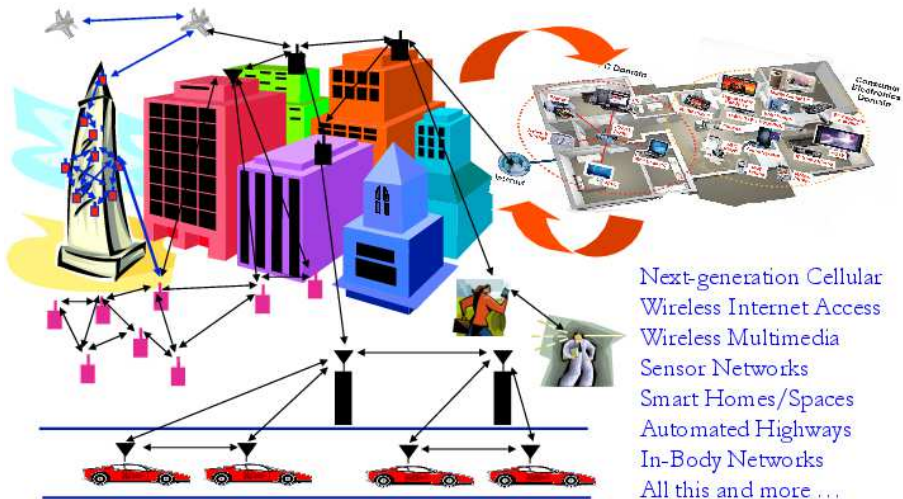


# Course Introduction



## Course Information

- ▶ Instructor: John Gill, [gill@ee.stanford.edu](mailto:gill@ee.stanford.edu)  
Packard 358, 650-723-4569  
Office hours: Th 11-12.
- ▶ Class homepage: <http://ee179.stanford.edu>
- ▶ Prerequisites: EE 102A or equivalent
- ▶ Textbook (recommended): Lathi & Ding, *Modern Digital and Analog Communications Systems*, 4th ed.
- ▶ Weekly homework assignments due on Fridays
- ▶ Grading: HW and Labs 40%, midterm 20%, final project 40%

# Class Policies

- ▶ Homework policy

- ▶ Assigned on Fridays, due following Friday at 5pm.
- ▶ You are free to talk with other students about the homework and problems, but everyone should turn in their own write up.

- ▶ Exam policy

- ▶ Midterm is open book, open notes, no internet.
- ▶ Final Project presentations will be given during final examination time. You will have 10 minutes to present your project and results.

# Course Syllabus

- ▶ Modern communications systems
- ▶ Signal processing in  $2\pi f$ , instead of  $\omega$  as in 102A
- ▶ Finding your way around the RF spectrum
- ▶ Analog Systems
  - ▶ Amplitude modulation (AM, SSB, QAM)
  - ▶ Pulse modulation (PAM, PWM, PPM)
  - ▶ Angle modulation (FM, PM, PSK, and FSK)
- ▶ Digital systems
  - ▶ Sampling and Quantization
  - ▶ Pulse code modulation (PCM)
  - ▶ Digital modulation (PAM, ASK, FSK, PSK, QPSK, and QAM)
  - ▶ Line Coding and ISI
- ▶ SNR and performance

# Early Communication Systems

## ▶ Telegraph

- ▶ 1830, Joseph Henry
- ▶ 1832, Pavel Schilling
- ▶ 1837, Samuel B. Morse, Morse code
- ▶ 1844, What Hath God Wrought

## ▶ Telephone

- ▶ 1876, Alexander G. Bell (“Watson come here; I need you.”)
- ▶ 1888, Strowger stepper switch
- ▶ 1915, US transcontinental service (requires amplifiers)

## ▶ Wireless telegraphy

- ▶ 1895, Jagadish Chandra Bose builds radio transmitter
- ▶ 1896, Marconi patents radio telegraphy
- ▶ 1901, Marconi, first transatlantic transmission

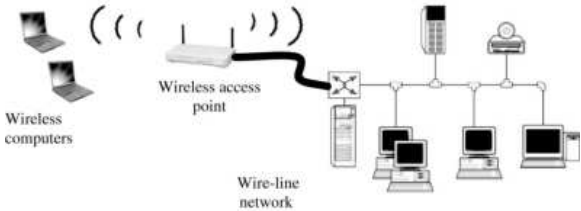
## ▶ Radio

- ▶ 1906, Reginald Fessenden, first broadcast
- ▶ 1920, first commercial AM radio station (Montreal XWA → CINW)

## Communication Systems Then



# Communication Systems Now

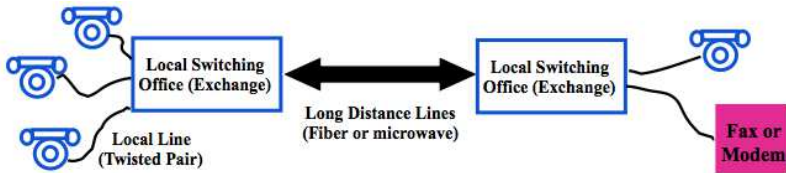


# Communication Systems Today

- ▶ Public Switched Telephone Network (PSTN) for voice, fax, modem
- ▶ Radio and TV broadcasting
- ▶ Citizens' band radio; ham short-wave radio
- ▶ Computer networks (LANs, WANs, and the Internet)
- ▶ Satellite systems (pagers, voice/data, movie broadcasts)
- ▶ Cable television (CATV) for video and data
- ▶ Cellular phones
- ▶ Bluetooth
- ▶ GPS
- ▶ Many others...

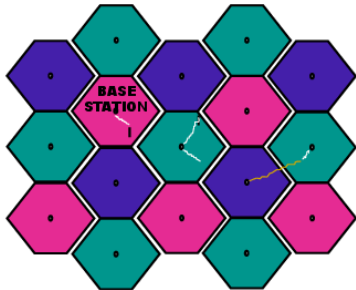


# PSTN Design



- ▶ Local exchange
  - ▶ Handles local calls
  - ▶ Routes long distance calls over multiplexed high-speed connections
- ▶ Circuit switched network tailored for voice
- ▶ Faxes and modems modulate data for voice channel
- ▶ DSL uses advanced modulation to get 1.5-6.0 Mbps

# Cellular System Basics



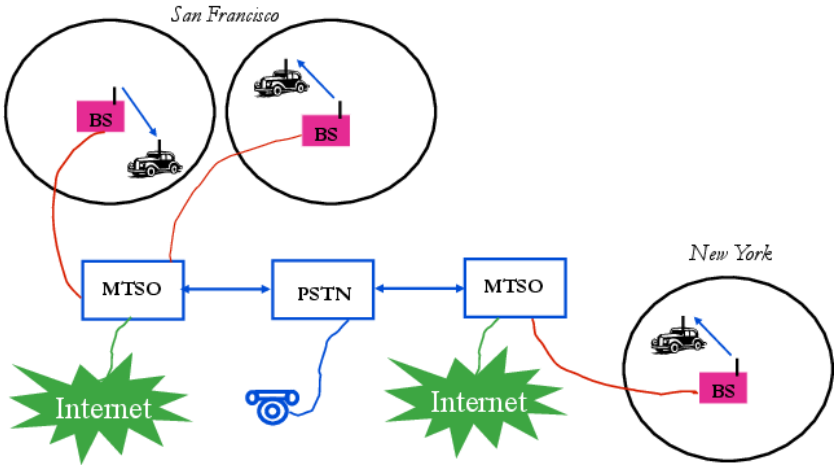
- ▶ Geographic region divided into hexagonal cells<sup>1</sup>
- ▶ Frequencies/timeslots/codes are reused at spatially-separated locations. (Analog systems use FD, digital systems use TD or CD.)
- ▶ Co-channel interference between same color cells
- ▶ Handoff and control coordinated through cell basestations

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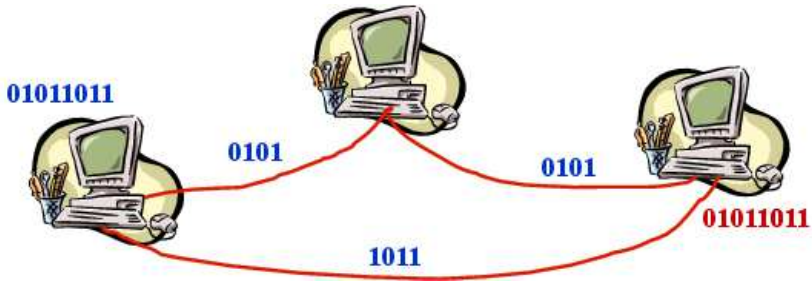
<sup>1</sup>proposed in 1947 by Douglas H. Ring and W. Rae Young, Bell Labs engineers

# Cellular Telephone Backbone Network

Mobile telephones depend on the PSTN — except for mobiles within the same MTSO (mobile telephone switching office)

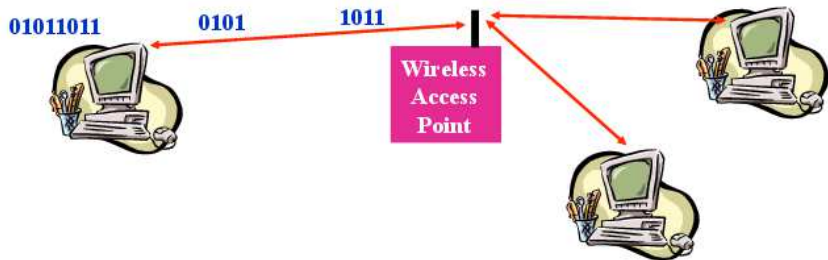


# Local Area Networks (LAN)



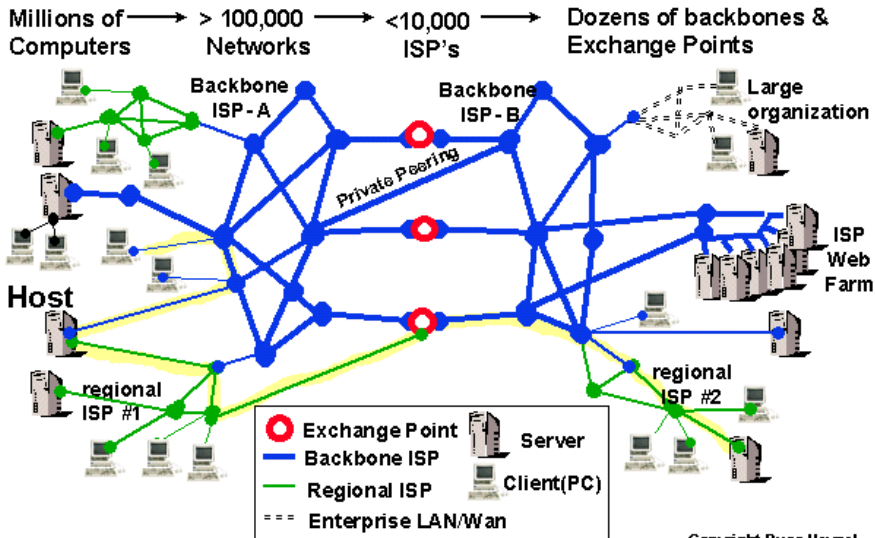
- ▶ “Local” means every computer can hear every other computer
- ▶ Packet switching instead of circuit switching (no dedicated channels)
- ▶ Data is broken down into packets
- ▶ Originally proprietary protocols; e.g., Ethernet was a collaboration between Intel, DEC, and Xerox. (DEC?)

# Wireless Local Area Networks (WLAN)



- ▶ WLANs connect “local” computers (100m range) to an access point
- ▶ As with LANs, data is broken down into packets
- ▶ Channel access is shared (random access)
- ▶ Access protocols for WLANs are much more complex than for LANs
- ▶ Backbone Internet provides best-effort service (no QOS guarantee)

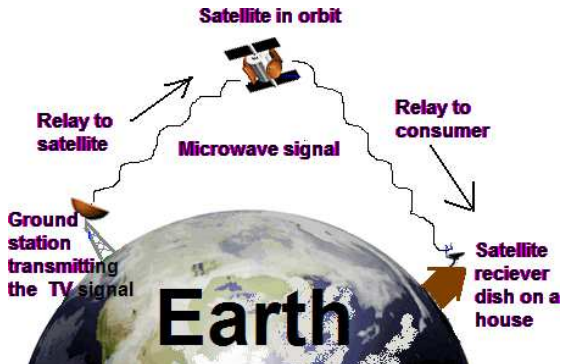
# Wide Area Networks; the Internet



Information Flows over MANY Paths

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# Satellite Systems



- ▶ Satellites cover very large areas
- ▶ Different orbit heights: GEOs (39000 Km) versus LEOs (2000 Km)
- ▶ Optimized for one-way transmission, such as radio (XM, DAB) and television (SatTV) broadcasting
- ▶ Latency (round trip delay) can be a problem

# Bluetooth



- ▶ Ericsson, 1994, named for King Harald Blåtand Gormsen
- ▶ Intended as replacement for cables, such as RS-232  
Now used for input devices, cell phones, laptops, PDAs, etc.
- ▶ Short range connection (10–100 m)
- ▶ Bluetooth 1.2 has 1 data (721 Kbps) and 3 voice (56 Kbps) channels, and rudimentary networking capabilities