Chapter 3 Internetworking

What Is an Internetwork?

- An internetwork is an arbitrary collection of networks interconnected to provide host-host to packet delivery service
  - The Internet (with a capital I) is an internetwork
- An internetwork is a logical network built out of a collection of physical networks
  - A physical network is either a directly connected or a switched network; a physical network is a single-technology network
  - The physical networks in an internetwork may use different technologies → An internetwork is heterogeneous
  - The nodes that interconnect the physical networks are called routers (also called gateways)
- The Internet Protocol (IP) is the key tool used to build scalable, heterogeneous internetworks
  - IP runs on all the nodes (both hosts and routers) in a collection of networks and allows these nodes and networks to function as a single logical internetwork

The IP Service Model

- IP offers a datagram (connectionless) model of data delivery, i.e., best effort service
  - Packets can get lost (IP service is unreliable)
  - Packets can get delivered out of order
  - Packets can be delayed for a long time
IPv4 datagram format (see slides)

IP Fragmentation and reassembly
- Every physical network type has a maximum transmission unit (MTU) - the largest IP datagram that it can carry in a frame
  - Ethernet MTU = 1500 bytes, Wi-Fi MTU = 2312 bytes
- A node (source host or router) divides an IP datagram into fragments if datagram size > MTU of the network over which the datagram is to be forwarded
  - All the fragments carry the same identifier chosen by the source host
  - Each fragment is a self-contained IP datagram that is transmitted independent of the other fragments
- Reassembly is done at destination host (see example in slides)
  - Destination host gives up reassembly if some fragments are lost → IP does not attempt to recover from missing fragments

IP Addresses
- Each host/router interface is assigned a globally unique 32-bit IP address
  - IP addresses are written using dotted decimal notation, e.g., 129.186.3.6
- IP addresses are hierarchical
  - An IP address contains two parts: network part and host part
  - All hosts attached to the same network have the same network part and different host part in their IP address
• IP addresses were originally divided into 3 classes

(a)  
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</tr>
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<tbody>
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(b)  
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(c)  
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<th>8</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
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</tbody>
</table>

• Today, IP addresses are “classless” (will study in next lecture)

Datagram forwarding in IP

• A node (host or router) makes forwarding decision based on destination IP address in the datagram
  o If the node is directly connected to the destination network, it sends the datagram directly to destination host (by encapsulating the datagram into a frame)
  o If the node is not directly connected to the destination network
    ▪ If the node is a host, it sends the datagram to its default router
    ▪ If the node is a router, it sends the datagram to the next hop router specified in its forwarding table

• Host datagram forwarding algorithm

\[
\text{if } \text{(NetworkNum of destination = my NetworkNum)} \text{ then deliver datagram to destination host directly} \\
\text{else deliver datagram to default router}
\]
• Each router maintains a forwarding table
  o Table contains <NetworkNum, NextHop> pairs
  o Table may contain a default entry specifying a default router
    that is used if none of the entries in the table matches
    destination host’s network number
• Router datagram forwarding algorithm

  \[
  \text{if (NetworkNum of destination = NetworkNum of one of my interfaces) then deliver datagram to destination over that interface}
  \]

  \[
  \text{else if (NetworkNum of destination is in my forwarding table) then deliver datagram to NextHop router}
  \]

  \[
  \text{else deliver datagram to default router}
  \]

• Hierarchical addressing improves scalability of a large internetwork
  because forwarding table lists only network numbers rather than all
  the hosts in the network