Lecture 21: IP Addressing, Forwarding, and Configuration

Oct 28, 2019

Today’s Plan

- IP Addressing
- IP forwarding
- IP Local Configuration

Announcements

- HW 5 due now
- Lab 7 today/tomorrow
- Should get Lab 5 back today/tomorrow
- Still working on HW 4 and Lab 6…we’re almost caught up!

TCL!
### Ethernet Frame Format

<table>
<thead>
<tr>
<th>PREAMBLE</th>
<th>TO</th>
<th>FROM</th>
<th>LENGTH/TYPE</th>
<th>DATA</th>
<th>ERROR CHECK</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>48</td>
<td>48</td>
<td>16</td>
<td>variable</td>
<td>32</td>
</tr>
</tbody>
</table>

### 802.11 (WiFi) Frame Format

<table>
<thead>
<tr>
<th>Frame Control</th>
<th>Duration</th>
<th>Addr 1</th>
<th>Addr 2</th>
<th>Addr 3</th>
<th>Sequence Control</th>
<th>Addr 4</th>
<th>Data</th>
<th>Error Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>16</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>16</td>
<td>32</td>
</tr>
</tbody>
</table>

- **Ver**: 2
- **Type**: 2
- **Subtype**: 4
- **To DS**: 1
- **From DS**: 1
- **More Fags**: 1
- **Retry**: 1
- **Power mg.**: 1
- **More data**: 1
- **WEP Order**: 1

[http://hsi.web.cern.ch/HSI/fcs/spec/overview.htm#b5_2](http://hsi.web.cern.ch/HSI/fcs/spec/overview.htm#b5_2)
How can different low level protocols co-exist??

- Campus internet is comprised of many different types of networks
- Need a common "language" to translate to/from
- IP (and the OS) to the rescue!

**IP Datagram Format**

<table>
<thead>
<tr>
<th>4</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP version</td>
<td>Hdr</td>
<td>Service class</td>
<td>Packet Length</td>
</tr>
<tr>
<td>Packet Number</td>
<td>Fragment Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTL</td>
<td>Protocol</td>
<td>Error Check</td>
<td></td>
</tr>
<tr>
<td>From Addr</td>
<td>To Addr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA (up to 65516 bytes)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IP**

<table>
<thead>
<tr>
<th>4</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP version</td>
<td>Hdr</td>
<td>Service class</td>
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<td>Packet Number</td>
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<td></td>
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<td>TTL</td>
<td>Protocol</td>
<td>Error Check</td>
<td></td>
</tr>
<tr>
<td>From Addr</td>
<td>To Addr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA (up to 65516 bytes)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**IP Encapsulation**

<table>
<thead>
<tr>
<th>Ethernet</th>
<th>IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREAMBLE</td>
<td>TO</td>
</tr>
<tr>
<td>64</td>
<td>48</td>
</tr>
<tr>
<td>DATA</td>
<td>variable size</td>
</tr>
</tbody>
</table>

**IP Addresses:**

Depend on your local network

\[137.165.8.7 = \text{kerry.cs.williams.edu}\]

\[137 = 1000 1001 ( = 128 + 8 + 1 )\]
\[165 = 1010 0101\]
\[8 = 0000 1000\]
\[7 = 0000 0111\]

\[137.165.8.7 = 1000 1001 1010 0101 0000 1000 0000 0111\]

**Ethernet Addresses:**

Unique to your hardware, required for data delivery

\[72:00:03:E4:1B:C0 = \text{rugger9.cs.williams.edu}\]

\[27 23 20\]
\[137 = 1000 1001 ( = 128 + 8 + 1 )\]
\[165 = 1010 0101\]
\[8 = 0000 1000\]
\[7 = 0000 0111\]

**Structured Addresses**

\[4135973218\]
\[413 597 3218\]

\[413 597 3218\]

\[413\]
\[597\]
\[3218\]

\[TCL309\]
\[TCL 3 09\]

\[EXCHANGE = \text{Williams College}\]

\[AREA CODE = \text{MA}\]

\[Building\]

\[Floor\]
IP Address Structure?

137.165.8.7 = kerry.cs.williams.edu
137.165.8.61 = rugger9.cs.williams.edu
137.165.8.142 = www.cs.williams.edu
137.165.6.26 = www.williams.edu
137.165.6.23 = mail.williams.edu
128.119.103.148 = umass.edu

IP Address Structure?

137.165.8.7 = kerry.cs.williams.edu
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137.165.8 = TCL (CS) Ethernet
137.165.6 = JESUP (OIT) Ethernet
137.165 = Williams?

Traceroute

http://www.net.princeton.edu/traceroute.html
https://www.telstra.net/cgi-bin/trace
**IP Forwarding Algorithm**

- If this machine is the packet’s destination, deliver packet to the correct application program.
- Else if destination is connected to one of my networks, send packet directly to the destination machine.
- Else send packet to “good” router on one of my networks.

**Prerequisites**

- If this machine is the packet’s destination, send packet directly to the destination machine.
  - **MUST KNOW YOUR OWN IP ADDRESS(ES)**
- Else if destination is connected to one of my networks, send packet directly to the destination machine.
  - **MUST KNOW DESTINATION'S ETHERNET ADDR**
- Else send packet to “good” router on one of my networks.
  - **MUST KNOW ROUTER'S ETHERNET ADDRESS**

**DHCP**

- **137.165.8.7** = kerry.cs.williams.edu
  - 40:6c:8f:bc:fe:db
- **72:00:03:E4:1B:C0** = dhcp.cs.williams.edu
  - 00:1c:42:00:00:01

**Who am I?**

- **WHO AM I?**
- **ERROR CK**
DHCP Summary

Dynamic Host Configuration Protocol

When a new machine joins network, DHCP server assigns the machine an IP address.

Server also tells machine the IP address of local routers and DNS servers (which are used to translate names like www.google.com to IP addresses).

ARP Summary

Address Resolution Protocol

Finds Ethernet (aka hardware) address for an IP address on local network.

Ethernet address is required for successfully delivering data.