Internet Architecture and IP Addresses

(1) Introduction of TCP/IP Internet

- Internet Architecture
  
  - **Physical network**: computers on the same physical network are physically connected.
  
  - **Computers on different physical networks** are not physically connected.
  
  - **IP router (or IP gateway)**: dedicated systems that connect two or more networks.
  
  - **Host**: end-user system. It connects to physical networks, and there are possibly many hosts per network.

- The two view of a TCP/IP Internet

- Packet Transmission
  
  - **Source Host**:
    
    - If the destination is on the same physical network, deliver it directly
    
    - Otherwise, send it to a router
  
  - **Intermediate Routers**:
    
    - The destination is not on the same physical network, forward the packet to another router
  
  - **Final Router**
    
    - The destination is physically connected to this final router, so send the packet directly to the destination.
How do routers work?
- Routers need to find the right routes when forwarding packets.
- Routers’ decision is based on the routing information they have
  - Routing table: use destination network, not the destination host; otherwise, the table will be huge.

(2) IP Address

- Overview
  - 32 bit binary value
  - Unique value assigned to each host
  - Values chosen to make routing efficient

- Dotted Decimal Notation:
  - Binary: 10000000 11100110 00000001 00001100
  - Dotted decimal notation: 128.230.1.12

- Classful Addressing Scheme (The original scheme, didn’t last long)

<table>
<thead>
<tr>
<th>Class A</th>
<th>0</th>
<th>netid</th>
<th>hostid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class B</td>
<td>1</td>
<td>netid</td>
<td>hostid</td>
</tr>
<tr>
<td>Class C</td>
<td>1 1</td>
<td>netid</td>
<td>hostid</td>
</tr>
<tr>
<td>Class D</td>
<td>1 1 1 0</td>
<td>IP multicast</td>
<td></td>
</tr>
<tr>
<td>Class E</td>
<td>1 1 1 1 0</td>
<td>reserved</td>
<td></td>
</tr>
</tbody>
</table>

- Classes
  - A: 1.0.0.0 --- 126.0.0.0
  - B: 128.1.0.0 --- 191.255.0.0
  - C: 192.0.1.0 --- 223.255.255.0
  - D: 224.0.0.0 --- 239.255.255.255
  - E: 240.0.0.0 --- 255.255.255.254
  - Example: IBM (9.0.0.0), AT&T (12.0.0.0), Syracuse University (128.230.0.0)
Properties of the classful addressing scheme?
- They are self-identifying: the boundary between netid and hostid is self-explained from the address. This can benefit routing because the entries of routing tables store mainly use netid, not the entire IP address.

Special Addresses
- 255.255.255.255: Limited broadcast (local net)
- 0.0.0.0: this host. Can only be used as source address. It is used during bootstrap before a computer knows its IP address. “0” means THIS.
- net + all 1s: directed broadcast for net
- 127.anything (often 1): loopback.

Classless Addressing Scheme (Devised in 1990s)
- Allow the division between prefix and suffix to occur at an arbitrary point.
- Allow more complete utilization of the address space.

(2) CIDR: Classless Inter-Domain Routing
a) Internet Part + Local Part
b) Internet Part + Physical Network + Host
   ii) 128 = 1000 0000, 230 = 1110 0110, 211 = 11010011
   iii) What is the CIDR representation? What are the lowest IP and highest IP addresses?
   iv) Is Apollo (128.230.208.46) on the same subnet? 208 = 1101 0000

(2) Reserved address prefixes
a) 10/8  10.0.0.0 - 10.255.255.255
b) 172.16/12  172.16.0.0 - 172.31.255.255
c) 192.168/16  192.168.0.0 - 192.168.255.255
d) 169.254/16  169.254.0.0 - 169.254.255.255