

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)

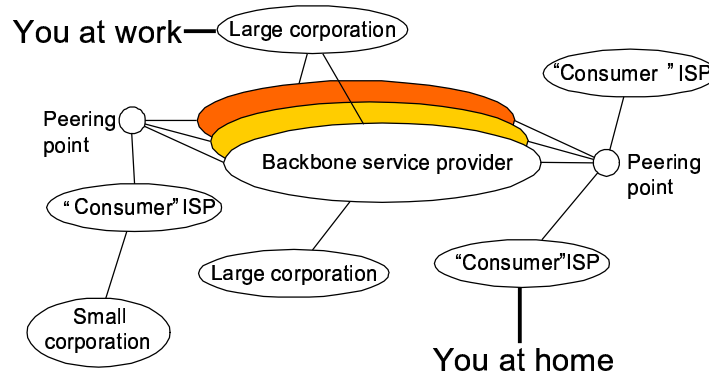
Application
Presentation
Session
Transport
Network
Data Link
Physical

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



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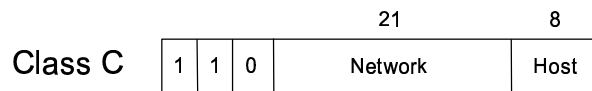
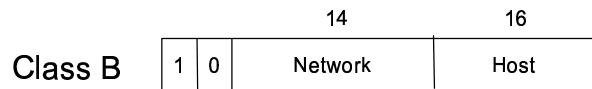
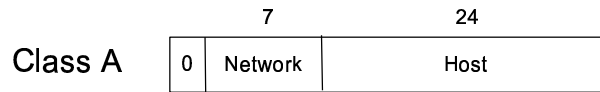
IP Addresses

- 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)

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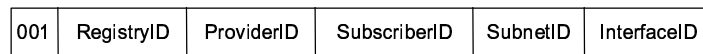
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IPv4 Address Formats



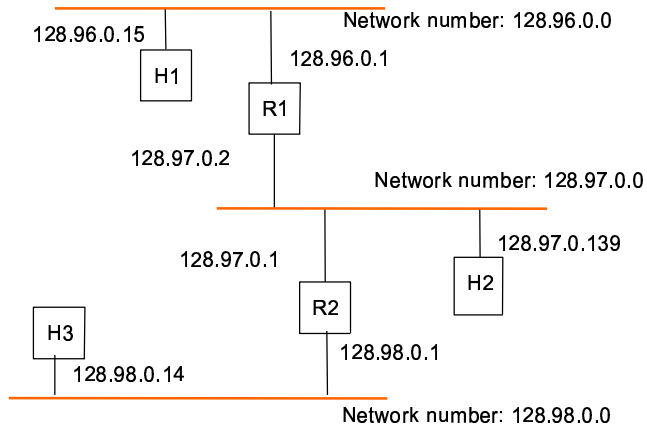
- 32 bits written in "dotted quad" notation, e.g., 18.31.0.135

IPv6 Address Format



- 128 bits written in 16 bit hexadecimal chunks
- Still hierarchical, just more levels

Network Example



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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)

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Getting an IP address

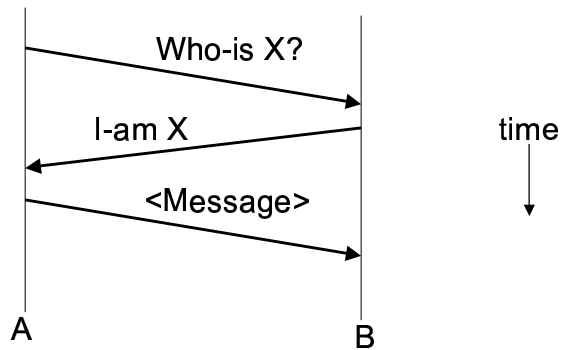
- Old fashioned way: sysadmin configured each machine
- Dynamic Host Configuration Protocol (DHCP)
 - One DHCP server with the bootstrap info
 - Host address, gateway address, subnet mask, ...
 - Find it using broadcast
 - Addresses may be leased; renew periodically
- “Stateless” Autoconfiguration (in 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



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Subnetting – More Hierarchy

- Split up one network number into multiple physical networks

Network number	Host number
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Class B address

- Internal structure isn't propagated

11111111111111111111111111111111	00000000
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Subnet mask (255.255.255.0)

- Helps allocation efficiency

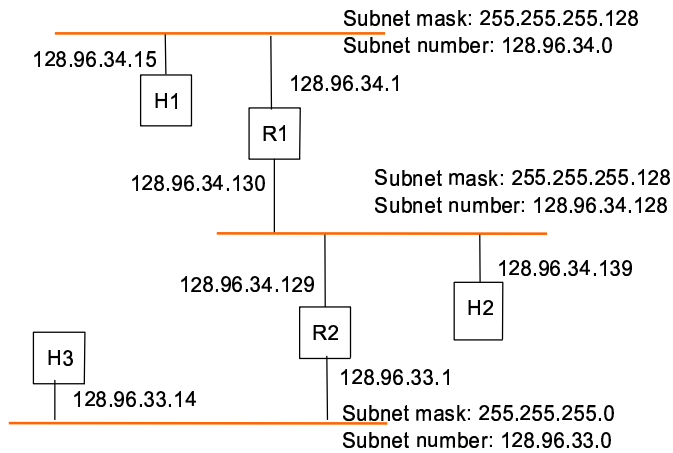
Network number	Subnet ID	Host ID
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Subnetted address

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Subnet Example



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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 :)

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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