The Future IP (IPv6)

Chapter 22

Motivation for Change

- The 32-bit IP address space is projected to be inadequate.
  - Classless Inter-Domain Routing (CIDR) and Network Address Translation (NAT) seem to be handling this issue for IPv4.
- IPv4 does not adequately address Quality of Service (QoS) issues.
  - DiffServ, RSVP, and MPLS are being explored to handle QoS in IPv4.
- Routing for groups and load balancing.

New Name and Version Number

- Researchers initially worked on IP – Next Generation (IPng).
- There were several competing proposals.
- IP version 5 was already assigned to an experimental protocol known as ST.
- Thus IP version 6 was assigned to the new version of IP protocol.

IPv6 Features

- Address Size
  - 16 bytes (128 bits) vs. 32 bits in IPv4.
- Header Format
  - No header checksum
  - IP options in Extension Headers
  - Fragmentation Info in Extension Headers
- Extension Headers for Flexibility
  - Allows features to be added
  - Efficient (Conserves Header Space, Overhead)
- Flow Label and Priority Fields to support QoS

IPv6 Datagram Format

- Base Header is followed by zero or more extension headers followed by the data.

IPv6 Base Header Format
**IPv6 Base Header Format**

- **SOURCE and DESTINATION ADDRESS** – 128 bits each.
- **VERS** – version 6.
- **TRAFFIC CLASS** – type of data in the packet used to select a route.
- **PAYLOAD LENGTH** – just the bytes of data.
- **HOP LIMIT**
- **FLOW LABEL** – used by applications that require performance guarantees to associate a datagram with a specific network path.
- **NEXT HEADER** – specifies the type of what is coming next in the packet (extension header or data).

**Example NEXT HEADER Field**

- (a) has no extension header.
- (b) has an extension header to specify the route.
- Both are followed by TCP segments.

**IPv6 Extension Headers**

- Some headers have fixed size.
- Others have variable size.
  - In such case there is a **HEADER LEN** field to specify the actual length of the header.

**Fragmentation, Reassembly and MTU**

- A prefix of the original is copied into each fragment.
- The presence of a fragment extension header identifies

**Purpose of Multiple Headers**

- **Efficient**
  - Less overhead because an extension header is added only if it is needed. (Fragmentation)
- **Protocol Extensible**
  - New functions can be added without redesigning the header. (Not true in IPv4.)

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<table>
<thead>
<tr>
<th>NEXT HEADER</th>
<th>HEADER LEN</th>
<th>ONE OR MORE OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unfragmentable Part</th>
<th>Frag. 1 Header</th>
<th>P1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfragmentable Part</td>
<td>Frag. 2 Header</td>
<td>P2</td>
</tr>
<tr>
<td>Unfragmentable Part</td>
<td>Frag. 3 Header</td>
<td>P3</td>
</tr>
</tbody>
</table>
### IPv6 Addressing

- Classless Routing like CIDR.
- No Broadcast Address.
- Each Address is one of the following:
  - Unicast - One to one
  - Multicast - One to Many (All must be members of a multicast group.)
  - Anycast - One to Any (Exactly one among the members of an anycast group)

### IPv6 Colon Hexadecimal Notation

- Numbers are written in base 16 to save space.
  - 105.0.136.100.255.255.255.0.18.128.0.10.255.0
  - 6900:8864:FFFF:FFFF:0:1280:A:FF00
- Zero Compression replaces sequences of zeros with two colons
  - FF0C:0:0:0:0:0:0:B1
  - FF0C::B1