

Lecture 2 Computer Communications and Networks

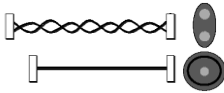
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Introduction

- Local communication
 - Encoding data
 - LANs
- Long Distance communication
 - Modulation
 - Modems and broadband connections

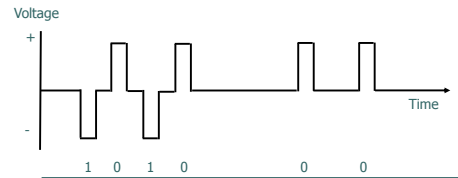
Transmission Media

- Copper Wires
 - Twisted Pair
 - Coaxial
- Fibre Optic
- Radio
- Microwave
- Infrared
- Satellites



Transmitting data over short distance

- Changes in electric current used to transmit bits over short distance
 - E.g. RS-232 (serial port)

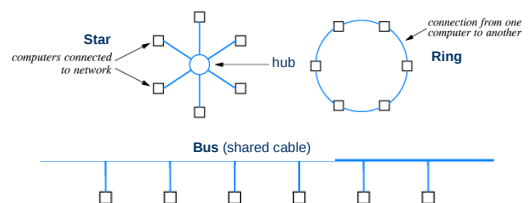


Shared Communication Channels

- Early local networks used dedicated links between each pair of computers
 - But poor scalability
- Shared LANs invented in the 1960s
- Rely on computers sharing a single medium
- Computers coordinate their access
- Low cost
- But not suitable for wide area - communication delays inhibit coordination

Local Area Network (LAN)

- How are computers wired together in a LAN? – 3 common topologies



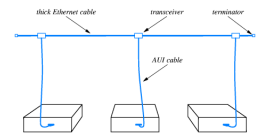
Ethernet

- Ethernet is a bus LAN topology
- Invented at Xerox PARC in the early '70s
- Developed commercially by 3COM later
- Standards controlled by IEEE
- Today it is the most widely used network topology for LANs

Older Ethernet wiring schemes

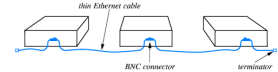
"Thick" Ethernet

- The original Ethernet standard
- Coaxial cable – computers connected via transceivers

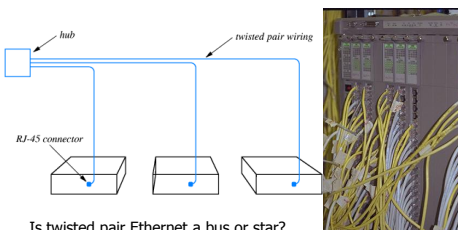


"Thin" Ethernet

- Coaxial cable – computers directly connected via BNC



Twisted Pair Ethernet

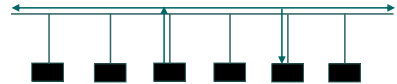


Is twisted pair Ethernet a bus or star?

- Logically it is a bus
- Physically it is a star

Sharing the Ether

- Data is divided into small chunks called "packets" which may be one of a number of standard types
- A packet sent from one computer propagates to either end of the cable
- The packet is ignored by every computer on the network except the destination computer



Ethernet Co-ordination

- Ethernet systems do not have a central controller telling computers when they can talk
- All computers on an Ethernet network use Carrier Sense Multiple Access (CSMA)
 - The electrical activity that occurs during packet transmission is called the carrier
 - Before transmitting a packet a computer checks for a carrier and only transmits when the network is quiet
 - Checking for a carrier is called Carrier Sense
 - The whole process is CSMA

Collision Detection

- CSMA prevents computers from interrupting ongoing transmissions
- CSMA does not prevent simultaneous transmissions
- Simultaneous signals will interfere – this is called a collision, which will damage data in both packets
- Ethernet has collision detection (CD)
 - The sending computer monitors the signal on the ether
 - If this signal differs from what was sent a collision must have occurred
- The whole system is CSMA/CD

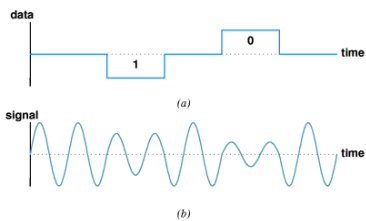
Collision Handling

- When CSMA/CD detects a collision, both computers must re-send their data
- This does not happen immediately (to avoid another collision)
- Both computers wait a random amount of time (the maximum allowed is a part of the Ethernet standard)
- The data is sent again, once the network is quite
- If there is a second, collision the maximum delay is doubled, etc.
- Exponential backoff

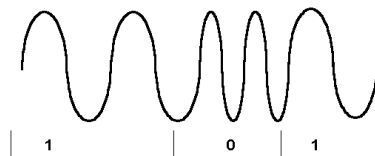
Sending bits over long distance

- Encoding data as discrete voltage changes doesn't work over long distance as the signal attenuates
- A continually oscillating wave travels further
- Bits of data are modulated onto a carrier wave
- Modulation and demodulation is done by a modem

Amplitude Modulation



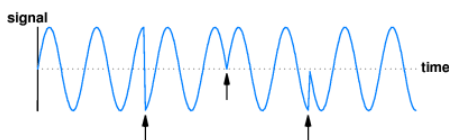
Frequency Modulation



Oakland University: SBA-MIS 405: Business Data Communications & Networking

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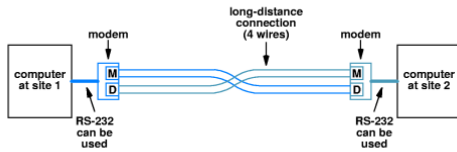
Phase shift modulation



Modems

- Hardware that takes bits and applies modulation is a *modulator*
- Hardware that takes a modulated wave and extracts bits is a *demodulator*
- Full duplex communication requires a combined modulator-demodulator (MODEM) at both ends

Example modem connection



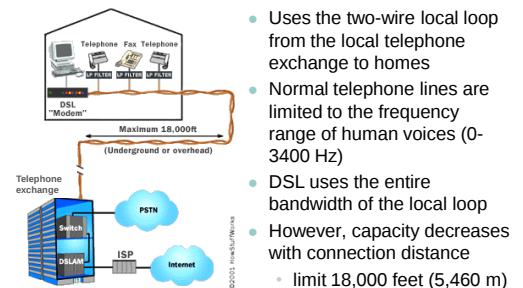
Dial-up modem configuration



Terminology

- **Bandwidth** – the number of signals per second that a medium can accommodate
- **Multiplexing** - several logical connections share a single physical connection
- **Broadband** - a transmission method which supports a relatively wide range of frequencies which may be divided into channels

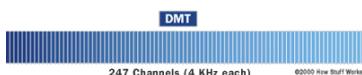
Digital Subscriber Line (DSL)



- Uses the two-wire local loop from the local telephone exchange to homes
- Normal telephone lines are limited to the frequency range of human voices (0-3400 Hz)
- DSL uses the entire bandwidth of the local loop
- However, capacity decreases with connection distance
 - limit 18,000 feet (5,460 m)

Digital Subscriber Line (DSL)

- DMT (Discrete MultiTone) divides the data into 247 separate channels, each 4 KHz wide



- equivalent of 247 modems connected to your computer at once!
- Channel 0 is used for voice
- Usually 80-90% of the rest of the channels are used for downstream communication (Asymmetrical DSL)

Digital Subscriber Line (DSL)

- ADSL speed – max. downstream 8 Mbps and max. upstream 1 Mbps
 - up to distance of 2 km
- As of 2009 the latest standard ADSL2+ can deliver up to 24 Mbps



Summary

- Local communication
 - Encoding data
 - LANs
 - Topologies
 - Ethernet (wiring schemes and coordination)
- Long Distance communication
 - Modulation
 - Modems and broadband connections