

ICS 351: Today's plan

- IPv4 addresses: network part and host part
- address masks
- IP interface configuration
- IPv6 addresses
- ARP protocol
- `arp` command

IPv4 addresses

- 32 bits, usually written in dotted-decimal notation:
128.241.5.17
- each address is split into a network part and a host number
- the network part of the address identifies the network
- for example, www.cmu.edu is 128.2.10.162
- the first 16 bits of the address, 128.2/16, identify the network
- the entire IP address, 128.2.10.162, identifies the host
- every network number should be unique
- host numbers should be unique within a network

IPv4 address details

- an IP address actually identifies an interface rather than a host -- a host or router with multiple interfaces has multiple IP addresses
- packets to destinations within the network are forwarded by using ARP to find the MAC address of the destination, and then sent using the LAN protocol
- packets to destinations outside the network are routed to the network number, ignoring the host part
 - the network number matches at least one routing table entry, which gives the interface and next hop

IPv4 subnetting

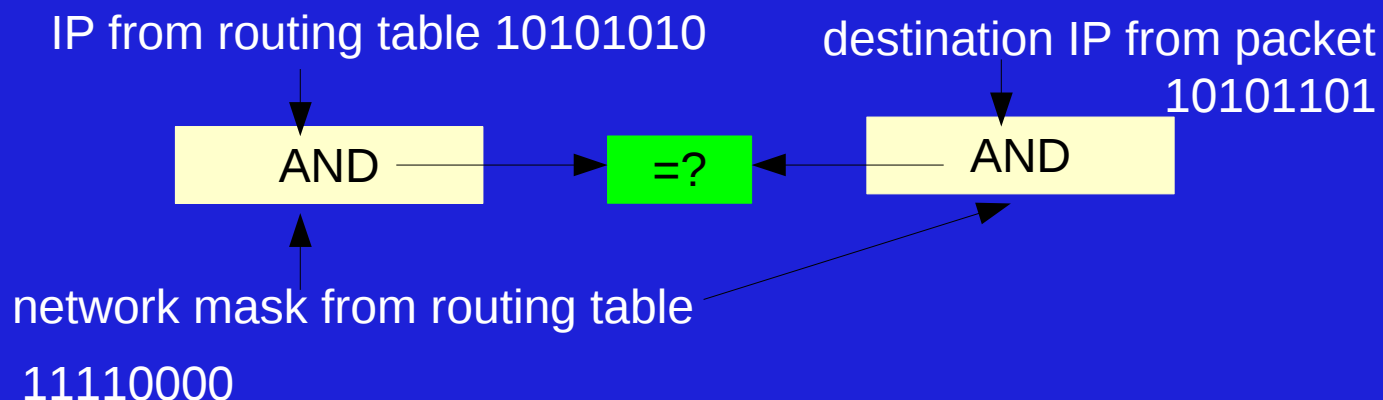
- different addresses have different numbers of bits assigned to the network part of the address
- one network can be split into subnetworks. For example, the network 128.2/16 could be split into 4 subnetworks, 128.2.0/18, 128.2.64/18, 128.2.128/18, and 128.2.192/18
- outside the network, packets are routed to 128.2/16
- within the 128.2/16 network, packets are routed to one of the four subnetworks
- within the subnetworks, packets are delivered using Ethernet

IPv4 network masks

- a routing table must hold
 - (a) the destination address, and
 - (b) the number of bits that make up the network number
- (b) is done by storing a **network mask** together with the destination address, e.g. 255.255.255.0 for a 24-bit mask
- to find out if a destination address (in an IP packet) matches a route (in the routing table), both addresses are ANDed with the network mask, and if the result is equal, the route is a match
- the outcome of this is that the length of the network part of an address is determined only by the accompanying network mask
- this is known as Classless InterDomain Routing (CIDR)

IPv4 network mask examples

- 128.2.128.162 matches 128.2.0.0/16
- 128.2.128.162 does not match 128.2.0.0/18
- 128.2.128.162 matches 128.2.128.0/18
- the network mask is also written in dotted-decimal notation, e.g. 255.255.0.0 for a 16-bit mask, or 255.255.192.0 for an 18-bit mask



IP interface configuration

- `ifconfig` on Unix systems, `ipconfig` on Windows
- when setting up an interface for IP, must specify:
 - the IP address
 - the network mask
- some IP interface configuration can be done automatically, e.g. using DHCP
- but even DHCP must be configured somehow
 - particularly when assigning static IP addresses

IPv6 addresses

- IPv6 addresses (128 bits) are also split into network and host parts
- this split is not determined by a netmask, but by the first few bits of the address
- an address beginning with 80 zero bits followed by 16 1 bits is an "IPv4-mapped IPv6 address", is valid as long as the interface's IPv4 address is used as the last 32 bits ($80+16+32 = 128$)
 - 0:0:0:0:0:ffff:abcd:ef01 is 171.205.239.1

Class based addressing

- using the first few bits to determine the class of the address was first developed for IPv4
 - but abandoned as inefficient when IPv4 addresses started to become scarce
- there are many IPv6 addresses!

IPv6 addresses: no netmasks

- IPv6 addresses (128 bits) are split into network and host parts
- "normal" IPv6 addresses have a global routing prefix (essentially a network number) and a subnet ID in the first 64 bits, followed by 64 bits of interface ID
- such an interface ID can, for example, be taken from the globally unique 48-bit Ethernet (MAC) address associated with the Ethernet/WiFi hardware
- RFC 4291 (<http://tools.ietf.org/html/rfc4291>) has many more details