Lecture 1 - EE 179: Introduction to Communications - Winter 2006

Introduction to Communication Systems

Lecture Outline

- **Course Information**
- **Communication Systems Today**
- **Future Systems**
- **Design Challenges**

1. **Communication Systems:** provide for electronic exchange of multimedia information
   - Information Types: voice, text, images, video, music, digital data.
   - Communication Systems: radio/TV broadcasting, PSTN, cellular phones, computer networks, satellite systems, Bluetooth.
2. **Public Switched Telephone Network (PSTN):**
   - Home telephones connected via twisted pair (copper) to a local switching office. The switching office routes calls to and from their final destination.
   - At switching office many calls multiplexed together for transmission over high-speed long distance lines/satellites.
   - The telephone system is a circuit-switched network (every call has a dedicated circuit).
   - Modems and fax machines use the standard telephone voice line with pre and post processing to put the original data into a suitable format for the analog voice phone lines (3 KHz bandwidth).
   - ADSL (Asymmetric Digital Subscriber Lines) systems use a very efficient digital modulation (multicarrier modulation) to send data at high speeds (1.5 Mbps) over a broad frequence spectrum of the telephone line.
3. **Cellular Systems.**
   - A cell is assigned some number of channels (timeslots, frequencies, codes)
   - Channels reused at spatially separated locations (frequency reuse). Reuse is efficient, but causes system to be interference limited.
   - Operation within a cell (access, handoff, mobile locating) is controlled by centralized base station
   - Base stations controlled by mobile telephone switching office (MTSO), which also handles call routing.
   - Cellular phones use the PSTN as the backbone network for routing calls throughout the world.
   - Analog cellular systems use FM modulation and frequence-division multiple access.
   - Digital systems use digital modulation and code-division (spread spectrum) and/or time-division multiple access/

4. **Local Area Networks (LANs)**

   - Connects computers located close together.
   - Breaks up bit sequences into packets for more efficient transmission and routing.
   - Typically use packet-switching: data sequences not assigned dedicated channel.
   - LANs often use proprietary protocols that are incompatible with other LANs.
   - In wireless LANs channel access is shared, and the range is typically on the order of about 100 meters.

5. **Wide Area Networks and the Internet**

   - A backbone WAN covers a wide area by interconnecting many metropolitan or local area networks (MANs and LANs).
   - These networks typically includes high-speed (fiber optic) and long distance (satellite) links.
   - Different MANs and LANs are connected by bridges which translate incompatible protocols
   - A global protocol is needed for transporting and routing data across the subnets.
   - The Internet uses the TCP/IP protocol as its global protocol.
   - The packet-based nature, access, and routing protocols of the Internet makes it difficult to guarantee a given data rate or delay. This complicates support for multimedia (especially video) applications.
   - The TCP/IP routing and addressing protocol make it difficult to support user mobility.
   - The power of the Internet is its flexibility and its ability to scale in size exponentially and still work extremely well.

6. **Satellite Systems.**

   - Satellite acts like a base station in the sky
   - Different orbits heights (LEO, GEO) impact design considerations (delay, handoff, etc).
   - Satellite transmissions typically cover very large areas
   - Optimized for one-way transmission (satellite to ground), i.e. paging applications.
   - Expensive alternative to terrestrial systems.

7. **Short-Range Wireless: Bluetooth, Zigbee, UWB**

   - Standards for replacing cables in electronic devices (cell phones, laptops, PDAs.)
   - Bluetooth operates in unregulated 2.4 GHz band. Range is about 10-100 m. Provides one data (721 Kbps) and 3 voice (56 Kbps) channels with rudimentary networking capabilities.
   - Zigbee is ultralow power wireless radio with data rates up to 250 Kbps and networking capabilities. Range is about 10-100 m. Used in sensor networks.
   - Ultrawideband (UWB) radio is an impulse radio using 7.5 GHz of bandwidth with up to 100 Mbps data rate. Range is about 10 m.

8. **Future Systems:**

   - Evolution of current cellular phone networks, LANs, and the Internet.
   - Wireless entertainment will consist of high fidelity movies and music outdoors and in the home.
   - Ad hoc networks where each node can communicate with every other node, directly or via multihop routing. No backbone infrastructure is needed, so the network is easily and quickly deployed. Such networks can support technology for smart homes and buildings, entertainment, industrial automation, etc.
   - Sensor networks will autonomously collect and process information. Such sensors can be imbedded into a structure, monitor disabled or elderly in their homes, or collect information in remote areas.
   - Automated highways will be enabled by autonomous control and communication between cars. Similar technology will automate factories.
   - Communication opens up great possibilities for remote learning and telemedicine.

   Design Challenges:

   - Hardware Design: precise components, small, lightweight, low power, cheap, high frequencies.
   - System Design: converting and transferring information, high data rates, robust to noise and interference, supports many users.
   - Network Design: worldwide anywhere any-time connectivity, speed.
   - Focus of this class is converting and transferring information.

Main Points:

- Communication systems send information electronically over communication channels.
- Many different types of systems which convey many different types of information.
- Design challenges include hardware, system, and network issues.
- Goal of the communication system is to recreate original information at the receiver with the highest possible fidelity.
- This class focuses on the design and performance of analog and digital communication systems to transmit and receive electronic information.