Interface-to-interface connectivity

• We now have links. How to get across the network?
Virtual circuits

- Static allocation of path

Datagrams

- Datagrams are forwarded independently
Internet Protocol

- **IP header**
  - Source and destination address
  - Datagram length
  - Upper layer protocol
    - Identifies TCP, UDP, etc.
  - Time to live
    - Protection against accidental loops
  - Header checksum
    - Protection against bit errors
  - Fragmentation possible
    - Link layer limited to some datagram size (min. MTU is 576 bytes)

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Type</th>
<th>Layer</th>
<th>Source</th>
<th>Destination</th>
<th>Options</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
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IP addresses

- **IP address is 32-bit field**
  - Uses dotted decimal notation:
- **How should addresses be allocated?**
Address aggregation

• IP addresses aggregated into subnets
  – Each subnet represented by “prefix”
  – Notation indicates length of prefix

• Example:
Address aggregation

- IP addresses may “move”
- Routers perform “longest prefix match”
  - Most specific information

Other IP aspects

- Routing
  - Determines forwarding
- ICMP
  - Error handling
- Link layer
  - Address resolution (ARP)
  - Dynamic IP addresses (DHCP)
- Application layer
  - Domain names (DNS)
- Transport layer
  - Network address translation (NAT)
- New IP version: IPv6