Network Protocols and Communications
The Rules
Communication Fundamentals

Human Communication

[Diagram showing the process of communication with steps: Message Source, Transmitter, Transmission Medium, Receiver, Message Destination]
Communication Fundamentals (Cont.)
Computer Communication
Rule Establishment

- Message Encoding
- Message Delivery Options
- Message Formatting and Encapsulation
- Message Timing
- Message Size
Message Encoding

```
Message Source → Encoder → Transmitter → Transmission Medium "The Channel" → Receiver → Decoder → Message Destination
```

Source Encoded

Destination Decoded
Message Encoding (cont.)
Message Formatting and Encapsulation

<table>
<thead>
<tr>
<th>Recipient (destination) Location address</th>
<th>Sender (source) Location address</th>
<th>Salutation (start of message indicator)</th>
<th>Recipient (destination) identifier</th>
<th>Content of Letter (encapsulated data)</th>
<th>Sender (source) identifier</th>
<th>End of Frame (End of message indicator)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400 Main Street Canton, Ohio 44203</td>
<td>4085 SE Pine Street Ocala, Florida 34471</td>
<td>Dear</td>
<td>Jane</td>
<td>I just returned from my trip. I thought you might like to see my pictures.</td>
<td>John</td>
<td></td>
</tr>
</tbody>
</table>
Message Formatting and Encapsulation

Example: Personal letter contains the following elements:

- An identifier of the recipient
- A salutation or greeting
- The message content
- A closing phrase
- An identifier of the sender
### Message Formatting and Encapsulation (cont.)

<table>
<thead>
<tr>
<th>Destination (physical / hardware address)</th>
<th>Source (physical / hardware address)</th>
<th>Start Flag (start of message indicator)</th>
<th>Recipient (destination identifier)</th>
<th>Sender (source identifier)</th>
<th>Encapsulated Data (bits)</th>
<th>End of Frame (end of message indicator)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frame Addressing</strong></td>
<td><strong>Encapsulated Message</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Message Size

Human Communication

You should see this sunset. It is beautiful. The colors are amazing.
Message Size

Computer Communication

• The source host breaks a long message into individual pieces or frames that meet both the minimum and maximum size requirements.

• Each frame will also have its own addressing information.

• At the receiving host, the pieces are reconstructed to be processed and interpreted.
Message Timing

Rules of engagement:

• Access Method
• Flow Control
• Response Timeout
Message Delivery Options
Message Delivery Options (cont.)

Source

Unicast  Multicast  Broadcast

Source

Unicast  Multicast  Broadcast

Source

Unicast  Multicast  Broadcast

Source

Unicast  Multicast  Broadcast
# Protocol Suites and Industry Standards

<table>
<thead>
<tr>
<th>Layer Name</th>
<th>TCP/IP</th>
<th>ISO</th>
<th>AppleTalk</th>
<th>Novell Netware</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td>HTTP DNS DHCP</td>
<td>ACSE</td>
<td>AFP</td>
<td>NDS</td>
</tr>
<tr>
<td></td>
<td>FTP</td>
<td>ROSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TRSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SESE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>TCP UDP</td>
<td>TP0 TP1</td>
<td>ATP AEP</td>
<td>SPX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TP2 TP3</td>
<td>NBP RTMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TP4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internet</strong></td>
<td>IPv4 IPv6 ICMPv4</td>
<td>CONP/CMNS</td>
<td>AARP</td>
<td>IPX</td>
</tr>
<tr>
<td></td>
<td>IPv6 ICMPv6</td>
<td>CLNP/CLNS</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Network Access</strong></td>
<td>Ethernet PPP</td>
<td>Frame Relay</td>
<td>ATM WLAN</td>
<td></td>
</tr>
</tbody>
</table>
TCP/IP Protocol Suite

Application Layer
- DNS
- BOOTP
- DHCP

Transport Layer
- UDP
- TCP

Internet Layer
- IP
- NAT
- ICMP
- OSPF
- EIGRP

Network Access Layer
- ARP
- PPP
- Ethernet
- Interface Drivers
TCP/IP Communication Process

Protocol Operation - Sending a Message
TCP/IP Communication Process

Protocol Operation – Receiving a Message
Reference Models
The Benefits of Using a Layered Model

A networking model is only a representation of a network operation. The model is not the actual network.

<table>
<thead>
<tr>
<th>OSI Model</th>
<th>TCP/IP Protocol Suite</th>
<th>TCP/IP Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>HTTP, DNS, DHCP, FTP</td>
<td>Application</td>
</tr>
<tr>
<td>Presentation</td>
<td>TCP, UDP</td>
<td>Transport</td>
</tr>
<tr>
<td>Session</td>
<td>IPv4, IPv6, ICMPv4, ICMPv6</td>
<td>Internet</td>
</tr>
<tr>
<td>Transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>PPP, Frame Relay, Ethernet</td>
<td>Network Access</td>
</tr>
<tr>
<td>Data Link</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The OSI Reference Model

1. Physical
2. Data Link
3. Network
4. Transport
5. Session
6. Presentation
7. Application
The TCP/IP Protocol Model

TCP/IP Model

- **Application**
  - Represents data to the user, plus encoding and dialog control.

- **Transport**
  - Supports communication between diverse devices across diverse networks.

- **Internet**
  - Determines the best path through the network.

- **Network Access**
  - Controls the hardware devices and media that make up the network.
OSI Model and TCP/IP Model Comparison

<table>
<thead>
<tr>
<th>OSI Model</th>
<th>TCP/IP Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Application</td>
<td>Application</td>
</tr>
<tr>
<td>6. Presentation</td>
<td>Transport</td>
</tr>
<tr>
<td>5. Session</td>
<td>Internet</td>
</tr>
<tr>
<td>4. Transport</td>
<td>Network Access</td>
</tr>
<tr>
<td>3. Network</td>
<td></td>
</tr>
<tr>
<td>2. Data Link</td>
<td></td>
</tr>
<tr>
<td>1. Physical</td>
<td></td>
</tr>
</tbody>
</table>
Data Transfer in the Network
Data Encapsulation
Message Segmentation

Communicating the Message

Segmentation - breaking communication into pieces.

Multiplexing - interleaving the pieces as they traverse the media.

Multiple communications are interleaved, giving each user a part of the bandwidth.
Message Segmentation (cont.)

Communicating the Message

Multiple pieces are labeled for easy direction and re-assembly.

Labeling provides for ordering and assembling the pieces when they arrive.
Communicating the Message

Segmenting Messages:

- Allows many different conversations to be interleaved
- Increases the efficiency of network communications
- Adds complexity
Data Access
Network Addresses and Data Link Addresses

- Physical: Timing and synchronization bits
- Data Link: Destination and source physical addresses
- Network: Destination and source logical network addresses
- Transport: Destination and source process number (ports)
- Upper Layers: Encoded application data
Network Addresses (cont.)

Layer 3 Network Addresses

Original Source

PC1
192.168.1.110

IP Packet

R1

IP Packet

R2

IP Packet

Final Destination

Web Server
172.16.1.99

Layer 3 IP Packet

Source IP
192.168.1.110

Destination IP
172.16.1.99

...
Data Link Addresses

Network Address

• Source IP address
• Destination IP address
• Responsible for delivering the IP packet from the original source to the final destination, either on the same network or to a remote network.

Data Link Address

• Source data link address
• Destination data link address
• Responsible for delivering the data link frame from one network interface card (NIC) to another NIC on the same network
Data Link Address (cont.)

Layer 2 Data Link Addresses

L2 = Layer 2
L3 = Layer 3
Data Link Address (cont.)

Layer 2 Data Link Addresses

PC1 192.168.1.110

Web Server 172.16.1.99

L2 = Layer 2
L3 = Layer 3