CSE/EE 461 – Lecture 11

IP Addressing

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Last Two Times …

- Focus
    - How do we calculate routes for packets?

- Routing Algorithms
    - Distance Vector routing (RIP)
    - Link State routing (OSPF)

Application
Presentation
Session
Transport
Network
Data Link
Physical

This Lecture

- New focus
  - How do we make routing scale?

- IP Addressing
  - Hierarchy (class A, B, C, subnets)
  - Also allocation (DHCP, ARP)

| |
|---|
| Application |
| Presentation |
| Session |
| Transport |
| Network |
| Data Link |
| Physical |

Scalability Concerns

- Routing burden grows with size of an internetwork
  - Size of routing tables
  - Volume of routing messages
  - Amount of routing computation

- RIP/OSPF do not scale to the size of the Internet

- We must apply further techniques:
  - Hierarchical addressing   ← Today
  - Use of structural hierarchy
  - Route aggregation

Structure of the Internet

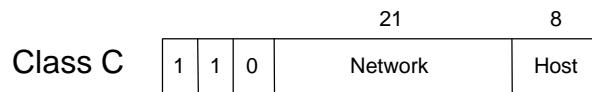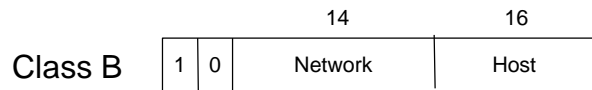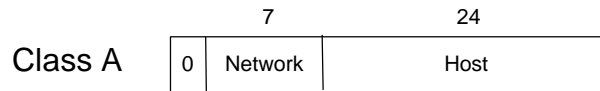- Inter-domain versus intra-domain routing
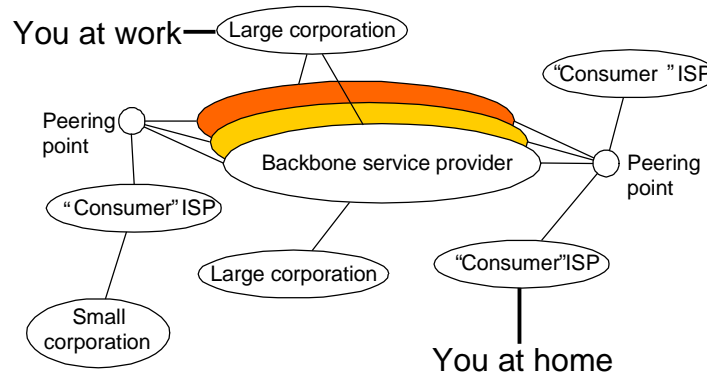
IP Addresses

- Reflect location in topology; used for scalable routing
  - Unlike "flat" Ethernet addresses

- Interfaces on same network share prefix
  - Prefix administratively assigned (IANA or ISP)
  - Addresses globally unique

- Routing only advertises entire networks by prefix
  - Local delivery in a single "network" doesn't involve router
  - (will make "network" precise later on)

IPv4 Address Formats

				7	24

Class A | 0 | Network | Host |

Class B | 1 | 0 | Network (14) | Host (16) |

Class C | 1 | 1 | 0 | Network (21) | Host (8) |

- 32 bits written in "dotted quad" notation, e.g., 18.31.0.135

IPv6 Address Format

001	RegistryID	ProviderID	SubscriberID	SubnetID	InterfaceID
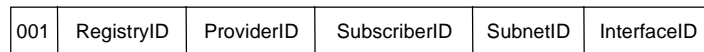
- 128 bits written in 16 bit hexadecimal chunks
- Still hierarchical, just more levels

Network Example

Network number: 128.96.0.0

128.96.0.15

H1

128.96.0.1

R1

128.97.0.2

Network number: 128.97.0.0

128.97.0.139

128.97.0.1

H2

H3

R2

128.98.0.14

128.98.0.1

Network number: 128.98.0.0
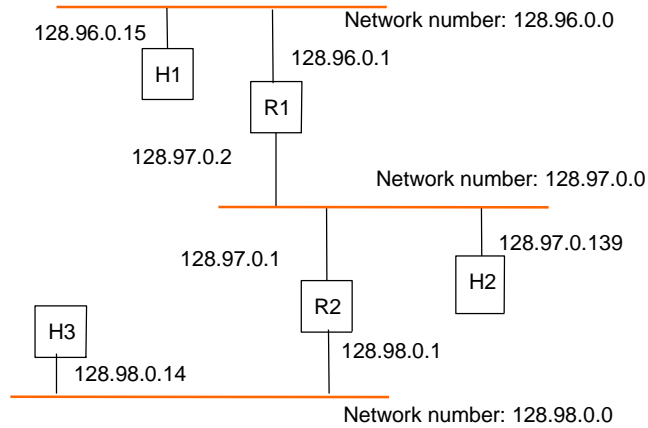
Updated Forwarding Routine

- Used to be "look up destination address for next hop"

- Now addresses have network and host portions:
  - If host: if destination network is the same as the host network, then deliver locally (without router). Otherwise send to the router
  - If router: look up destination network in routing table to find next hop and send to next router. If destination network is directly attached then deliver locally.

- (Note that it will get a little more complicated later)

Getting an IP address

- Old fashioned way: sysadmin configured each machine

- Dynamic Host Configuration Protocol (DHCP)
  – One DHCP server with the bootstrap info
    • Host address, gateway address, subnet mask, …
    • Find it using broadcast
  – Addresses may be leased; renew periodically

- "Stateless" Autoconfiguration (in IPv6)
  – Get rid of server – reuse Ethernet addresses for lower portion of address (uniqueness) and learn higher portion from routers

Address Resolution Protocol (ARP)

- On a single link, need Ethernet addresses to send a frame … source is a given, but what about destination?
  – Requires mapping from IP to MAC addresses

- ARP is a dynamic approach to learn mapping
  – Node A sends broadcast query for IP address X
  – Node B with IP address X replies with its MAC address M
  – A caches (X, M); old information is timed out (~15 mins)

  – Also: B caches A's MAC and IP addresses, other nodes refresh

ARP Example

- To send first message use ARP to learn MAC address
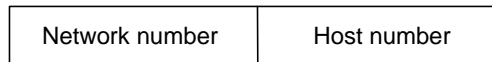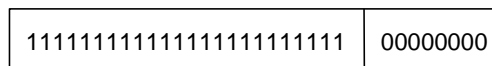- For later messages (common case) don't need to ARP
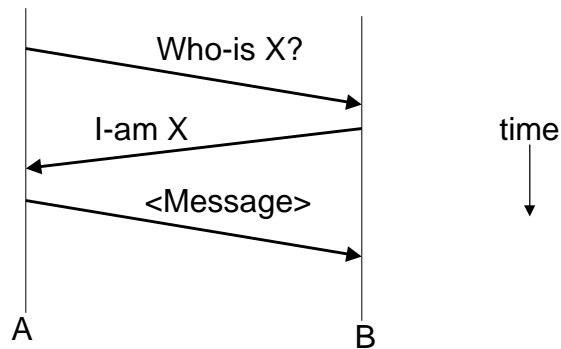
Subnetting – More Hierarchy

- Split up one network number into multiple physical networks

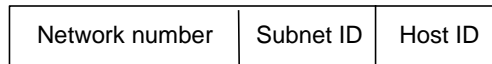| Network number	Host number

Class B address

- Internal structure isn't propagated

11111111111111111111111	00000000

Subnet mask (255.255.255.0)

- Helps allocation efficiency

Network number	Subnet ID	Host ID

Subnetted address

Subnet Example

Subnet mask: 255.255.255.128
Subnet number: 128.96.34.0

128.96.34.15

H1

128.96.34.1

R1

128.96.34.130

Subnet mask: 255.255.255.128
Subnet number: 128.96.34.128

128.96.34.139

128.96.34.129

H2

H3

R2

128.96.33.14

128.96.33.1

Subnet mask: 255.255.255.0
Subnet number: 128.96.33.0
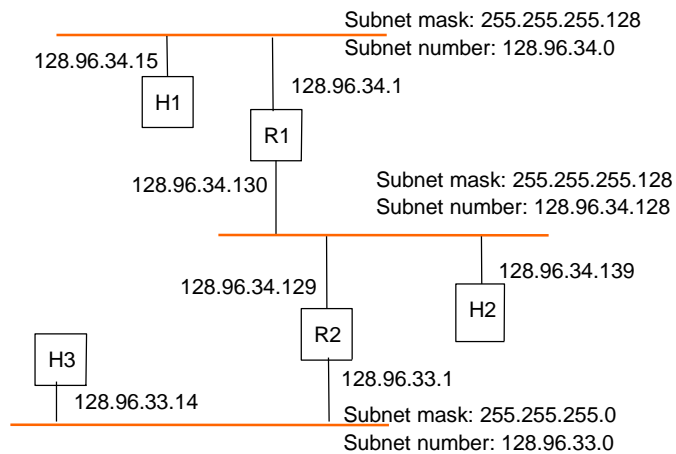
Updated Forwarding Routine

- Used to know network from address (class A, B, C)

- Now need to "search" routing table for right subnet
  - If host: easy, just substitute "subnet" for "network"
  - If router: search routing table for the subnet that the destination belongs to, and use that to forward as before

- (Note that it will get a little more complicated later :)

Key Concepts

- Hierarchical address allocation helps routing scale
  - Addresses are constrained by topology
  - Only need to advertise and compute routes for networks
  - Hide internal structure within a domain via subnets
  - Keep host simple and let routers worry about routing

- ARP learns the mapping from IP to MAC address