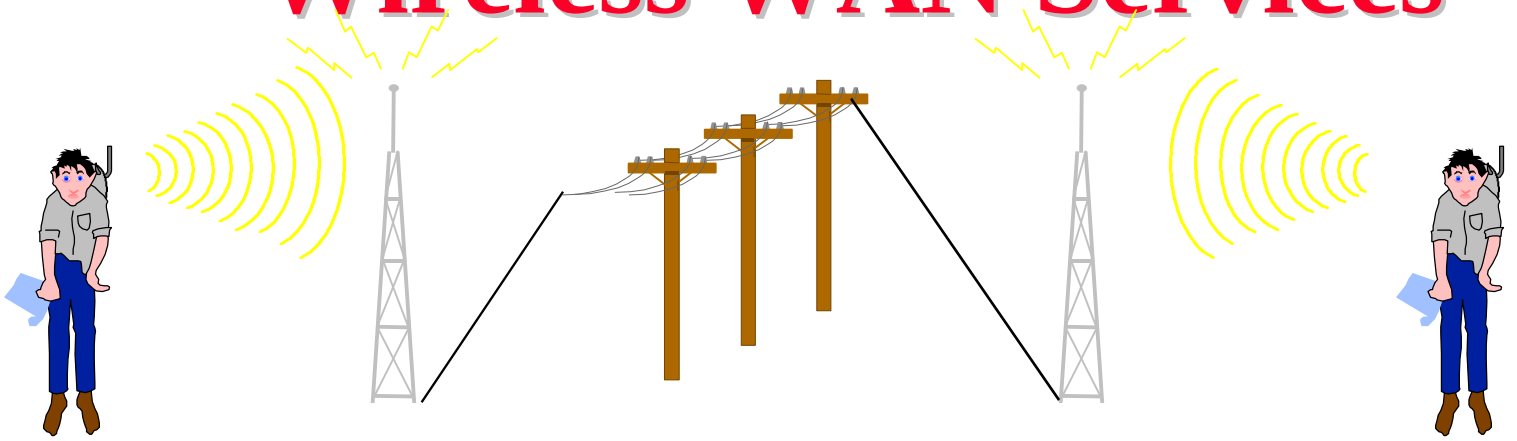
- IR ⇒ Line of sight, short range, indoors
- RF ⇒ Need license
- Spread-Spectrum: Resistance to interference



Wireless LANs



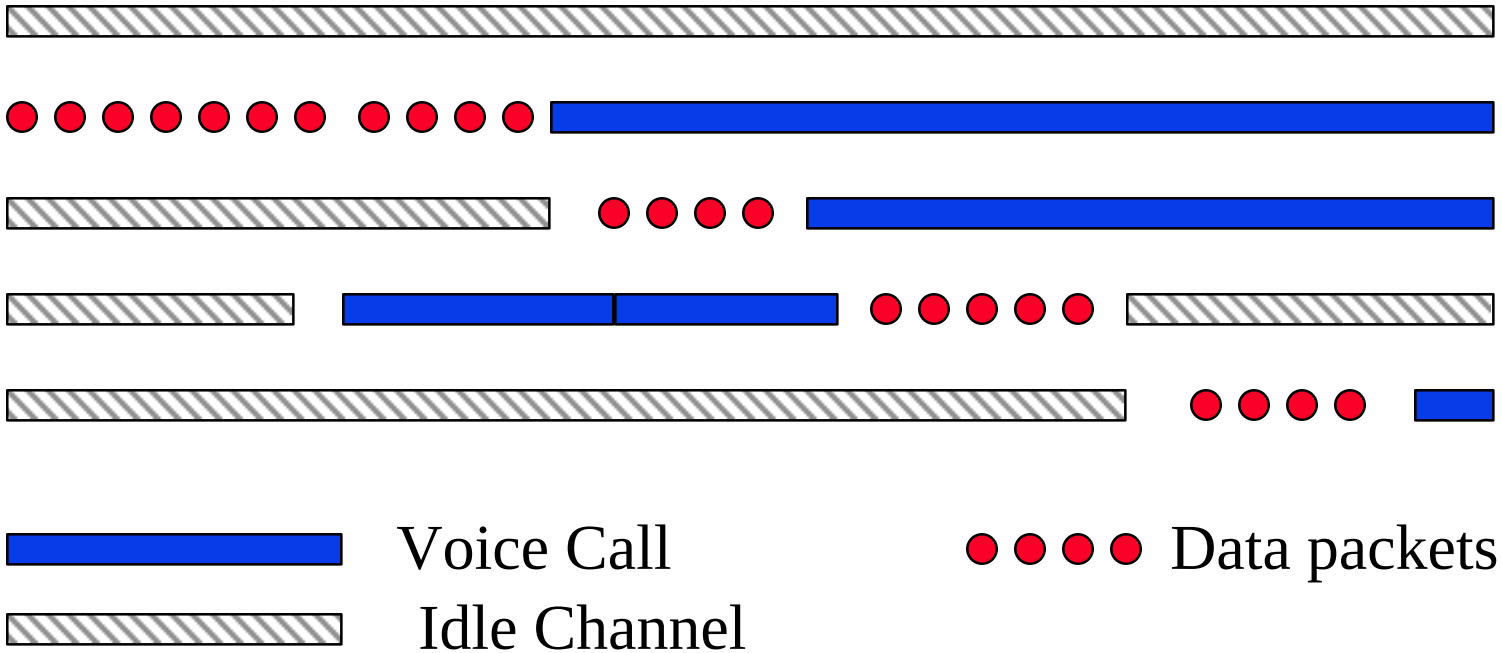
Wireless WAN Services



- 4.8 kbps to 19.2 kbps nominal
- Throughput 2 to 8 kbps
- Wired backbone using leased lines
- Packetized short transmission
- Email, stock quotes, weather
- Options: ARDIS, RAM Mobile Data, Cellular, Cellular Digital Packet Data (CDPD), NWN, and Metricom

Cellular Digital Packet Data (CDPD)

- Originally named "Celluplan" by IBM
- Allows data to use idle channels on cellular system
- Data hops from one channel to next as the channels become busy or idle



CDPD

- Backed by 9 major service providers
- Nationwide cellular packet data service
- Connectionless and connection-oriented service
  Connectionless ⇒ No ack, no guarantees
  Connection-oriented ⇒ reliable delivery, sequencing, flow control
- Point-to-point and multipoint connections
- Uses only idle 30 kHz channels in the cellular system
- Quickly hops-off a channel grabbed by cellular system
  - Currently, extra channels dedicated for CDPD
- Subscriber unit (SU) registers on power-up and periodically
- Deregisters before power-down
- Subscriber unit initiates handoff

Metricom

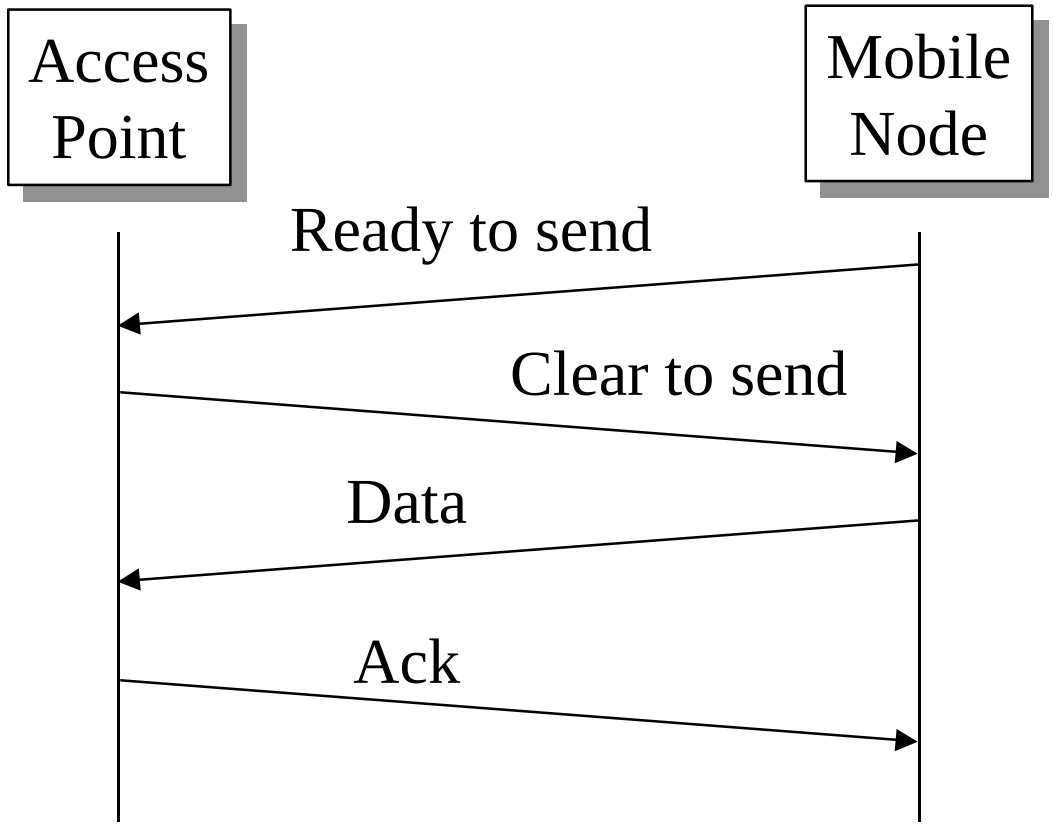
- Spread-Spectrum in the 902-928 MHz band
- In-building, campus, and metropolitan area networking
- Nearby units can communicate directly.
- If the intended destination is not directly reachable, go via a "node" through the network. Up to 56 kbps.
- Nodes are cheap (less than $1000)
- You can have a campus network of your own with a connection to the Metricom's metropolitan area network
- Flat monthly rate based on speed only

Ref: http://www.metricom.com/ricohom.html

IEEE 802.11 MAC: CSMA/CA

- Carrier Sense Multiple Access with Collision Avoidance
- Listen before you talk.
- If the medium is busy, the transmitter backs off for a random period.
- Avoids collision by sending a short message:
  Ready to send (RTS)
  RTS contains destination address and duration of message.
  Tells everyone that they should backoff for the duration.
- Destination sends: Clear to send (CTS)
- Can not detect collision ⇒ Each packet is acked.
- MAC level retransmission if not acked.

4-Way Handshake



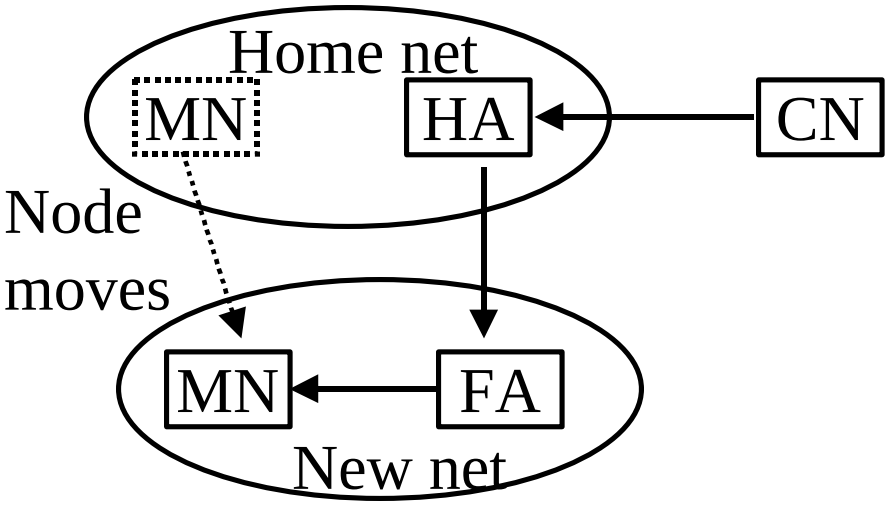
Mobile IP: Features

- You can take you notebook to any location
- Finds nearby IP routers and connects *automatically*
  You don't even have to find a phone jack
- Only "Mobility Aware" routers and mobile units need new s/w
- Other routers and hosts can use current IP
- No new IP addresses or address formats
- Secure: Allows authentication
- Also supports mobile networks
  (whole airplane/car load of mobile units)

Impact

- Your Email is continuously delivered
- You can start a telnet or x-window session as if local
- Continuous access to your home resources
- Access to local resources: Printers
- You wouldn't miss a mail even during meetings
- Airports, Hotels, Hospitals will provide "Mobile IP connectivity"
- Better connectivity
  $\Rightarrow$ More productive meetings and conferences
- Cities will feature "Mobile IP Accessways"
- You can compute while driving

Mobile IP: Terminology



- Mobile Node (MN)
- Home Agent (HA), Foreign Agent (FA)
- Care-of-address (COA): Address of the end-of-tunnel towards the mobile node
- Correspondent Node (CN):
- Home Address: Mobile node's permanent IP address

Mobile IP: Processes

- Agent Discovery: To find agents
  - Home agents and foreign agents advertise periodically on network layer and optionally on datalink
  - They also respond to solicitation from mobile node
  - Mobile selects an agent and gets/uses care-of-address
- Registration
  - Mobile registers its care-of-address with home agent
  - Either directly or through foreign agent
  - Home agent sends a reply to the mobile node via FA
  - Each "Mobility binding" has a negotiated lifetime limit
  - To continue, reregister within lifetime

Processes (Cont)

- Return to Home:
  - Mobile node deregisters with home agent
    sets care-of-address to its permanent IP address
  - Lifetime = 0 $\Rightarrow$ Deregistration
- Deregistration with foreign agents is not required.
  Expires automatically
- Simultaneous registrations with more than one COA allowed (for handoff)

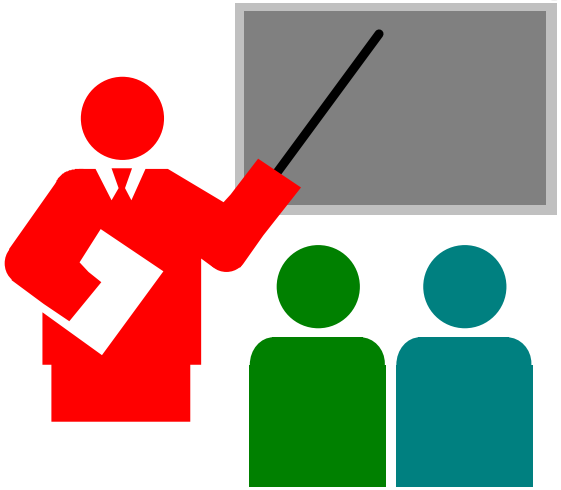
Encaptulation/Tunneling

- Home agent intercepts mobile node's datagrams and forwards them to care-of-address
- Home agent tells local nodes and routers to send mobile node's datagrams to it
- Decaptulation: Datagram is extracted and sent to mobile node

Current Issues

- **Datalink layer:**
  - Media access control, channel allocation, security,
- **Network layer:**
  - Mobility management, Handover, Call admission, Resource allocation, peer-to-peer routing, QoS
- **Transport Layer:**
  - High error rates, variable delays
- **Applications:**
  - Mobile computing, Replication, Emulation, Synchronization, Resource location, Multimedia

Summary



- CDMA = Spread spectrum: Frequency hopping or direct sequence
- LAN Alternatives: Photonics, RangeLan, ALTAIR
- WAN Alternatives: ARDIS, RAM, Cellular, CDPD, Metricom, NWN
- IEEE 802.11: 1 to 2 Mbps, CSMA/CA
- IP: Provides transparent mobility via home/foreign agents

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