ICS 351: Today's plan

- routing protocols
- linux commands
Routing protocols: overview

• maintaining the routing tables is very labor-intensive if done manually
  – so routing tables are maintained automatically:
  – each router knows what networks it is connected to
  – and communicates that to other routers
  – a routing protocol defines how routing information is communicated among routers
  – popular routing protocols are OSPF, BGP, RIP

• with the information from the routing protocol, each router can build and maintain its routing tables
Routing protocols: properties

- routing is not a perfect process: sometimes the routing tables are inconsistent, because it takes time for a router to discover changes and it takes time to communicate the new information
  - if a router doesn't have a route to a packet's destination, it will drop the packet, i.e., not forward it
- most of the time routing protocols maintain the routing tables correctly
  - much faster than with manual updates
Router hardware and software

- big, expensive Cisco routers
- inexpensive Linux boxes with multiple network interfaces
- a Linux general-purpose computer can:
  - use routing software to route packets
  - just as the expensive Cisco router can
  - but not as fast
  - and perhaps not on the same media
- an expensive router should have hardware acceleration for
  - looking up routes in a routing table, and
  - forwarding packets from one interface to another
- the software to run the routing protocol might be very similar on a
generic box and on an expensive specialized router
**Command line**

- the part of an operating system (or an application) that interfaces with a user is the **user interface**, sometimes called a **shell**
- most user interfaces are graphical: significant parts of the functionality are accessible through the mouse and windows
- many system functions use a simpler user interface, which is text based
- the user gets a prompt whenever the system is ready to handle new commands
- the user can type commands, which the system then executes
- the commands may print output on the screen or, less commonly, request input from the users
on Unix systems, including Linux, commands are interpreted by an application program called the **shell**

there are many possible Linux shells, but this class will use the default, which is bash (Bourne-Again SHeLl). Another notable shell is tcsh.

some commands are built-in to the shell, but usually a command entered on the shell results in executing an application

the typical shell command syntax is:

*command* -switch .. --switch parameter .. parameter

the most important command to remember is man, short for *manual*, which gives information about other commands

* e.g. `man ls` gives the manual "page" for the `ls` command
Useful Unix commands and concepts

- shells on Linux usually implement commands from the Unix family of operating systems
- `ls` lists files and directories (`ls -a` also lists files beginning with ".")
- `pwd` displays the name of the current directory, and `cd` changes the current directory
- `mkdir name` creates the directory `name`, and `rmdir name` removes it if it is empty
- `rm name` removes the file (permanently!)
- `rm -i name` asks first
- `cp name1 name2` copies the file `name1` to another file (or directory) `name2`
- `mv name1 name2` moves/renames the file `name1` to another file (or directory) `name2`
- In Unix, the root of the file system is "/", and "/" is also used as a separator at the end of directory names, e.g. `/etc/hosts` is the name of a file in the directory `/etc` (or `/etc/`)
- `mount /dev/sdb1 /mnt/mydisk` makes the file system on the device `/dev/sdb1` accessible as `/mnt/mydisk`, assuming such a device is connected and such file system exists
- To safely remove the device, simply `umount /mnt/mydisk`
Unix/Linux file commands

gedit file runs the gedit text editor on the file
more file displays the contents of the file, one screenful at a time
cat file does the same, without stopping
the output of a command can be sent ("piped") to the input of another command, or directly to a file
cat file > file2 is another way of copying file to file2
cat file >> file2 appends file to the end of file2
cat file | tee file2 shows the contents of file and also writes them to file2
command x > file & tail -f file puts the output of the command into file, and also shows the growing contents of file
the & at the end of the command puts its execution into the background, so the shell prompts again while the command is still running
a command in the background can be brought to the foreground with fg
Ctrl-Z (^Z) can be used to suspend a running foreground command, and bg will send it to the background
Ctrl-C (^C) will normally kill a foreground command
jobs will show the running background command, kill %3 will kill background command 3, and pkill abcd will kill command abcd
Special shell constructs

- A pipe is a sequence of commands separated by `|`
  - The output of the first command is the input to the second command
  - The output of the (n-1)th command is the input to the nth command
  - An input redirect `<` is usually only found on the first command in a pipe
  - An output redirect `>` is usually only found for the last command in a pipe
    - Example: `tr \n ' ' < file.html | sed 's/<[^>]*>/ /g' > file.txt`
- An `&` starts the previous command in the background, then executes the next command (if any)
  - Example: `sleep 100 &`
- `'jobs' lists the commands that are running in the background`
- `'fg' puts a background command in the foreground`
  - Control-Z stops the currently executing command
  - Control-C kills the currently executing command
- Part of a command in `backticks` is executed and replaced with its output
  - Example: `more `grep -l foo *` runs “more” on the file names printed by grep`
- Single quotes and “double quotes” are used for any parameter that contains spaces or other special chars
  - Example: `the backslash \ is used as an escape`
- The star * matches anything, e.g. ba* matches bar and baz
Unix/Linux networking commands

telnet host port connects to the given port on the given host:
if there is a telnet server on that port of the given host, then allows entering commands remotely
(but very insecurely)
ftp host opens a File Transfer Protocol session to the given host (assuming there is an FTP server
running there)
ftp supports simple commands to transfer files, including ls, cd, lcd, binary, ascii, get, mget, put, mput, quit
both telnet and ftp transfer everything in the clear
anyone with access to the network can see what is transferred
modern systems use encrypted transfers, particularly based on the secure shell with the two
commands ssh and scp
ssh host or ssh -p port host
scp file host:remote/path, or scp host:remote/path local/path, or scp -P
port host:remote/path local/path
ping host sends packets to a host that are likely to elicit replies, and prints any replies it gets
traceroute host sends packets that are likely to be dropped enroute to a host, and prints the error
messages
on one computer, or in one window, run:
```
nc -l 12345
```
on the other side, run:
```
nc <IP address> 12345
```
now, anything typed in one (window, computer) appears in the other