IP ADDRESSING
Outline

→ Network architecture
→ Address format
→ Netmask
NETWORK ARCHITECTURE
Logical IP Subnet (LIS)

Set of interfaces with common address prefix

Prefix

1 physical network

1 logical IP network
Logical and Physical Networks

→ All interfaces with the same address prefix must be connected to the same physical network
→ All interfaces of the same physical network must have the same address prefix

What does this imply?
A Network Identifier

Address prefix is unique to a given (physical/logical) network

<table>
<thead>
<tr>
<th>Network</th>
<th>Host</th>
</tr>
</thead>
</table>

→ Network part
→ Host part

What is the reason for this?
Scalability!

Addressing and routing are closely related
Does It Come for Free?

→ Address space waste
→ Addressing efficiency
  → Commonly below 25%
ADDRESS FORMAT
IP Addresses

→ 32 bits (4 bytes)
→ Represented in dotted decimal notation
→ Each byte expressed as a decimal number separated by a dot

→ 12.4.56.38  193.129.3.215

→ Each element from 0 to 255
How Large is the Prefix?

- Fixed size is too limited
- Three sizes:
  - Class A: 1 byte
  - Class B: 2 bytes
  - Class C: 3 bytes

Check the first byte!
Class A

→ E.g., 84.240.20.1

→ Max 128 network prefixes
→ Max 16M host addresses
Class B

→ E.g., 153.240.20.1

2 7 16 31

10 | Network | Host
128 191

→ Max 16K network prefixes
→ Max 64K host addresses
Class C

→ Example: 203.240.20.1

→ Max 2M network prefixes
→ Max 255 host addresses
And It Goes On ...

- **Class D**

- **E.g., 225.240.20.1**

- Used for multicast

- **Class E: anycast**

- Not associated to interfaces
Reserved Host Field Values

→ All ones:
  directed broadcast
→ E.g., 203.240.20.255
→ Routed
→ Cannot be associated to an interface
All zeros: the LIS
E.g., 203.240.20.0
Could be associated to an interface
Available Host Identifiers

\[n\text{ bit host field}\]
\[\downarrow\]
\[2^n-2 \text{ available identifiers}\]

Possibly \[2^n-1\] if network address is associated to an interface
Reserved Addresses

- All ones: limited broadcast
  - 255.255.255.255
  - Not received by all stations
  - Not routed
- This host: 0.0.0.0
- Loopback: 127.*.*.*
NETMASK
Issues With Classful Addressing

→ Lack of flexibility
  → Low addressing efficiency
→ Centralized address space assignment
Netmask and Classless Addressing

- Associated to IP address
- Marks boundary of network and host parts
Any size network/host part
### Valid Netmask Byte Values

<table>
<thead>
<tr>
<th>Value</th>
<th>Binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0000 0000</td>
</tr>
<tr>
<td>128</td>
<td>1000 0000</td>
</tr>
<tr>
<td>192</td>
<td>1100 0000</td>
</tr>
<tr>
<td>224</td>
<td>1110 0000</td>
</tr>
<tr>
<td>240</td>
<td>1111 0000</td>
</tr>
<tr>
<td>248</td>
<td>1111 1000</td>
</tr>
<tr>
<td>252</td>
<td>1111 1100</td>
</tr>
<tr>
<td>254</td>
<td>1111 1110</td>
</tr>
<tr>
<td>255</td>
<td>1111 1111</td>
</tr>
</tbody>
</table>
Natural Netmaks/Prefixes

→ Class A  ➔  255.0.0.0
→ Class B  ➔  255.255.0.0
→ Class C  ➔  255.255.255.0
Subnetting and Supernetting

- Subnetting: prefix shorter than natural one
- Supernetting: prefix longer than natural one
Subnetting Examples

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
<th>31</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Network: 11111111.11111111.11111111.11000000

Netmask: 255.255.255.192

From 65 to 126

Net (natural prefix):

192.168.10.

Net (natural prefix):

10000000

From 129 to 190

Network field

Host

Subnet
Subnetting and Centralized Address Assignment

Addresses assigned to organization in natural prefixes
→ One large set of addresses
→ Organizations use subnetting to devise a prefixes for each network