TCP/IP Protocol
Some Background

- Two parts to an address
  - Network Segment Address
    - The particular network
  - Network Node Address
    - The device on a particular network segment
- Routers are used to link networks
Network Addressing

Physical Topology

Source Workstation

Segment Address: A
Node Address: 16

default gateway router

Segment Address: C
Node Address: 2

Internetwork Link

Segment Address: A
Node Address: 2

LAN A

Segment Address: C
Node Address: 1

router

Segment Address: B
Node Address: 22

LAN B

Segment Address: B
Node Address: 1

Ultimate Destination Workstation

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FIG: 04-02
• Routing is used to move packets between Network Segments
• Encapsulate/de-encapsulate is used to place a packet within the appropriate frame.
• Routing performs address processing
TCP/IP Protocol

- The world’s most popular network protocol.
- Pre-dates the OSI model
- Functionally equivalent at the layer 4 level and 7 (no level 5 and 6)
- The current version is IPV4 with IPV6 being tested
## TCP/IP & OSI Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>OSI</th>
<th>INTERNET</th>
<th>Data Format</th>
<th>Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Application</td>
<td>Application</td>
<td>Messages or Streams</td>
<td>TELNET, FTP, TFTP, SMTP, SNMP, CMOT, MIB</td>
</tr>
<tr>
<td>6</td>
<td>Presentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
<td>Transport or Host-Host</td>
<td>Transport Protocol Packets</td>
<td>TCP, UDP</td>
</tr>
<tr>
<td>4</td>
<td>Transport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
<td>Internet</td>
<td>IP Diagrams</td>
<td>IP</td>
</tr>
<tr>
<td>2</td>
<td>Data Link</td>
<td></td>
<td>Frames</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Physical</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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FIG: 04-19
• The IP address identifies the network segment and the particular node
• The address must be interpreted using the subnet mask. For example:
  24.5.22.155
  255.0.0.0
### IP Addressing

<table>
<thead>
<tr>
<th>Binary IP Address:</th>
<th>01101110 11101010 00001001 11001010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decimal Representation of Each Octet:</td>
<td>110 234 9 202</td>
</tr>
<tr>
<td>Dotted Decimal IP Address:</td>
<td>110 . 234 . 9 . 202</td>
</tr>
</tbody>
</table>

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FIG: 04-21
## IP Address Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Class ID</th>
<th>Network ID</th>
<th>Host ID</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLASS A</strong></td>
<td>0 (1 bit)</td>
<td>126 different Network IDs (7 bits)</td>
<td>16,777,214 different Host IDs (24 bits)</td>
</tr>
<tr>
<td><strong>CLASS B</strong></td>
<td>1 0 (2 bits)</td>
<td>16,382 different Network IDs (14 bits)</td>
<td>65,534 different Host IDs (16 bits)</td>
</tr>
<tr>
<td><strong>CLASS C</strong></td>
<td>1 1 0 (3 bits)</td>
<td>2,097,150 different Network IDs (21 bits)</td>
<td>254 different Host IDs (8 bits)</td>
</tr>
</tbody>
</table>

address packet totals to 32 bits

**NOTE:** The contents of each CLASS ID segment is constant for each CLASS.

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FIG: 04-24
IP Addressing

- IP addresses are shown in dotted decimal notation.
- The binary address, octet, is converted to a decimal number between 0 and 255

<table>
<thead>
<tr>
<th>Binary Number</th>
<th>0 1 1 0 1 1 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decimal Value</td>
<td>128 64 32 16 8 4 2 1</td>
</tr>
<tr>
<td>Decimal Number</td>
<td>110</td>
</tr>
</tbody>
</table>
IP Addressing

An IP Address is a **UNIQUE** identifier assigned to **EVERY** device on a network. It is used to allow communications between devices on a network.

An IP Address is **32 bits** (or 4 bytes) in length.

It takes the form of

N.N.N.N

where N is a number from 0 to 255

i.e. 142.4.56.89
Subnet Mask

• A 32 bit number divided into octets where each octet has a value of 0-255
• Represents a logical boundary between the Network and Host addresses in an IP network
• All IP Addresses have an associated Network Mask
• We see dotted decimal representation of 4 octets
• Configured Statically or Dynamically
• Examples:
  – 255.255.255.0 is the same as
  – 11111111.11111111.11111111.00000000
A Network Mask is associated with an IP Address and defines a boundary IP devices use to determine whether or not packets need to be forwarded to a Gateway.

A Network Mask is 32 bits (or 4 bytes) in length.

It takes the form of N.N.N.N where N is a number from 0 to 255

i.e. 255.255.255.0
Subnet Mask

- Default Mask for a Class A Network is 255.0.0.0,
- Default Mask for a Class B Network is 255.255.0.0,
- Default Mask for a Class C Network is 255.255.255.0
- The Network Mask indicates how many bits are being used for the Network Portion of an Address
IP Routing

**Packet**
(Addressed to 10.1.0.5)

- **IP Address:** 10.1.0.1
- **SubNet Mask:** 255.255.0.0

- **IP Address:** 10.2.0.1
- **SubNet Mask:** 255.255.0.0

10.1.0.0 Subnetwork

10.2.0.0 Subnetwork

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FIG: 04-26
IP Version 6

• Improvements
  – Larger addressing space
    • IPv4 is 4 octets, IPv6 is 16 octets
  – Performance enhancements
  – Authentication and encryption supported
Layer 4 Protocols

- **TCP**
  - Connection oriented
  - Reliable
- **UDP**
  - Connectionless
  - Un-reliable
TCP Reliability

TCP Connection Creation

1. SYN
2. SYN & ACK
3. ACK

Originating Node → Destination Node

TCP Connection Tear-Down

1. FIN
2. FIN & ACK
3. ACK

Node 1 → Node 2

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FIG: 04-38