



Chapter 10

Linux

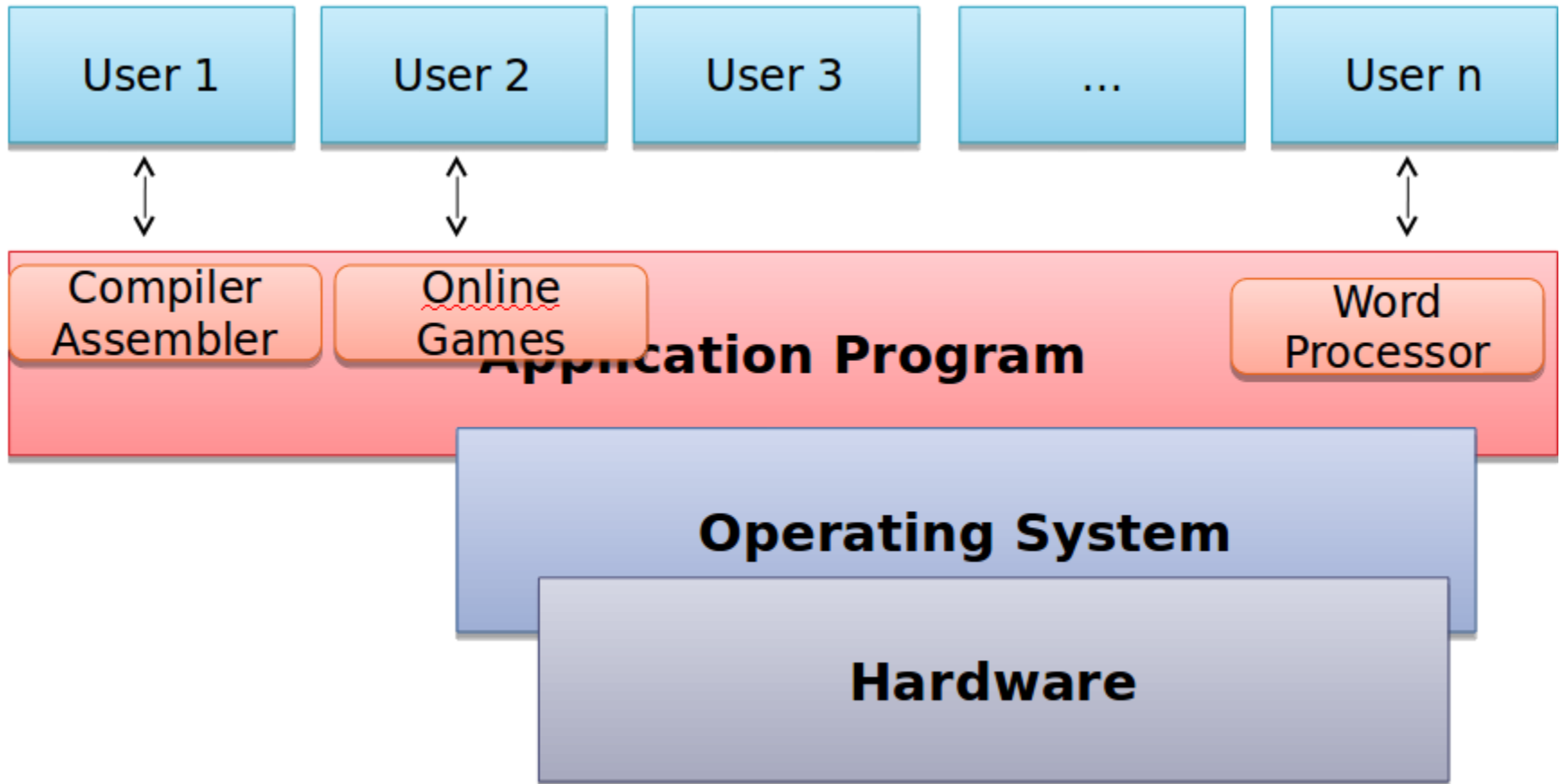
Open Source SW Development
CSE22300



Operating System

- An operating system is the software that **provides the interface between the hardware of a computer system and the applications** programs that are used on it.

Operating System



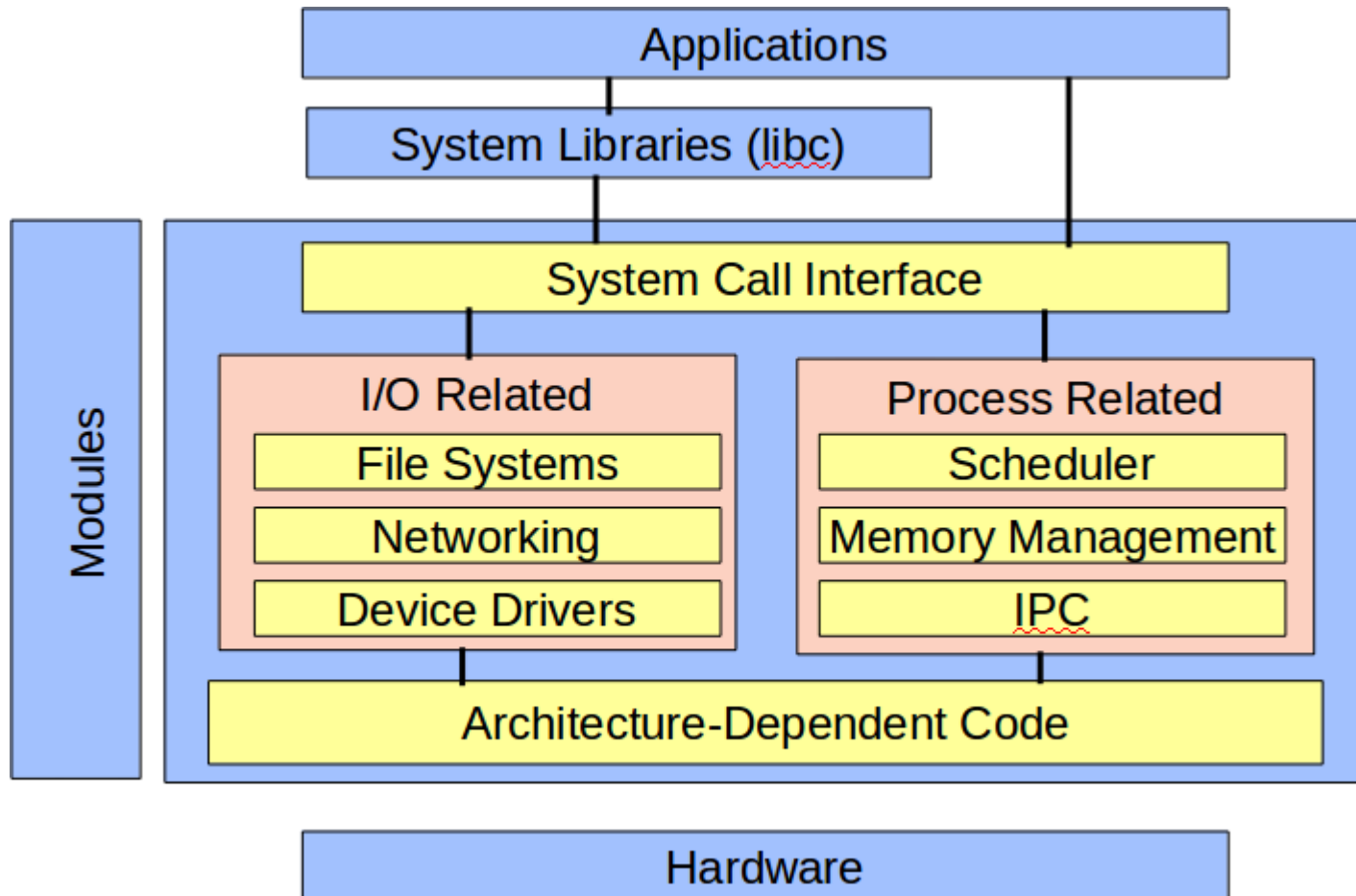
Kernel

- **System monitor.**
- **Controls and mediates access to hardware**
- **Implements and supports fundamental abstractions**
 - Processes, files, devices etc
- **Schedules / allocates system resources**
 - Memory, CPU, disk, descriptors, etc
- **Enforces security and protection**
- **Responds to user requests for service**
 - system calls

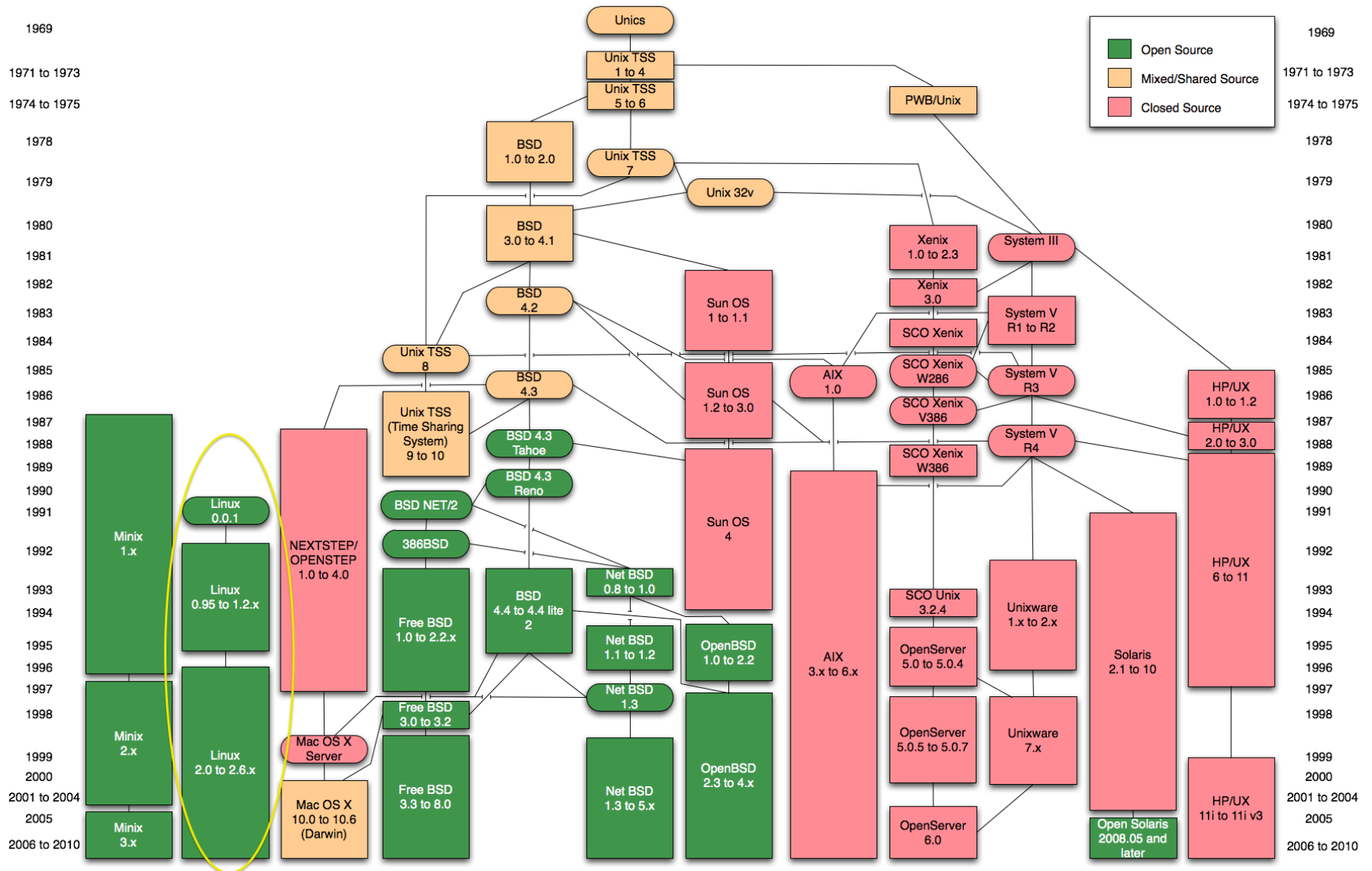
Kernel Design Goal

- **Performance: efficiency, speed.**
 - Utilize resources to capacity with low overhead.
- **Stability: robustness, resilience.**
 - Uptime, graceful degradation.
- **Capability: features, flexibility, compatibility.**
- **Security, protection.**
 - Protect users from each other & system from bad users.
- **Portability.**
- **Extensibility.**

Kernel



UNIX/Linux History



UNIX and Linux

- **Are they the same?**
 - Yes, at least in terms of operating system interfaces
 - Linux was developed independently from Unix
 - Unix is much older (1969 vs. 1991)
- **Scalability and reliability**
 - Both scale very well and work well under heavy load
- **Flexibility**
 - Both emphasize small, interchangeable components
- **Manageability**
 - Remote logins rather than GUI
 - Scripting is integral
- **Security**
 - Due to modular design has a reasonable security model
 - Linux and its applications are not without blame

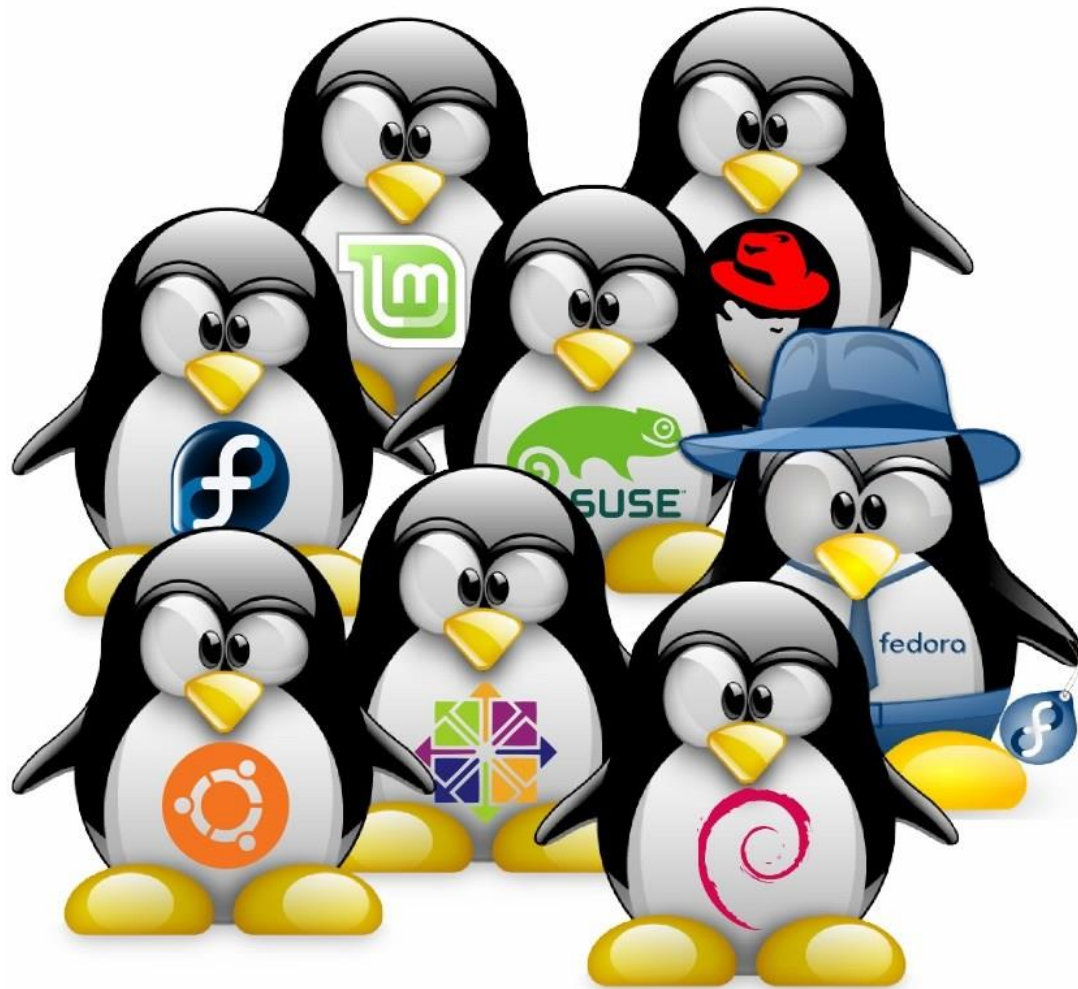
Why Linux?

- **It's free!**
- **Open Source (modifiability, extensibility, ...)**
- **Works on several platforms**
- **Robustness (after several revisions, and several people working on it)**
- **Widespread Usage**
- **Compatibility with several other platforms.**

Linux Features

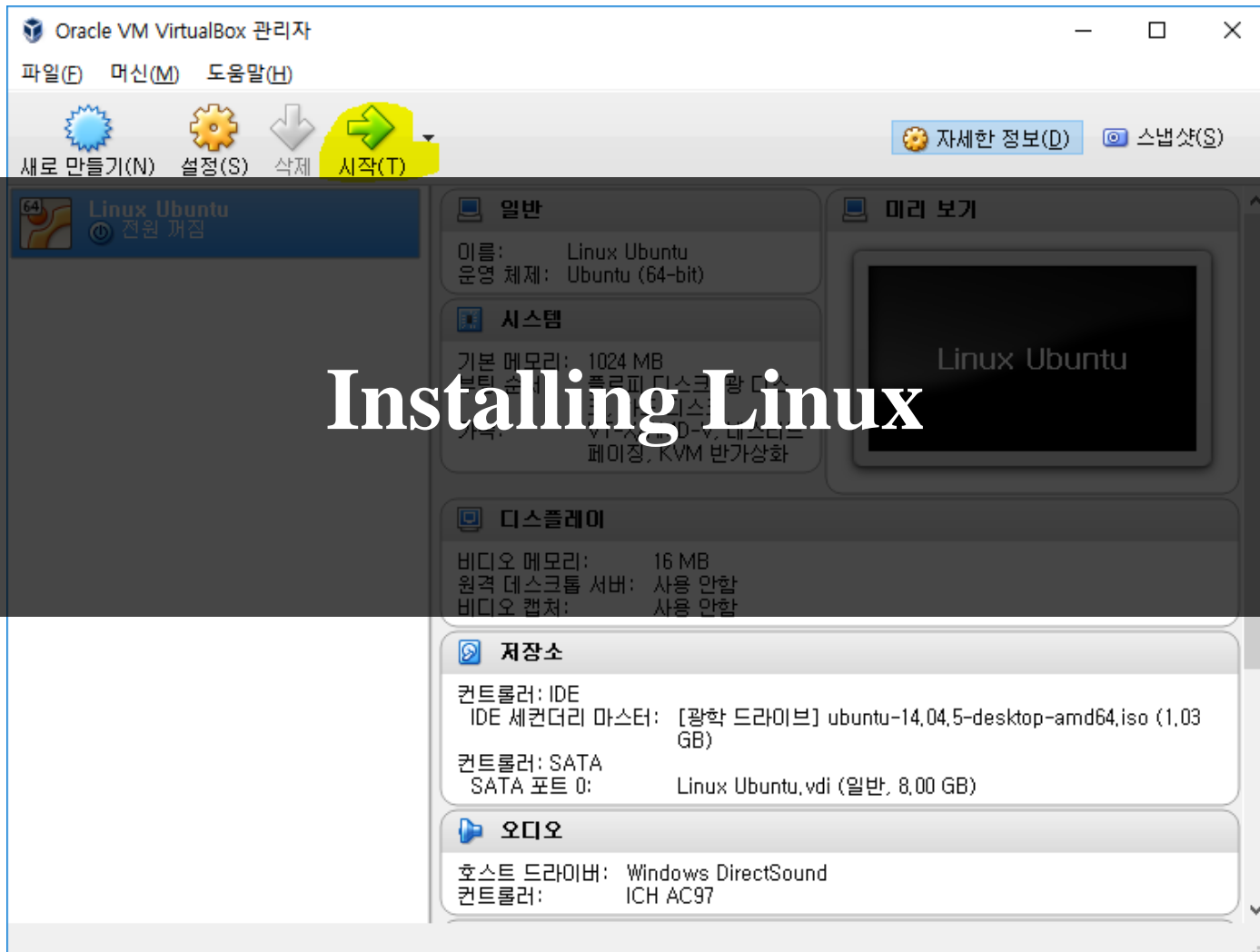
- **Monolithic kernel (but well-defined interfaces)**
- **Multi-tasking**
- **Multi-user capability**
- **Multi-processing Support**
- **Architecture Independence (PCs, Alpha, Sparc,...)**
- **Demand loaded executables (on fork, shared address space, and copy-on-write)**
- **4K Pages, demand-paging with memory protection**
- **Dynamic size for disk cache**
- **Shared Libraries (dll)**
- **Support for Posix standard**
- **Several Executables formats**
- **Several File Systems**
- **Several network protocols**

Linux Distribution

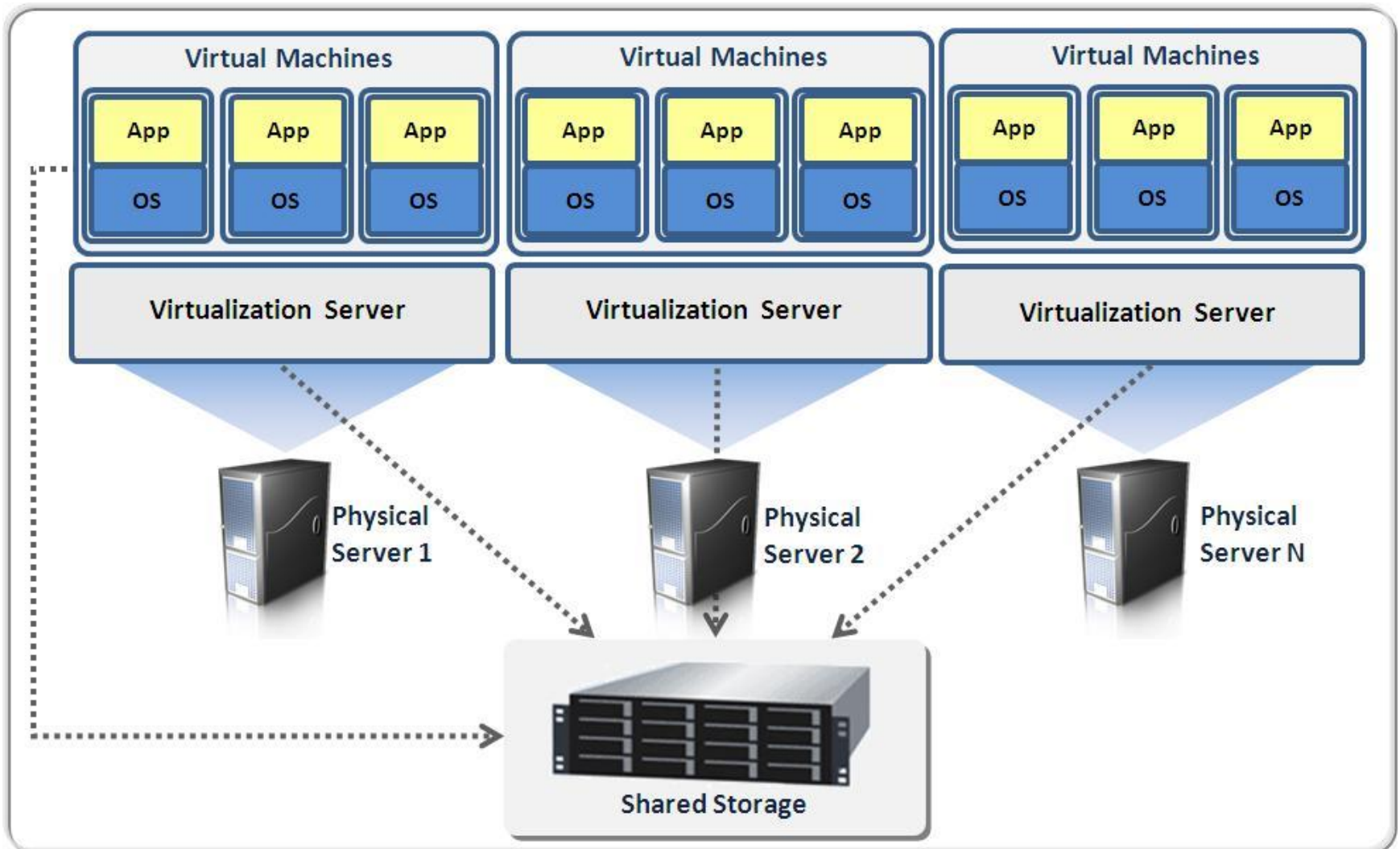


Linux Distribution

- **Red Hat**
 - One of the earliest players in the game, Red Hat now position itself strongly in the business market. It has created a community-supported distribution, Fedora Core, which is the choice of many for desktop use.
- **Debian**
 - The most popular community-created distribution. Debian is an excellent choice for server environments. Debian has also been used as the base for many specialist distributions.
- **Ubuntu**
 - Desktop usability, out of the box. Taglined "Linux for human beings," Based on Debian.
- **SUSE**
 - Novell's answer to Red Hat, comes in "enterprise" and a community-based OpenSUSE
- **All Distributions have their respective strengths.**



Virtualization



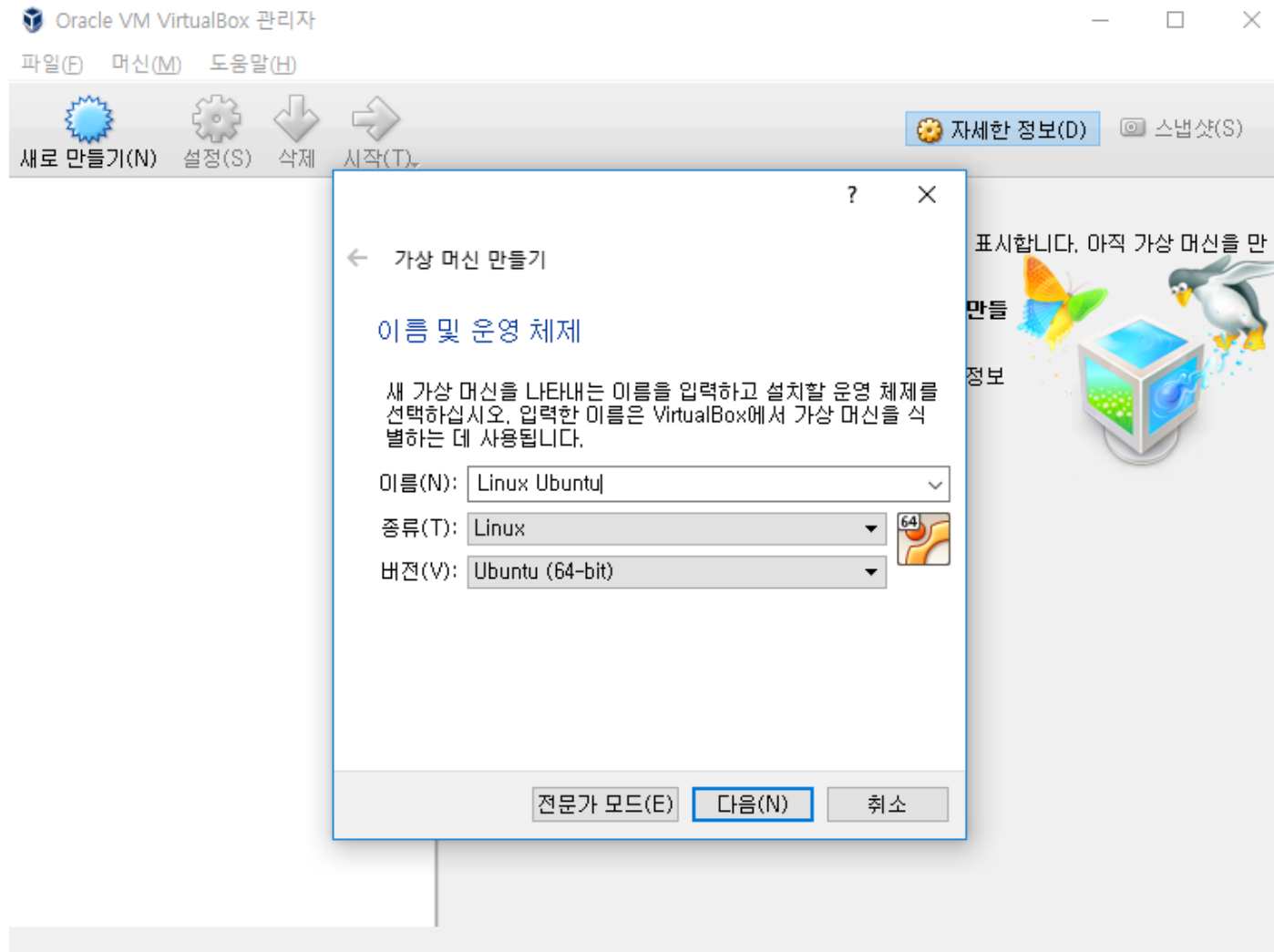
Installing Virtualbox

- Oracle VM VirtualBox
 - a free and open-source hypervisor for x86 computers
 - Supported Platform : Linux, OS X, Windows, Solaris, and OpenSolaris
- Creation and management of guest virtual machines
 - Windows, Linux, BSD, OS/2, Solaris, Haiku, OSx86 and others
- Download
 - <http://download.virtualbox.org/virtualbox/5.2.0/VirtualBox-5.2.0-118431-Win.exe>
 - Next, Next, Next...

Download Ubuntu Image

- Direct Download
 - <http://ftp.daumkakao.com/ubuntu-releases/16.04.3/ubuntu-16.04.3-desktop-amd64.iso>
 - <http://ftp.neowiz.com/ubuntu-releases/16.04.3/ubuntu-16.04.3-desktop-amd64.iso>

Create Virtual Machine



Create Virtual Machine

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← 가상 머신 만들기

메모리 크기

가상 머신에 할당할 메모리(RAM) 크기를 메가바이트 단위로 입력하십시오.

추천 메모리 크기는 **1024 MB**입니다.

1024 MB

4 MB

4096 MB

다음(N)

취소

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← 가상 머신 만들기

하드 디스크

필요하다면 새 가상 머신에 가상 하드 디스크를 추가할 수 있습니다. 새 하드 디스크 파일을 만들거나, 목록에서 선택하거나, 폴더 아이콘을 통하여 다른 위치에 있는 가상 하드 디스크 파일을 선택할 수 있습니다.

더 자세한 구성이 필요하다면 이 단계를 건너뛰고 가상 머신을 만든 다음 설정을 진행하십시오.

추천하는 하드 디스크 크기는 **8.00 GB**입니다.

☐ 가상 하드 디스크를 추가하지 않음(D)

☒ 지금 새 가상 하드 디스크 만들기(C)

☐ 기존 가상 하드 디스크 파일 사용(U)

비어 있음

만들기

취소

Create Virtual Machine

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← 가상 하드 디스크 만들기

하드 디스크 파일 종류

새 가상 하드 디스크 파일 형식을 선택하십시오. 다른 가상화 소프트웨어에서 디스크를 사용하지 않으려면 선택을 변경하지 않아도 됩니다.

☒ VDI (VirtualBox 디스크 이미지)
☐ VHD (가상 하드 디스크)
☐ VMDK (가상 머신 디스크)

전문가 모드(E) 다음(N) 취소

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← 가상 하드 디스크 만들기

물리적 하드 드라이브에 저장

새 가상 하드 디스크 파일을 사용하는 대로 커지게 할 것인지(동적 할당) 최대 크기로 만들 것인지(정적 할당) 선택하십시오.

동적 할당 하드 디스크 파일은 가상 디스크를 사용할 때 **고정된 최대 크기까지** 파일 크기가 커지지만, 사용량이 줄어들어도 자동적으로 작아지지 않습니다.

고정 크기 하드 디스크 파일은 만드는 데 더 오래 걸리지만 사용할 때 더 빠릅니다.

☒ 동적 할당(D)
☐ 고정 크기(E)

다음(N) 취소


Create Virtual Machine

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← 가상 하드 디스크 만들기

파일 위치 및 크기

새 가상 하드 디스크 파일의 이름을 아래 상자에 입력하거나 폴더 아이콘을 눌러서 파일을 생성할 폴더를 지정할 수 있습니다.

Linux Ubuntu 

새 가상 하드 디스크 크기를 메가바이트 단위로 입력하십시오. 가상 머신에서 가상 하드 드라이브에 저장할 수 있는 데이터의 최대 크기입니다.

4,00 MB2,00 TB

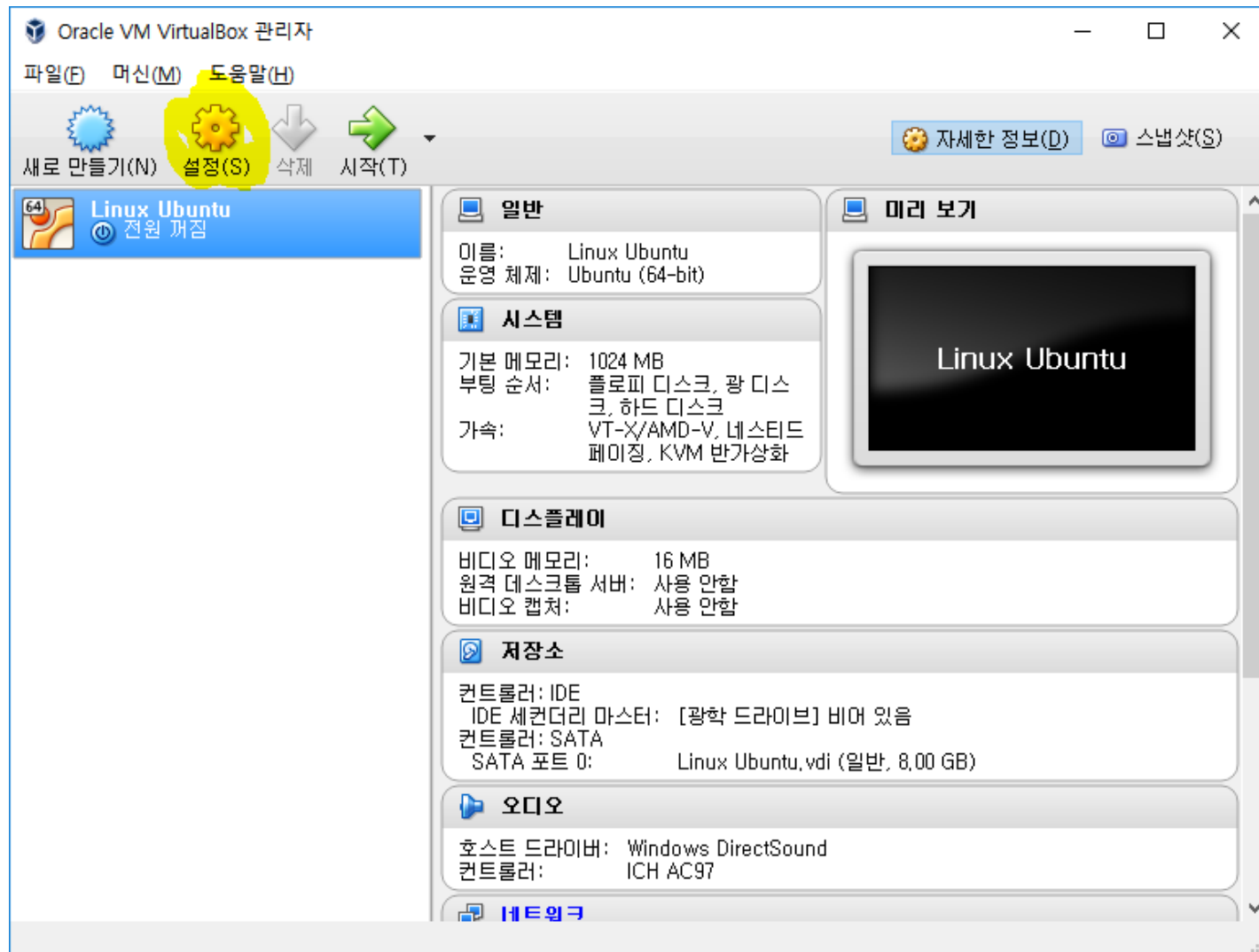
8,00 GB

만들기

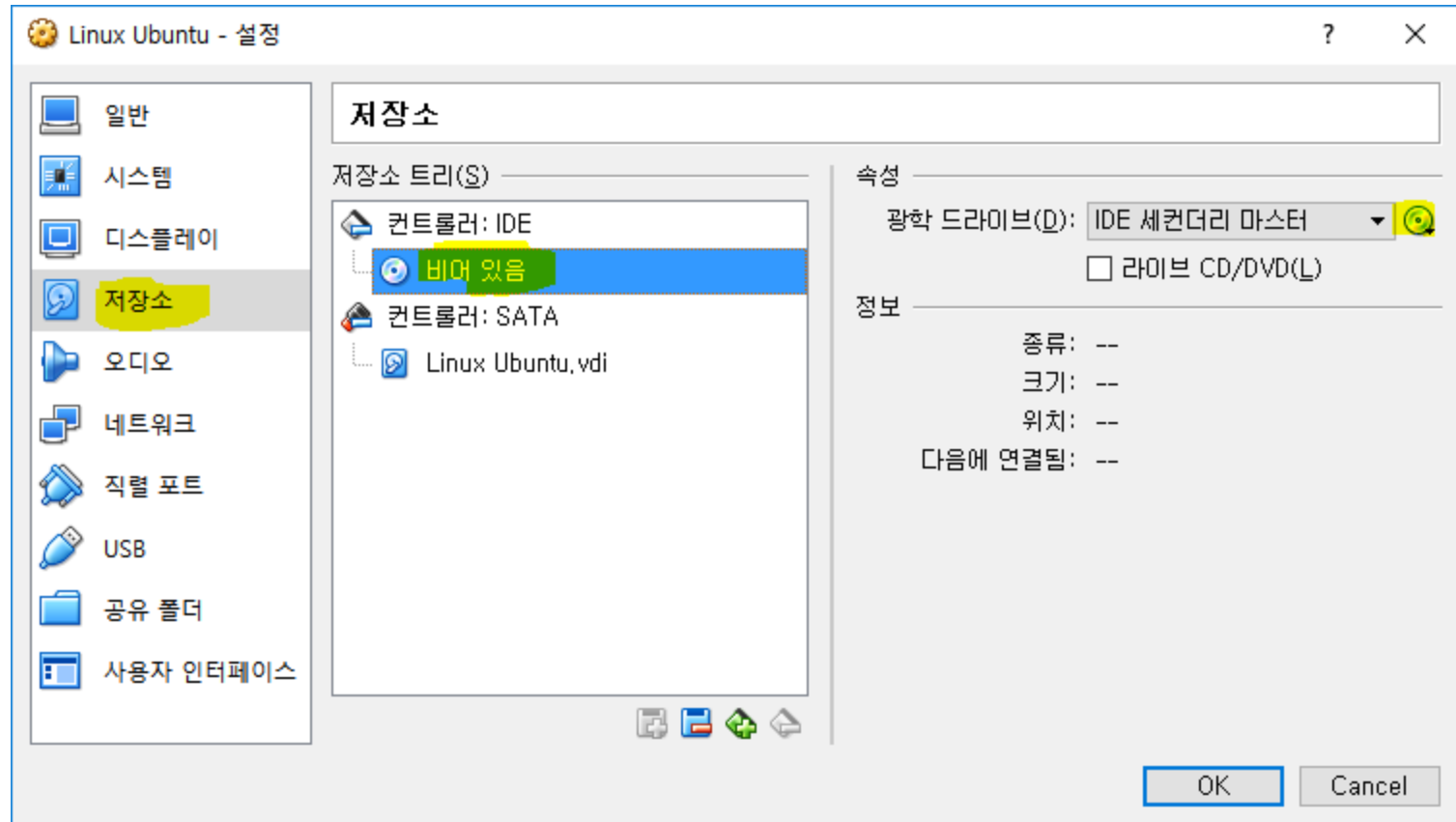
취소

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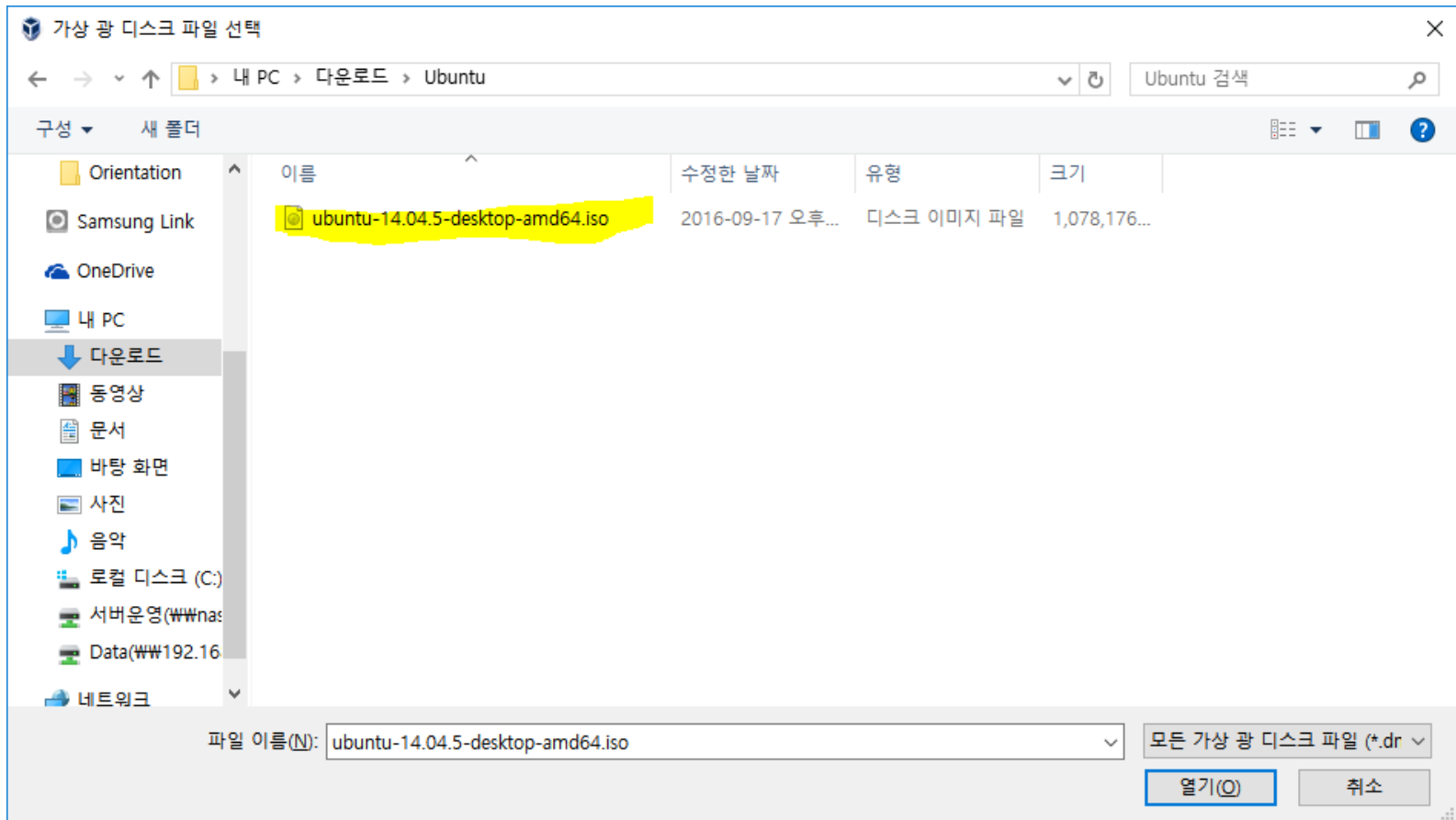
Create Virtual Machine



Create Virtual Machine



Create Virtual Machine



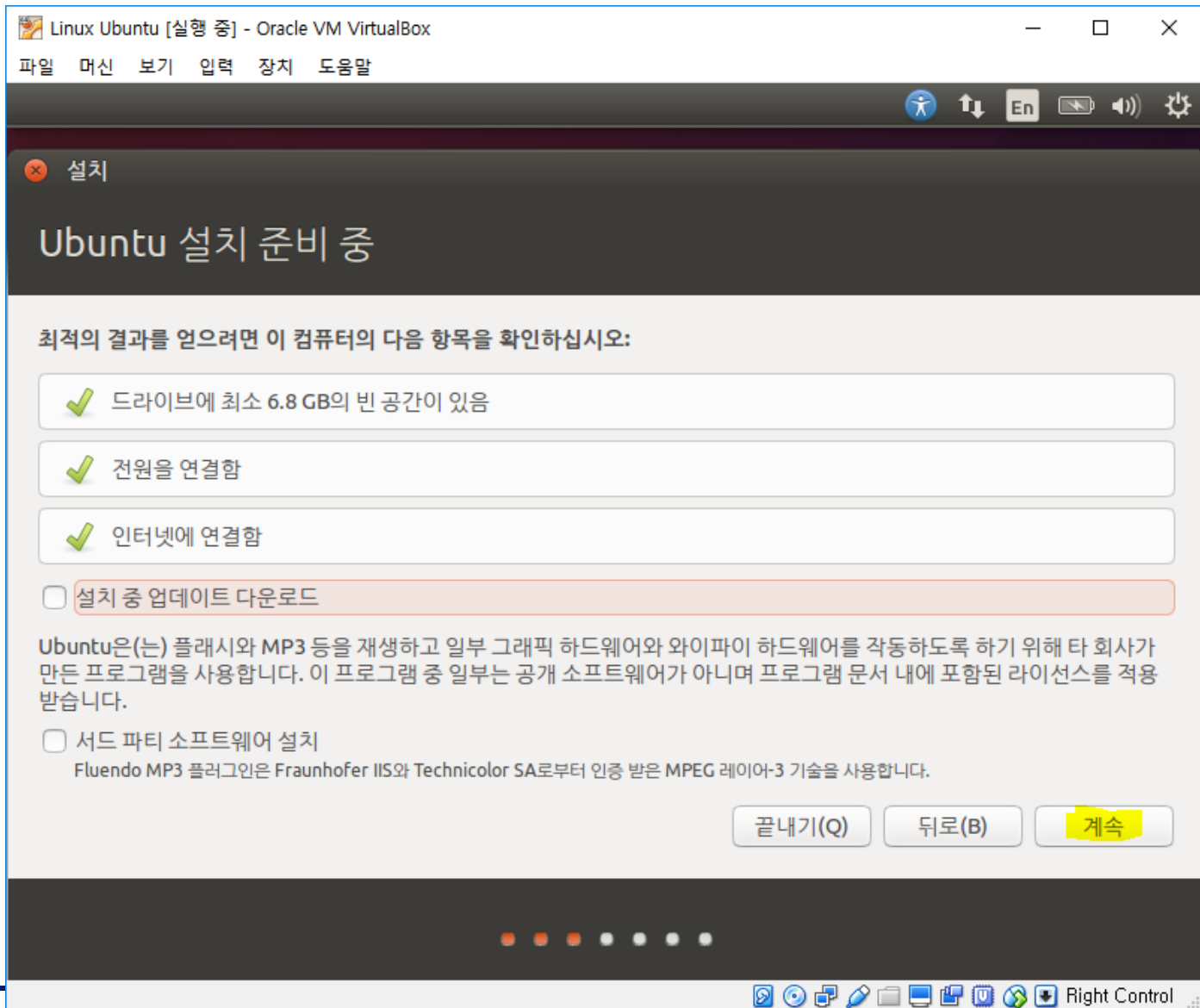
Create Virtual Machine



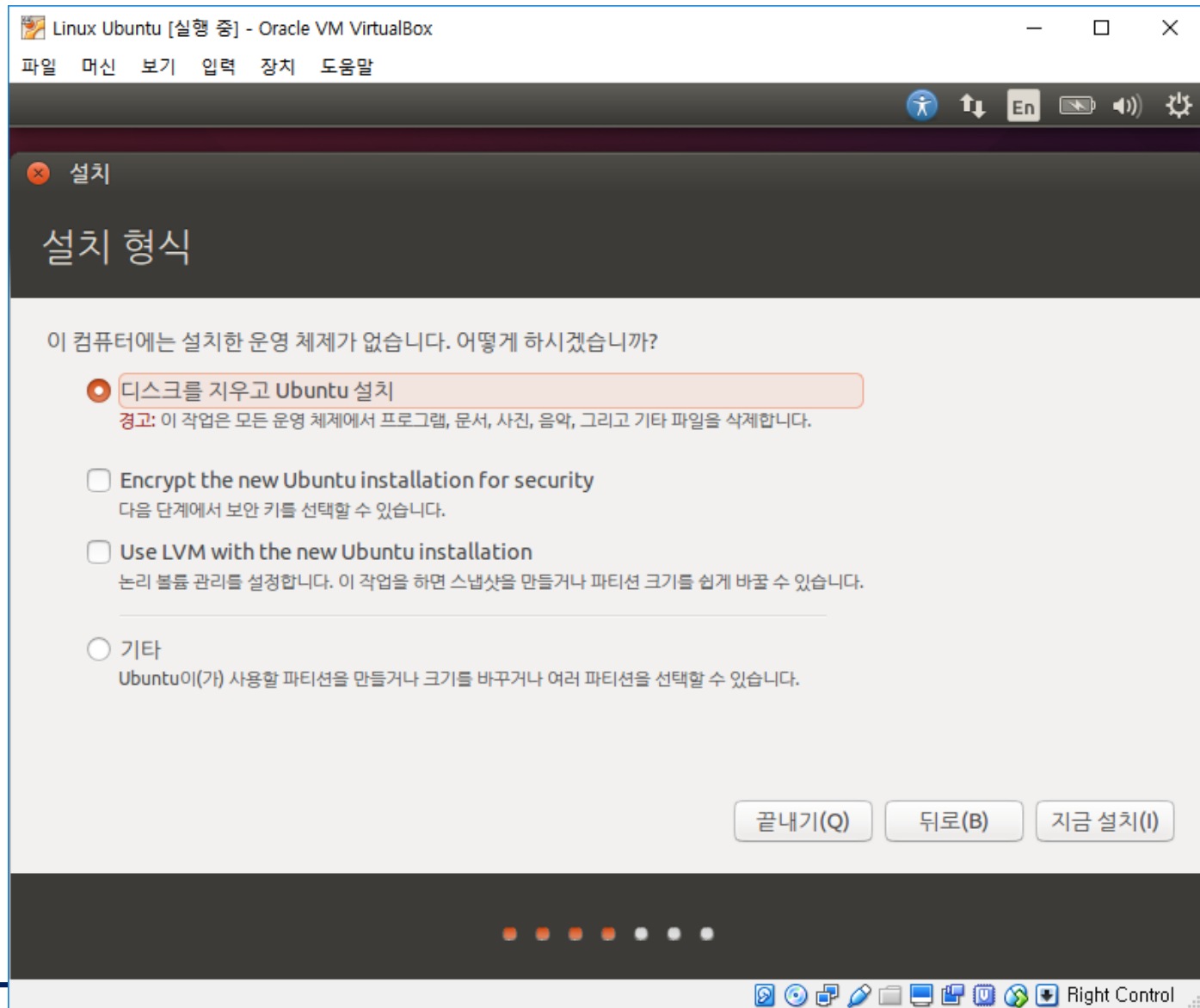
Installing Linux



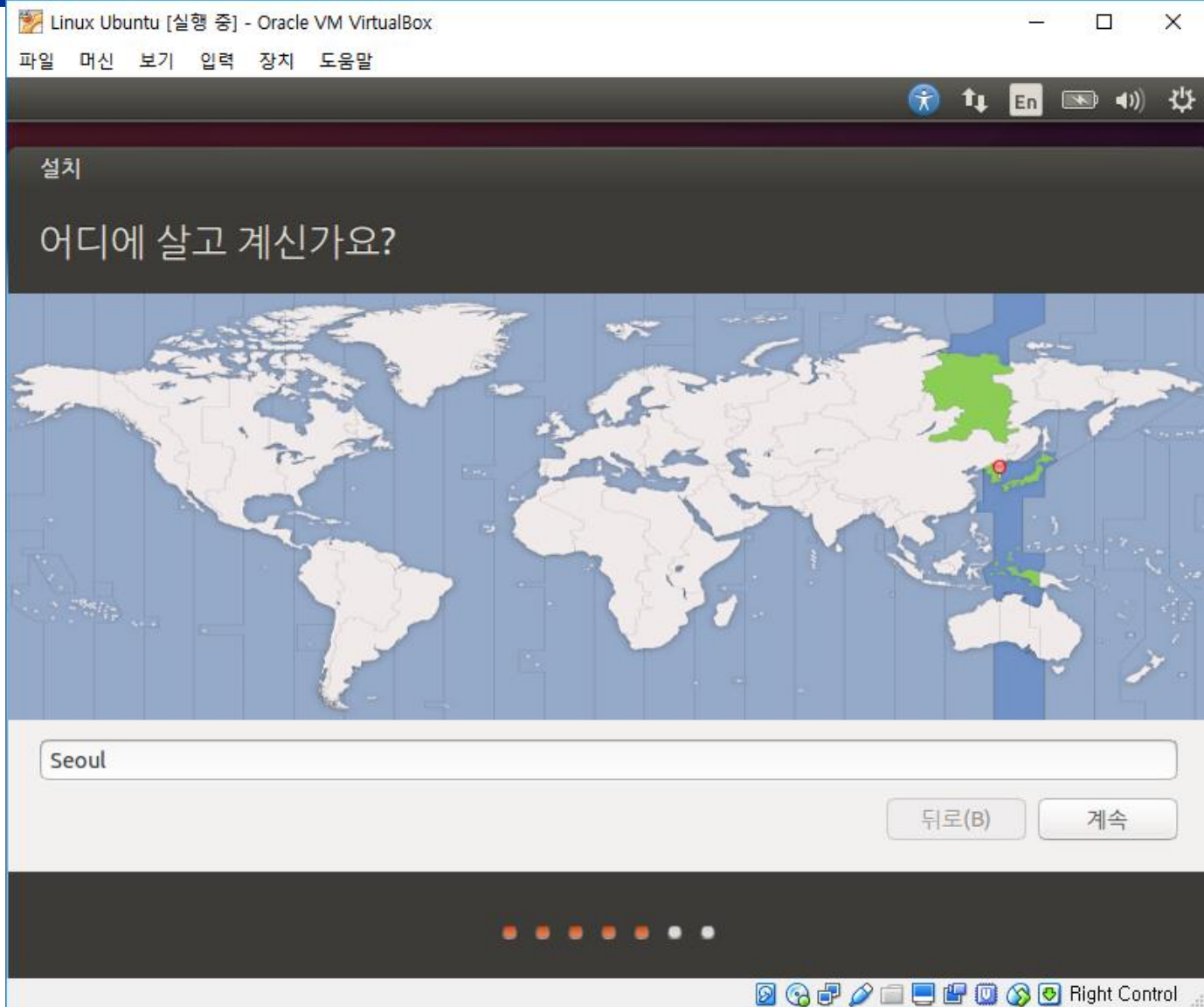
Installing Linux



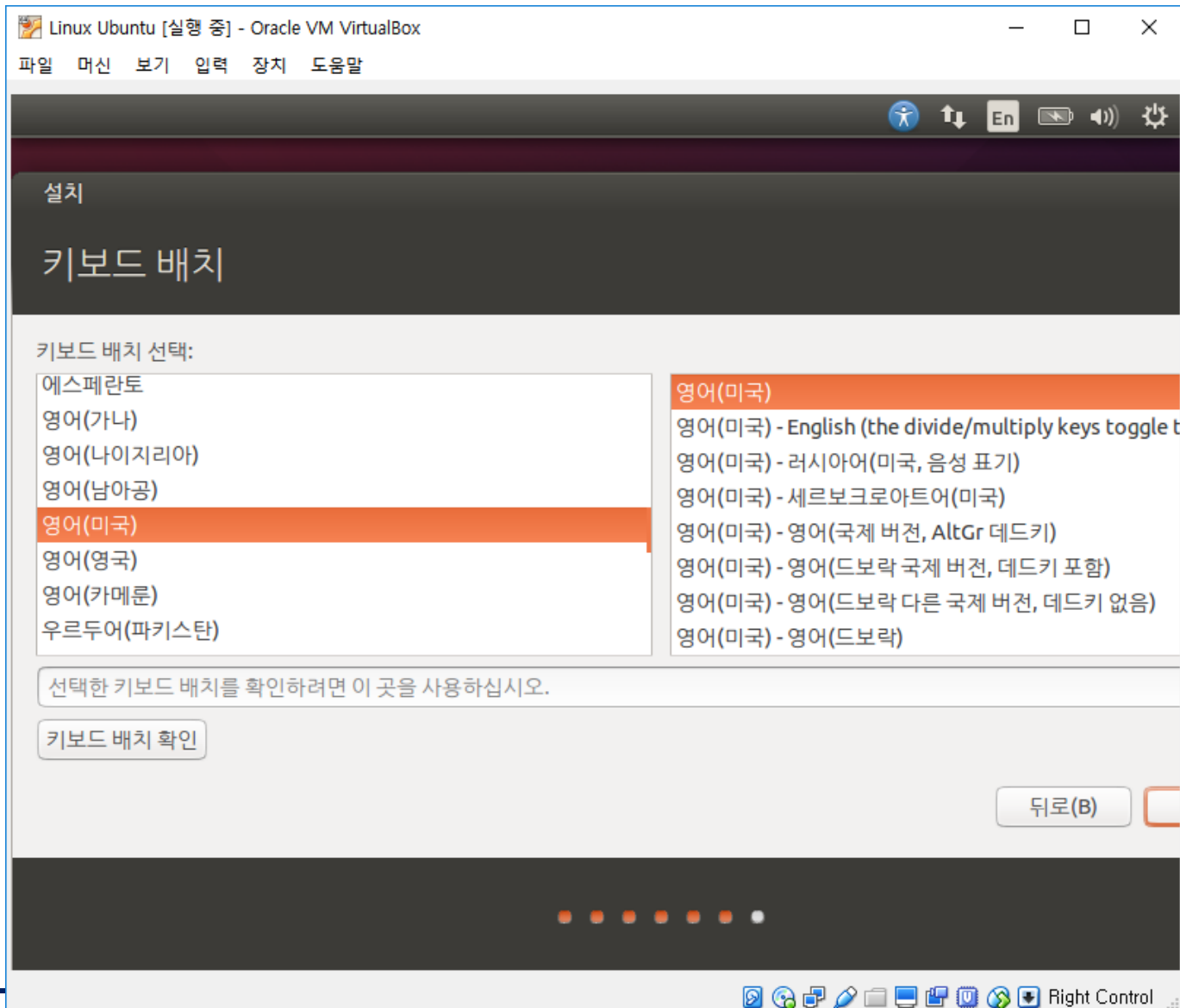
Installing Linux



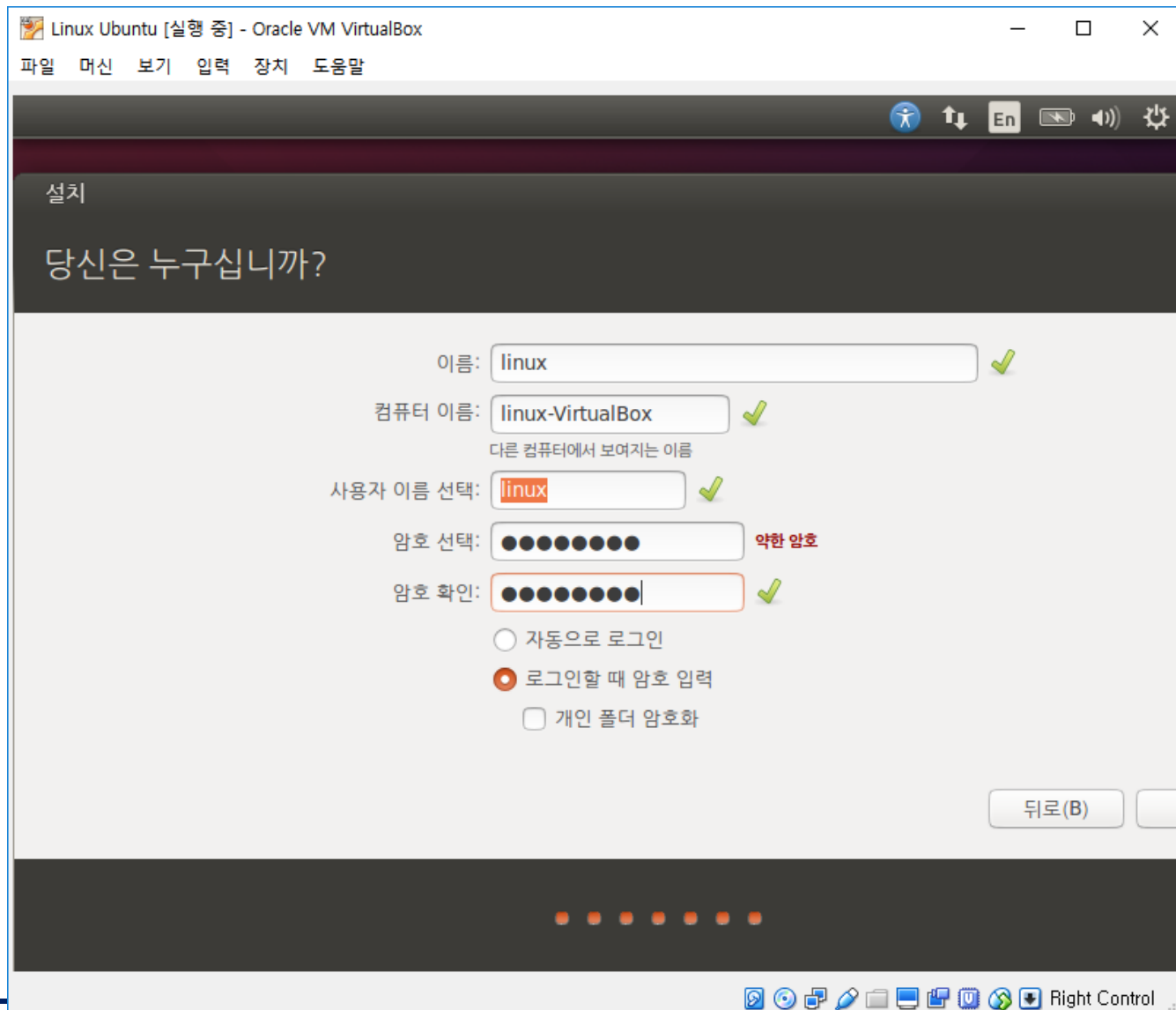
Installing Linux



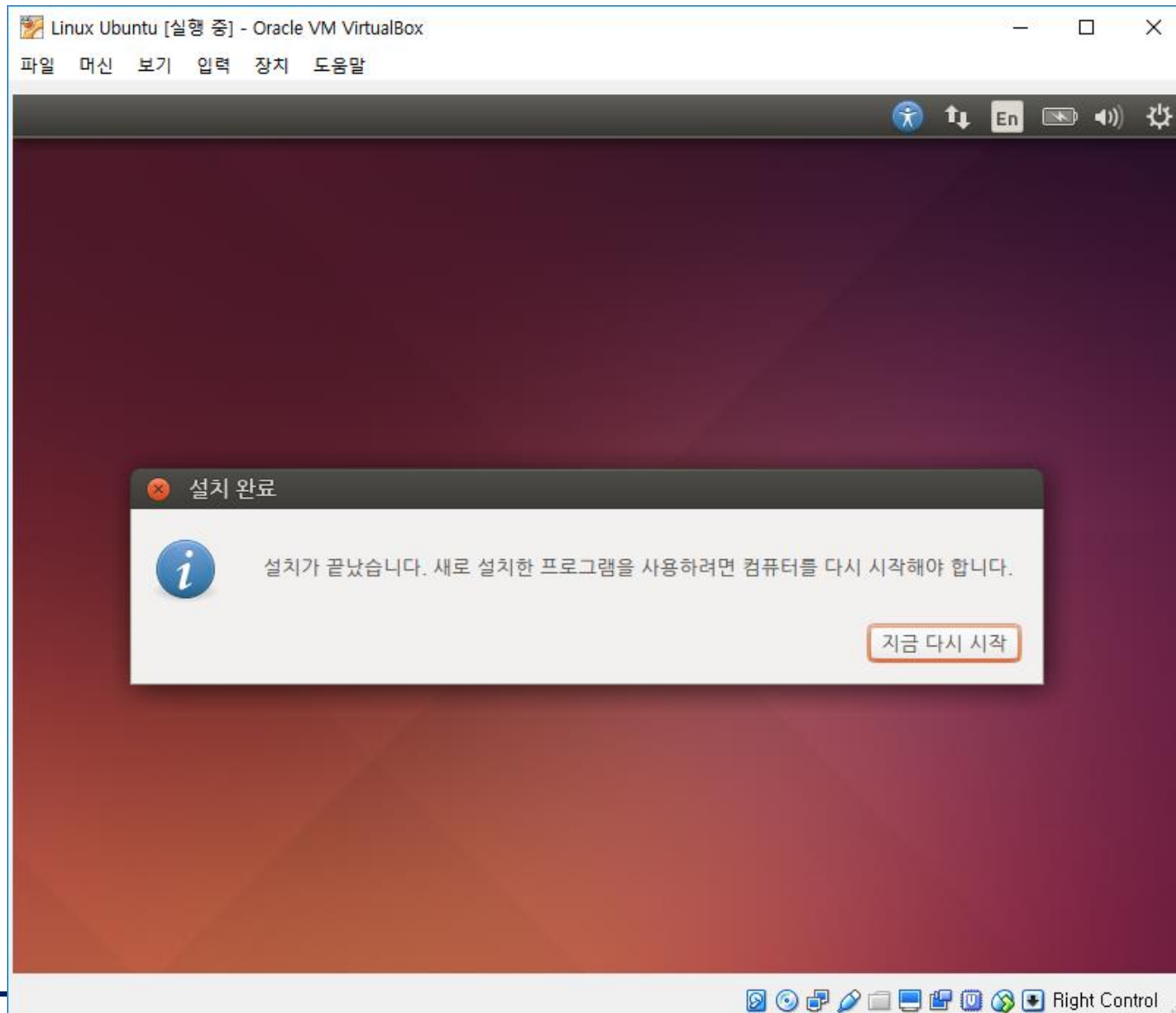
Installing Linux



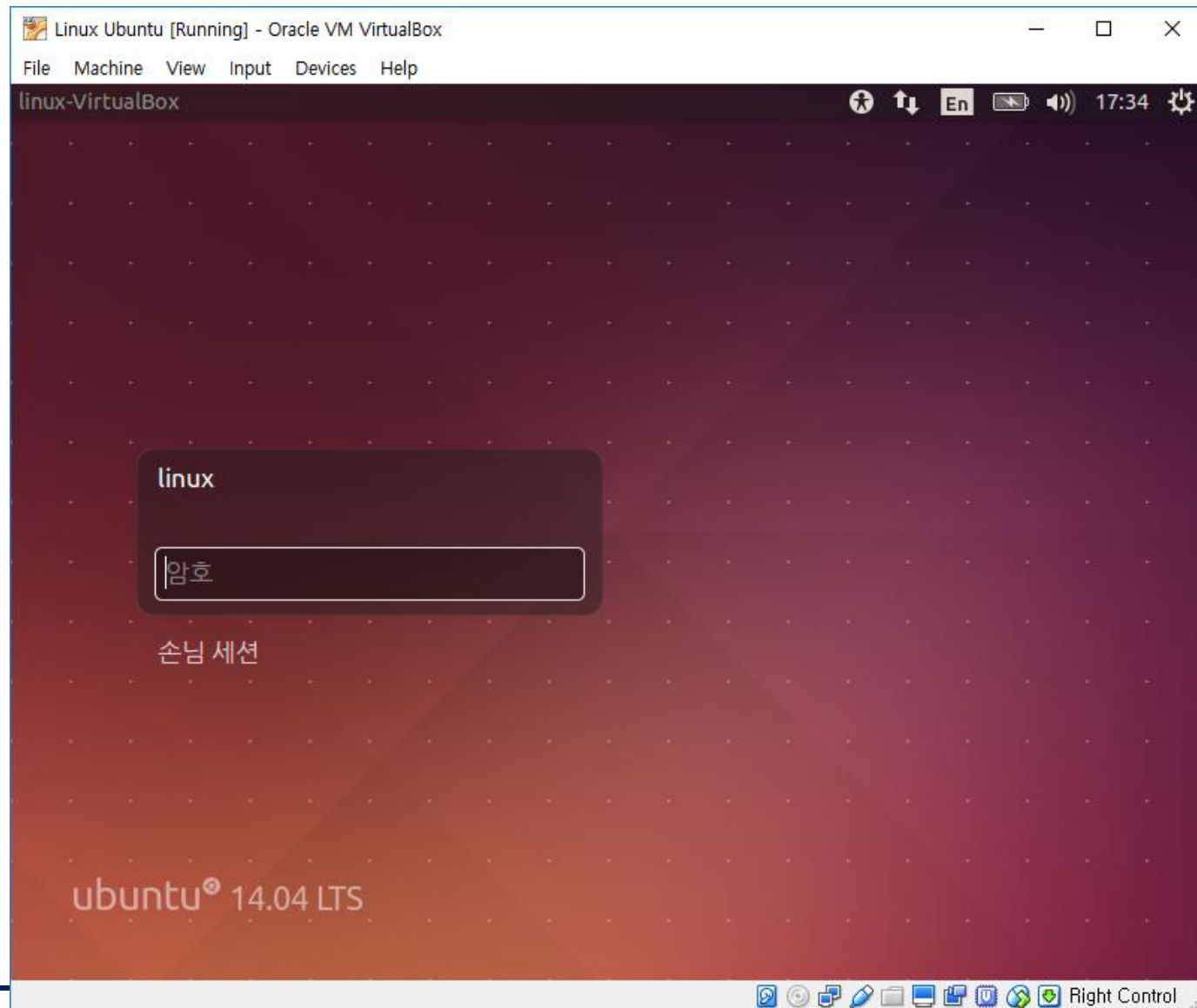
Installing Linux



Installing Linux



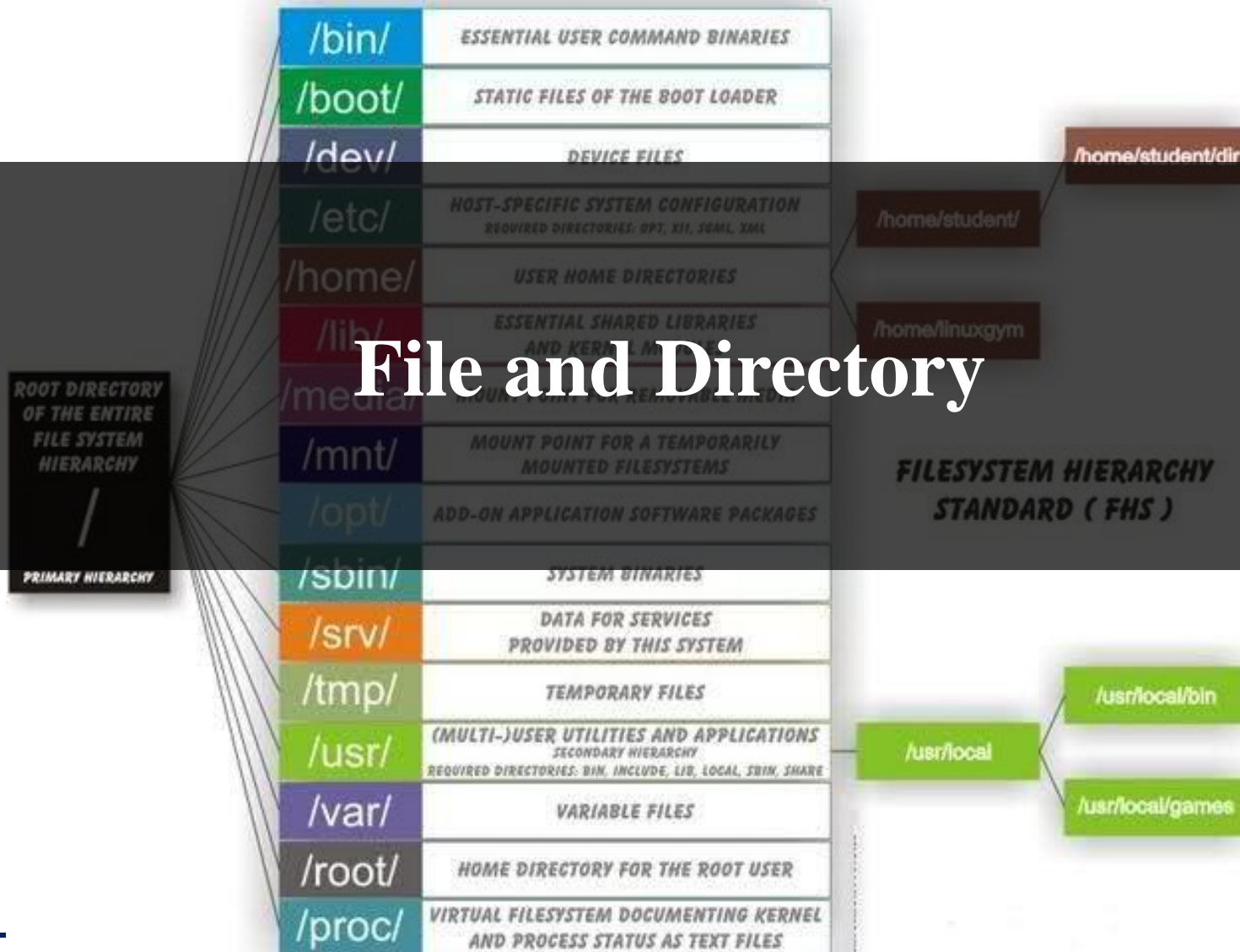
Installing Linux



Installing Linux



File and Directory



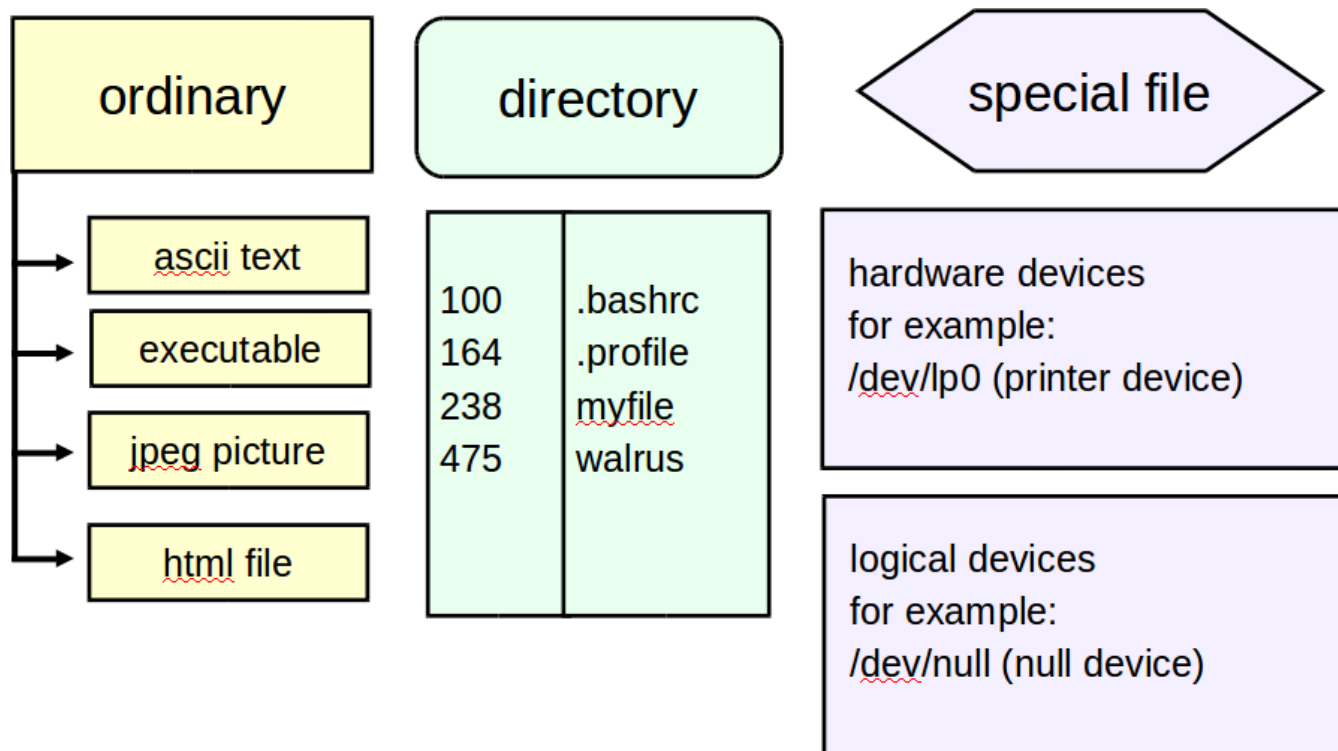
Filesystem

- **Filesystem**
 - How are data stored in storage?
 - How do users access the data?
 - Data organization, files and directories
- **Filesystem types**
 - Disk FS: ext3, ext4, FAT, FAT32 & NTFS
 - Network FS: Samba & NFS
 - Flash FS: JFFS2
 - Special FS: proc FS

File

- **File**

- A collection of data
- A stream of characters or a “byte stream”



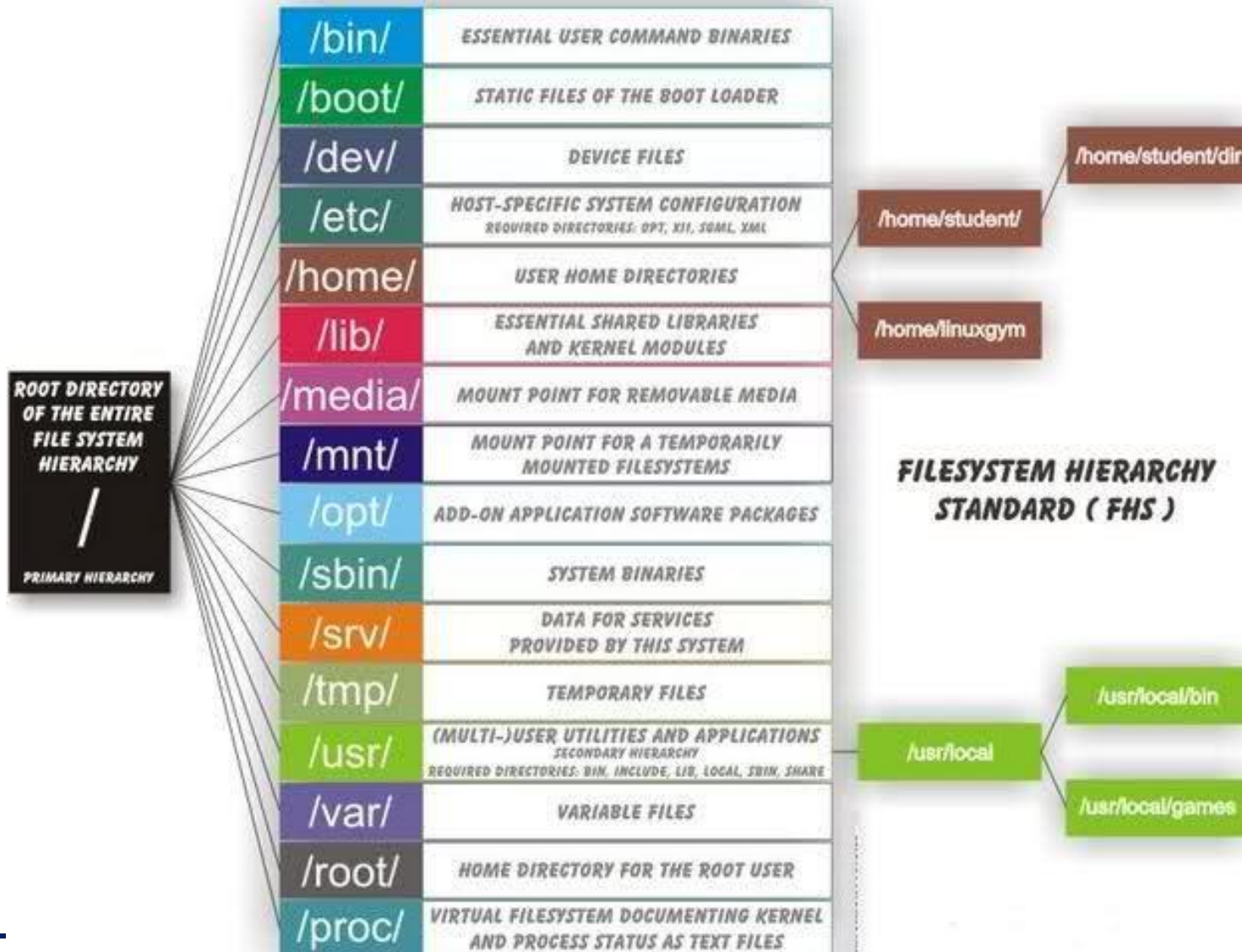
Filenames

- **Should be descriptive of the content**
- **Should use only alphanumeric characters:**
 - UPPERCASE, lowercase, number, @, _
- **Should not contain shell metacharacters**
 - * ? > < / ; & ! | \ ` ' " [] () { }
- **Should not begin with + or - sign**
- **Case sensitive**
- **Hidden if the first character is a . (period)**
- **Can have a maximum of 255 characters**

Directory Structure

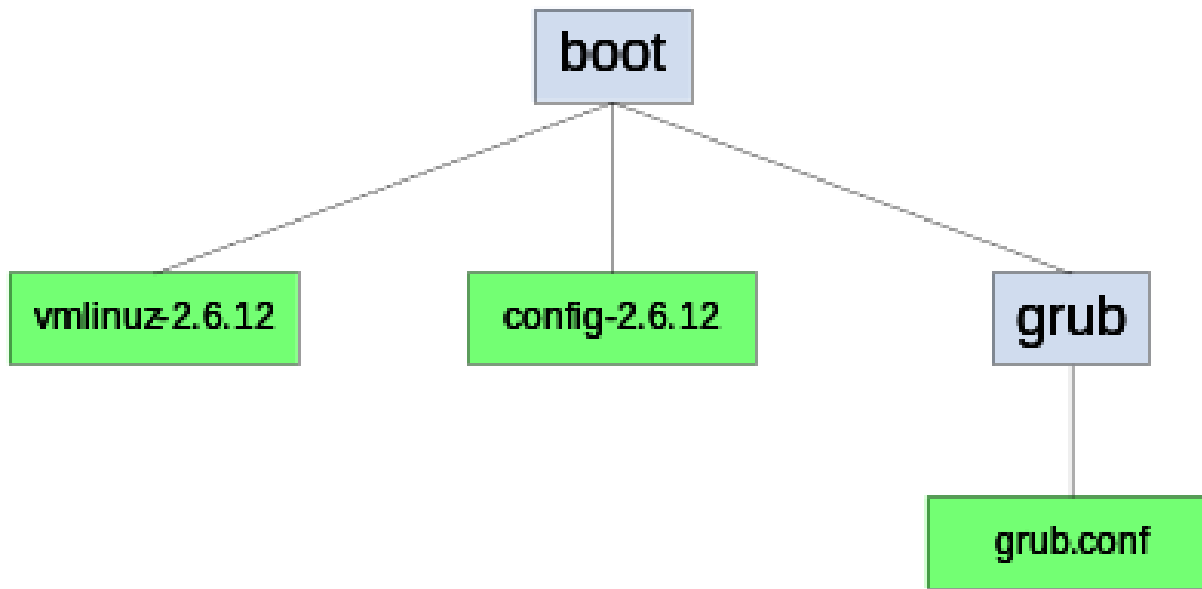
- **All Linux directories are contained in one, virtual, unified filesystem.**
- **Physical devices are mounted on mount points:**
 - Floppy disks
 - Hard disk partitions
 - CD-ROM drives
- **No drive letters like A:, C:, ...**

Linux Directory



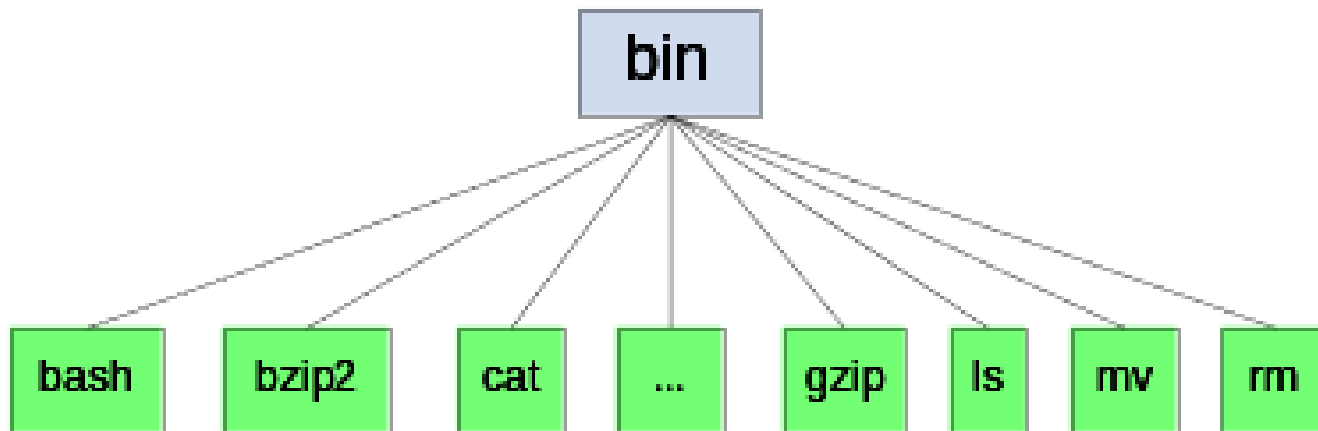
Directory : Boot

- **Linux kernel**
- **Boot loader configuration**
- **If you lost boot**
 - You cannot boot your OS



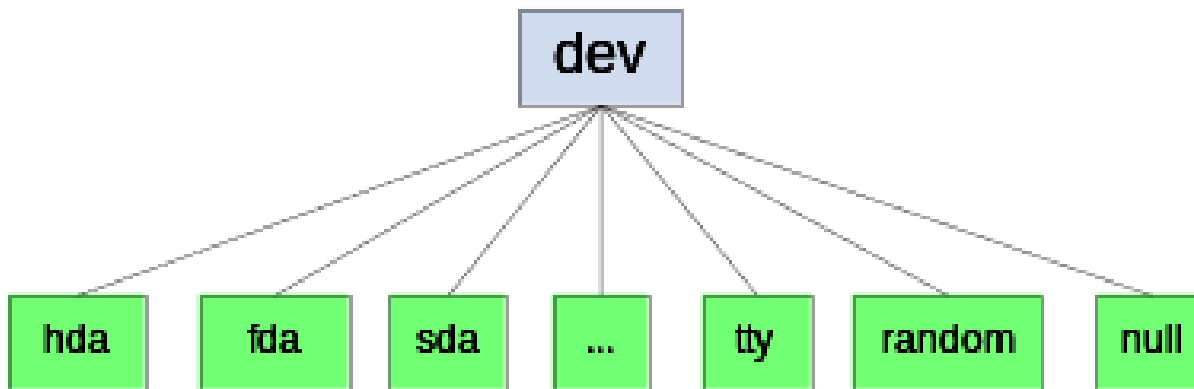
Directory : Bin

- **Essential programs**
- **Need for system startup**
- **Basic commands for**
 - **Navigating in filesystem**
 - **File management**



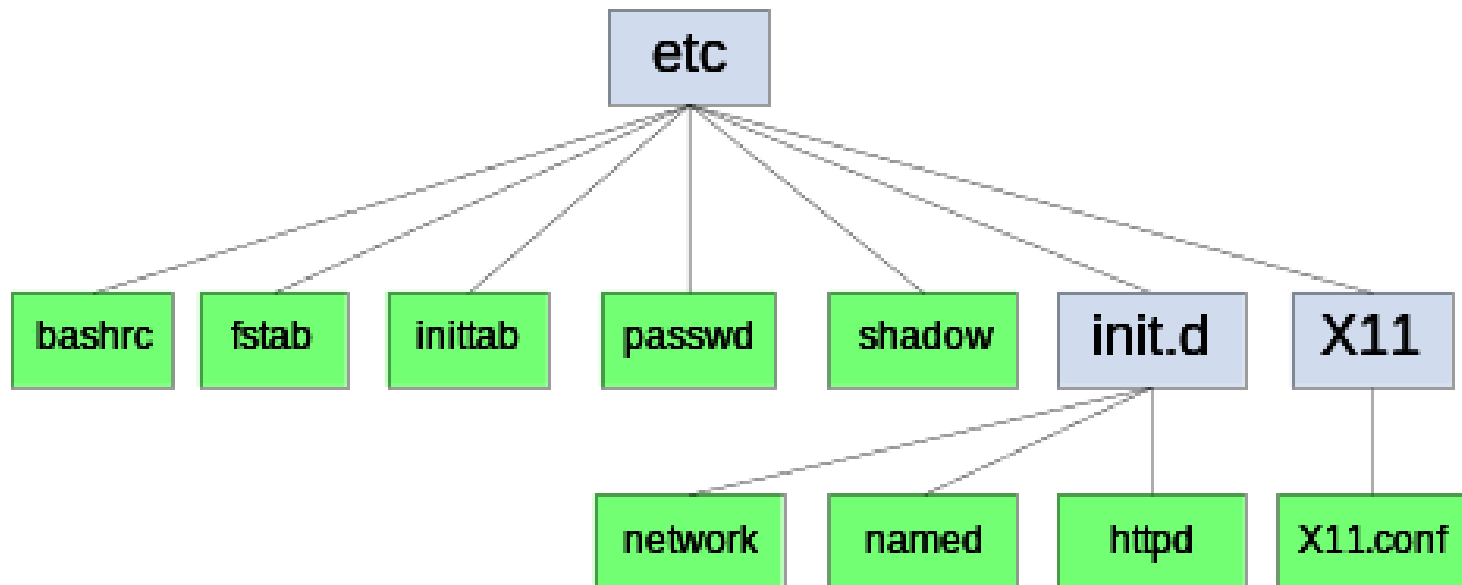
Directory : dev

- **Everything is file**
 - Hardware components (devices) are file
 - Hard disk
 - Key board
- **All device files are here**
- **Direct interaction with device driver**
 - Open the device file
 - Read & Write



Directory : etc

- **System configuration directory**
 - Similar with the registry in Windows
- **All configuration file are text files**
 - You can view and edit it manually

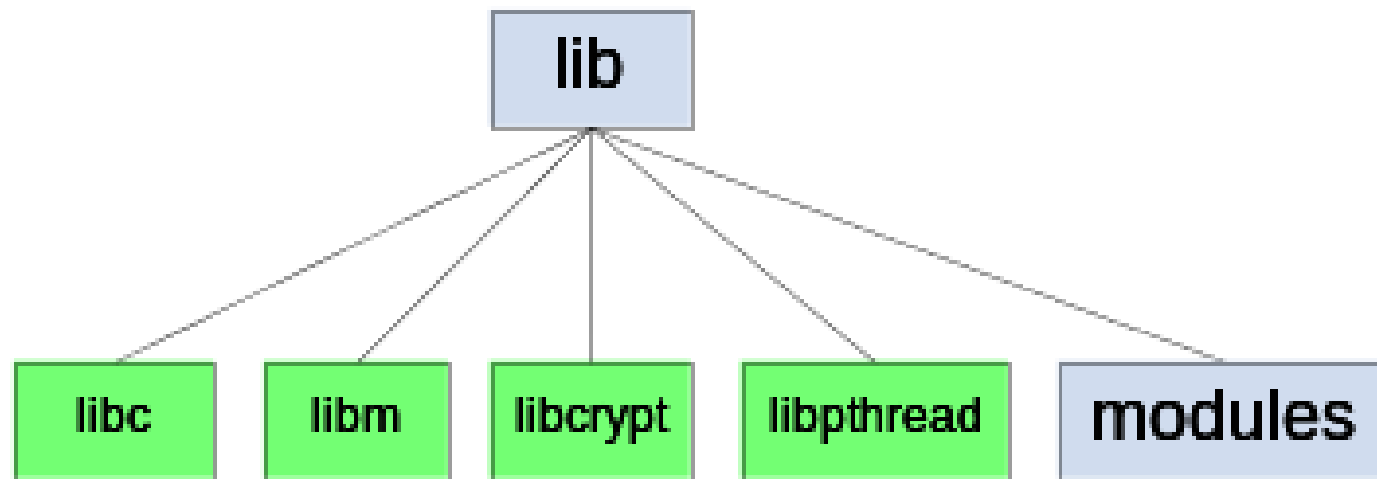


Directory : home

- **Home directory of user**
- **Each user has a directory**
 - **/home/user01**
 - **/home/user02**
- **All files of user are stored here**

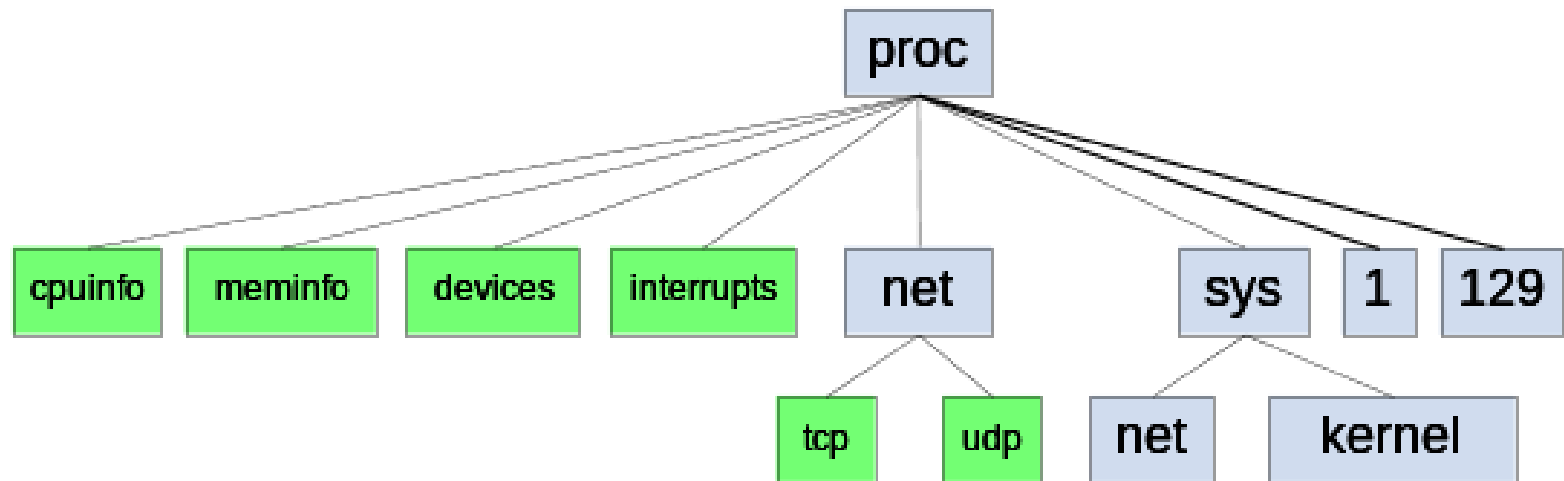
Directory : lib

- **Programs need libraries**
 - Dynamically linked libraries
- **Programmers need libraries**
- **All essential libraries are here**
 - Needed for system startup



Directory : proc

- **Kernel's interface**
 - Kernel pseudo-directory
- **Special directory**
 - It is **NOT** a directory on hard disk
- **Kernel Configuration**
- **Kernel State monitoring**

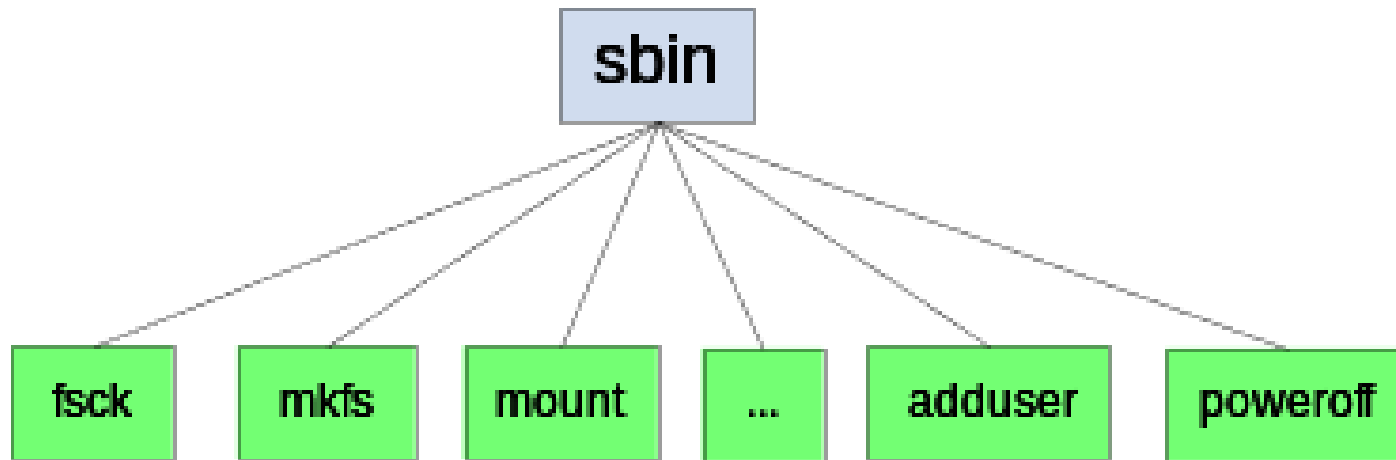


Directory : root

- **Home directory of root**
- **Don't confuse**
 - / is the “root of Filesystem”
 - root is the name of system admin
 - /root is home directory of root

Directory : sbin

- **System configuration programs**
 - Format hard disk
 - Manage hardware
- **Only “root” can run the programs**

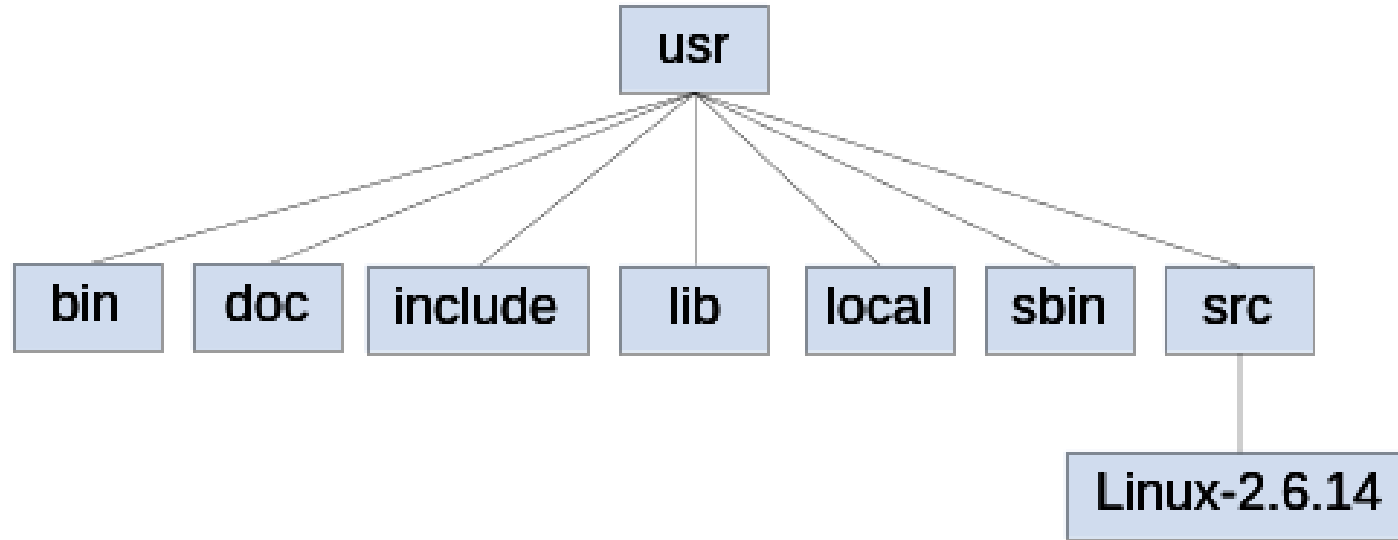


Directory : tmp

- **Temporary directory**
- **All temp files are created by programs**
- **Your temp files**
- **It is emptied regularly**

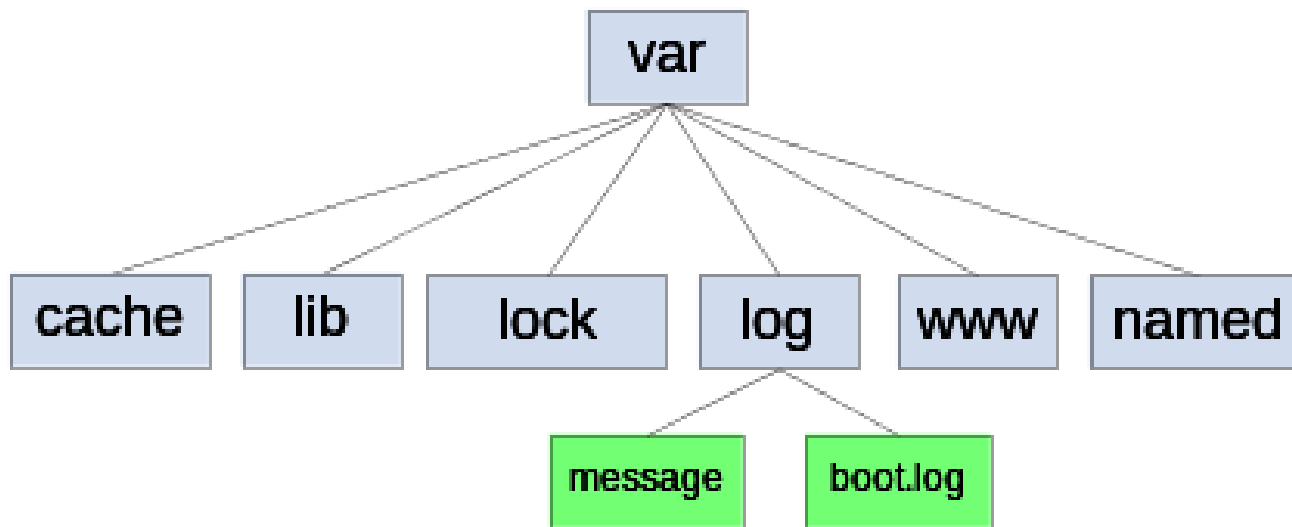
Directory : usr

- **Secondary hierarchy**
- **Very useful programs**
 - We usually use them
 - compiler, tools
- **Are not essential for system startup**



Directory : var

- The variable directory
- All dynamic files
- User cannot change the files



Permission

Owner			Group			All		
r	w	x	r	w	x	w	w	x

Legend

r = 'read access' (1 = yes, 0 = no)

w = 'write access' (1 = yes, 0 = no)

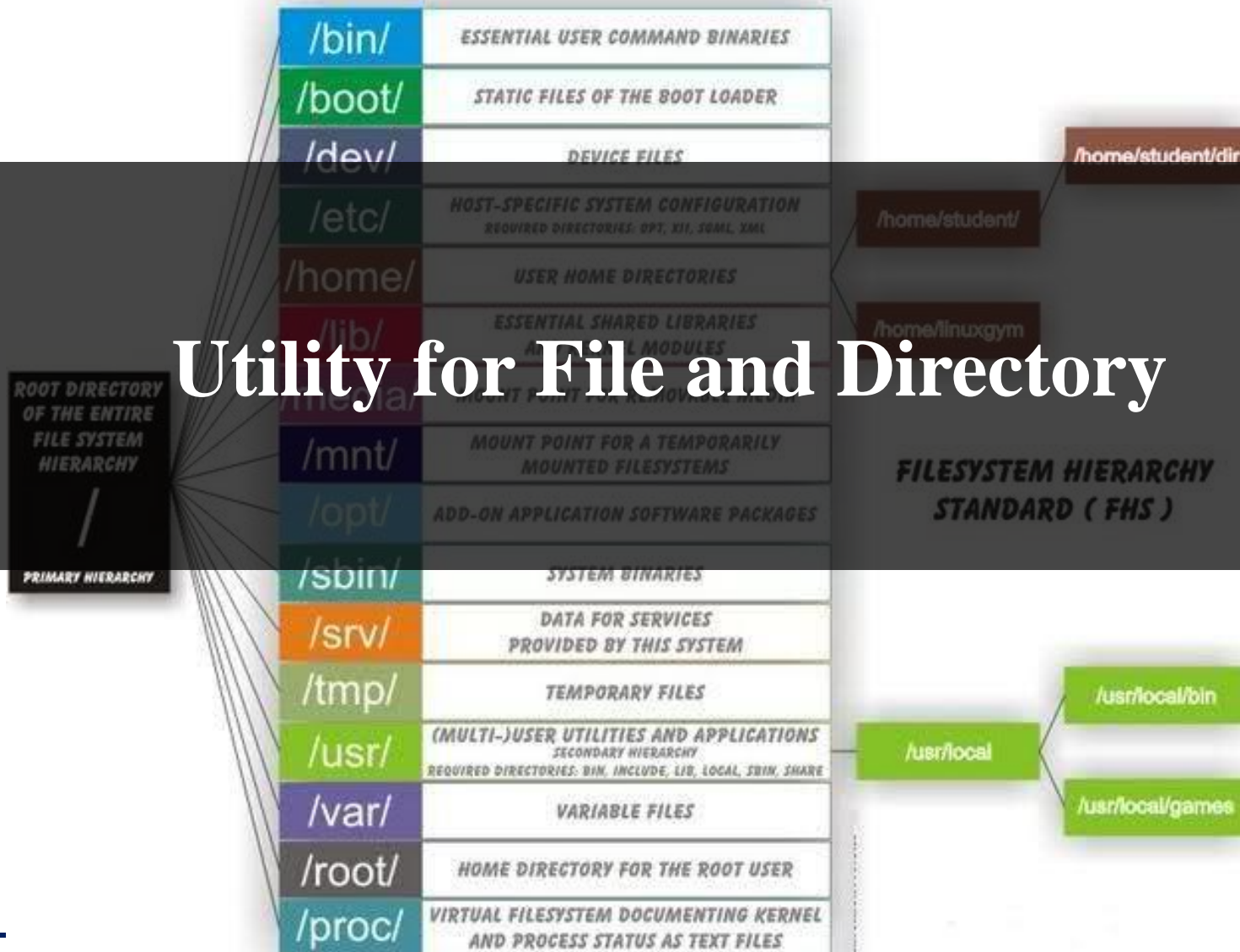
x = 'execute access' (1 = yes, 0 = no)

Bitmap-example: 110-100-100

Octal representation: 0644

ASCII-representation: rw-r--r--

Utility for File and Directory



Utility : pwd

- **Print Working Directory**
- **Find out what your current working directory**



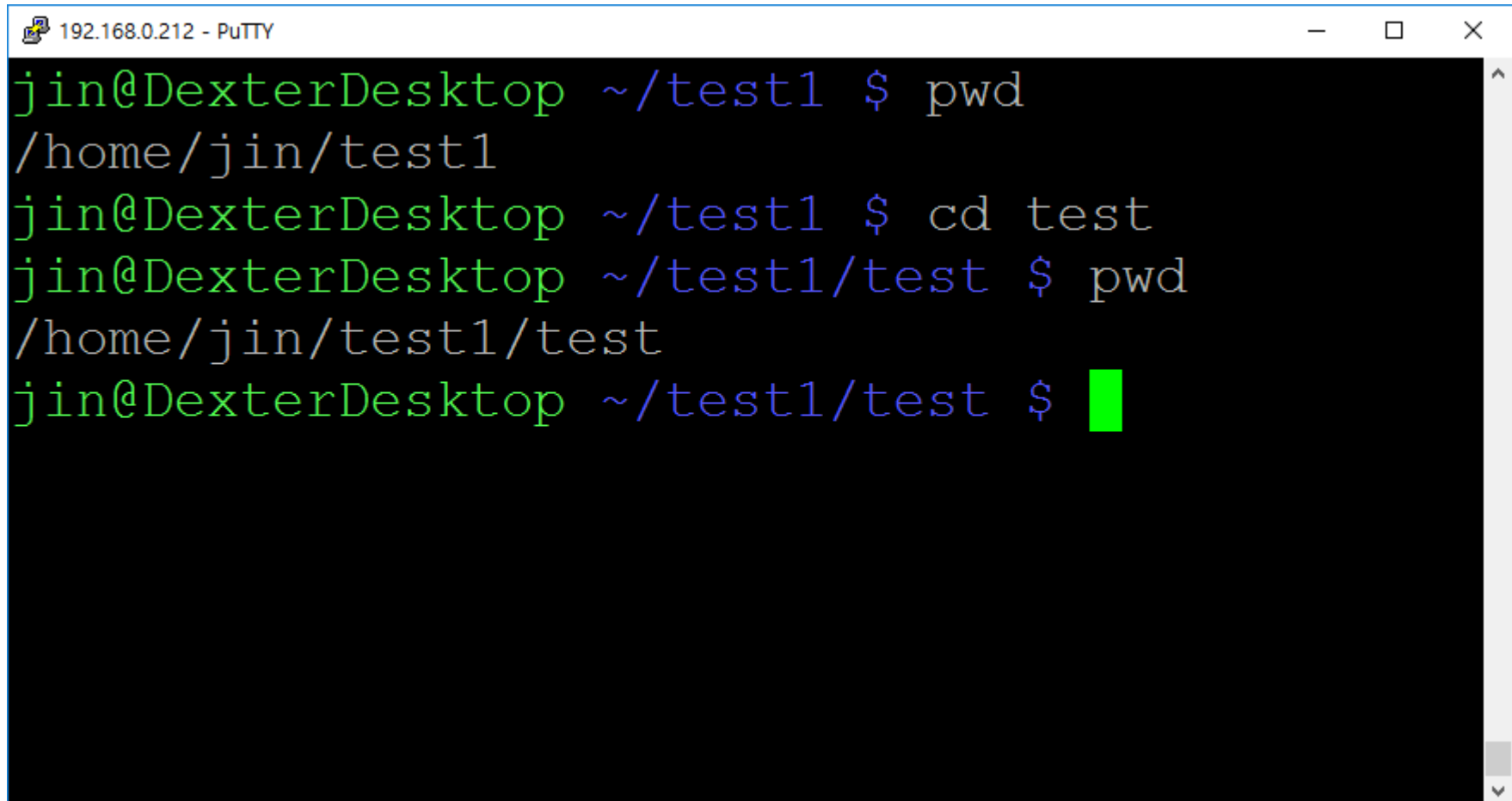
The screenshot shows a PuTTY terminal window titled "192.168.0.212 - PuTTY". The terminal displays the following sequence of commands and output:

```
jin@DexterDesktop ~ $ pwd
/home/jin
jin@DexterDesktop ~ $ pwd
/home/jin
jin@DexterDesktop ~ $ pwd
/home/jin
jin@DexterDesktop ~ $
```

The prompt "jin@DexterDesktop ~ \$" is shown in green. The command "pwd" is shown in blue. The output "/home/jin" is shown in white. A red cursor is visible at the end of the last prompt.

Utility : cd

- **Change Directory**

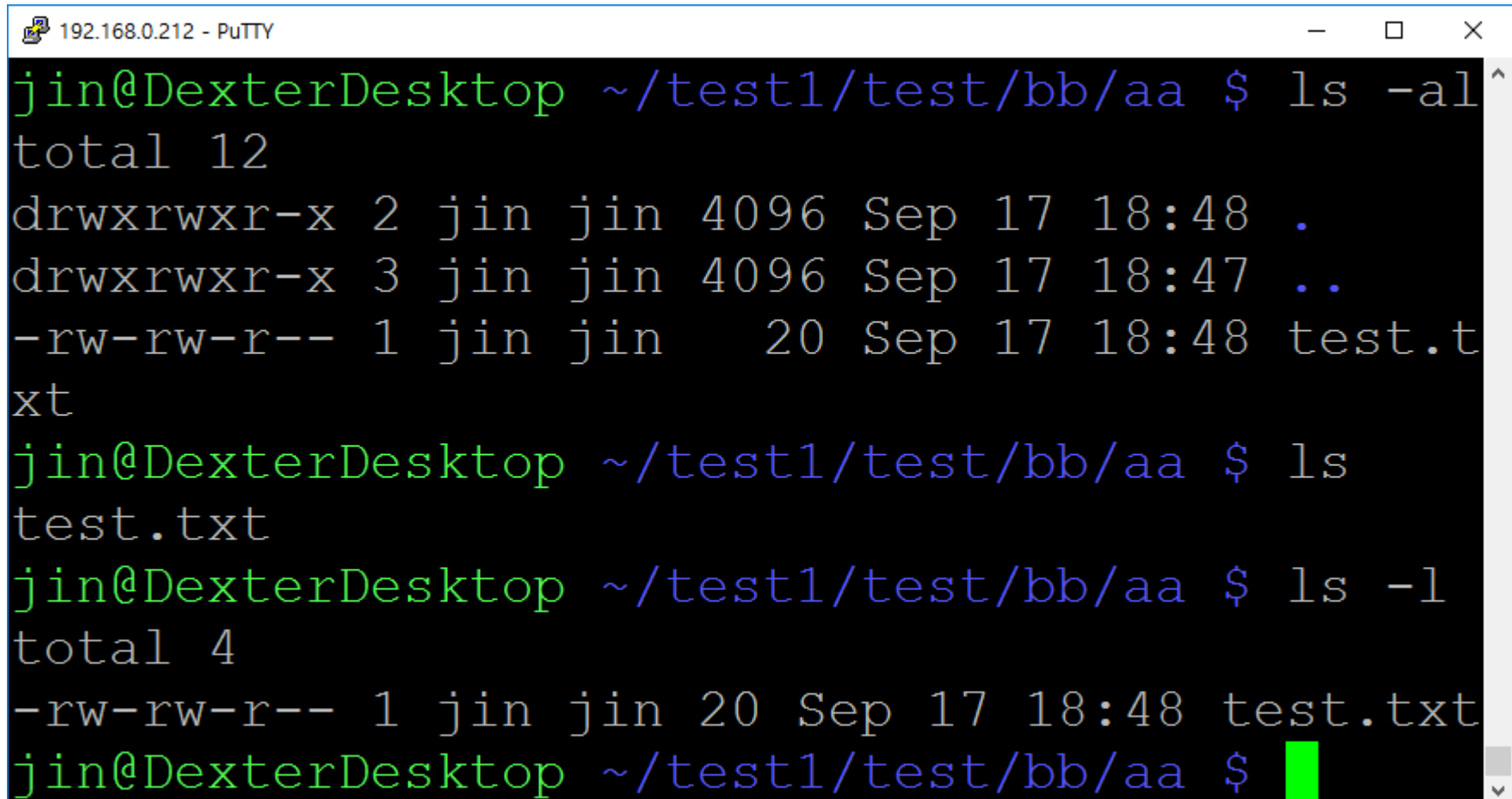


A screenshot of a PuTTY terminal window titled "192.168.0.212 - PuTTY". The terminal shows a user named 'jin' at a host named 'DexterDesktop'. The user is in the directory '~/test1' and runs the command 'pwd', which outputs '/home/jin/test1'. Then, the user runs 'cd test', and the prompt changes to '~/test1/test'. Finally, the user runs 'pwd' again, which outputs '/home/jin/test1/test'. The terminal ends with a green cursor block after the prompt 'jin@DexterDesktop ~/test1/test \$'.

```
jin@DexterDesktop ~/test1 $ pwd
/home/jin/test1
jin@DexterDesktop ~/test1 $ cd test
jin@DexterDesktop ~/test1/test $ pwd
/home/jin/test1/test
jin@DexterDesktop ~/test1/test $
```


Utility : ls

- List contents of a directory

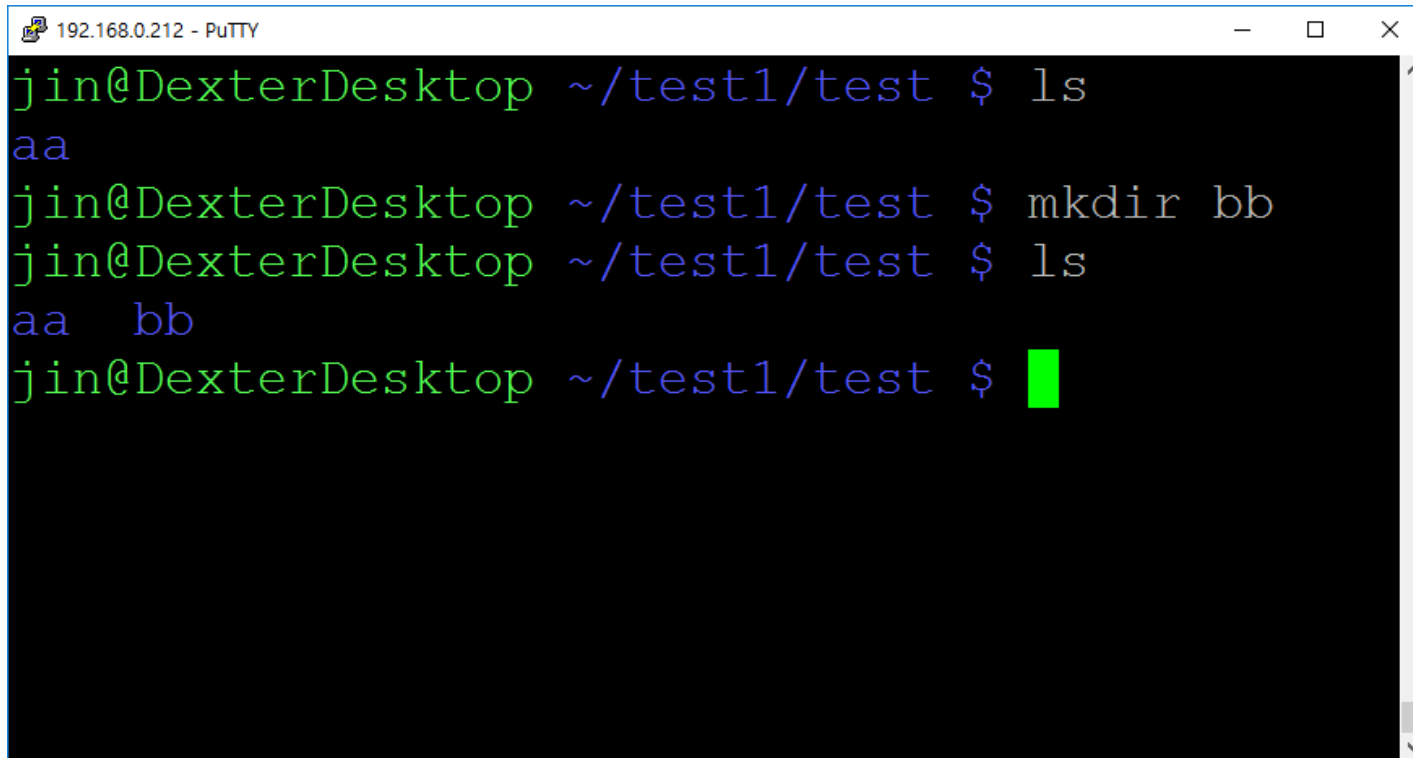


The screenshot shows a PuTTY terminal window titled "192.168.0.212 - PuTTY". The user is at the prompt "jin@DexterDesktop ~/test1/test/bb/aa" and has entered the command "ls -al". The output shows the contents of the directory, including the current directory ".", the parent directory "..", and a file named "test.txt". The permissions for each entry are listed on the left, followed by the number of links, the owner, the group, the size in bytes, the date and time, and the file name. The user then enters "ls" again, and the output shows only the file "test.txt". Finally, the user enters "ls -l", and the output shows the file "test.txt" with its permissions and size. The terminal window has a black background with green text for the prompt and blue text for the command.

```
jin@DexterDesktop ~/test1/test/bb/aa $ ls -al
total 12
drwxrwxr-x 2 jin jin 4096 Sep 17 18:48 .
drwxrwxr-x 3 jin jin 4096 Sep 17 18:47 ..
-rw-rw-r-- 1 jin jin 20 Sep 17 18:48 test.txt
jin@DexterDesktop ~/test1/test/bb/aa $ ls
test.txt
jin@DexterDesktop ~/test1/test/bb/aa $ ls -l
total 4
-rw-rw-r-- 1 jin jin 20 Sep 17 18:48 test.txt
jin@DexterDesktop ~/test1/test/bb/aa $
```

Utility : mkdir

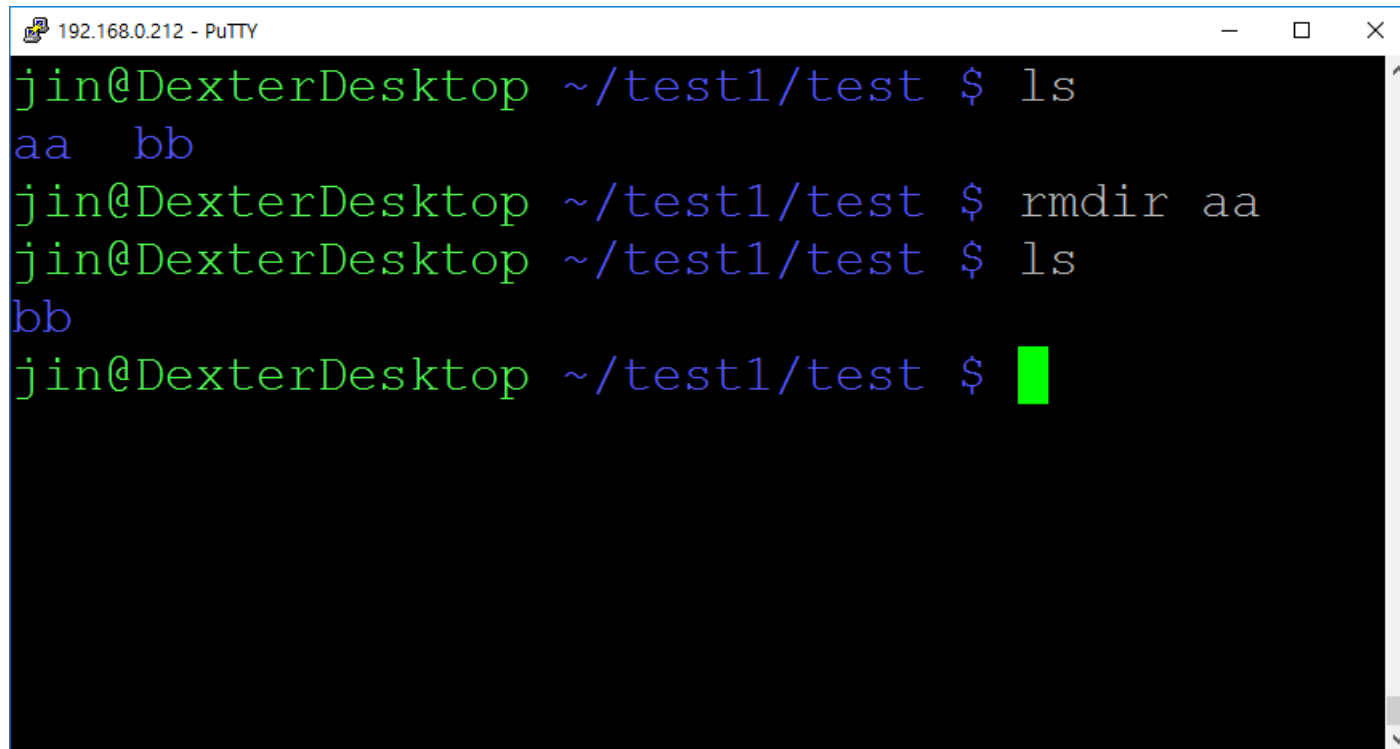
- **mkdir command: creates new directories**
- **Arguments specify directory's absolute or relative pathname**

A terminal window titled "192.168.0.212 - PuTTY" with standard window controls. The terminal shows a user named 'jin' at a 'DexterDesktop' machine in the directory '~/test1/test'. The user runs 'ls' and sees 'aa'. Then they run 'mkdir bb' and run 'ls' again to see 'aa' and 'bb'. The prompt is then followed by a red cursor.

```
jin@DexterDesktop ~/test1/test $ ls
aa
jin@DexterDesktop ~/test1/test $ mkdir bb
jin@DexterDesktop ~/test1/test $ ls
aa  bb
jin@DexterDesktop ~/test1/test $
```

Utility : rmdir

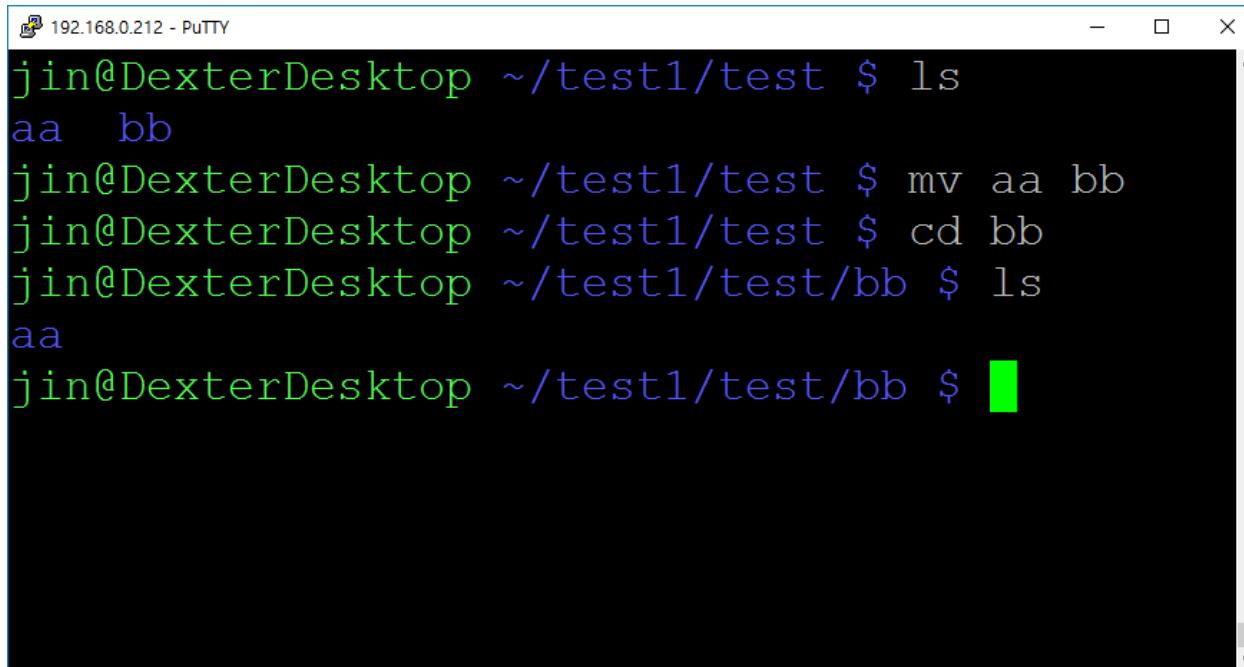
- **Removes directories**
 - Arguments are a list of files
 - Cannot be used to remove directory full of files

A terminal window titled "192.168.0.212 - PuTTY" with standard window controls. The terminal shows a user 'jin' at 'DexterDesktop' in the directory '~/test1/test'. The user runs 'ls', showing 'aa' and 'bb'. Then they run 'rmdir aa'. Finally, they run 'ls' again, showing only 'bb'. The prompt is currently at a green cursor.

```
jin@DexterDesktop ~/test1/test $ ls
aa  bb
jin@DexterDesktop ~/test1/test $ rmdir aa
jin@DexterDesktop ~/test1/test $ ls
bb
jin@DexterDesktop ~/test1/test $
```

Utility : mv

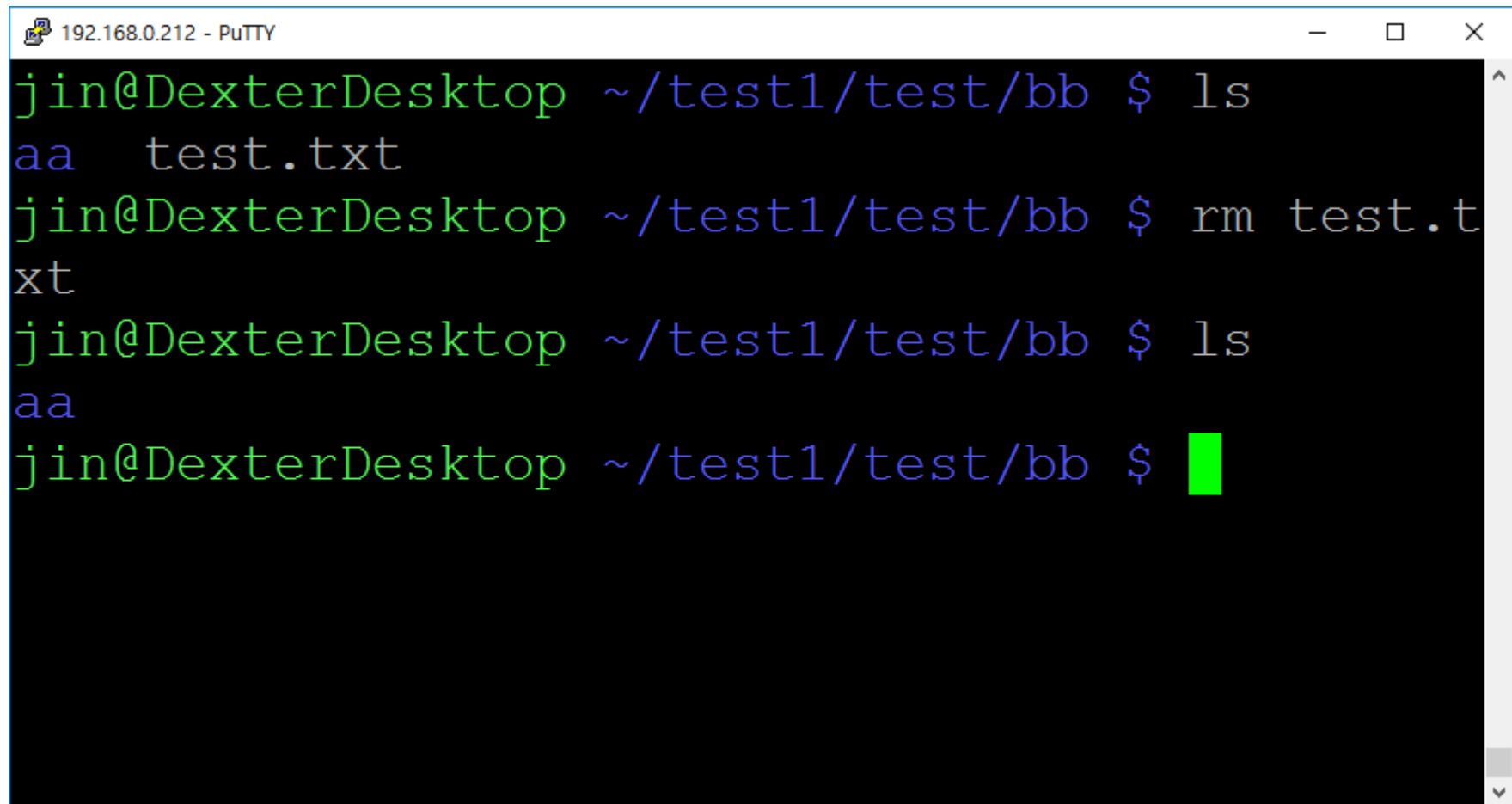
- Moves files
- Minimum of two arguments:
 - Source file/directory (may specify multiple sources)
 - Target file/directory
- Also used to rename files or directories



```
192.168.0.212 - PuTTY
jin@DexterDesktop ~/test1/test $ ls
aa  bb
jin@DexterDesktop ~/test1/test $ mv aa bb
jin@DexterDesktop ~/test1/test $ cd bb
jin@DexterDesktop ~/test1/test/bb $ ls
aa
jin@DexterDesktop ~/test1/test/bb $
```

Utility : rm

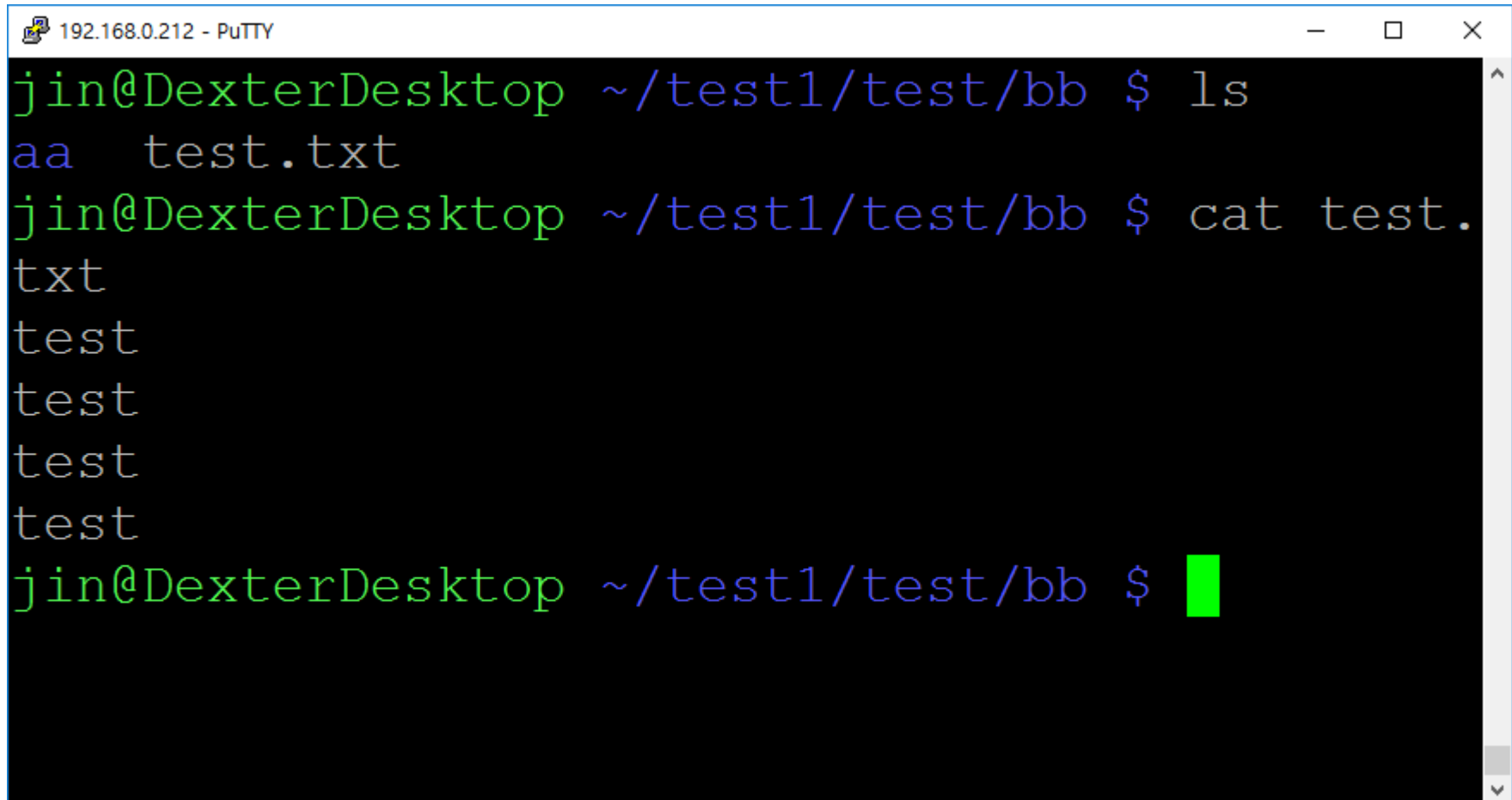
- **Removes files**
 - Arguments are a list of files

A terminal window titled "192.168.0.212 - PuTTY" with standard window controls. The terminal shows a user named 'jin' at a host named 'DexterDesktop' in the directory '~/test1/test/bb'. The user runs 'ls' and sees 'aa' and 'test.txt'. Then they run 'rm test.txt'. Finally, they run 'ls' again and only 'aa' is listed. The prompt is followed by a red cursor.

```
jin@DexterDesktop ~/test1/test/bb $ ls
aa  test.txt
jin@DexterDesktop ~/test1/test/bb $ rm test.txt
jin@DexterDesktop ~/test1/test/bb $ ls
aa
jin@DexterDesktop ~/test1/test/bb $
```

Utility : cat

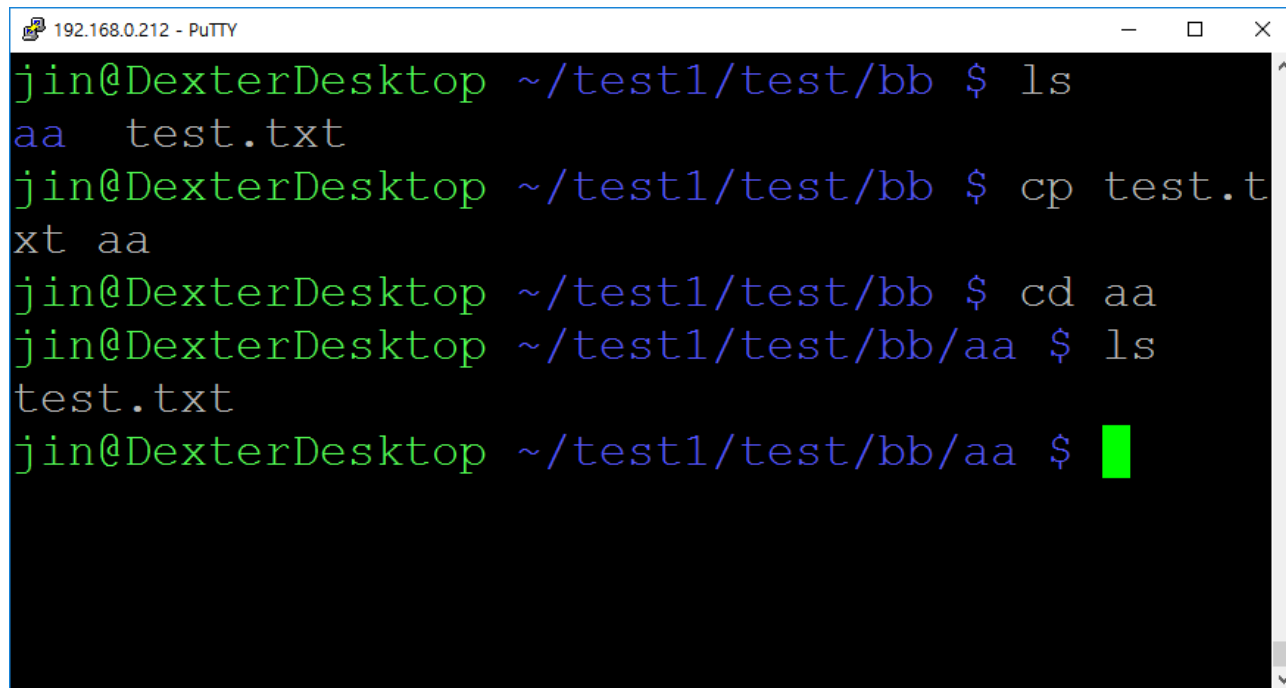
- Prints contents of file

A terminal window titled "192.168.0.212 - PuTTY" with standard window controls. The prompt is "jin@DexterDesktop ~/test1/test/bb \$". The user enters "ls", and the output is "aa test.txt". The user then enters "cat test.txt", and the output is "test", "test", "test", "test" on four separate lines. The prompt "jin@DexterDesktop ~/test1/test/bb \$" is followed by a red cursor.

```
jin@DexterDesktop ~/test1/test/bb $ ls
aa test.txt
jin@DexterDesktop ~/test1/test/bb $ cat test.
txt
test
test
test
test
jin@DexterDesktop ~/test1/test/bb $
```

Utility : cp

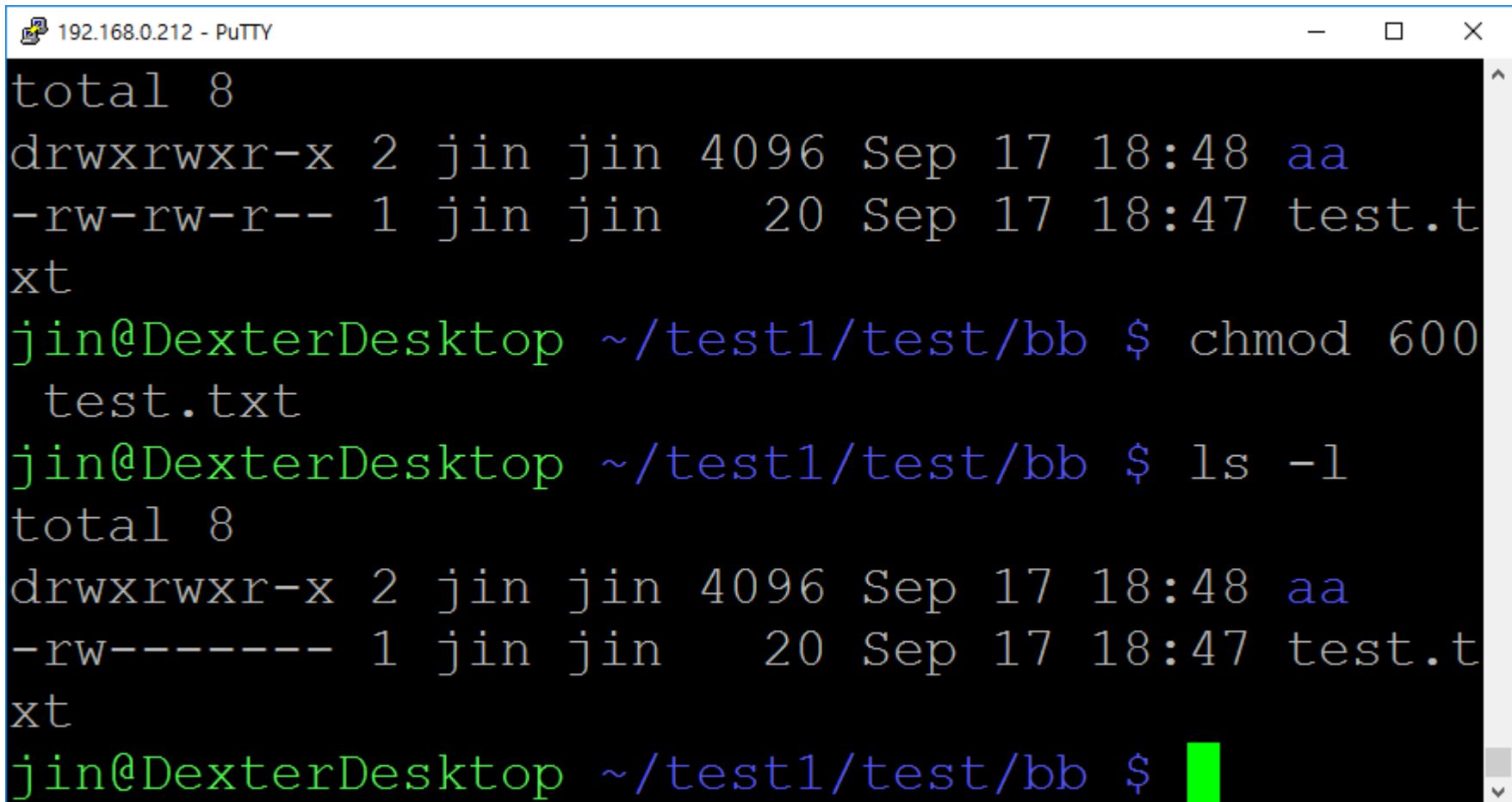
- **Copies files**
 - **Recursive:** referring to itself and its own contents
 - **Recursive copy command** copies the directory and all subdirectories and contents
 - **Use `-r` option**



```
192.168.0.212 - PuTTY
jin@DexterDesktop ~/test1/test/bb $ ls
aa  test.txt
jin@DexterDesktop ~/test1/test/bb $ cp test.txt aa
jin@DexterDesktop ~/test1/test/bb $ cd aa
jin@DexterDesktop ~/test1/test/bb/aa $ ls
test.txt
jin@DexterDesktop ~/test1/test/bb/aa $
```

Utility : chmod

- Change the file permission



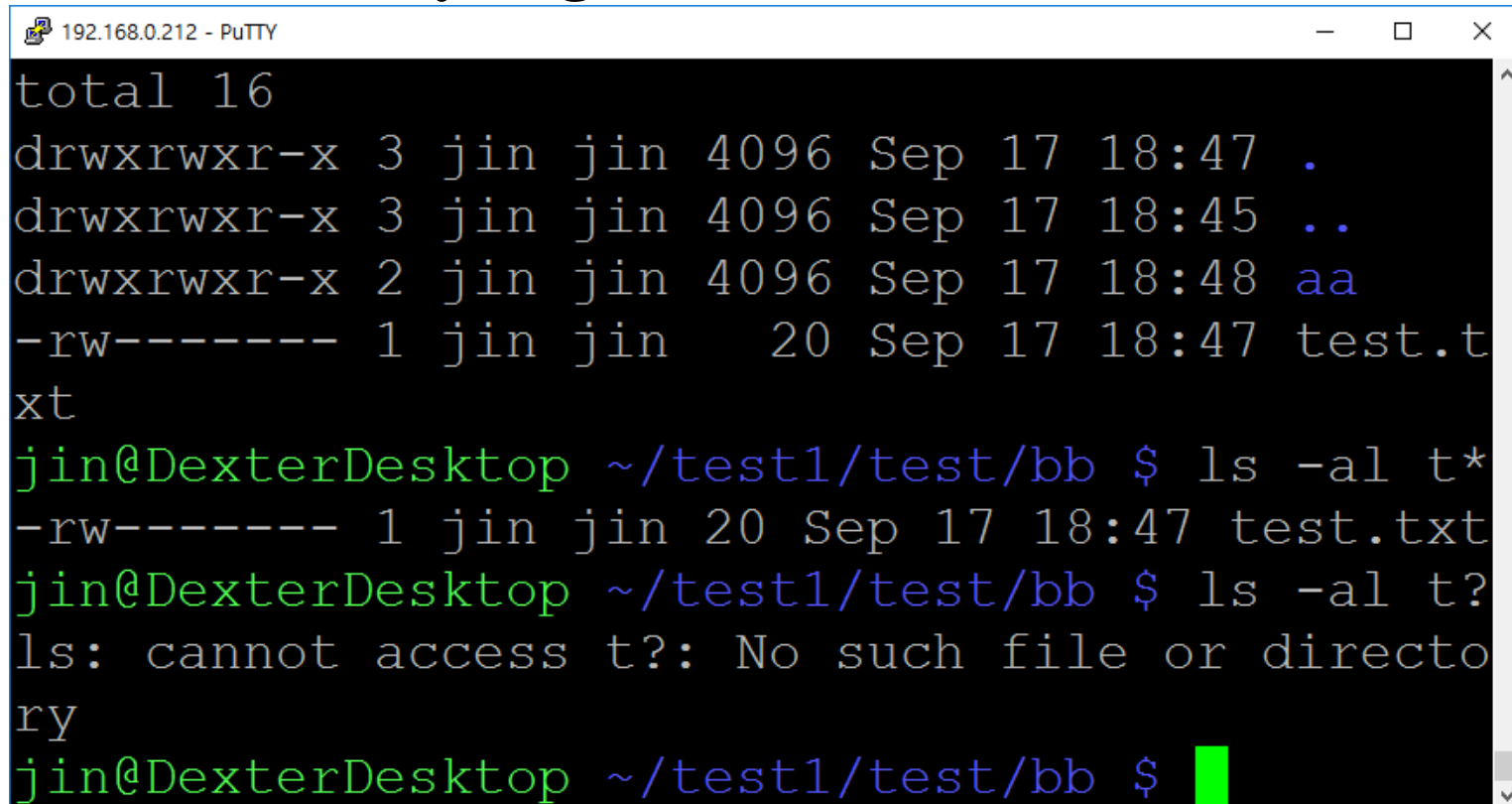
The screenshot shows a PuTTY terminal window titled "192.168.0.212 - PuTTY". The terminal output is as follows:

```
total 8
drwxrwxr-x 2 jin jin 4096 Sep 17 18:48 aa
-rw-rw-r-- 1 jin jin 20 Sep 17 18:47 test.txt
jin@DexterDesktop ~/test1/test/bb $ chmod 600 test.txt
jin@DexterDesktop ~/test1/test/bb $ ls -l
total 8
drwxrwxr-x 2 jin jin 4096 Sep 17 18:48 aa
-rw----- 1 jin jin 20 Sep 17 18:47 test.txt
jin@DexterDesktop ~/test1/test/bb $
```

The terminal shows the initial state of a directory with two files: 'aa' (permissions drwxrwxr-x) and 'test.txt' (permissions -rw-rw-r--). The user 'jin' runs the command 'chmod 600 test.txt'. After running the command, the user runs 'ls -l' to verify the change. The output shows that 'test.txt' now has permissions -rw-----, indicating that only the owner (jin) has read and write permissions, and no permissions are granted to the group or others.

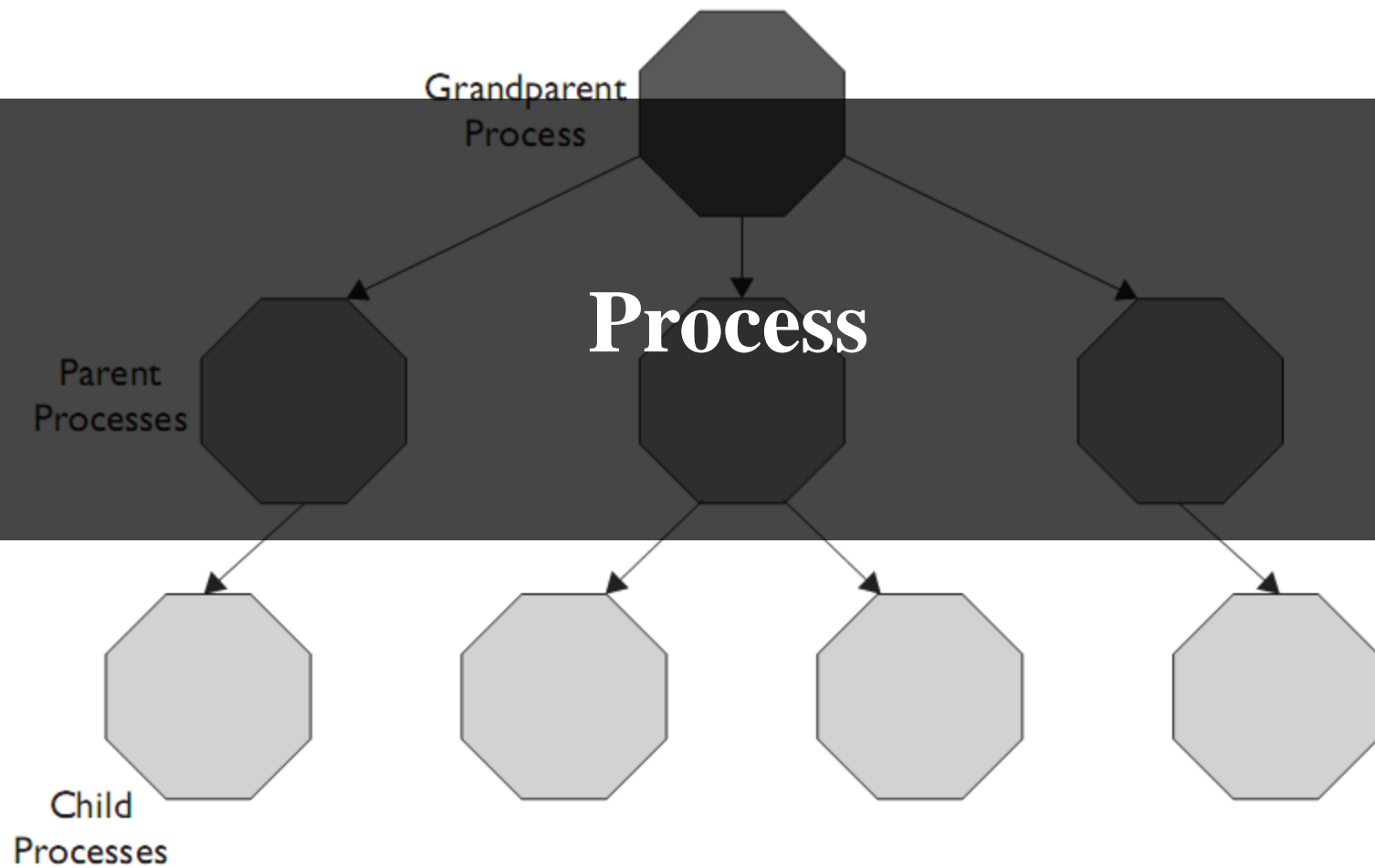
Metacharacter

- *** = Matches any sequence of zero or more characters, except for "." (a dot) at the beginning of a filename.**
- **? = Matches any single character.**



The screenshot shows a PuTTY terminal window titled "192.168.0.212 - PuTTY". The terminal output is as follows:

```
total 16
drwxrwxr-x 3 jin jin 4096 Sep 17 18:47 .
drwxrwxr-x 3 jin jin 4096 Sep 17 18:45 ..
drwxrwxr-x 2 jin jin 4096 Sep 17 18:48 aa
-rw----- 1 jin jin 20 Sep 17 18:47 test.txt
jin@DexterDesktop ~/test1/test/bb $ ls -al t*
-rw----- 1 jin jin 20 Sep 17 18:47 test.txt
jin@DexterDesktop ~/test1/test/bb $ ls -al t?
ls: cannot access t?: No such file or directory
jin@DexterDesktop ~/test1/test/bb $
```



Process

- **The kernel considers each program running to be a process**
- **A process lives as it executes, with a lifetime that may be short or long**
- **A process is said to die when it terminates**
- **The kernel identifies each process by a number known as a process id (PID)**

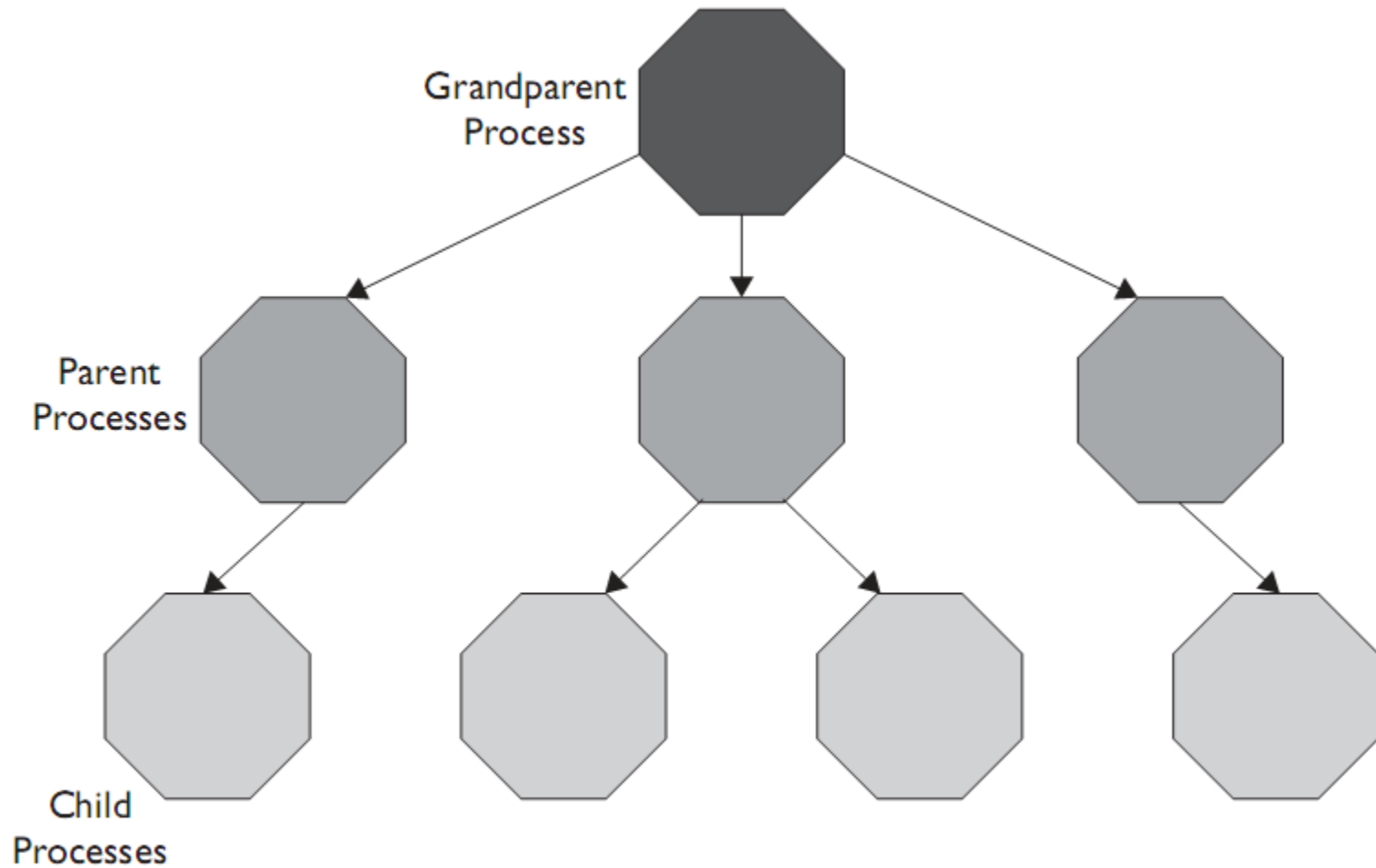
Type of Process

- **Init**
 - The parent of all processes.
- **User Processes**
 - Created by the end user
- **System processes or daemons**
 - Web server, an FTP server, a file service such as Samba, a print service such as CUPS, a logging service, and so on.

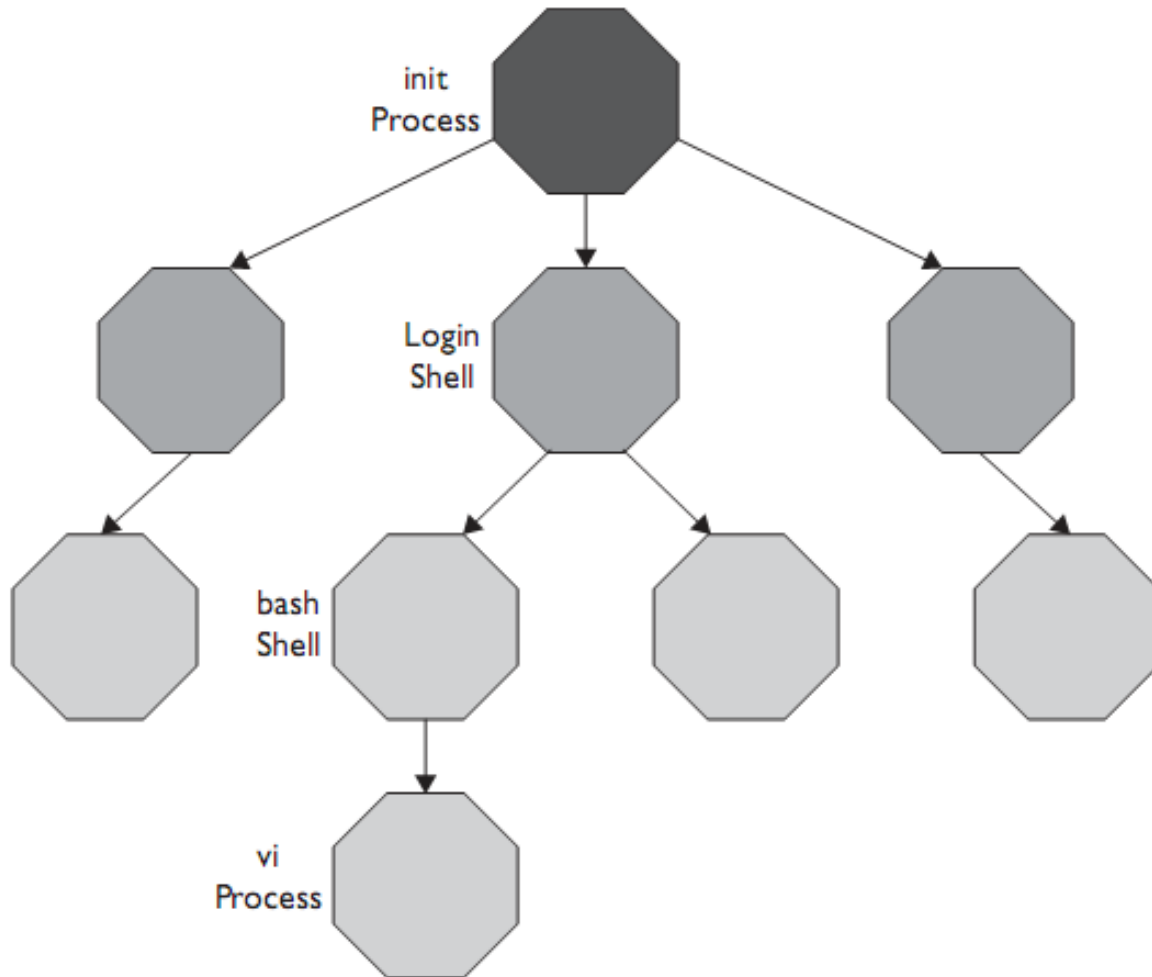
Attribute of Process

- **PID**
 - process ID, an integer.
- **PPID**
 - parent process ID, an integer.
- **TTY**
 - the terminal to which the process is connected.
- **RUID**
 - Real user ID. The user issuing the command.
- **RGID**
 - real group owner. The group of the user who started the process

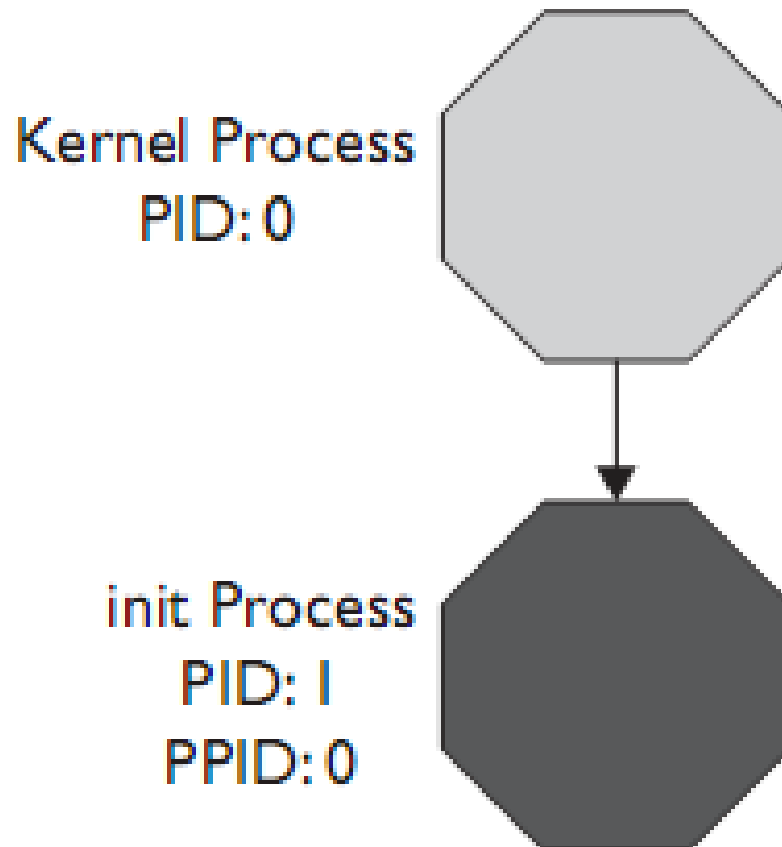
The Heredity of Linux Processes

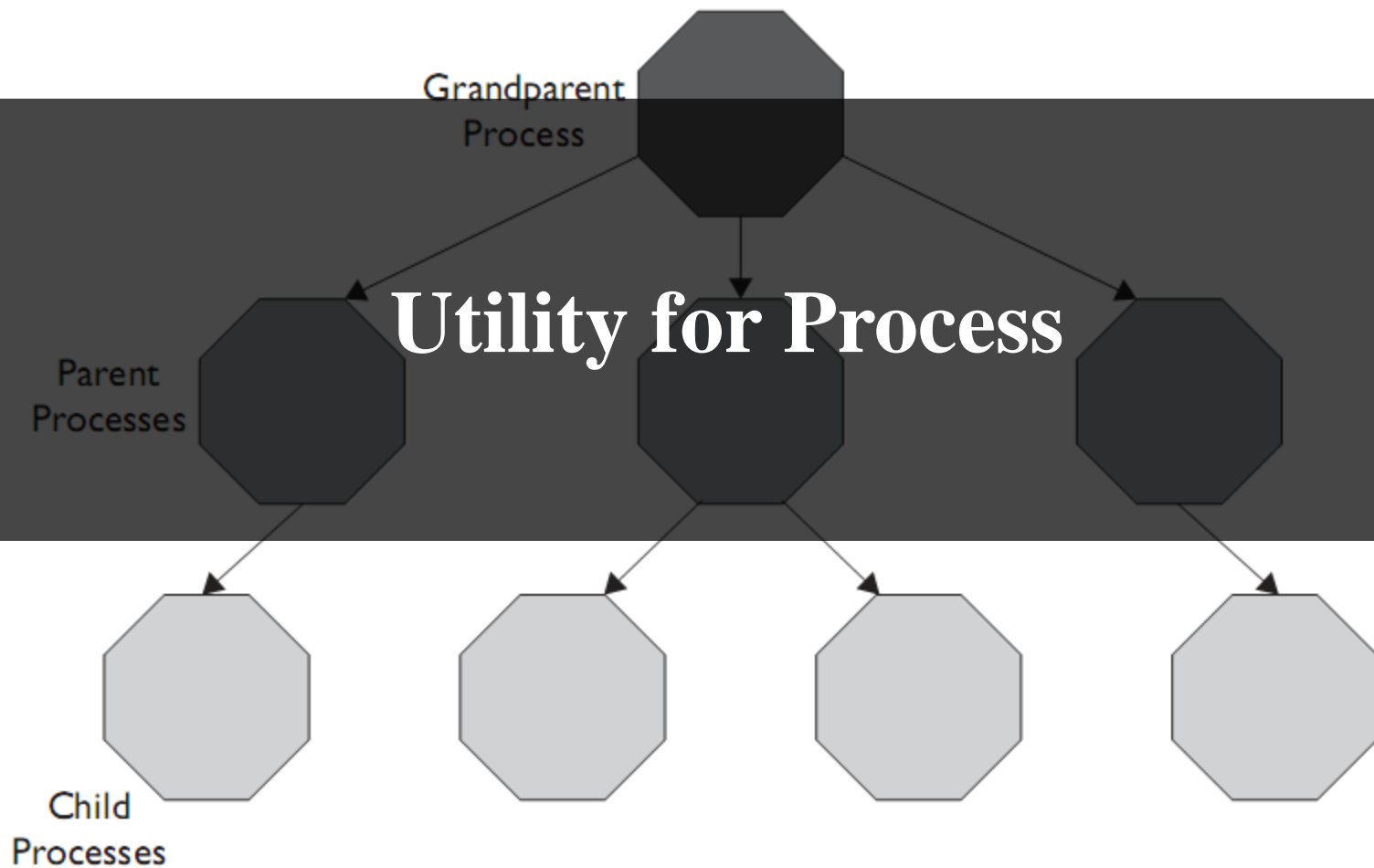


The Heredity of Linux Processes



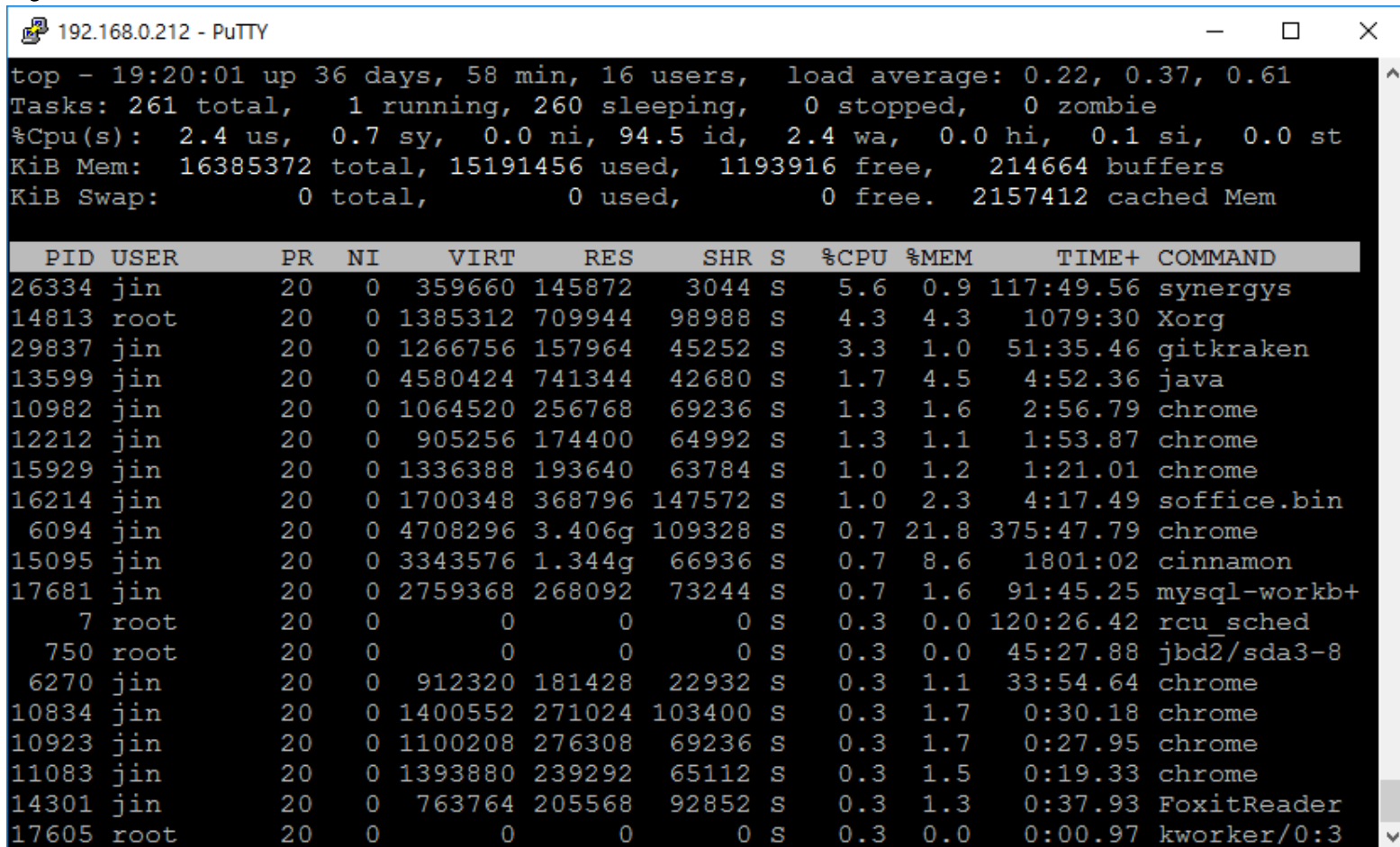
Parent Process ID





Utility : top

- Display a dynamic real-time view of a running system.



The screenshot shows a PuTTY window titled '192.168.0.212 - PuTTY'. The terminal displays the output of the 'top' command, which provides a dynamic real-time view of the system's running processes. The output includes system statistics such as uptime, load average, tasks, CPU usage, memory usage, and swap usage. Below these statistics is a table of running processes, sorted by CPU usage. The table has columns for PID, USER, PR, NI, VIRT, RES, SHR, S, %CPU, %MEM, TIME+, and COMMAND. The processes listed include synergys, Xorg, gitkraken, java, chrome, soffice.bin, cinnamon, mysql-workb+, rcu_sched, jbd2/sda3-8, and kworker/0:3.

```
top - 19:20:01 up 36 days, 58 min, 16 users,  load average: 0.22, 0.37, 0.61
Tasks: 261 total,  1 running, 260 sleeping,  0 stopped,  0 zombie
%Cpu(s):  2.4 us,  0.7 sy,  0.0 ni, 94.5 id,  2.4 wa,  0.0 hi,  0.1 si,  0.0 st
KiB Mem: 16385372 total, 15191456 used, 1193916 free, 214664 buffers
KiB Swap:  0 total,  0 used,  0 free. 2157412 cached Mem

  PID USER      PR  NI   VIRT   RES   SHR  S  %CPU  %MEM     TIME+ COMMAND
26334 jin       20   0 359660 145872 3044  S   5.6   0.9 117:49.56 synergys
14813 root       20   0 1385312 709944 98988  S   4.3   4.3 1079:30 Xorg
29837 jin       20   0 1266756 157964 45252  S   3.3   1.0 51:35.46 gitkraken
13599 jin       20   0 4580424 741344 42680  S   1.7   4.5  4:52.36 java
10982 jin       20   0 1064520 256768 69236  S   1.3   1.6  2:56.79 chrome
12212 jin       20   0  905256 174400 64992  S   1.3   1.1  1:53.87 chrome
15929 jin       20   0 1336388 193640 63784  S   1.0   1.2  1:21.01 chrome
16214 jin       20   0 1700348 368796 147572  S   1.0   2.3  4:17.49 soffice.bin
 6094 jin       20   0 4708296 3.406g 109328  S   0.7  21.8 375:47.79 chrome
15095 jin       20   0 3343576 1.344g 66936  S   0.7   8.6 1801:02 cinnamon
17681 jin       20   0 2759368 268092 73244  S   0.7   1.6 91:45.25 mysql-workb+
    7 root       20   0      0      0      0  S   0.3   0.0 120:26.42 rcu_sched
   750 root       20   0      0      0      0  S   0.3   0.0 45:27.88 jbd2/sda3-8
 6270 jin       20   0  912320 181428 22932  S   0.3   1.1 33:54.64 chrome
10834 jin       20   0 1400552 271024 103400  S   0.3   1.7  0:30.18 chrome
10923 jin       20   0 1100208 276308 69236  S   0.3   1.7  0:27.95 chrome
11083 jin       20   0 1393880 239292 65112  S   0.3   1.5  0:19.33 chrome
14301 jin       20   0  763764 205568 92852  S   0.3   1.3  0:37.93 FoxitReader
17605 root       20   0      0      0      0  S   0.3   0.0  0:00.97 kworker/0:3
```

Utility : ps

- Report a snapshot of the current processes.

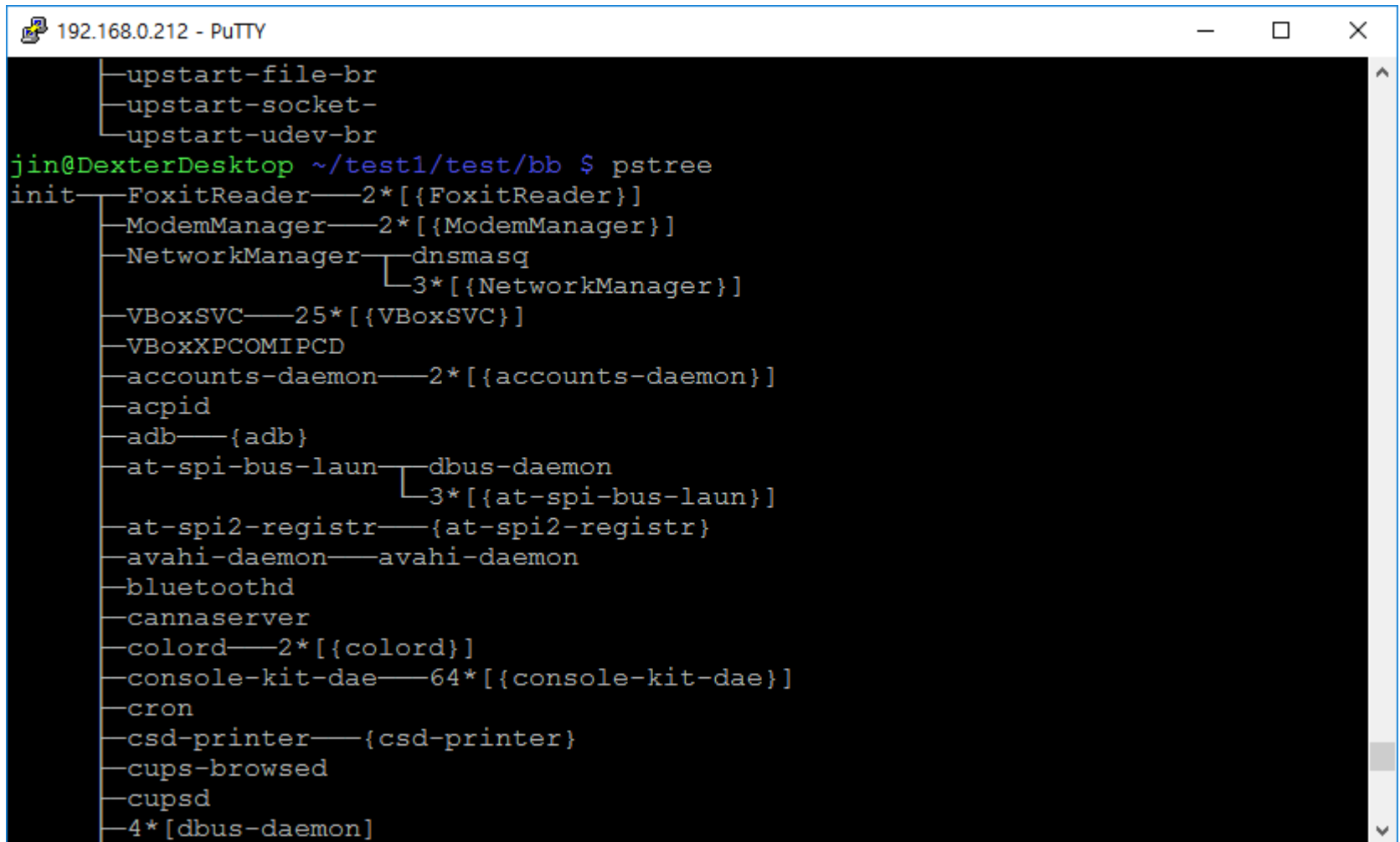
```
192.168.0.212 - PuTTY
PID TTY          TIME CMD
17117 pts/3        00:00:00 bash
17715 pts/3        00:00:00 ps
jin@DexterDesktop ~/test1/test/bb $ ps u
```

USER	PID	%CPU	%MEM	VSZ	RSS	TTY	STAT	START	TIME	COMMAND
jin	1631	0.0	0.0	48668	1068	pts/22	S+	Sep12	0:02	ssh -L 3312:kiwi
jin	1843	0.0	0.0	25200	3416	pts/7	Ss+	Sep12	0:00	bash
jin	14333	0.0	0.0	25216	3432	pts/11	Ss	Sep13	0:00	bash
jin	14424	0.0	0.0	51164	2688	pts/11	S+	Sep13	0:00	vi redzone.csv
jin	15570	0.0	0.0	25212	3420	tty2	S	Aug17	0:00	-bash
jin	15737	0.0	0.0	45984	4004	tty2	S+	Aug17	0:34	ssh -L 3307:kiwi
jin	15752	0.0	0.0	25116	3320	tty3	S	Aug17	0:00	-bash
jin	15777	0.0	0.0	44568	1056	tty3	S+	Aug17	0:21	ssh -L 3308:kiwi
jin	15792	0.0	0.0	25116	3320	tty4	S+	Aug17	0:00	-bash
jin	16541	0.0	0.0	25124	3300	pts/14	Ss+	Sep13	0:00	bash
jin	17074	0.0	0.0	25124	6752	pts/2	Ss+	18:37	0:00	bash
jin	17117	0.0	0.0	25196	6912	pts/3	Ss	18:38	0:00	-bash
jin	17716	0.0	0.0	19672	2824	pts/3	R+	19:21	0:00	ps u
jin	18364	0.0	0.0	25120	3288	pts/6	Ss+	Sep08	0:00	bash
jin	18699	0.0	0.0	25124	3332	pts/12	Ss+	Sep09	0:00	bash
jin	20500	0.0	0.0	25128	3336	pts/22	Ss	Sep01	0:00	bash
jin	21830	0.0	0.0	25124	3328	pts/13	Ss+	Sep13	0:00	bash
jin	21883	0.0	0.0	25124	3328	pts/15	Ss+	Sep13	0:00	bash
jin	22027	0.0	0.0	25120	3328	pts/17	Ss+	Sep08	0:00	bash
jin	22862	0.0	0.0	25140	3344	pts/16	Ss+	Sep08	0:00	bash

```
jin@DexterDesktop ~/test1/test/bb $
```

Utility : pstree

- Display a tree of processes

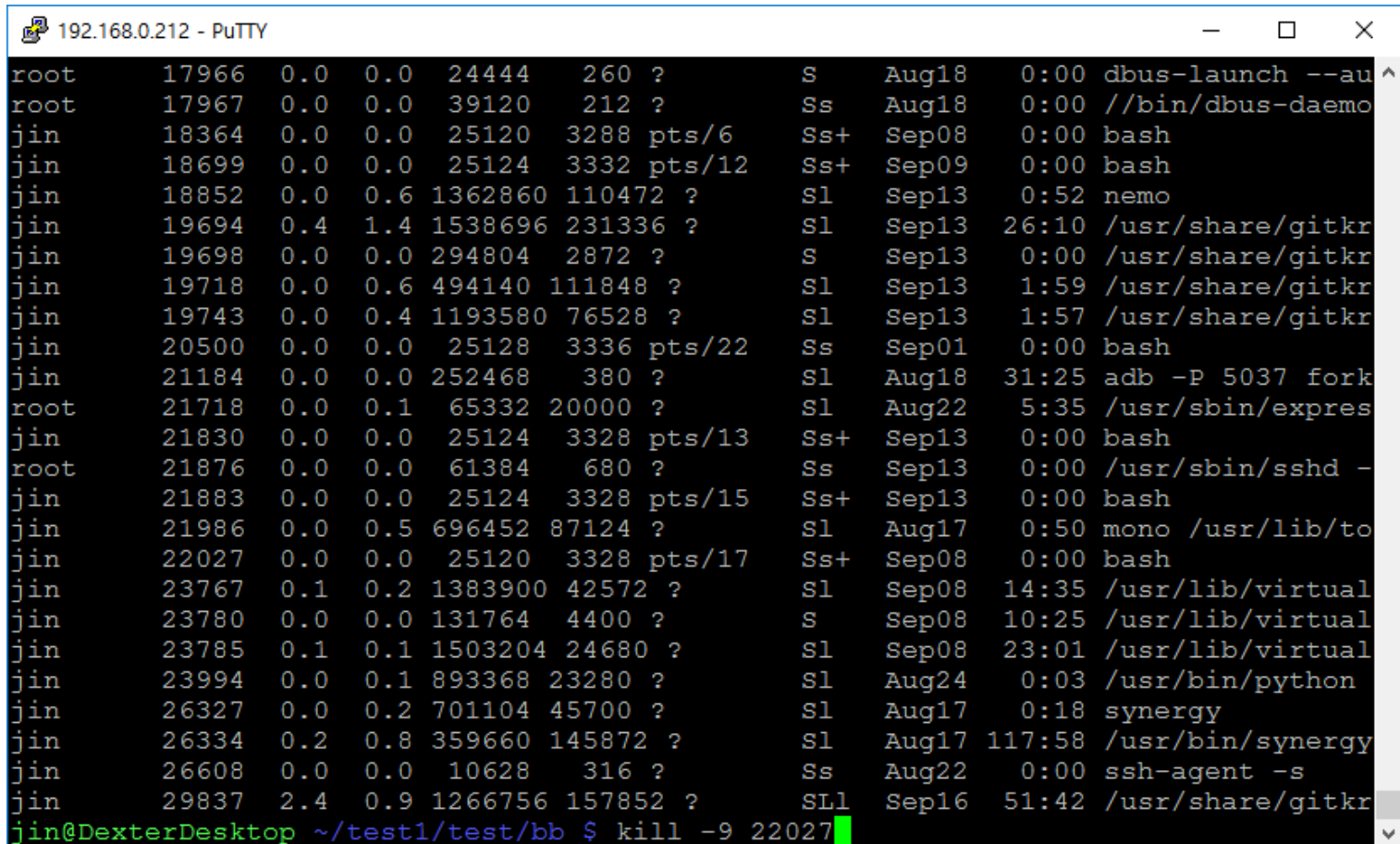


The screenshot shows a terminal window titled "192.168.0.212 - PuTTY". The user is logged in as "jin" on a machine named "DexterDesktop". The command "pstree" has been executed, displaying a hierarchical tree of running processes. The root process is "init", which has several children, including "FoxitReader", "ModemManager", "NetworkManager", "VBoxSVC", "VBoxXPCOMIPCD", "accounts-daemon", "acpid", "adb", "at-spi-bus-laun", "at-spi2-registr", "avahi-daemon", "bluetoothd", "cannaserver", "colord", "console-kit-dae", "cron", "csd-printer", "cups-browsed", "cupsd", and "dbus-daemon". Some processes have multiple instances, indicated by numbers in brackets.

```
192.168.0.212 - PuTTY
jin@DexterDesktop ~/test1/test/bb $ pstree
init--upstart-file-br
init--upstart-socket-
init--upstart-udev-br
init--FoxitReader--2*[{FoxitReader}]
init--ModemManager--2*[{ModemManager}]
init--NetworkManager--dnsmasq
init--NetworkManager--3*[{NetworkManager}]
init--VBoxSVC--25*[{VBoxSVC}]
init--VBoxXPCOMIPCD
init--accounts-daemon--2*[{accounts-daemon}]
init--acpid
init--adb--{adb}
init--at-spi-bus-laun--dbus-daemon
init--at-spi-bus-laun--3*[{at-spi-bus-laun}]
init--at-spi2-registr--{at-spi2-registr}
init--avahi-daemon--avahi-daemon
init--bluetoothd
init--cannaserver
init--colord--2*[{colord}]
init--console-kit-dae--64*[{console-kit-dae}]
init--cron
init--csd-printer--{csd-printer}
init--cups-browsed
init--cupsd
init--4*[{dbus-daemon}]
```

Utility : kill

- Send a signal to a process.
- **kill -9** : sends a termination signal



The screenshot shows a PuTTY terminal window titled "192.168.0.212 - PuTTY". The terminal displays the output of the 'ps' command, listing various processes with their PIDs, PPIDs, CPU and memory usage, names, and command lines. The processes include system daemons like dbus-launch and dbus-daemon, user shells like bash, and applications like nemo, gitkr, adb, sshd, mono, and synergy. At the bottom of the terminal, the user 'jin' at 'DexterDesktop' has entered the command 'kill -9 22027' in a green prompt, with a green cursor at the end of the line.

```
root      17966  0.0  0.0  24444   260 ?        S      Aug18   0:00 dbus-launch --au ^
root      17967  0.0  0.0   39120   212 ?        Ss     Aug18   0:00 //bin/dbus-daemo
jin       18364  0.0  0.0   25120  3288 pts/6    Ss+    Sep08   0:00 bash
jin       18699  0.0  0.0   25124  3332 pts/12   Ss+    Sep09   0:00 bash
jin       18852  0.0  0.6  1362860 110472 ?      Sl     Sep13   0:52 nemo
jin       19694  0.4  1.4  1538696 231336 ?      Sl     Sep13  26:10 /usr/share/gitkr
jin       19698  0.0  0.0   294804   2872 ?        S      Sep13   0:00 /usr/share/gitkr
jin       19718  0.0  0.6   494140 111848 ?      Sl     Sep13   1:59 /usr/share/gitkr
jin       19743  0.0  0.4  1193580  76528 ?      Sl     Sep13   1:57 /usr/share/gitkr
jin       20500  0.0  0.0   25128  3336 pts/22   Ss     Sep01   0:00 bash
jin       21184  0.0  0.0   252468   380 ?        Sl     Aug18  31:25 adb -P 5037 fork
root      21718  0.0  0.1    65332 20000 ?        Sl     Aug22   5:35 /usr/sbin/expres
jin       21830  0.0  0.0   25124  3328 pts/13   Ss+    Sep13   0:00 bash
root      21876  0.0  0.0    61384   680 ?        Ss     Sep13   0:00 /usr/sbin/sshd -
jin       21883  0.0  0.0   25124  3328 pts/15   Ss+    Sep13   0:00 bash
jin       21986  0.0  0.5   696452 87124 ?        Sl     Aug17   0:50 mono /usr/lib/to
jin       22027  0.0  0.0   25120  3328 pts/17   Ss+    Sep08   0:00 bash
jin       23767  0.1  0.2  1383900 42572 ?        Sl     Sep08  14:35 /usr/lib/virtual
jin       23780  0.0  0.0   131764   4400 ?        S      Sep08  10:25 /usr/lib/virtual
jin       23785  0.1  0.1   1503204 24680 ?      Sl     Sep08  23:01 /usr/lib/virtual
jin       23994  0.0  0.1   893368 23280 ?        Sl     Aug24   0:03 /usr/bin/python
jin       26327  0.0  0.2   701104 45700 ?        Sl     Aug17   0:18 synergy
jin       26334  0.2  0.8   359660 145872 ?      Sl     Aug17 117:58 /usr/bin/synergy
jin       26608  0.0  0.0    10628   316 ?        Ss     Aug22   0:00 ssh-agent -s
jin       29837  2.4  0.9  1266756 157852 ?      SLl    Sep16  51:42 /usr/share/gitkr
jin@DexterDesktop ~/test1/test/bb $ kill -9 22027
```

Utility : command &

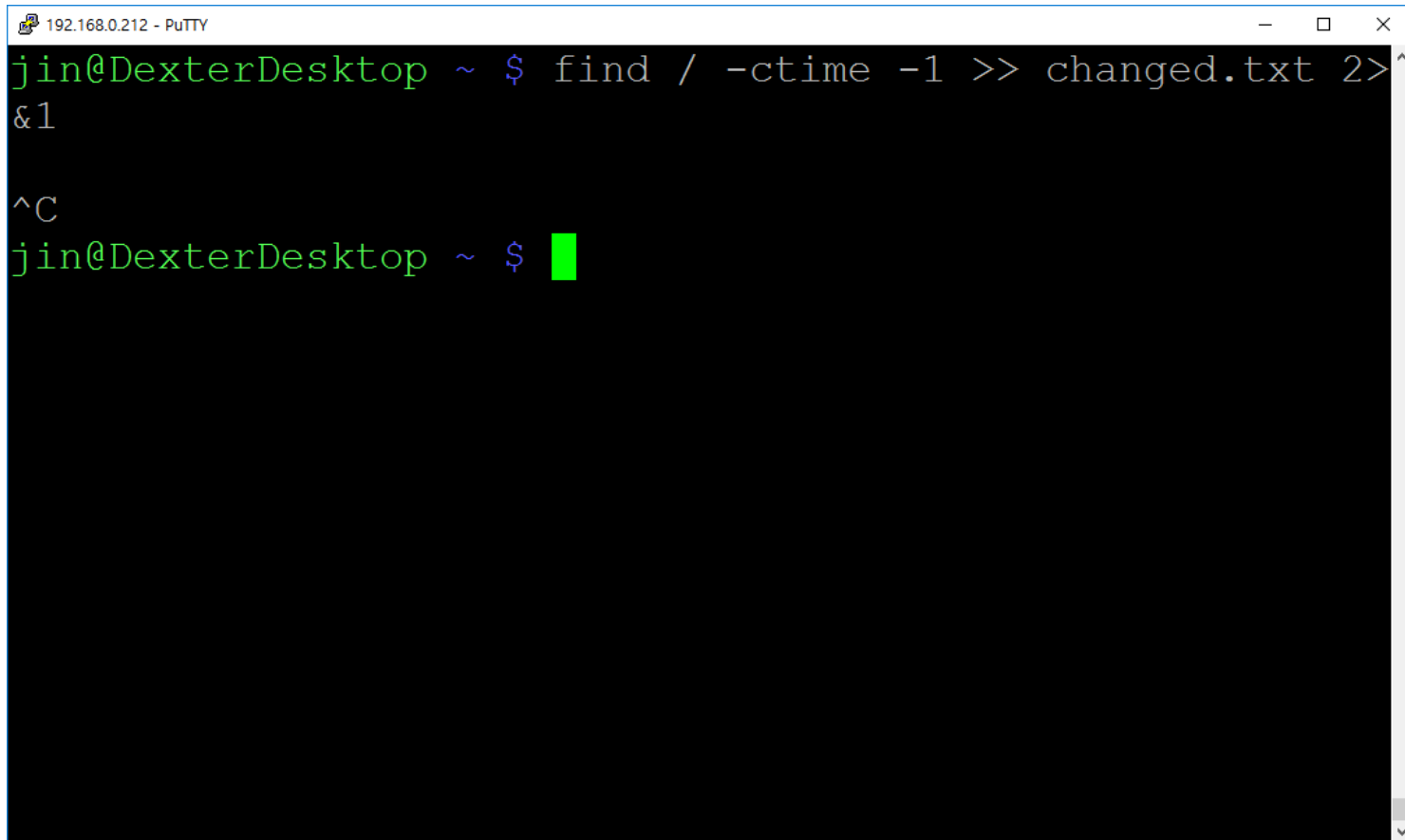
- **command &**
 - Run command in the background.
- **find / -ctime -1 > changed-file-list.txt 2>&1**
- **find / -ctime -1 > changed-file-list.txt 2>&1 &**



```
192.168.0.212 - PuTTY
jin@DexterDesktop ~ $ find / -ctime -1 >> changed.txt 2>^
&1 &
[1] 17885
jin@DexterDesktop ~ $
jin@DexterDesktop ~ $
jin@DexterDesktop ~ $
jin@DexterDesktop ~ $
[1]+  Exit 1                  find / -ctime -1 >> change
d.txt 2>&1
jin@DexterDesktop ~ $
```

Utility : Ctrl + C

- **Ctrl + C**
 - Terminate a process running in the foreground.



A screenshot of a PuTTY terminal window titled "192.168.0.212 - PuTTY". The terminal shows a user prompt "jin@DexterDesktop ~ \$" followed by the command "find / -ctime -1 >> changed.txt 2> ^&1". The user then presses Ctrl+C, which is represented by "^C" on the next line. The terminal then shows the user prompt "jin@DexterDesktop ~ \$" followed by a red cursor block, indicating the process has been terminated.

```
192.168.0.212 - PuTTY
jin@DexterDesktop ~ $ find / -ctime -1 >> changed.txt 2> ^&1
^C
jin@DexterDesktop ~ $ █
```

Utility : Ctrl + Z

- **Ctrl + Z**
 - Suspend a process running in the foreground.



The screenshot shows a PuTTY terminal window titled "192.168.0.212 - PuTTY". The user 'jin' is at the 'DexterDesktop' machine. They have entered the command `find / -ctime -1 >> changed.txt 2>&1`. After pressing Ctrl+Z, the terminal shows `^Z` followed by `[1]+ Stopped find / -ctime -1 >> change`. The prompt `jin@DexterDesktop ~ $` is shown with a green cursor.

```
192.168.0.212 - PuTTY
jin@DexterDesktop ~ $ find / -ctime -1 >> changed.txt 2>&1
^Z
[1]+  Stopped                  find / -ctime -1 >> change
d.txt 2>&1
jin@DexterDesktop ~ $
```


Utility : bg

- **bg**
 - **Reactivate a suspended program in the background.**



```
192.168.0.212 - PuTTY
jin@DexterDesktop ~ $ find / -ctime -1 >> changed.txt 2>&1
^Z
[1]+  Stopped                  find / -ctime -1 >> change
d.txt 2>&1
jin@DexterDesktop ~ $ bg
[1]+  find / -ctime -1 >> changed.txt 2>&1 &
jin@DexterDesktop ~ $
```

Utility : fg

- **fg**
 - Place a job in the foreground, and make it the current job.



```
192.168.0.212 - PuTTY
jin@DexterDesktop ~ $ find / -ctime -1 >> changed.txt 2>&1 &
[3] 17917
jin@DexterDesktop ~ $ fg
find / -ctime -1 >> changed.txt 2>&1
[3]-  Exit 1                  find / -ctime -1 >> change
d.txt 2>&1
jin@DexterDesktop ~ $
```