

CSE 461 - Module 11: IPv4 / DHCP, ARP, NAT

IPv4 Address Architecture

- Addresses are 32-bits, interpreted as:

network	host
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- Unicast, multicast, and broadcast addresses
 - Address is unicast if it's not broadcast or multicast
 - Broadcast
 - 255.255.255.255 – all hosts on **this** IP network
 - Relies on link layer broadcast (e.g., MAC address FF.FF.FF.FF.FF.FF)
 - |network|11...1| – all hosts on the named network
 - E.g., 172.19.255.255 is all hosts on 172.19.0.0/16
 - I wouldn't count on this being implemented...
 - Multicast
 - 224.0.0.0/4 are multicast addresses
 - Probably implemented only within the local IP network or perhaps the administrative domain (i.e., not the wide area)
 - Some are *well known*...
 - 224.0.0.5 – OSPF (Open Shortest Path First link state implementation)
 - 224.0.0.9 – RIP (Routing Information Protocol distance vector implementation)
 - 224.0.1.1 – NTP (Network Time Protocol clock synchronization)
 - 239.255.255.250 – SSDP (Simple Service Discovery Protocol (UpnP))
- Address scope
 - Private networks
 - Don't need to ask anyone to use these addresses
 - Addresses are *non-routable* on Internet – can't be used to cross Internet
 - 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16
 - Link local
 - Addresses won't pass through any routers
 - Used for auto-configuration (talked about later)
 - 169.254.0.0/16
 - Host only
 - 10.0.0.0/8 – loopback (“localhost”)

IPv4 Supporting Protocols

- **DHCP** (Dynamic Host Configuration Protocol)
 - Machine boots, needs an IP address and possibly config parameters. This is one way to obtain them.
 - UDP packets are sent to broadcast IP address: 255.255.255.255
 - Uses ports 67 (server) and 68 (client)
 - DHCP header contains a transaction ID
 - Random 32-bit int
 - Client identifier is (by default) [IP subnet number, MAC address].
 - DHCP Discover →
 - ← DHCP Offer
 - ← DHCP Offer
 - DHCP Request →
 - ← DHCP ACK
 - Addresses are “leased”
 - Must issue a DHCP Request to renew lease before it expires
 - DHCP server can also supply other configuration information
 - Host name
 - Name server
 - Time server
 - Gateway
- **ARP** (Address resolution protocol)
 - Suppose a host wants to send an IP packet to a destination on the same network it is on
 - For example, a router receives a packet intended for a destination on a network it is connected to
 - The IP packet must be encapsulated in a link layer frame whose destination MAC address is that of the host with the destination IP address
 - How do we determine a MAC address given an IP address?
 - ARP
 - ARP Request
 - Sent to link layer broadcast addresses
 - Contains senders MAC and IP addresses
 - Contains 00:00:00:00:00:00 for destination's MAC and the destination IP we want to query
 - ARP response
 - Sent to requester's MAC
 - Contains requester's IP and MAC
 - Contains responder's IP and MAC
 - All nodes maintain an ARP cache

- Harvest information from the broadcast packets, plus responses to their own requests
- ***DHCP + ARP***
 - DHCP server wants to be sure that IP addresses it thinks are free are in fact free
 - A host assigned a new address by a DHCP server wants to make sure it isn't already in use
 - They can use ARP to check if any node thinks it currently has an IP
 - “Gratuitous ARP”
 - If there is no DHCP server, eventually give up and pick a random link-local address
 - Use ARP to verify that you haven't created a collision
 - (You should be able to talk to other nodes on the same network.)
- ***NAT*** (Network Address Translation)
 - Problem: running out of IPv4 addresses
 - Solution:
 - use private network addresses, because an unlimited number of hosts can use the same private address (but only one inside a single private network)
 - new problem: if you send a packet into the Internet with a private IP as the source address, you can't receive a reply
 - Solution: translate the source address from the host's private IP to the public IP of the gateway/router that connects the private network to the Internet

