

ITP20004 – Open-Source Software Labs

Linux Environment

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Spring, 2023

Handong Global University

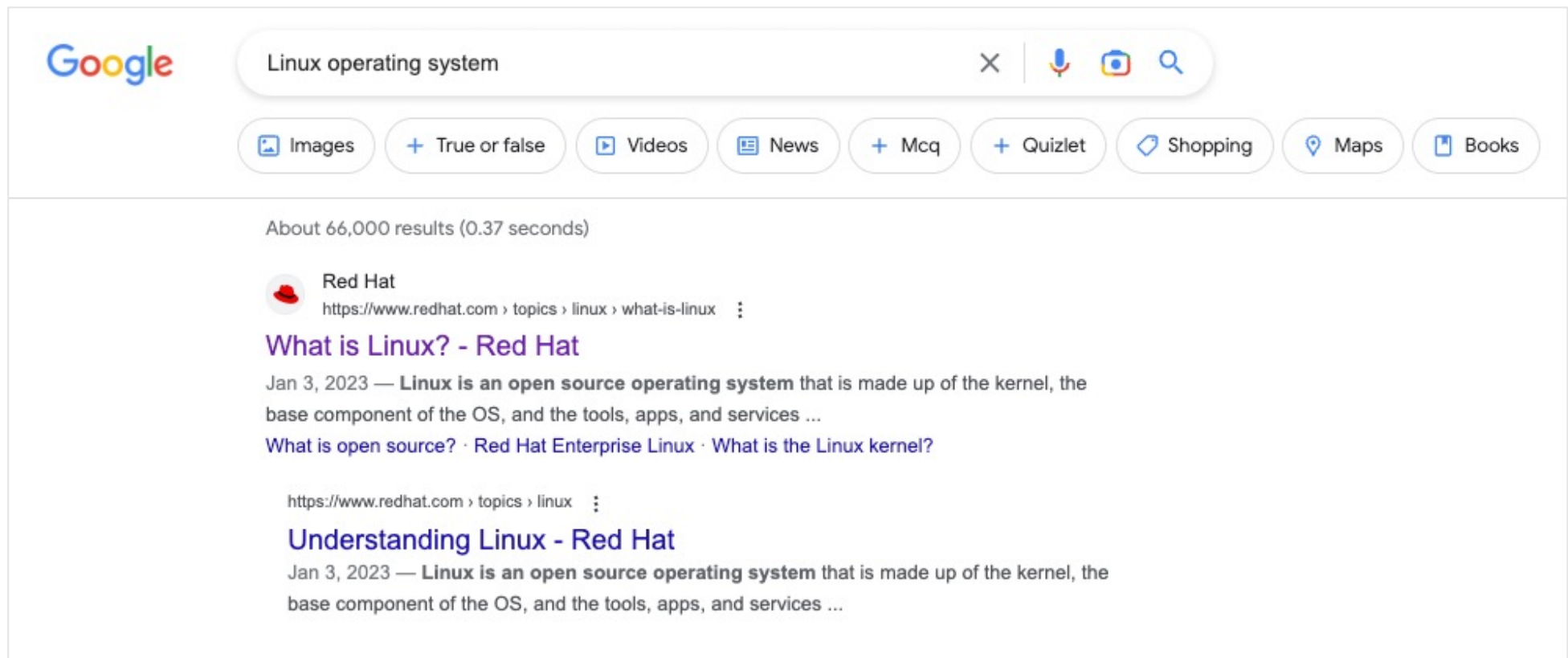


Agenda

- A gentle introduction to Linux
- Getting familiar with Linux
 - Bash
 - First key strokes: ls, cd/mkdir/rmdir, cat, more, less, top
 - Built-in manual: man
- Connecting to a Linux machine

A Flood of Jargons

- “Linux is an open-source operating system”



The screenshot shows a Google search interface. The search bar contains the text "Linux operating system". Below the search bar, there are several filters: Images, True or false, Videos, News, Mcq, Quizlet, Shopping, Maps, and Books. The search results show "About 66,000 results (0.37 seconds)". The first result is from Red Hat, with the URL "https://www.redhat.com › topics › linux › what-is-linux". The title of the result is "What is Linux? - Red Hat". The snippet below the title reads: "Jan 3, 2023 — Linux is an open source operating system that is made up of the kernel, the base component of the OS, and the tools, apps, and services ...". Below the snippet, there are links: "What is open source?", "Red Hat Enterprise Linux", and "What is the Linux kernel?". The second result is also from Red Hat, with the URL "https://www.redhat.com › topics › linux". The title of the result is "Understanding Linux - Red Hat". The snippet below the title reads: "Jan 3, 2023 — Linux is an open source operating system that is made up of the kernel, the base component of the OS, and the tools, apps, and services ...".

Google

Linux operating system

Images True or false Videos News Mcq Quizlet Shopping Maps Books

About 66,000 results (0.37 seconds)

Red Hat
https://www.redhat.com › topics › linux › what-is-linux

What is Linux? - Red Hat

Jan 3, 2023 — Linux is an open source operating system that is made up of the kernel, the base component of the OS, and the tools, apps, and services ...

What is open source? · Red Hat Enterprise Linux · What is the Linux kernel?

https://www.redhat.com › topics › linux

Understanding Linux - Red Hat

Jan 3, 2023 — Linux is an open source operating system that is made up of the kernel, the base component of the OS, and the tools, apps, and services ...

A Flood of Jargons

- “Linux is an open-source operating system”
 - *Open-source*
 - *Operating system*
 - *Linux*



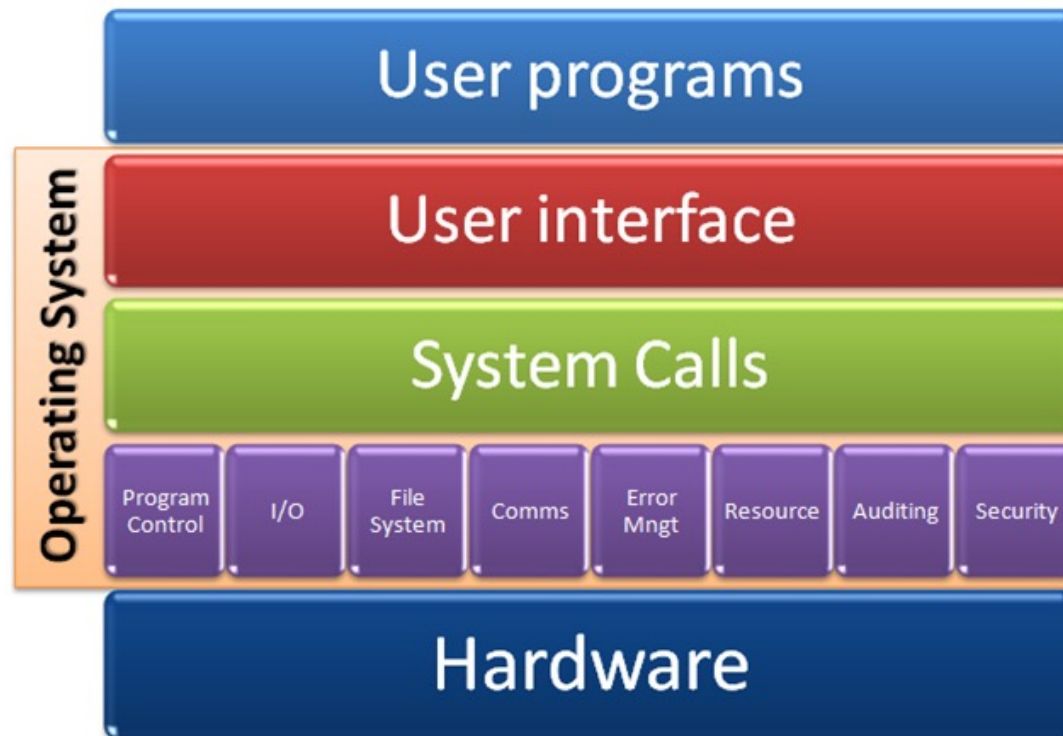
Open-Source Software

- Software products that include **permission to use its source code, design documents, or contents**
 - Source code is released under an *open-source license*, in which the copyright holder grants users the **right to study, change, and distribute** the software to anyone and for any purpose (Laurent, 2008)
- This is in contrast to **proprietary software**
 - The software is under restrictive copyright
 - The source code is usually hidden from the users

무료가 아닌
그래서 open source가 있고 proprietary software가 있다

Operating System

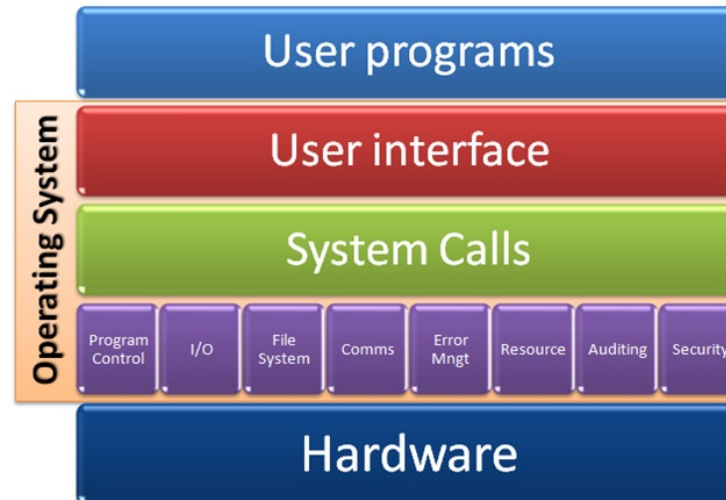
- System software that acts as an **interface** between the user programs and the computer hardware



* Image src: <https://www.cs.bgu.ac.il/~spl181/index.php?page=Runtime-environments>

Operating System

- System software that acts as an **interface** between the user programs and the computer hardware
 - **Manages** computer hardware and software **resources** cpu time, momory, other I/O
 - Provides **common services** for computer programs
 - **Supports communications** among the user programs



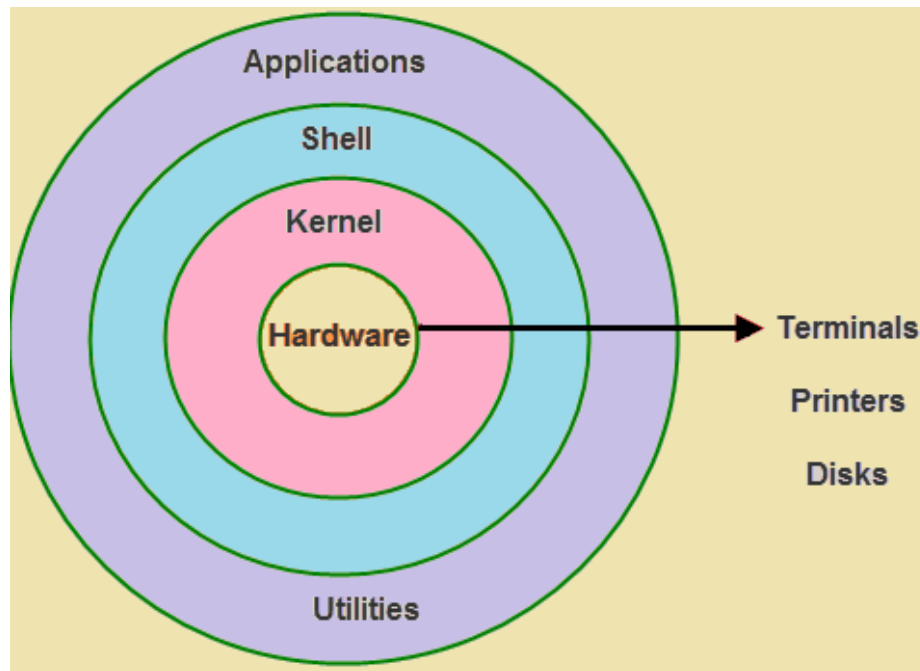
* Image src: <https://www.cs.bgu.ac.il/~spl181/index.php?page=Runtime-environments>

Linux

- Linux is a *family* of free and open-source software operating systems based on the **Linux kernel**
- Key components
 - Linux kernel: The **operating system core**
 - Talks to the hardware and software
 - Resource control – Process/memory/file system/device management
 - Shell: User interface
 - Command interpreter
 - Offers easier way to launch applications, navigate thru directories, ...
 - Applications
 - Programming tools – *e.g., Gcc, Eclipse*
 - Editors – *e.g., Vim, Nano, Emacs*
 - Productivity – *e.g., Gimp, OpenOffice*

Linux

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- Key components

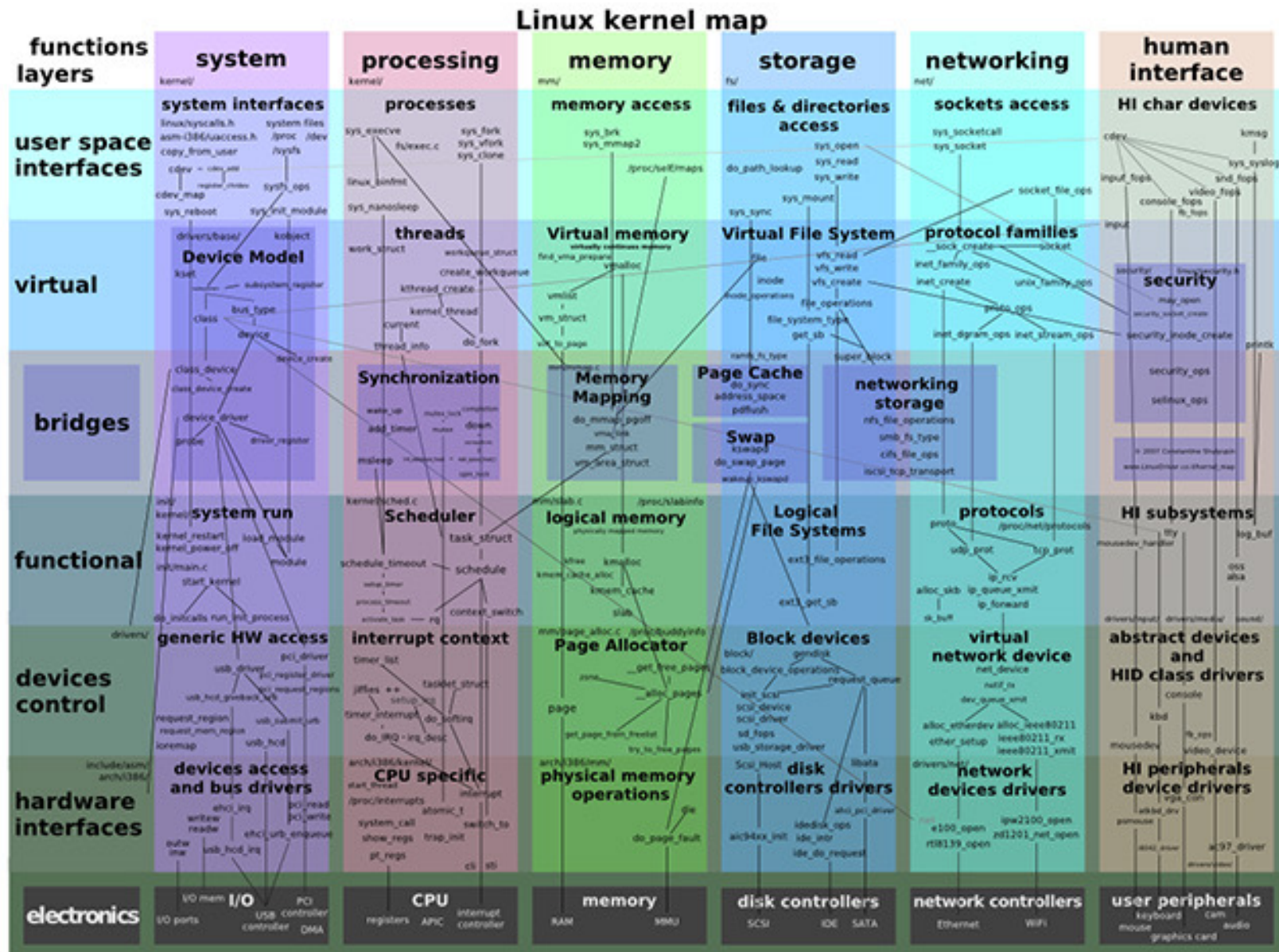


Graphic Card Shell

- KDE
- GNOME
- COCOA

* Image src: <https://ssd-pqr.medium.com/introduction-b702cc939cae>

Linux



Linux Distros

linux = pre-defined SW purchase collection

- Linux distribution (aka distro): a software collection consists of the Linux kernel and other open-source software packages
 - Widely used Linux distros
 - Ubuntu, Debian, Mate
 - Fedora, CentOS, RedHat
 - Slackware, OpenSUSE
 - Arch

personal user

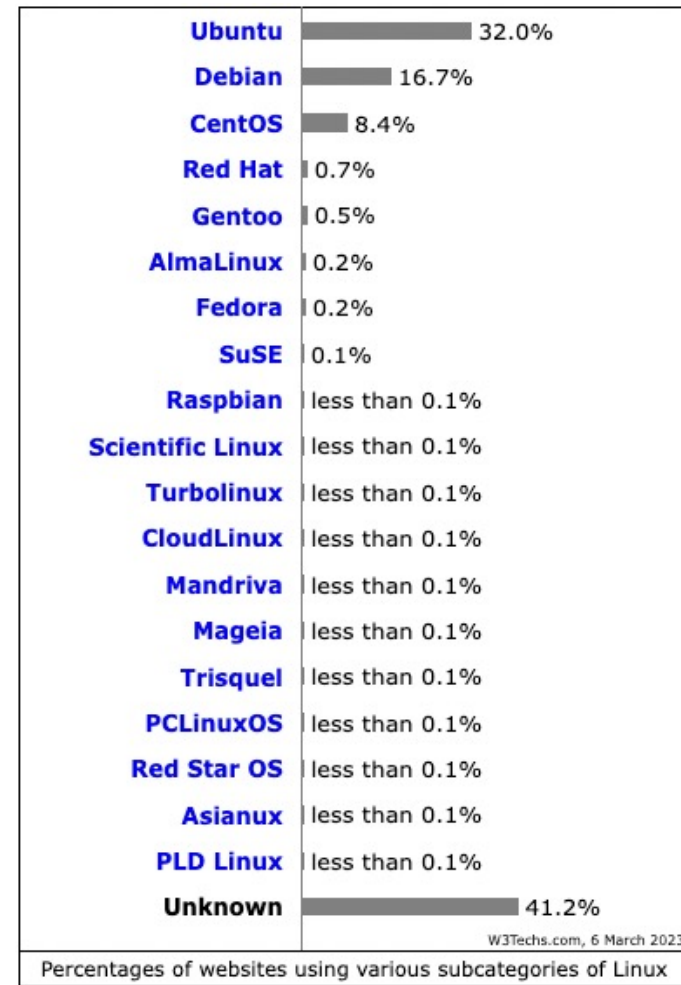
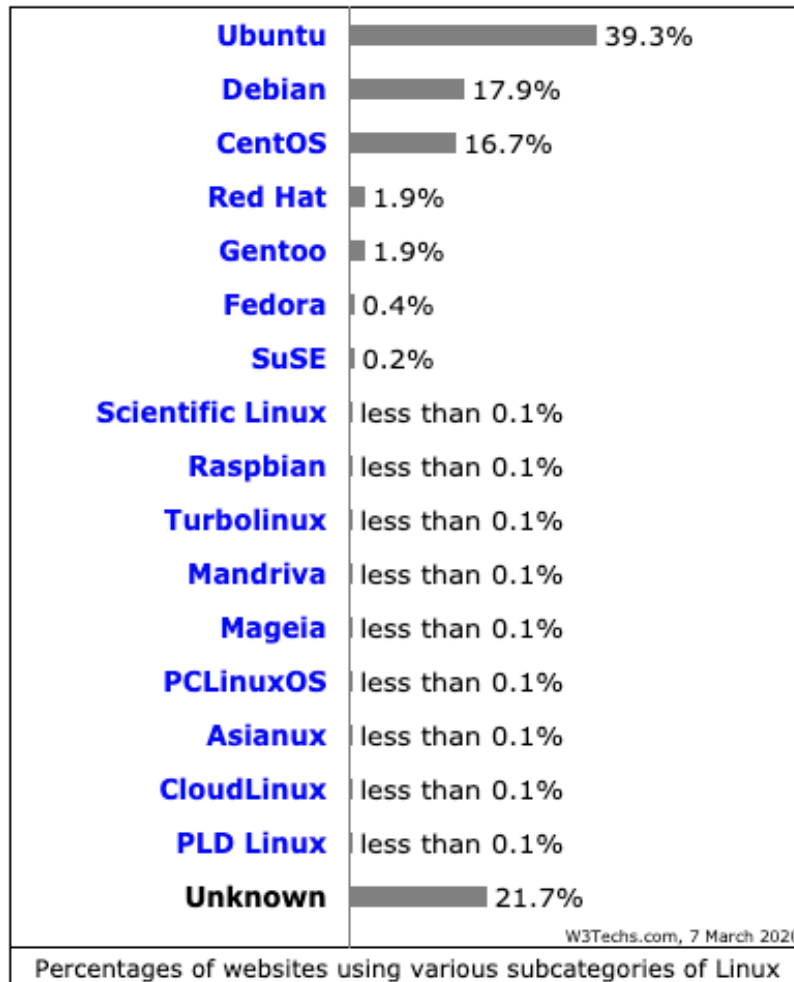
commerical

server

Linux Distros



- Ubuntu is the most popular Linux distro





Red Star OS

June 23, 2017 by pavroo

Last Updated on: **8th May 2022, 11:26 am**

Web site: www.naenara.com.kp/en/kcc/ (not active)

Origin: North Korea

How to put things together?

- Open-source
- Operating system
- Linux



* Image src: <https://arstechnica.com/gadgets/2019/08/unix-at-50-it-starts-with-a-mainframe-a-gator-and-three-dedicated-researchers/>;
<https://www.datacenterdynamics.com/en/news/compuwares-topaz-wants-to-simplify-mainframes/>; <https://www.pngfuel.com/free-png/noai>

How to put things together?

- Open-source
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* Image src: <http://alexb.org/2015/04/21/unix/>; <https://medium.com/@amogh/the-story-of-open-source-so-far-bfcb685d85a4>

In the Beginning...



Richard M. Stallman

Xerox 9700



copy machine
UNIX
- proprietary
- but codes were available



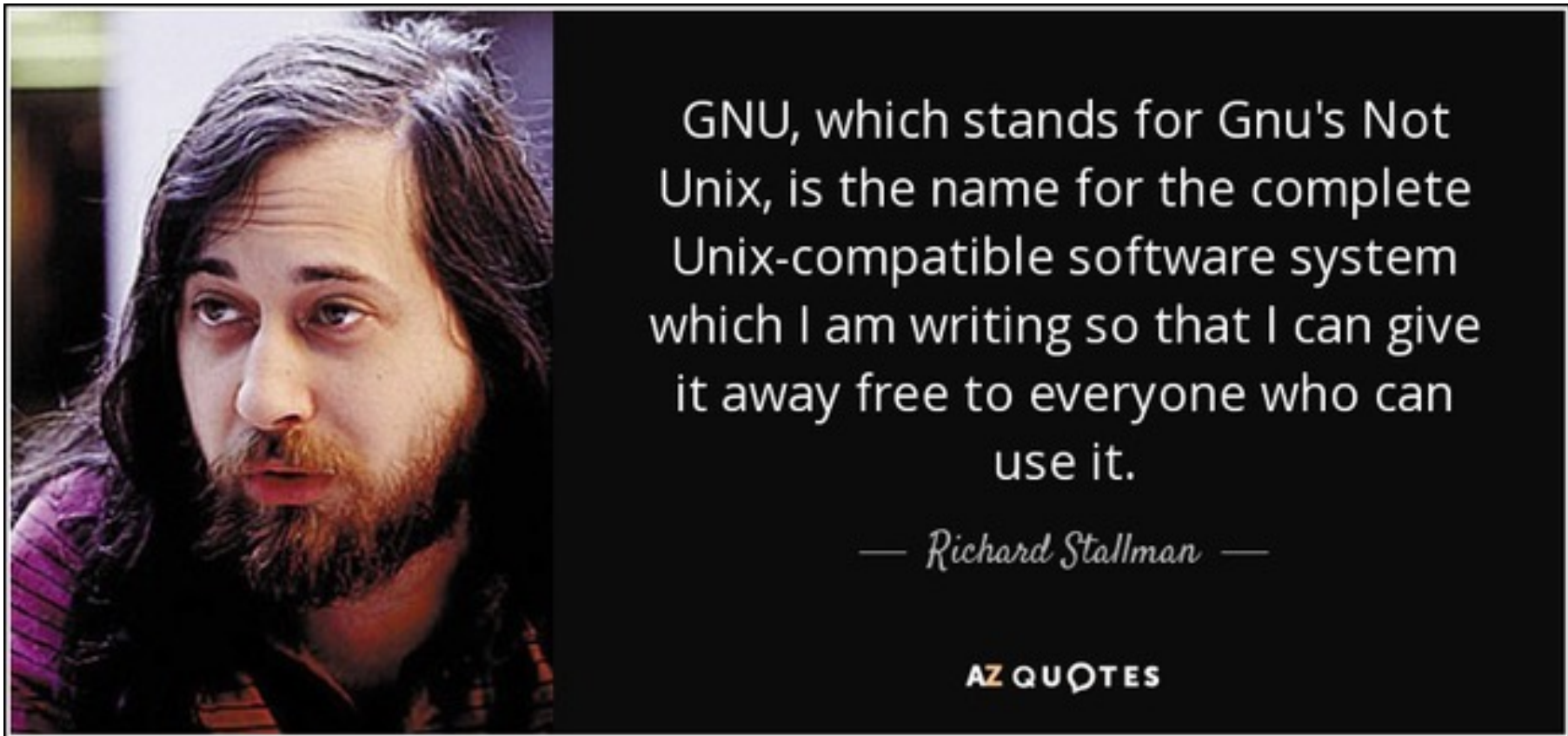
UNIX®



* Image src: <http://alexb.org/2015/04/21/unix/>; <https://medium.com/@amogh/the-story-of-open-source-so-far-bfcb685d85a4>

In the Beginning...

- GNU: To complete UNIX-compatible software system that can be used freely for all



* Image src: https://www.azquotes.com/author/13994-Richard_Stallman

GNU: GNU is Not Unix

- The GNU project (1983)
 - GNU: GNU is Not Unix (*recursion!*)
 - Build a complete suite of UNIX-compatible non-proprietary software system
- Free Software Foundation (1985)
 - Released a collection of some software
 - Text editor
 - Shell
 - Compiler
 - Did not have an operating system

+ SWTS



* Image src: <http://alexb.org/2015/04/21/unix/>; <https://medium.com/@amogh/the-story-of-open-source-so-far-bfcb685d85a4>

UNIX on PC?



IBM 5150 (First IBM PC, 1981)



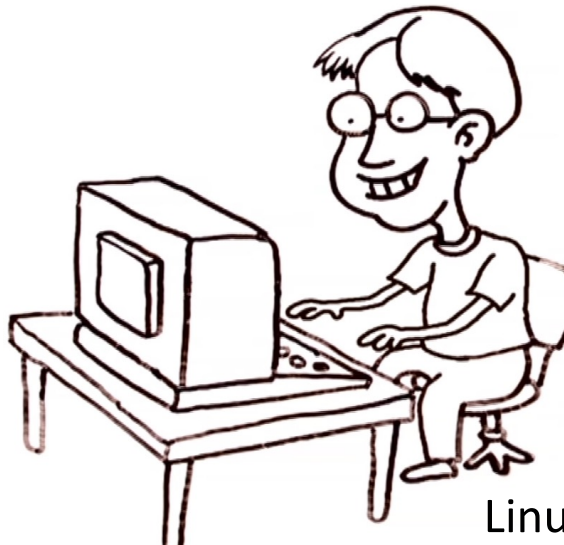
* Image src: <http://alexb.org/2015/04/21/unix/>;

<https://www.telegraph.co.uk/technology/2016/08/12/the-first-ibm-pc-was-released-35-years-ago-today---how-it-change/>;

Birth of Linux



$$+ \text{UNIX}^{\text{®}} = \text{freax (Free + Unix)} \\ = \text{Linux}$$



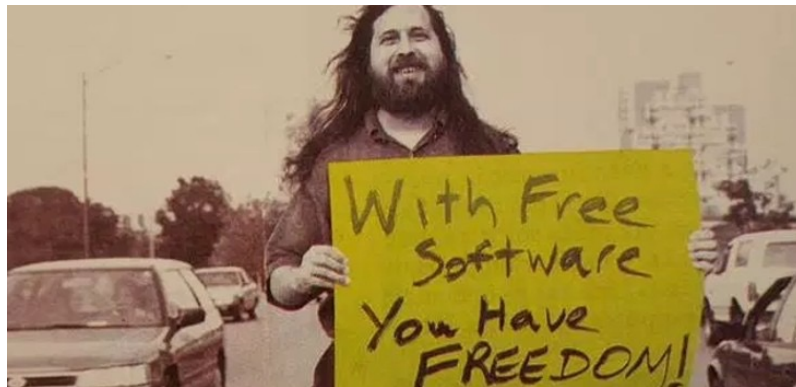
Linus Torvalds
a student at University of Helsinki

* Image src: <http://alexsb.org/2015/04/21/unix/>; https://www.youtube.com/watch?v=5ocq6_3-nEw (by the Linux Foundation)
<https://www.telegraph.co.uk/technology/2016/08/12/the-first-ibm-pc-was-released-35-years-ago-today---how-it-change/>;

How to put things together?

- “Linux is an open-source operating system”
 - *Open-source*
 - *Operating system*
 - *Linux*

Richard M. Stallman



Linus Torvalds



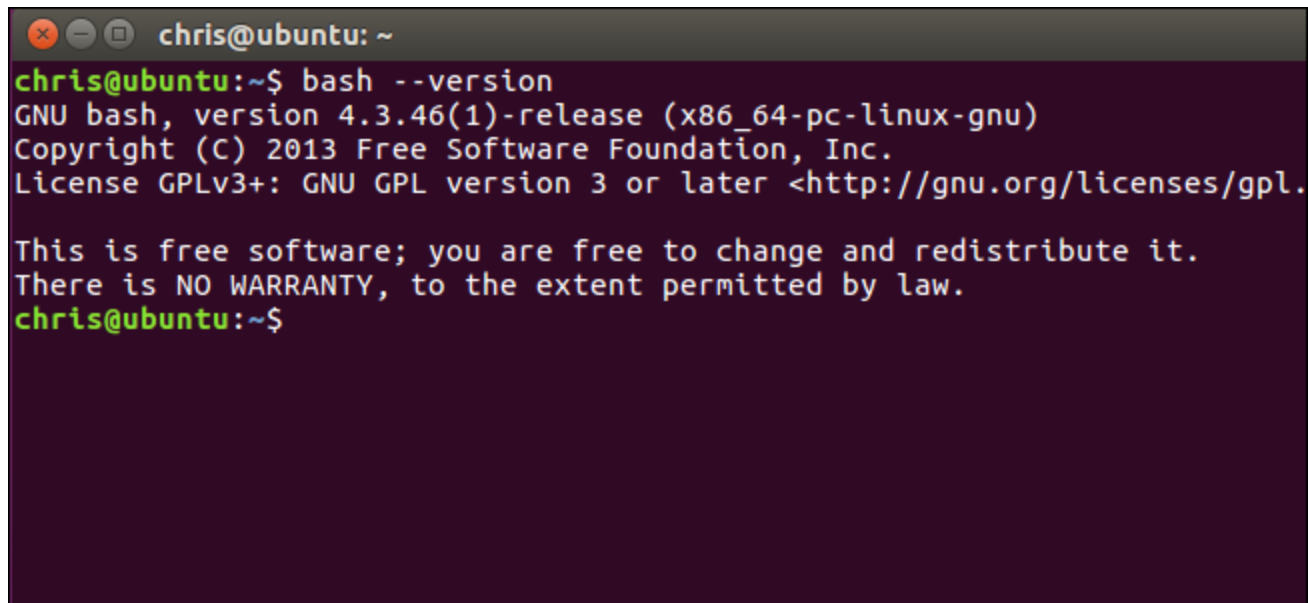
* Image src: <https://opensource.com/>; Linux Foundation

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 - First key strokes: ls, cd/mkdir/rmdir, cat, more, less, top
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Getting Familiar with Linux

- Bash shell
 - A command processor/interpreter
 - Allows the user to type commands that cause actions
 - Supports script programming
 - Helps the user maintain the system easily

A terminal window titled 'chris@ubuntu: ~' with a dark background. The user has entered the command 'bash --version'. The output shows the GNU bash version 4.3.46(1)-release for x86_64-pc-linux-gnu, copyright information for 2013, and the GPLv3 license. It also includes a disclaimer about free software and warranty.

```
chris@ubuntu:~$ bash --version
GNU bash, version 4.3.46(1)-release (x86_64-pc-linux-gnu)
Copyright (C) 2013 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.

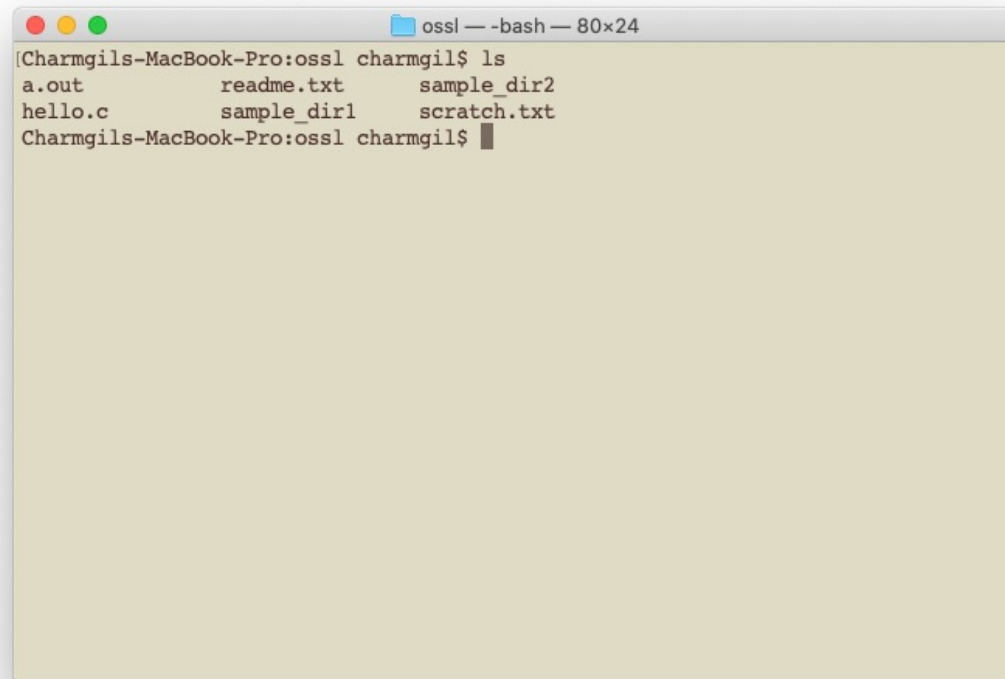
This is free software; you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
chris@ubuntu:~$
```

First Key Strokes

- ls
- cd/mkdir/rmdir
- cat
- more
- less
- top
- vim

ls -- list directory contents

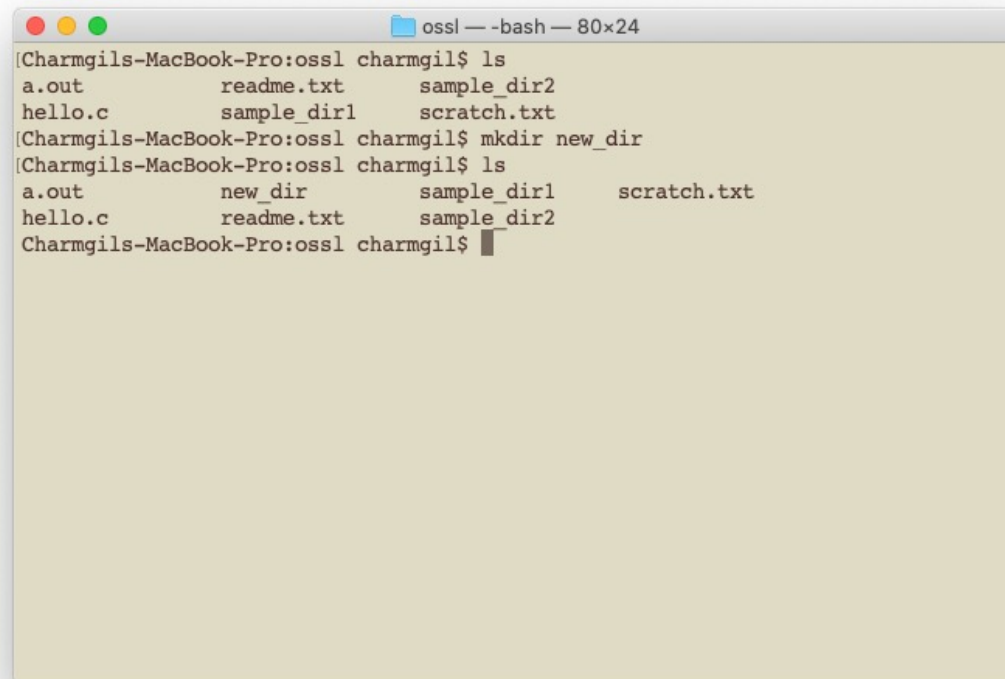
- Displays the names of files contained within a directory, as well as any requested, associated information

A screenshot of a macOS terminal window titled "ossl -- bash -- 80x24". The terminal shows the command "ls" being executed in a directory named "charmgil". The output lists nine files and directories in three columns: "a.out", "readme.txt", "sample_dir2", "hello.c", "sample_dir1", "scratch.txt", and "Charmgils-MacBook-Pro:ossl charmgil\$".

```
ossl -- bash -- 80x24
[Charmgils-MacBook-Pro:ossl charmgil$ ls
a.out      readme.txt  sample_dir2
hello.c    sample_dir1 scratch.txt
Charmgils-MacBook-Pro:ossl charmgil$
```

cd/mkdir/rmdir -- maneuver directories

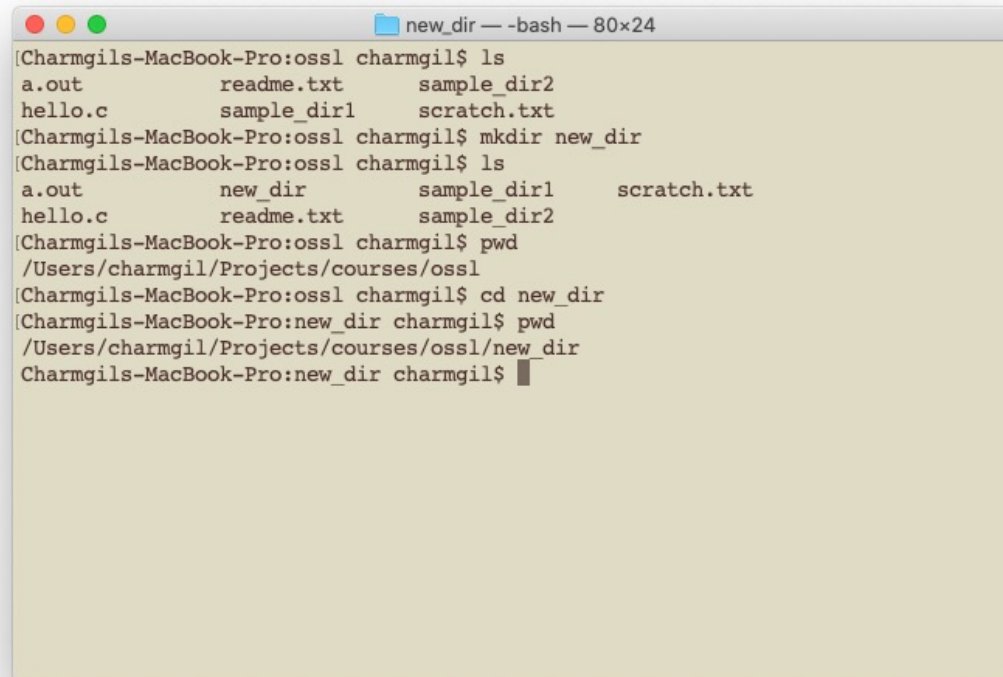
- cd – change working directory
- mkdir – make directories
- rmdir – remove a directory

A terminal window titled "ossl -- -bash -- 80x24" showing a series of commands and their outputs. The user is in a directory named "charmgil" on a machine named "Charmgils-MacBook-Pro:ossl". The initial "ls" command shows files "a.out", "hello.c", "readme.txt", "sample_dir1", "sample_dir2", and "scratch.txt". Then, the user runs "mkdir new_dir", and a subsequent "ls" command shows the new directory "new_dir" added to the list of files and directories.

```
ossl -- -bash -- 80x24
[Charmgils-MacBook-Pro:ossl charmgil$ ls
a.out      readme.txt  sample_dir2
hello.c    sample_dir1 scratch.txt
[Charmgils-MacBook-Pro:ossl charmgil$ mkdir new_dir
[Charmgils-MacBook-Pro:ossl charmgil$ ls
a.out      new_dir    sample_dir1  scratch.txt
hello.c    readme.txt sample_dir2
Charmgils-MacBook-Pro:ossl charmgil$
```

cd/mkdir/rmdir -- maneuver directories

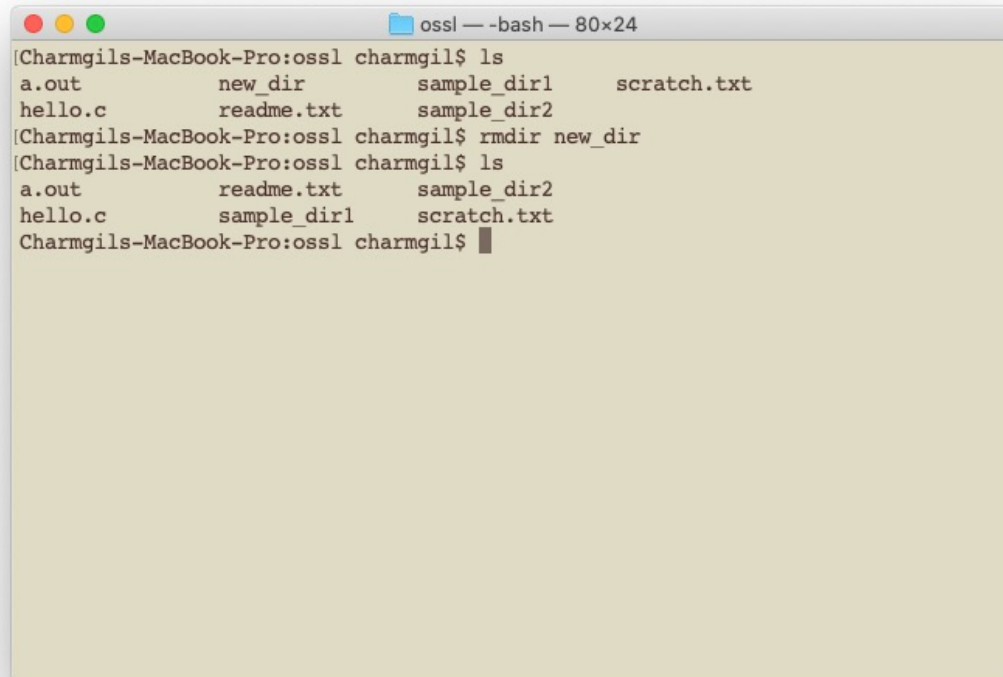
- cd – change working directory
- mkdir – make directories
- rmdir – remove a directory

A terminal window titled 'new_dir -- -bash -- 80x24' showing a series of commands and their outputs. The commands include 'ls', 'mkdir new_dir', 'ls', 'pwd', 'cd new_dir', and 'pwd' again, demonstrating the creation and navigation into a new directory.

```
[Charmgils-MacBook-Pro:ossl charmgil$ ls  
a.out      readme.txt  sample_dir2  
hello.c    sample_dir1 scratch.txt  
[Charmgils-MacBook-Pro:ossl charmgil$ mkdir new_dir  
[Charmgils-MacBook-Pro:ossl charmgil$ ls  
a.out      new_dir     sample_dir1  scratch.txt  
hello.c    readme.txt  sample_dir2  
[Charmgils-MacBook-Pro:ossl charmgil$ pwd  
/Users/charmgil/Projects/courses/ossl  
[Charmgils-MacBook-Pro:ossl charmgil$ cd new_dir  
[Charmgils-MacBook-Pro:new_dir charmgil$ pwd  
/Users/charmgil/Projects/courses/ossl/new_dir  
Charmgils-MacBook-Pro:new_dir charmgil$
```

cd/mkdir/rmdir -- maneuver directories

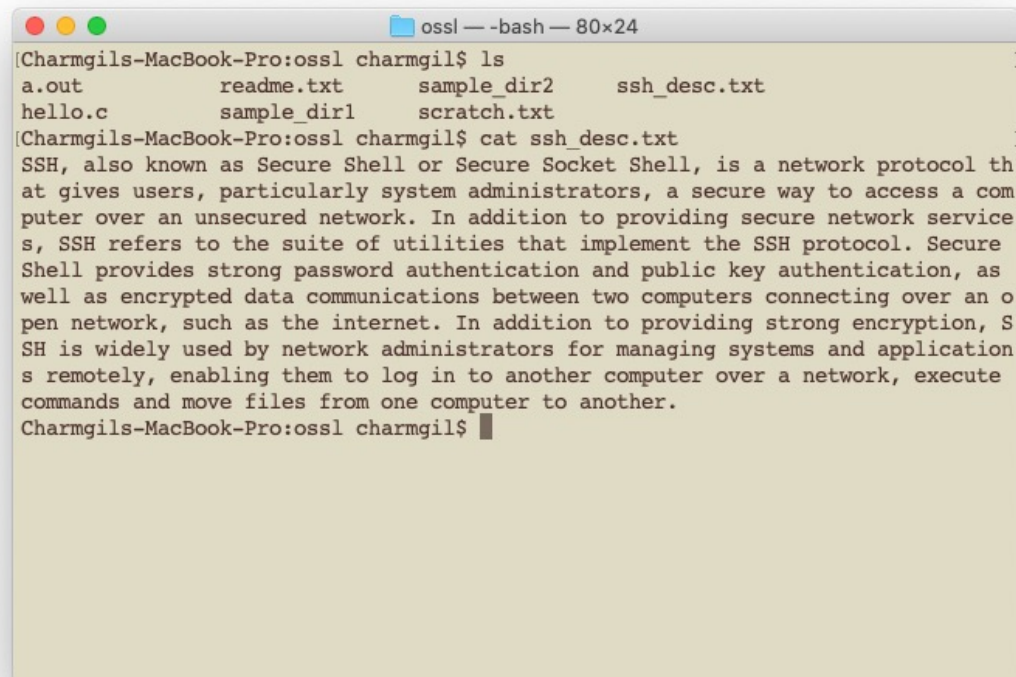
- cd – change working directory
- mkdir – make directories
- rmdir – remove a directory



```
ossl — -bash — 80x24
[Charmgils-MacBook-Pro:ossl charmgil$ ls
a.out          new_dir        sample_dir1    scratch.txt
hello.c        readme.txt     sample_dir2
[Charmgils-MacBook-Pro:ossl charmgil$ rmdir new_dir
[Charmgils-MacBook-Pro:ossl charmgil$ ls
a.out          readme.txt     sample_dir2
hello.c        sample_dir1    scratch.txt
Charmgils-MacBook-Pro:ossl charmgil$
```

cat -- concatenate and print files

- Reads files sequentially, writing them to the **standard output** (screen)



```
ossl -- -bash -- 80x24
[Charmgils-MacBook-Pro:ossl charmgil$ ls
a.out      readme.txt  sample_dir2  ssh_desc.txt
hello.c    sample_dir1  scratch.txt
[Charmgils-MacBook-Pro:ossl charmgil$ cat ssh_desc.txt
SSH, also known as Secure Shell or Secure Socket Shell, is a network protocol th
at gives users, particularly system administrators, a secure way to access a com
puter over an unsecured network. In addition to providing secure network service
s, SSH refers to the suite of utilities that implement the SSH protocol. Secure
Shell provides strong password authentication and public key authentication, as
well as encrypted data communications between two computers connecting over an o
pen network, such as the internet. In addition to providing strong encryption, S
SH is widely used by network administrators for managing systems and application
s remotely, enabling them to log in to another computer over a network, execute
commands and move files from one computer to another.
Charmgils-MacBook-Pro:ossl charmgil$
```

more -- file perusal filter for crt viewing

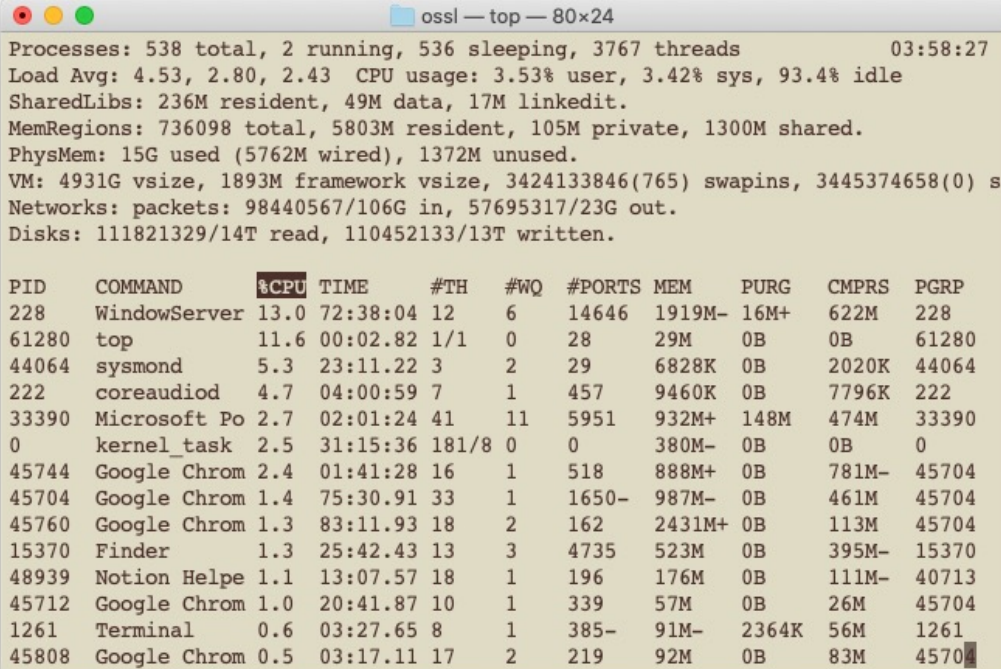
- Archaic text viewer

less -- opposite of more

- Similar to 'more;' but more improved
 - Allows bi-directional movement
 - Does not have to read the entire input file before starting
- “*less* is more than *more*; *more* is less than *less*”

top -- display sorted information about processes

- Periodically displays a sorted list of system processes
- The list can be sorted by CPU usage, memory usage,

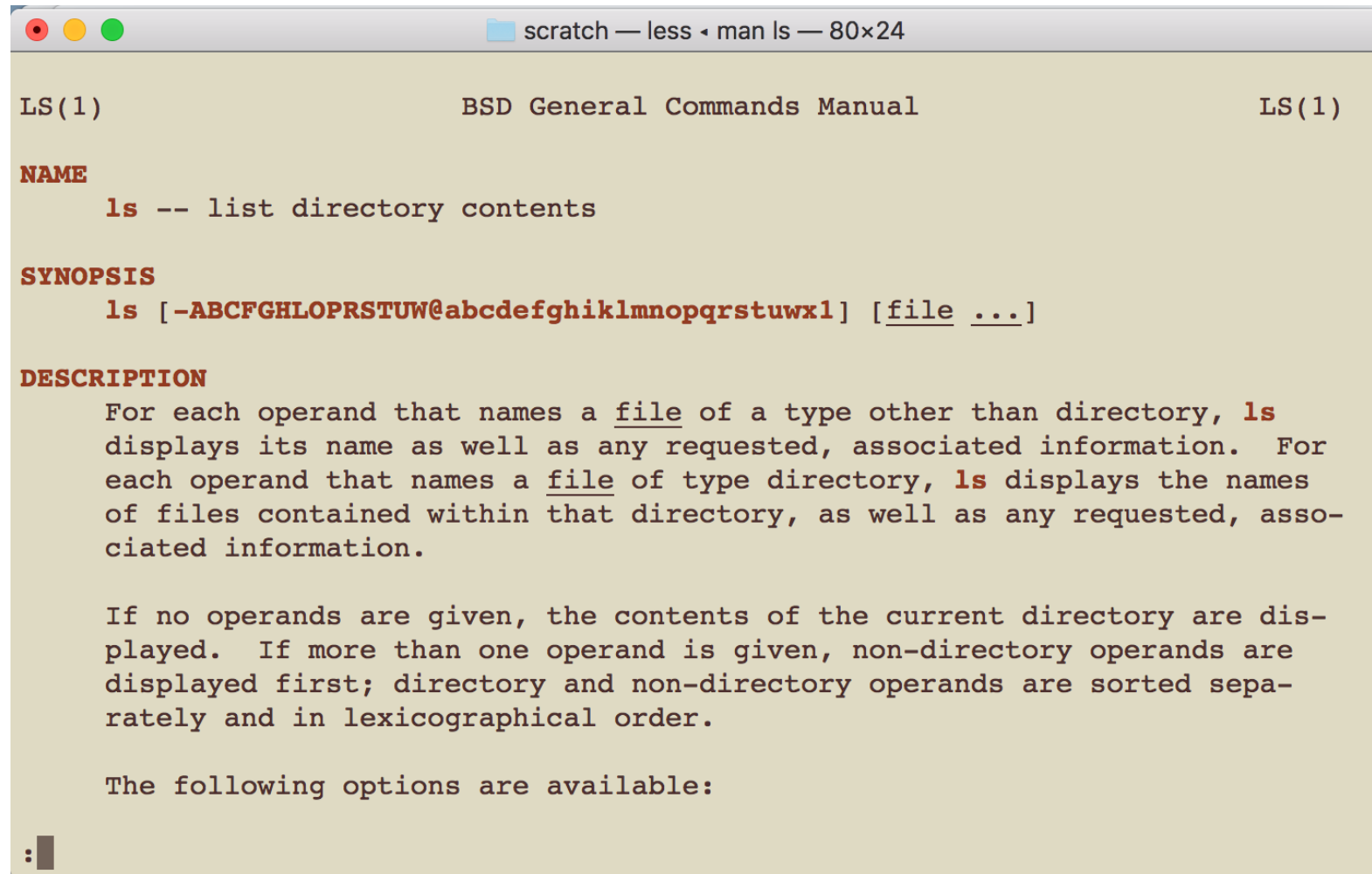


```
Processes: 538 total, 2 running, 536 sleeping, 3767 threads          03:58:27
Load Avg: 4.53, 2.80, 2.43  CPU usage: 3.53% user, 3.42% sys, 93.4% idle
SharedLibs: 236M resident, 49M data, 17M linkedit.
MemRegions: 736098 total, 5803M resident, 105M private, 1300M shared.
PhysMem: 15G used (5762M wired), 1372M unused.
VM: 4931G vsize, 1893M framework vsize, 3424133846(765) swapins, 3445374658(0) s
Networks: packets: 98440567/106G in, 57695317/23G out.
Disks: 111821329/14T read, 110452133/13T written.

PID    COMMAND      %CPU  TIME    #TH   #WQ   #PORTS MEM    PURG   CMPRS  PGRP
228    WindowServer 13.0   72:38:04 12     6    14646  1919M- 16M+   622M  228
61280  top           11.6   00:02.82 1/1     0     28    29M    0B     0B    61280
44064  sysmond       5.3    23:11.22 3       2     29    6828K  0B     2020K  44064
222    coreaudiod    4.7    04:00:59 7       1     457   9460K  0B     7796K  222
33390  Microsoft Po  2.7    02:01:24 41      11    5951  932M+  148M   474M   33390
0      kernel_task   2.5    31:15:36 181/8   0     0     380M-  0B     0B     0
45744  Google Chrom  2.4    01:41:28 16       1     518   888M+  0B     781M-  45704
45704  Google Chrom  1.4    75:30.91 33       1    1650-  987M-  0B     461M   45704
45760  Google Chrom  1.3    83:11.93 18       2     162   2431M+ 0B     113M   45704
15370  Finder        1.3    25:42.43 13       3    4735  523M   0B     395M-  15370
48939  Notion Helpe  1.1    13:07.57 18       1     196   176M   0B     111M-  40713
45712  Google Chrom  1.0    20:41.87 10       1     339   57M    0B     26M    45704
1261   Terminal      0.6    03:27.65 8        1     385-  91M-   2364K  56M    1261
45808  Google Chrom  0.5    03:17.11 17       2     219   92M    0B     83M    45704
```


man: Built-in Linux Manual

- Man-page



```
scratch — less ◀ man ls — 80x24

LS(1)                                BSD General Commands Manual                                LS(1)

NAME
  ls -- list directory contents

SYNOPSIS
  ls [-ABCFGHLOPRSTUW@abcdefghijklmnopqrstuvwxyz1] [file ...]

DESCRIPTION
  For each operand that names a file of a type other than directory, ls
  displays its name as well as any requested, associated information. For
  each operand that names a file of type directory, ls displays the names
  of files contained within that directory, as well as any requested, asso-
  ciated information.

  If no operands are given, the contents of the current directory are dis-
  played. If more than one operand is given, non-directory operands are
  displayed first; directory and non-directory operands are sorted sepa-
  rately and in lexicographical order.

  The following options are available:

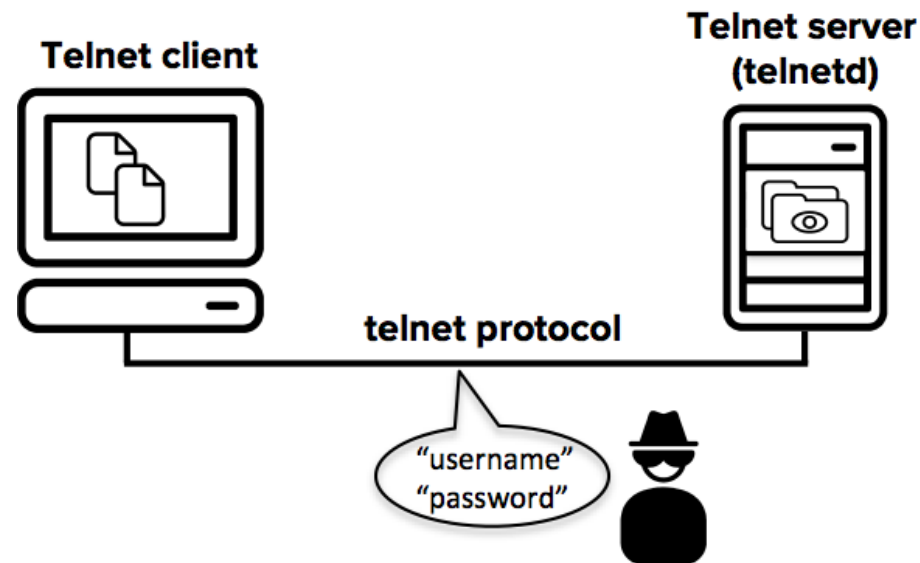
:█
```

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SSH: Secure Shell

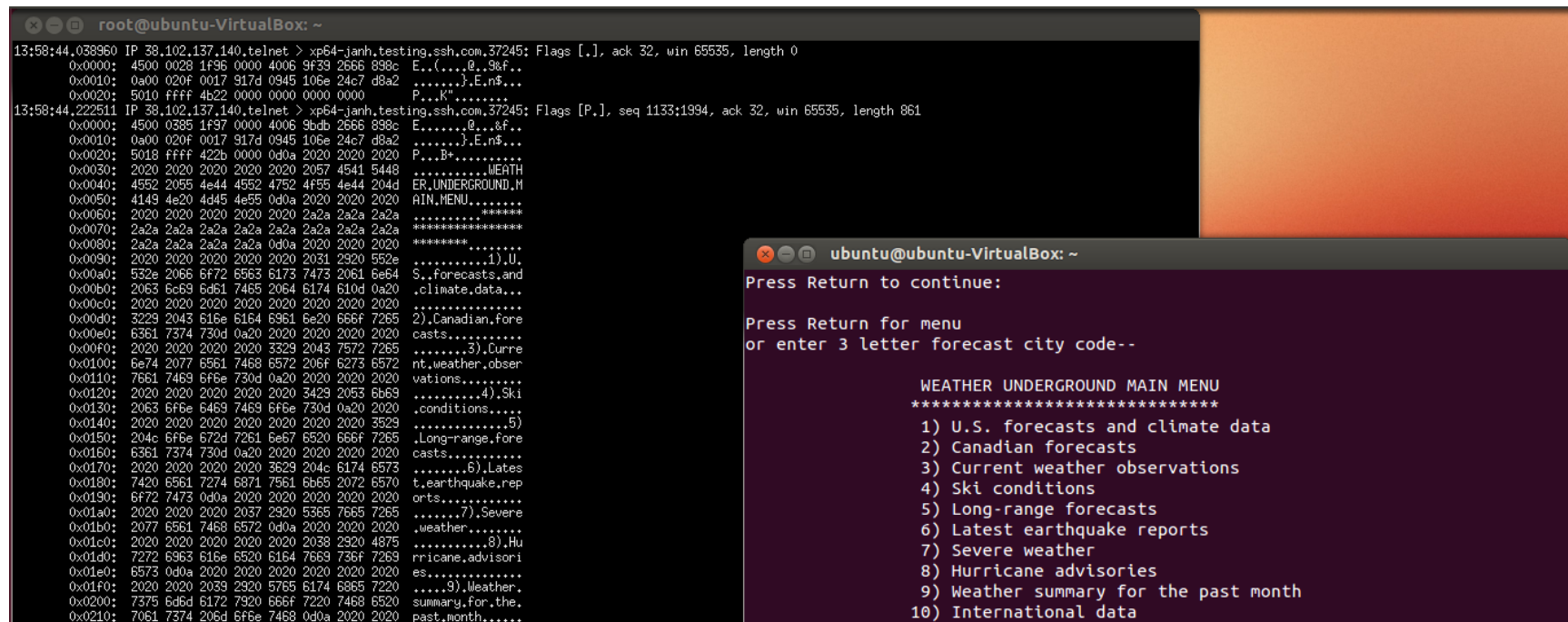
- SSH: A network protocol that grants users a **secure way to access** a computer over an **unsecured network**
- “Packet sniffin” with Telnet



* Image source: <https://www.ssh.com/academy/ssh/telnet>

SSH: Secure Shell

- SSH: A network protocol that grants users a **secure way to access** a computer over an **unsecured network**
 - Provides **encrypted data communication** between two computers connecting over an open network (such as the Internet)



The image shows two terminal windows. The left window is a root@ubuntu-VirtualBox terminal showing an SSH connection to xp64-janh.testing.ssh.com. The right window is an ubuntu@ubuntu-VirtualBox terminal showing a telnet session to xp64-janh.testing.ssh.com, which displays a weather service menu.

```
root@ubuntu-VirtualBox: ~
13:58:44.038960 IP 38.102.137.140.telnet > xp64-janh.testing.ssh.com,37245: Flags [.] , ack 32, win 65535, length 0
0x0000: 4500 0028 1f96 0000 4006 9f39 2666 898c E...@...%F..
0x0010: 0a00 020f 0017 917d 0945 106e 24c7 d8a2 .....}.E.n$...
0x0020: 5010 ffff 4b22 0000 0000 0000 0000 P...K".....
13:58:44.222511 IP 38.102.137.140.telnet > xp64-janh.testing.ssh.com,37245: Flags [P.] , seq 1133:1994, ack 32, win 65535, length 861
0x0000: 4500 0385 1f97 0000 4006 9bdb 2666 898c E.....@...&f..
0x0010: 0a00 020f 0017 917d 0945 106e 24c7 d8a2 .....}.E.n$...
0x0020: 5018 ffff 422b 0000 0d0a 2020 2020 2020 P...B+.....
0x0030: 2020 2020 2020 2020 2020 2057 4541 5448 .....WEATH
0x0040: 4552 2055 4e44 4552 4752 4f55 4e44 204d ER_UNDERGROUND.M
0x0050: 4149 4e20 4d45 4e55 0d0a 2020 2020 2020 AIN.MENU.....
0x0060: 2020 2020 2020 2020 2020 2a2a 2a2a 2a2a .....*****
0x0070: 2a2a 2a2a 2a2a 2a2a 2a2a 2a2a 2a2a 2a2a .....*****
0x0080: 2a2a 2a2a 2a2a 2a2a 0d0a 2020 2020 2020 .....*****
0x0090: 2020 2020 2020 2020 2020 2031 2920 552e .....1).U.
0x00a0: 532e 2066 6f72 6563 6173 7473 2061 6e64 S..forecasts.and
0x00b0: 2063 6c69 6d61 7465 2064 6174 610d 0a20 .climate.data...
0x00c0: 2020 2020 2020 2020 2020 2020 2020 2020 .....
0x00d0: 3229 2043 616e 6164 6961 6a20 666f 7265 2).Canadian.fore
0x00e0: 6361 7374 730d 0a20 2020 2020 2020 2020 casts.....
0x00f0: 2020 2020 2020 2020 3329 2043 7572 7265 .....3).Curre
0x0100: 6e74 2077 6561 7468 6572 206f 6273 6572 nt.weather,obser
0x0110: 7661 7469 6f6e 730d 0a20 2020 2020 2020 vations.....
0x0120: 2020 2020 2020 2020 2020 3429 2053 6b69 .....4).Ski
0x0130: 2063 6f6e 6469 7468 6f6e 730d 0a20 2020 .conditions....
0x0140: 2020 2020 2020 2020 2020 2020 2020 3529 .....5).
0x0150: 204c 6f6e 672d 7261 6e67 6520 666f 7265 .Long-range,fore
0x0160: 6361 7374 730d 0a20 2020 2020 2020 2020 casts.....
0x0170: 2020 2020 2020 2020 3629 204c 6174 6573 .....6).Lates
0x0180: 7420 6561 7274 6871 7561 6b65 2072 6570 t,earthquake,rep
0x0190: 6f72 7473 0d0a 2020 2020 2020 2020 2020 orts.....
0x01a0: 2020 2020 2020 2037 2920 5365 7665 7265 .....7).Severe
0x01b0: 2077 6561 7468 6572 0d0a 2020 2020 2020 .weather.....
0x01c0: 2020 2020 2020 2020 2020 2038 2920 4875 .....8).Hu
0x01d0: 7272 6963 616e 6520 6164 7669 736f 7269 rricane.advisori
0x01e0: 6573 0d0a 2020 2020 2020 2020 2020 2020 es.....
0x01f0: 2020 2020 2039 2920 5765 6174 6865 7220 .....9).Weather
0x0200: 7375 6d6d 6172 7920 666f 7220 7468 6520 summary.for,the
0x0210: 7061 7374 206d 6f6e 7468 0d0a 2020 2020 past.month.....
```

```
ubuntu@ubuntu-VirtualBox: ~
Press Return to continue:

Press Return for menu
or enter 3 letter forecast city code--

WEATHER UNDERGROUND MAIN MENU
*****
1) U.S. forecasts and climate data
2) Canadian forecasts
3) Current weather observations
4) Ski conditions
5) Long-range forecasts
6) Latest earthquake reports
7) Severe weather
8) Hurricane advisories
9) Weather summary for the past month
10) International data
```

* Image source: <https://www.ssh.com/academy/ssh/telnet>

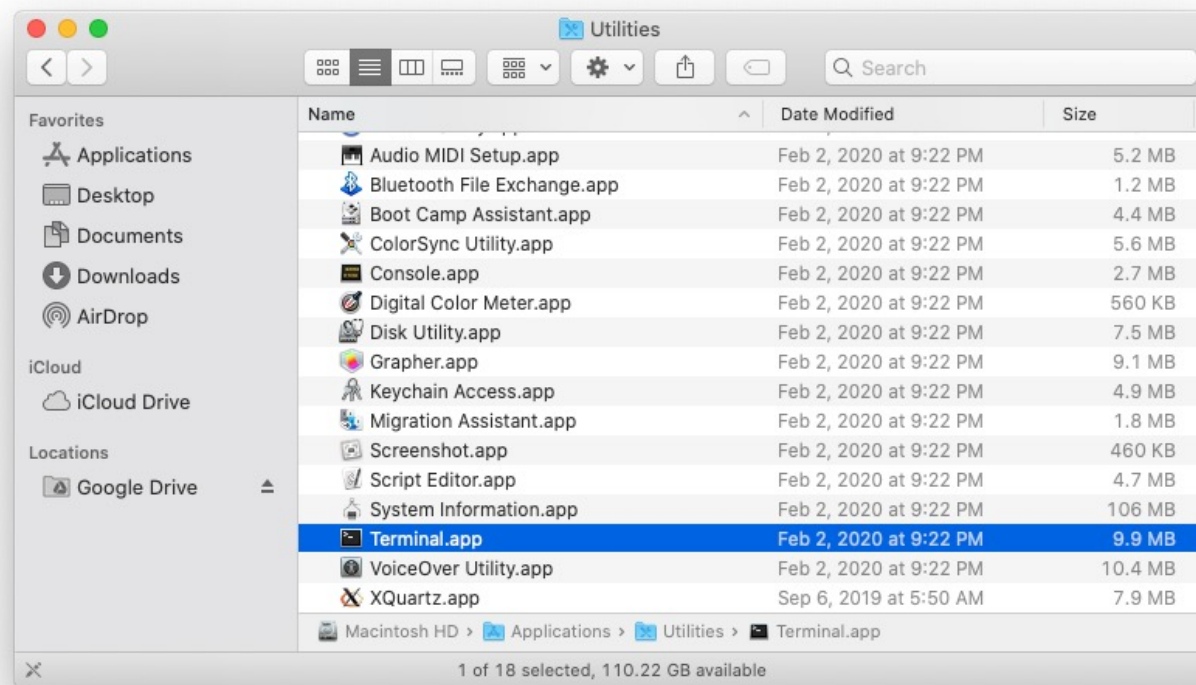
SSH: Secure Shell

- Invented by Tatu Ylönen in 1995
 - SSH-1: initial version; not considered to be safe any more
 - SSH-2: current version
 - Supports many encryption methods, including Advanced Encryption Standard (AES) and Blowfish
 - As yet, no known exploitable vulnerabilities in SSH-2
- We will use SSH to connect to one of the departmental Linux servers for labs



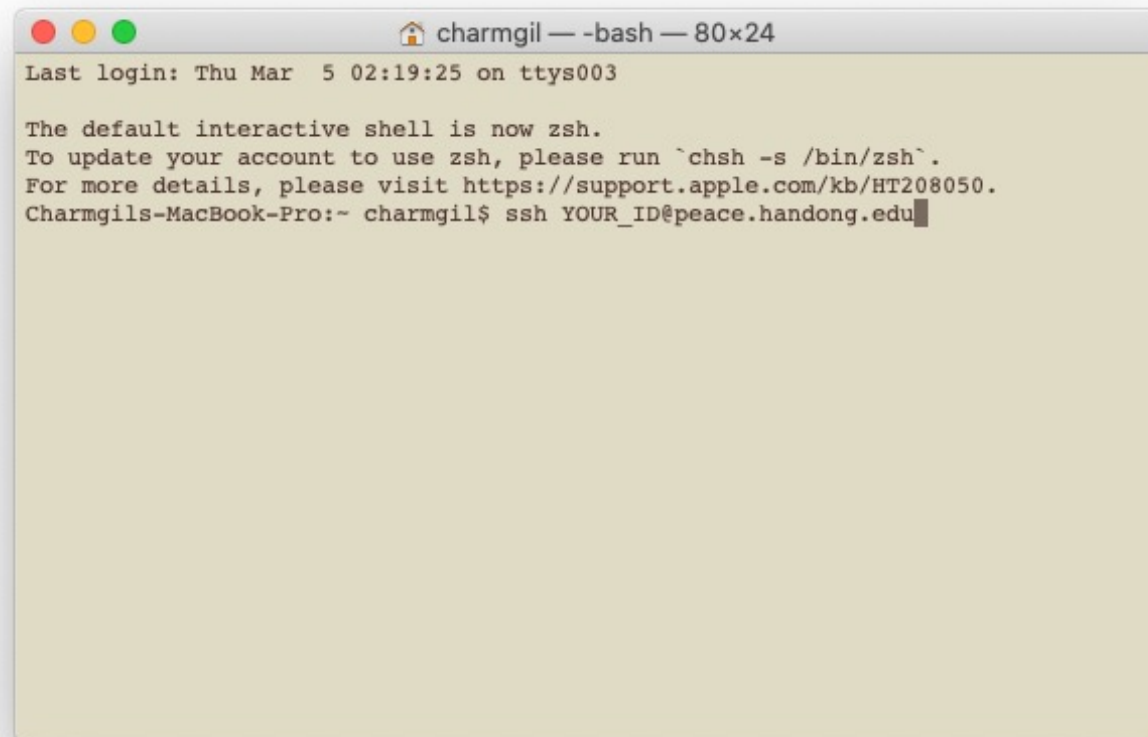
Connecting to peace.handong.edu (Mac)

- Mac has a built-in Terminal program
 - Run *Terminal* in *Applications > Utilities*



Connecting to peace.handong.edu (Mac)

- Type: `ssh YOUR_ID@peace.handong.edu` and press enter
 - YOUR_ID should be your account on the peace server
 - One account per student will be issued



```
charmgil — -bash — 80x24
Last login: Thu Mar  5 02:19:25 on ttys003

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
Charmgils-MacBook-Pro:~ charmgil$ ssh YOUR_ID@peace.handong.edu
```

Connecting to peace.handong.edu (Mac)

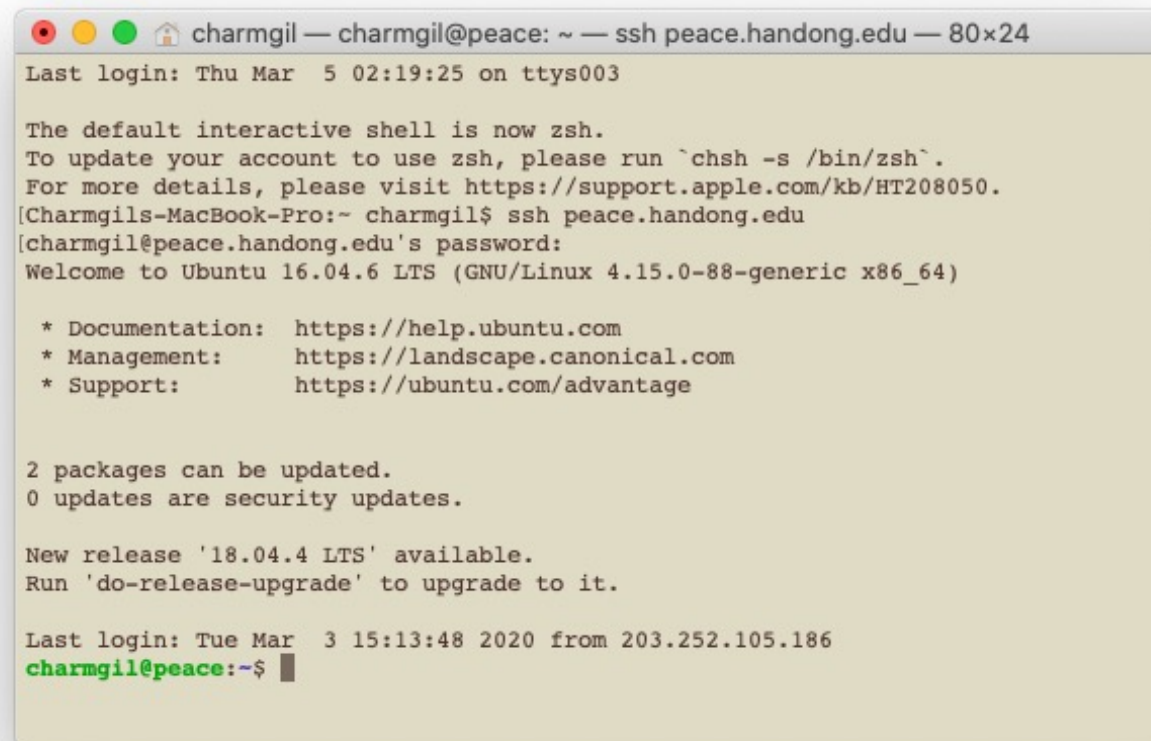
- Type: `ssh YOUR_ID@peace.handong.edu` and press enter
 - YOUR_ID should be your account on the *peace* server
 - One account per student will be issued before Friday, March 13
 - On the first connection to the *peace* server, you will see a message like below, notifying that you have not used this server before:

```
The authenticity of host 'sample.ssh.com' cannot be established.  
DSA key fingerprint is 01:23:45:67:89:ab:cd:ef:ff:fe:dc:ba:98:76:54:32:10.  
Are you sure you want to continue connecting (yes/no)?
```

- Enter yes and continue
- When challenged, enter your password

Connecting to peace.handong.edu (Mac)

- You are in!
 - A prompt (YOUR_ID@peace:~\$) will be displayed on the terminal
 - When you want to close, enter exit
 - Pressing *Control+d* does the same (sending an EOF character)

A screenshot of a macOS terminal window titled 'charmgil — charmgil@peace: ~ — ssh peace.handong.edu — 80x24'. The terminal shows the output of an SSH session. It starts with 'Last login: Thu Mar 5 02:19:25 on ttys003'. Then it says 'The default interactive shell is now zsh. To update your account to use zsh, please run `chsh -s /bin/zsh`. For more details, please visit https://support.apple.com/kb/HT208050.' This is followed by a prompt change from '[Charmgils-MacBook-Pro:~ charmgil\$]' to '[charmgil@peace.handong.edu's password:]'. After password entry, it says 'Welcome to Ubuntu 16.04.6 LTS (GNU/Linux 4.15.0-88-generic x86_64)'. Then it lists links for documentation, management, and support. Next, it reports '2 packages can be updated. 0 updates are security updates.' and 'New release '18.04.4 LTS' available. Run 'do-release-upgrade' to upgrade to it.' Finally, it shows 'Last login: Tue Mar 3 15:13:48 2020 from 203.252.105.186' and the prompt 'charmgil@peace:~\$' with a cursor.

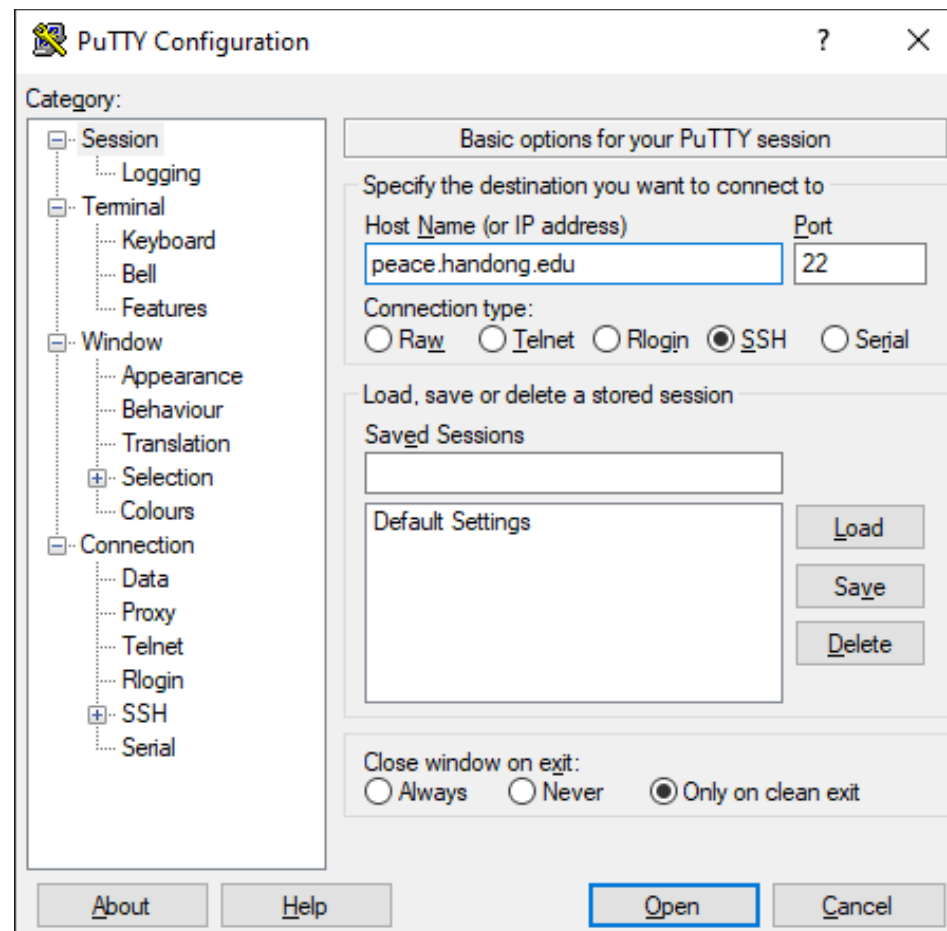
Connecting to peace.handoang.edu (Windows)

- There are multiple ssh client programs
 - *PuTTY*
 - *mobaXterm*
 - *SmarTTY*
 - *Terminus*
 - *mRemoteNG*
- PuTTY is perhaps the simplest ssh client
 - Download link: <https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>
 - Download 64-bit MSI



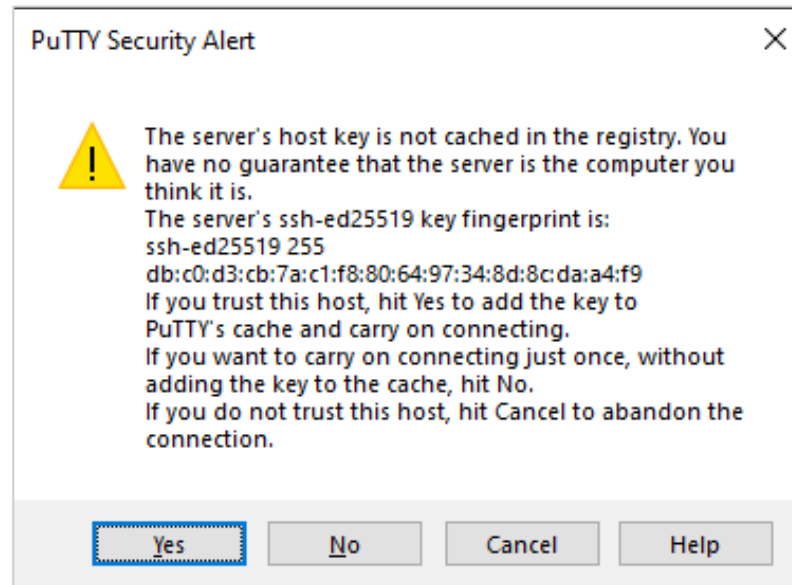
Connecting to peace.handoang.edu (Windows)

- Open *putty.exe* and enter *peace.handong.edu* under the Host Name



Connecting to peace.handoang.edu (Windows)

- Open *putty.exe* and enter *peace.handong.edu* under the Host Name
 - On the first connection to the *peace* server, you will see a dialogbox like below, notifying that you have not used this server before
 - Press Yes



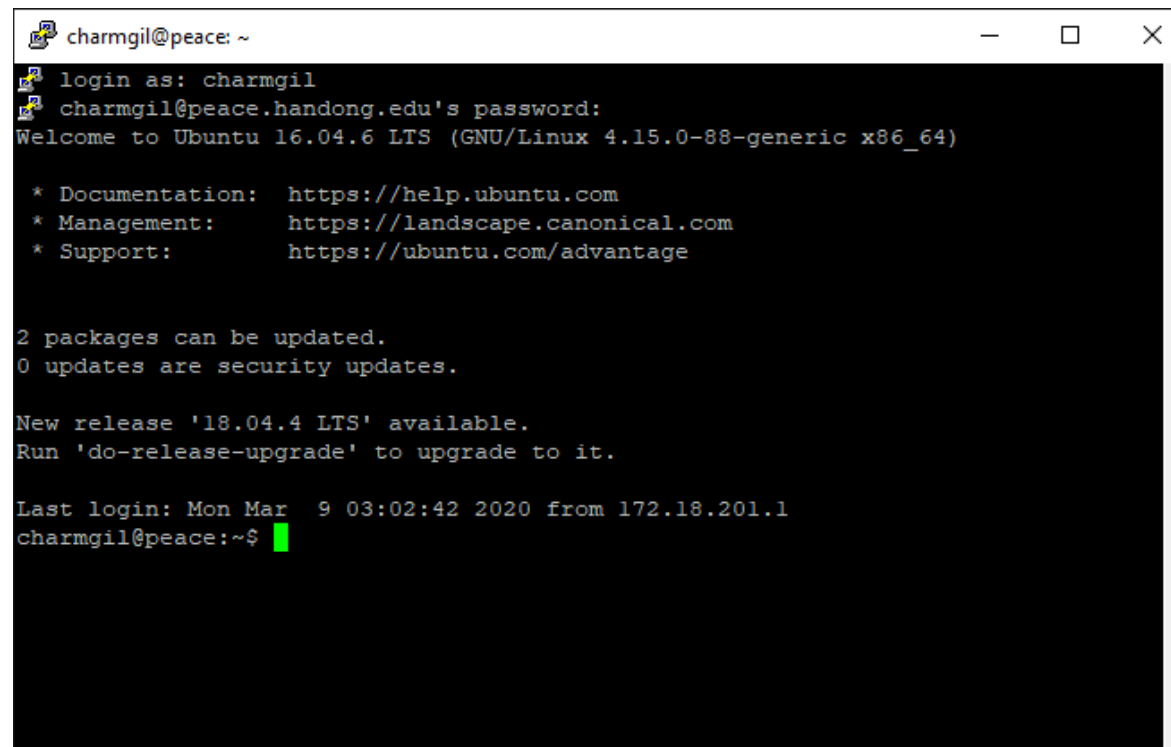
Connecting to peace.handong.edu (Windows)

- Enter your login credential



Connecting to peace.handong.edu (Windows)

- You are in!
 - A prompt (YOUR_ID@peace:~\$) will be displayed on the terminal
 - When you want to close, enter exit
 - Pressing *Control+d* does the same (sending an EOF character)



```
charmgil@peace: ~
login as: charmgil
charmgil@peace.handong.edu's password:
Welcome to Ubuntu 16.04.6 LTS (GNU/Linux 4.15.0-88-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

2 packages can be updated.
0 updates are security updates.

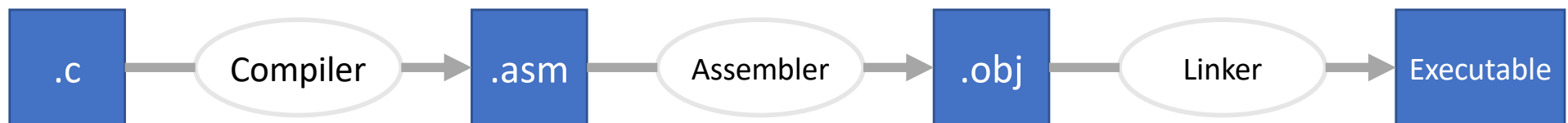
New release '18.04.4 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

Last login: Mon Mar  9 03:02:42 2020 from 172.18.201.1
charmgil@peace:~$
```


Linux and C Programming Language

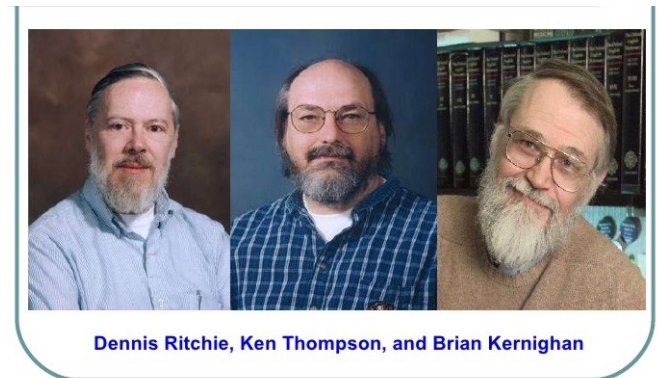
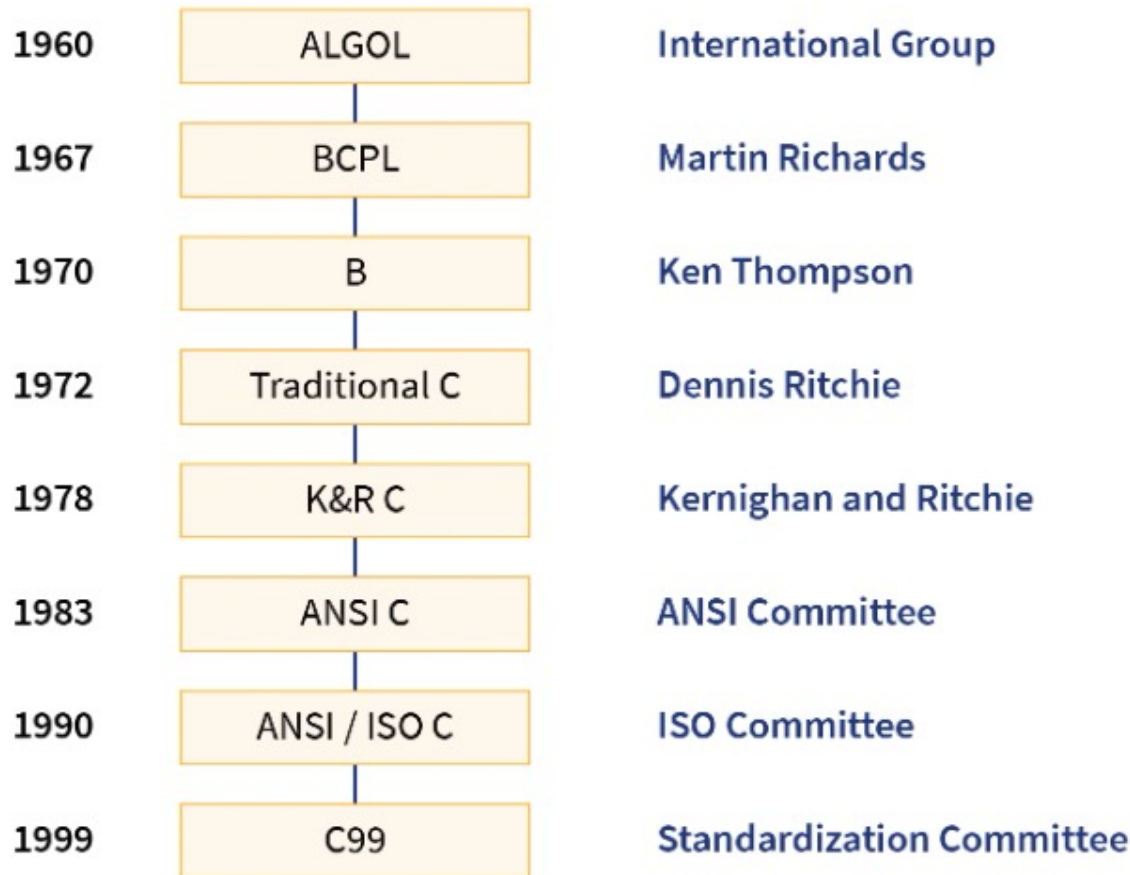
- UNIX started with the C programming language
 - *“The C programming language was devised in the early 1970s as a system implementation language for the nascent Unix operating system”*
 - Originally, Ken Thompson desired to make a programming language for the new Unix platform
 - Thompson modified the BCPL system language and created B
 - Not many utilities were ever written in B due to its slow nature
 - This led to Ritchie improving on B, and thus creating C

C was originally user was invented as an assembly replacement



Linux and C Programming Language

- The C programming language and its ancestors



Corollary

- Fibonacci in C

```
#include <stdio.h>

int main(void) {
    int x, y, z;

    while (1) {
        x = 0;
        y = 1;
        do {
            printf("$d\n", x);

            z = x + y;
            x = y;
            y = z;
        } while (x < 255);
    }
}
```

```
% gcc fib.c -o fib
% ./fib
0
1
1
2
3
5
8
13
21
34
55
89
144
233
0
1
1
2
3
5
8
13
21
34
55
89
144
233
```

Corollary

- C to assembly

```
#include <stdio.h>

int main(void) {
    int x, y, z;

    while (1) {
        x = 0;
        y = 1;
        do {
            printf("$d\n", x);

            z = x + y;
            x = y;
            y = z;
        } while (x < 255);
    }
}
```

```
% gcc fib.c -o fib
% otool -tv fib
Fib:
(__TEXT,__text) section
_main:
00000000100000f20 pushq    %rbp
00000000100000f21 movq    %rsp, %rbp
00000000100000f24 subq    $0x20, %rsp
00000000100000f28 movl    $0x0, -0x4(%rbp)
00000000100000f2f movl    $0x0, -0x8(%rbp)
00000000100000f36 movl    $0x1, -0xc(%rbp)
00000000100000f3d leaq    0x56(%rip), %rdi
00000000100000f44 movl    -0x8(%rbp), %esi
00000000100000f47 movb    $0x0, %al
00000000100000f49 callq   0x100000f78
00000000100000f4e movl    -0x8(%rbp), %esi
00000000100000f51 addl    -0xc(%rbp), %esi
00000000100000f54 movl    %esi, -0x10(%rbp)
00000000100000f57 movl    -0xc(%rbp), %esi
00000000100000f5a movl    %esi, -0x8(%rbp)
00000000100000f5d movl    -0x10(%rbp), %esi
00000000100000f60 movl    %esi, -0xc(%rbp)
00000000100000f63 movl    %eax, -0x14(%rbp)
00000000100000f66 cmpl    $0xff, -0x8(%rbp)
00000000100000f6d jl     0x100000f3d
00000000100000f73 jmp     0x100000f2f
```

- Asm to machine code

```
0x0: ldi    0x1
0x1: sta    [0xe]
0x2: ldi    0x0
0x3: out
0x4: add    [0xe]
0x5: sta    [0xf]
0x6: lda    [0xe]
0x7: sta    [0xd]
0x8: lda    [0xf]
0x9: sta    [0xe]
0xa: lda    [0xd]
0xb: jc     0x0
0xc: jmp     0x3
0xd:
0xe:
0xf:
```

```
0000: 0111 0001
0001: 0100 1110
0010: 0111 0000
0011: 0101 0000
0100: 0010 1110
0101: 0100 1111
0110: 0001 1110
0111: 0100 1101
1000: 0001 1111
1001: 0100 1110
1010: 0001 1101
1011: 1000 0000
1100: 0110 0011
```

References

- St. Laurent, Andrew M. (2008). *Understanding Open Source and Free Software Licensing*. O'Reilly Media. p. 4.
- Rouse, Margaret. Secure Shell (SSH). URL: <https://searchsecurity.techtarget.com/definition/Secure-Shell>
- Ben Eater. Comparing C to machine language. URL: <https://www.youtube.com/watch?v=yOyaJXpAYZQ>