Today’s lecture

- Implementing routers/switches
- Network address translation
- IPv6

Workstation-based router

- Aggregate throughput (bandwidth)
  - 1/2 of the I/O bus bandwidth
  - capacity shared among all hosts connected to switch
  - ex: 1Gbps bus can support 5 x 100Mbps (in theory)

- Packets per second
  - must be able to switch small packets
  - 300,000 packets-per-second is achievable
  - e.g., 64-byte packets implies 155Mbps
Serious routers and switches

- Design Goals
  - throughput
  - scalability (a function of n)

- Ports
  - forwarding decision (route lookup)
  - buffering (input and/or output)

- Fabric
  - as simple as possible
  - sometimes do buffering (internal)

Buffering

- Wherever contention is possible
  - input port (content for fabric)
  - internal (content for output port)
  - output port (content for link)

- Head-of-Line Blocking (input buffering)

Fabric example: crossbar switches
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Network Address Translation

• Multiple clients access network through NAT box using single IP address
• **Advantages:**
  – Fewer IP addresses used (clients have private RFC 1918 addresses)
  – Outside hosts cannot connect to NATed clients
• **Disadvantages:**
  – Breaks end to end reachability
  – Outside hosts cannot connect to NATed clients
• Works by rewriting IP, TCP, and UDP headers

NAT box maintains table with translations

<table>
<thead>
<tr>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.1.1</td>
<td>128.105.4.12, 1330</td>
</tr>
<tr>
<td>192.168.1.2, 1331</td>
<td></td>
</tr>
<tr>
<td>192.168.1.3, 1332</td>
<td></td>
</tr>
<tr>
<td>192.168.1.4, 1333</td>
<td></td>
</tr>
</tbody>
</table>
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IP version 6

- Proposed successor of IPv4
- Uses 128 bit addresses
  - IP address includes 48 bit MAC address
  - Renumbering still necessary when network moves to different provider
- Simplifies header to allow more efficient packet processing at routers

IPv6 header

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