Basic Tools and Commands

ITL

Network Masks - Review

- Are always used to compare addresses
- Are **not** connected to an address, they are specified independently
- Are **not** transmitted in IP packets
- The two most common uses:
  - Define a “subnet”, i.e. a set of addresses that are mutually reachable (“local”) on a single set of hardware without the use of routers
  - Decide which route to use in a routing table (next lecture)

Addressing Example

- What is the subnet containing 132.235.67.19/29?
  - 132.235.67.19 -->
  - 132.235.67.<0 0 0 1 0 0 1 1>
  - 132.235.67.<0 0 0 1 0 0 1 1>
- Network address
  - 132.235.67.<0 0 0 1 0 0 0 0>
  - 132.235.67.16
- Subnet Broadcast
  - 132.235.67.<0 0 0 1 0 1 1 1>
  - 132.235.67.23

Cheat:
128 64 32 16 8 4 2 1

Number of hosts

- Network 132.235.67.16/29
- Broadcast 132.235.67.23
- Number of addresses
  - 23 - 16 + 1 = 8
- Number of hosts
  - 8 - 2 = 6
- A quirky example: 132.235.67.16/31
  - broadcast 132.235.67.17
  - 2 addresses, 0 hosts!
  - /30 is the smallest usable subnet (4 addresses, 2 hosts)

You of course get the same answer from the number of bits in the "host portion":

1 bit = 2 addresses
2 bits = 4 addresses
3 bits = 8 addresses
4 bits = 16 addresses, etc.

A bigger subnet

- 132.235.66.0/23
  - 132.235.<0 1 0 0 0 0 1 0>.<0 0 0 0 0 0 0 0>
  - broadcast
  - 132.235.<0 1 0 0 0 0 1 1>.<1 1 1 1 1 1 1 1>
  - 132.235.67.255
- Addresses
  - (67 - 66 + 1) * 256 = 512

Or, 9 bits = 10^9 = 512 addresses

- Hosts
  - 512 - 2 = 510
- More in the routing lectures/labs

Configuring Workstations

- Reminder: we need to specify:
  - IP Address
  - Network Mask
    - Verify Broadcast Address (we will talk about that in a moment)
  - Default Route (aka Gateway)
  - Name servers (optional, but we will always add these)

Address Rules

- The host part of an IP address must not be all zero
  - Hint: determine the network address first
  - Count up by one from the network address to get the lowest usable host address
- An IP address with the host portion set to all Ones is a “Subnet Broadcast”; this is not a valid host address

Address Conventions

- Give a router the highest usable IP address in the subnet; i.e. the address one less than the broadcast.
- Start numbering hosts with the lowest available address, counting up.

Windows XP/2003/2008

- Enter all information into the GUI
  - Start->Settings->Network Connections
  - Properties (for the correct interface)
  - TCP/IP (v4 for 2008)
  - Properties
- Command line tool IPCONFIG
  - /all
  - other options (e.g. DHCP) later

Mac OS X

- System Preferences from the “Dock”
  - Select Network
  - Select the “Built In Ethernet” interface (from a pull-down menu in 10.4, side-bar in 10.5)
    (ifconfig will later show this as en0)
  - Fill in the property sheet (we will usually use “manual” addressing)
  - Click Apply

ifconfig and Mac OS

- On all Unix systems, ifconfig can set the properties network interfaces
  - Usually you create a configuration file on disk
  - During startup, the system calls ifconfig with the parameters given in the file
- Mac OS X
  - Uses a process called “configd” to dynamically change interfaces as configurations change and interface states change
  - Anything you do with ifconfig will likely be overwritten by configd

Linux

- ifconfig
  - ifconfig -a
    - shows all interfaces (including some you will never use)
  - ifconfig <name> inet <address>
  - ifconfig <name> netmask <mask>
    - or ifconfig <name> inet <address>/<prefix>
  - ifconfig <name> up
    - used if the interface was not configured before
- Note: This is not how you permanently configure a Linux machine; but very useful for testing and debugging. All changes you make with ifconfig are lost after a reboot.

Other Settings

- Default Gateway (Router)
  - Windows and Mac OS
    - In the property sheets
  - Linux command line
    - route add default gw <gateway-address>
      - Note that the keyword “gw” is not used by some other versions of “route”
    - check with netstat -rn
- Name Servers (132.235.64.1 and 132.235.64.2)
  - Windows and Mac OS: in the property sheets
  - Linux: set up for you (/etc/resolv.conf)

You build it...

- ... and it does not work!
  - One: determine if a cabling problem is the cause
    - GUI status displays, ifconfig
  - Two: determine if a correct network path exists
    - ping (to things close-by first)
  - Three: Discover intermediate network gateways (routers) and determine the path of the packet.
    - traceroute, tracert
  - Note: there are no guarantees; diagnostics and real applications are different...

Ethernet cabling

- Since Ethernet requires a “Carrier Sense” function, an Ethernet device can provide simple diagnostics
- “Link” indicator on hubs/switches and some NICs
- Workstation diagnostic utilities:
  - IPCONFIG in Windows NT/2000/XP
    - also a status icon in the system tray
  - Mac OS X: Network Status in System Settings
  - IFCONFIG in Unix
    - Gnome network indicator (top right)

The IP built-in diagnostic

- ICMP - Internet Control Message Protocol
  - RFC 792
- Looks like a “transport” protocol on top of IP
- Used by routers and workstations to report errors

Basic Connectivity - ping

- Program found in Unix and in Windows (command line and third-party GUI versions)
  - Builds and sends a series of ICMP “Echo” messages
  - Receiver of the message is obliged to return an ICMP “Echo Reply” preserving the original request packet content
  - NOTE: Because the packet content is undefined in the standard, ICMP Echo may be a “covert channel” from a security perspective, and sites may block ICMP.
  - Useful options:
    - ping -n ... (Unix) - prevents name lookups

traceroute

- Used to determine the failure point if PING reports no connectivity
- Also used to map the packet path for more detailed diagnostics
- Available in Unix, in the Windows command prompt as TRACERT, and as third-party GUI
- Selectively triggers ICMP error messages and report these error message returns
  - Useful option: traceroute -n (unix) no name lookup
  - On Windows you use -d