IPv6 Address Representation

- An IPv6 address is represented by 8 groups of 16-bit hexadecimal values separated by colons (:

- Can be abbreviated:
  - omit leading zeroes in a 16-bit value
  - replace one group of consecutive zeroes by a double colon

- Example:
  - 2606:4100:38c0:9::5 vs 2606:4100:38c0:0009:0000:0000:0000:0005
Special Use IPv6 Addresses

- ::/128 - Unspecified address
- ::1/128 - Loopback address
- ::FFFF:0:0/96 - IPv4-mapped address
- FE80::/10 - Link-local unicast
- FF00::/8 - Multicast
# Special Use IPv6 Addresses

**From RFC 4291:**

<table>
<thead>
<tr>
<th>Address type</th>
<th>Binary prefix</th>
<th>IPv6 notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unspecified</td>
<td>00...0 (128 bits)</td>
<td>::/128</td>
</tr>
<tr>
<td>Loopback</td>
<td>00...1 (128 bits)</td>
<td>::1/128</td>
</tr>
<tr>
<td>Multicast</td>
<td>11111111</td>
<td>FF00::/8</td>
</tr>
<tr>
<td>Link-Local unicast</td>
<td>111111010</td>
<td>FE80::/10</td>
</tr>
<tr>
<td>Global Unicast</td>
<td>(everything else)</td>
<td></td>
</tr>
</tbody>
</table>

- **FF00::/8** - Multicast
  - second byte:
    - 4 bits **flags** (e.g., permanent/transient mcast group)
    - 4 bits **scope** (e.g., interface, link, site, global)

Example: **FF02:0:0:0:0:0:0:101** means all NTP servers on the same link as the sender.
Neighbor Discovery Protocol

- Replaces ARP in IPv6 (multicast vs broadcast based)
- Built into ICMPv6, defines ICMPv6 messages:
  - Router Solicitation
  - Router Advertisement
  - Neighbor Solicitation
  - Neighbor Advertisement
  - Redirect

- RFC 4861
Routing

- Finding a good path from source to destination
  - topology discovery
  - route selection

- Network as a graph...
  - links (point to point and L2 subnets) and routers
  - destinations are typically L2 subnets, not individual nodes
  - links may have “weights”
Link weights

‣ What is a good measure of “weight” of a link?

‣ Weight of a path?
Link & Path Measures

**Link measures:**
- Throughput / bit rate
- Latency
- Loss probability
- Availability
- Current load
- Security
- Monetary cost

**Path measure:**
- **Sum**
  - Latency
  - Monetary cost
- **Min/Max**
  - Throughput / bit rate
- **Product**
  - Loss probability
Hop-by-hop Forwarding

Approaches:

- First find a path from source to destination and then follow it… *(Source Routing)*

- Go to the first corner, ask for direction to the next corner that is on the way to the destination*. Repeat until you reach the destination… *(Hop-by-hop Forwarding)*

* Routing tables give you that information
Routing Table Content

- Automatically populated with entries based in local L2 configuration
- Static entries - added by the network administrator
- Dynamic entries - added by dynamic routing protocols
Routing Protocols - Categories

‣ **Link State**
- exact neighbor information flooded to everyone
- topology of the entire networks is discovered in each node
- shortest paths calculated and used to populate the routing tables

‣ **Distance Vector**
- estimates of distances to all nodes in the network sent to all neighbors
- estimates are improved based on information from neighbors
- the process is repeated and routing tables are populated based on the estimates
DISTANCE VECTOR - EXAMPLE

1st Exchange:
1 to C + 4 C -> A = 5
or
4 to B + 1 B -> A = 5

2nd Exchange:
C to C + 2 C -> B -> A
= 3