Electrical Signal Transmission

Noise, attenuation and amplifiers.

Sending bits:

Acoustic couplers

Modern Modems
Nyquist: $D = 2B \log_2(K)$

- $D =$ bits / second
- $B =$ Bandwidth (Hz)
- $K =$ number of encoded levels
  $(\log_2(K) =$ bits of encoding)

Shannon: $C = B \log_2(1 + S/N)$

- $C =$ channel capacity (bits / second)
- $S/N =$ signal / noise ratio
Connecting Computers: Signals

(a) Data

(b) Signal
Connecting Computers: Signals

Phase Shift Modulation
Connecting Computers

Comer *The Internet*: Chapters 4, 5, 6
RS 232 (DB25 connector)
Computer transmits on pin 2, receives on pin 3
(Modem transmits on pin 3, receives on pin 2)
Ground: pin 7
ISO OSI Stack

stack on computer 1
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical (network hardware)

stack on computer 2
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical (network hardware)
Networking Computers

Diagram:
- Computer at site 1
  - Modem
  - RS-232 can be used
- Voice Telephone System
- Modem
- Computer at site 2
  - RS-232 can be used
Multiplexing
ISO OSI Stack

stack on computer 1
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical (network hardware)

stack on computer 2
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical (network hardware)
**Protocol Stacks**

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Stack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novell Corporation</td>
<td>Netware</td>
</tr>
<tr>
<td>Banyan System Corporation</td>
<td>VINES</td>
</tr>
<tr>
<td>Apple Computer Corporation</td>
<td>AppleTalk</td>
</tr>
<tr>
<td>Digital Equipment Corporation</td>
<td>DECNET</td>
</tr>
<tr>
<td>IBM</td>
<td>SNA</td>
</tr>
<tr>
<td>(many vendors)</td>
<td>TCP/IP</td>
</tr>
</tbody>
</table>
Local Area Networks

Point-to-Point Connections
Facts About LANs

- LANs are incompatible.
- Many LANs and fewer WANs
- The desirability of a single network.
LAN Taxonomy Tree

- Access Control
- Transmission Media
- Topology
- Transmission Technique
- Typical data rates
Point-to-Point Network

Point-to-Point Connections over a Network
Star Topology

computers connected to network — hub
Ring Topology

connection from one computer to another
Bus Topology

Bus (shared cable)
Ethernet began at Xerox PARC - 1970’s

DEC, Intel, Xerox cooperated on “standards”

IEEE now controls Ethernet standard

multiple versions
originally shared coaxial cable (ether)
10Mb/s
Fast Ethernet: 100Mb/s
Ethernet Data Flow

- Sending computer transmits bits of a frame
- Destination computer receives a copy of each bit
- Signal propagates along the entire cable
LAN Connectivity

- Bridges
- Routers
- Gateways
- Servers