Networking

- Read Chapter 9

- Linux network utilities
  - finger, ftp, host, hostname, msg, rcp, rlogin, rsh, scp, sftp, slogin, ssh, talk, telnet, users, w, wall, who, write, ...
Networking

Important to know

- common network terminology
- how networks are built
- how to talk to other people on the network
- how to use other computers on the network
Networking

- Local Area Networks
- Simplest LAN
Networking

- Local Area Networks
  - Ethernet (Standardized as IEEE 802.3)
  - You have seen the RJ45 connectors
Networking

- Bridges
  - Bridge passes Ethernet message between different segments of the network as if both segments were a single Ethernet cable.
  - Used when one has to go beyond the allowed length of a single section of wire.
Networking

- **Routers**
  - Route traffic to where it is needed. Or, does not route messages where they are not needed.
  - Example of 4 networks: now argue router vs bridge
Networking

- Gateway
- High-capacity routers
Internetworking

Packet Switching and Circuit Switching

Circuit Switching
- establish, maintain and terminate dedicated circuit
- e.g., traditional telephone networks

Packet Switching
- network nodes send messages that are split up into small packets
- packets get routed from source to destination
Internetworking

Packet Switching Issues

- How big are the packets
- How do packets get routed, all along the same route or not
- What if packets get lost, arrive out of order
- What if packet sizes change
- Who’s packet is it?
Internetworking

Most of the Internet revolves around:

- Transmission Control Protocols (TCP/UDP)
- Internet Protocol (IP)
LAN Protocols in Context

Application Layer

TCP Layer

IP Layer

LLC Layer

MAC Layer

TCP segment

IP datagram

LLC protocol data unit

MAC frame
Internetworking

- Internet Protocol
- IPv4 Header

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Source Address

Destination Address

Options + Padding
```

20 octets
Internetworking

- **IP Address Formats**

  - **Class A**
    - Network (7 bits) | Host (24 bits)

  - **Class B**
    - 1 0  | Network (14 bits) | Host (16 bits)

  - **Class C**
    - 1 1 0  | Network (21 bits) | Host (8 bits)

  - **Class D**
    - 1 1 1 0 | Multicast

  - **Class E**
    - 1 1 1 1 0 | Future Use
Internetworking

- So what network are we?

- 129.101.153.117
IP Addresses - Class B

• Start with binary 10
• Range 128.x.x.x to 191.x.x.x
• Second Octet also included in network address
• $2^{14} = 16,384$ class B addresses
• All allocated
Internetworking

- IPv6
  - extended addressing
  - 128-bit addresses
  - but that is not all, e.g., security, ...
Networking

- Naming
  - What associations exist?
  - hostname, IP address, MAC address
  - address resolution protocol (arp)

```bash
/sbin/arp -a
bender.cs.uidaho.edu (129.101.153.101) at 00:0E:0C:69:7B:E7 [ether] on eth0
bunyan.cs.uidaho.edu (129.101.153.110) at 00:D0:B7:B6:C1:5C [ether] on eth0
varanid.cs.uidaho.edu (129.101.153.119) at 00:03:BA:5C:48:0E [ether] on eth0
granite.cs.uidaho.edu (129.101.153.125) at 00:03:BA:5C:48:17 [ether] on eth0
```

-bash-3.2$
Networking

- Routing
  - Dynamic routing
  - Static routing
Networking

Security

User Authentication

- e.g., login with username and password
- e.g., remote procedure call

RPC: execute a command, say *date* on another computer

- `commet:~ krings$ rsh eternium.cs.uidaho.edu date`
- works if one establishes “machine equivalence”
- this is defined in *hosts* file
- can also be done in `/etc/hosts.equiv`
Networking

- Security
  - Data Encryption
  - Example
    - use `telnet` to connect to other computer and all communication is in clear-text --- ouch!
    - use secure shell, e.g., based on Open Secure Socket Layer OpenSSL
Networking

- Ports and Common Services
  - Services like ftp, mail or http use TCP or UDP
  - /etc/services shows the ports and their services
  - take a look
  - Linux interprocess communication allows you to communicate with other programs at a known IP address and port. See Chapter 12 “Systems Programming”
Networking

Network Users

- *users*, list the users on the local host
- *who*, like *users* except that it gives you more information
- *w*, like *who* except that it gives you even more information
- *hostname*, displays your local host's name
- *finger*, gives information about specific users
Networking

- **Communication with Network Users**
  - `write`, allows you to send individual lines to a user, one at a time
  - `talk`, allows you to have an interactive split-screen two-way conversation
  - `wall`, allows you to send a message to everyone on the local host
  - `mail`, allows you to send mail messages
Networking

Distributing Data

- *rcp* (remote copy) and *scp* (secure copy) allow you to copy files between your local Linux host and another remote Linux or UNIX host.

- *ftp* (file transfer protocol or program) and *sftp* (secure ftp) allow you to copy files between your local Linux host and any other host (possibly non-Linux) that supports FTP (the File Transfer Protocol). *ftp* is thus more powerful than *rcp*.

- *uucp* (unix-to-unix copy) is similar to *rcp*, and allows you to copy files between any two Linux or UNIX hosts.
Networking

Distributing Data

sftp

sftp eternium.cs.uidaho.edu
Connecting to eternium.cs.uidaho.edu...

****************************************************************
WARNING: To protect the system from unauthorized use and to
ensure that the system is functioning properly, activities
on this system are monitored recorded and subject to audit.
Use of this system is expressed consent to such monitoring
and recording. Any unauthorized access or use of this system
is prohibited and subject to criminal and civil penalties.
****************************************************************

krings@eternium.cs.uidaho.edu's password:
sftp> ? [check out the commands displayed with the “?” option]
Networking

- Distributed Processing

- `rlogin` and `slogin`, which allow you to log in to a remote Linux or UNIX host

- `rsh` and `ssh`, which allow you to execute a command on a remote Linux or UNIX host

- `telnet`, which allows you to execute commands on any remote host that has a telnet server
Networking

- **rlogin** how does it work?
  - *rlogin* asks for password
    - -l option is used to specify username other than current one
    - if remote hosts has local host in `/etc/rhosts` file then no passwd needed
    - what are the advantages or disadvantages of this?
  - what is the difference to *telnet*?
    - similar but less customizable, connects only to unix hosts
  - wisdom: *telnet* and *rlogin* should be avoided. Use *ssh* and *slogin*
Networking

- *rlogin* how does it work?
  - *rlogin* asks for password
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Word of wisdom:

- *telnet* and *rlogin* should be avoided! Use *ssh* and *slogin*!