Chapter 10
Linux

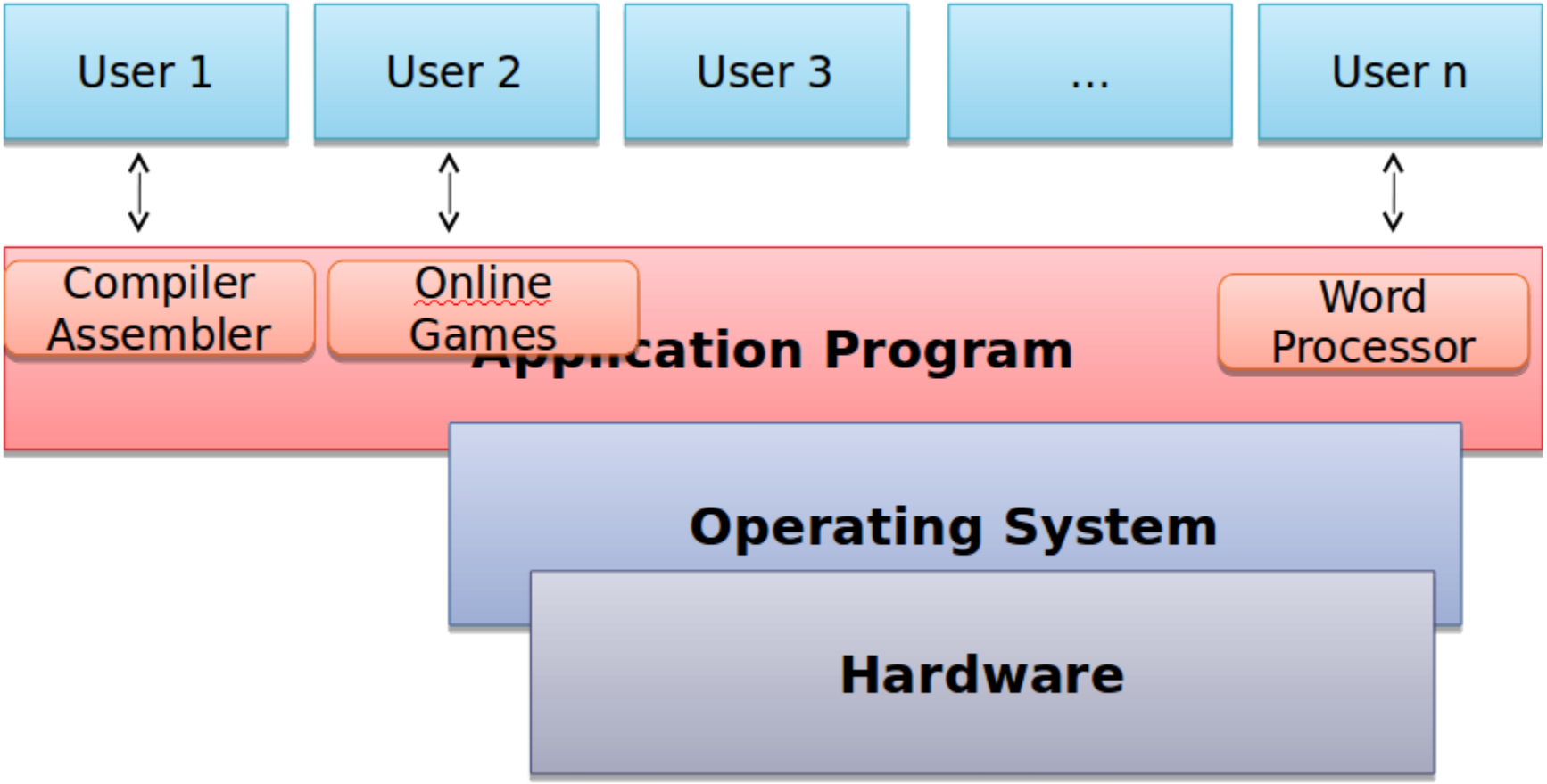
Open Source SW Development
CSE22300

Linux Overview

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



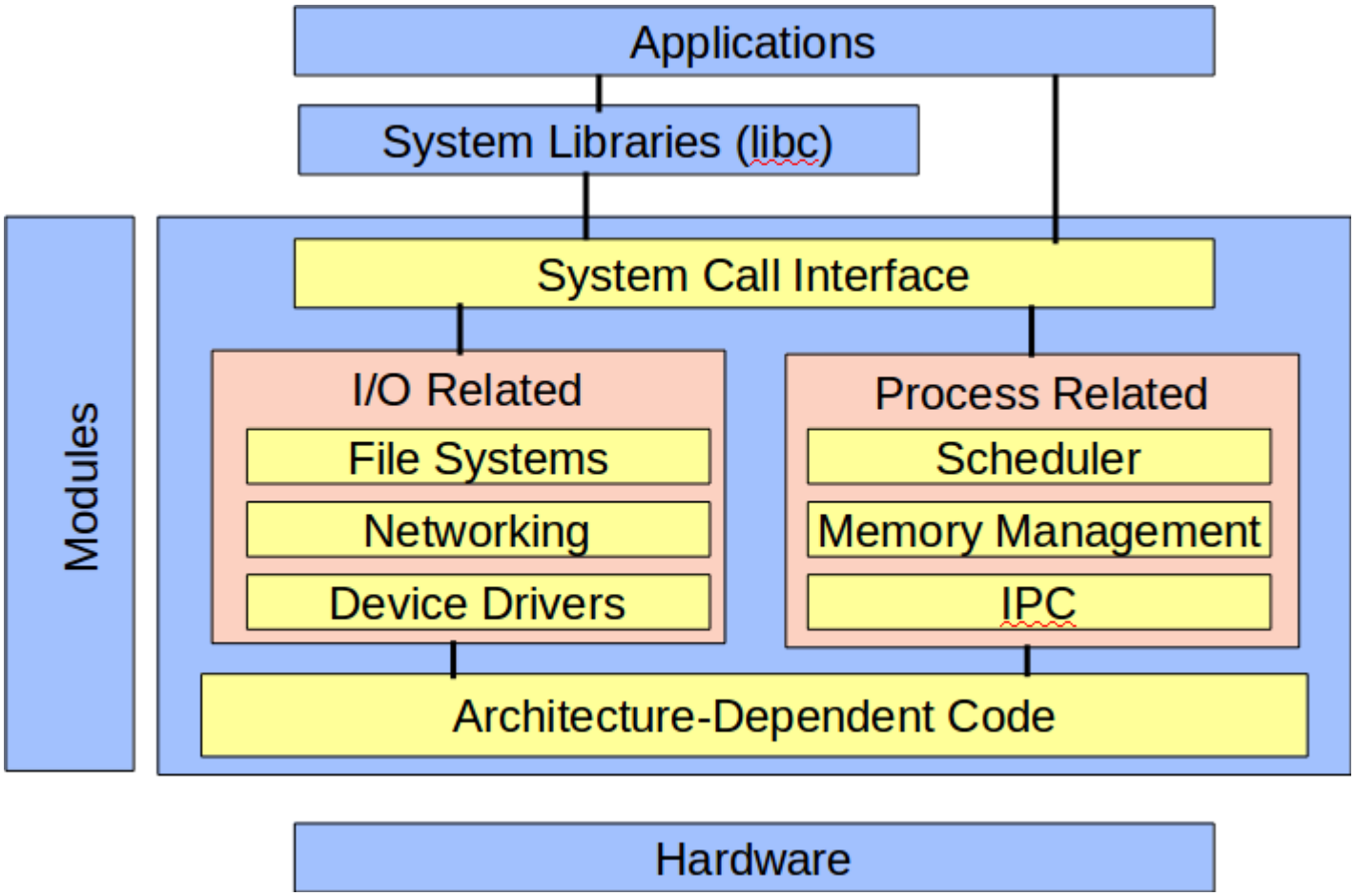
Kernel

- 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

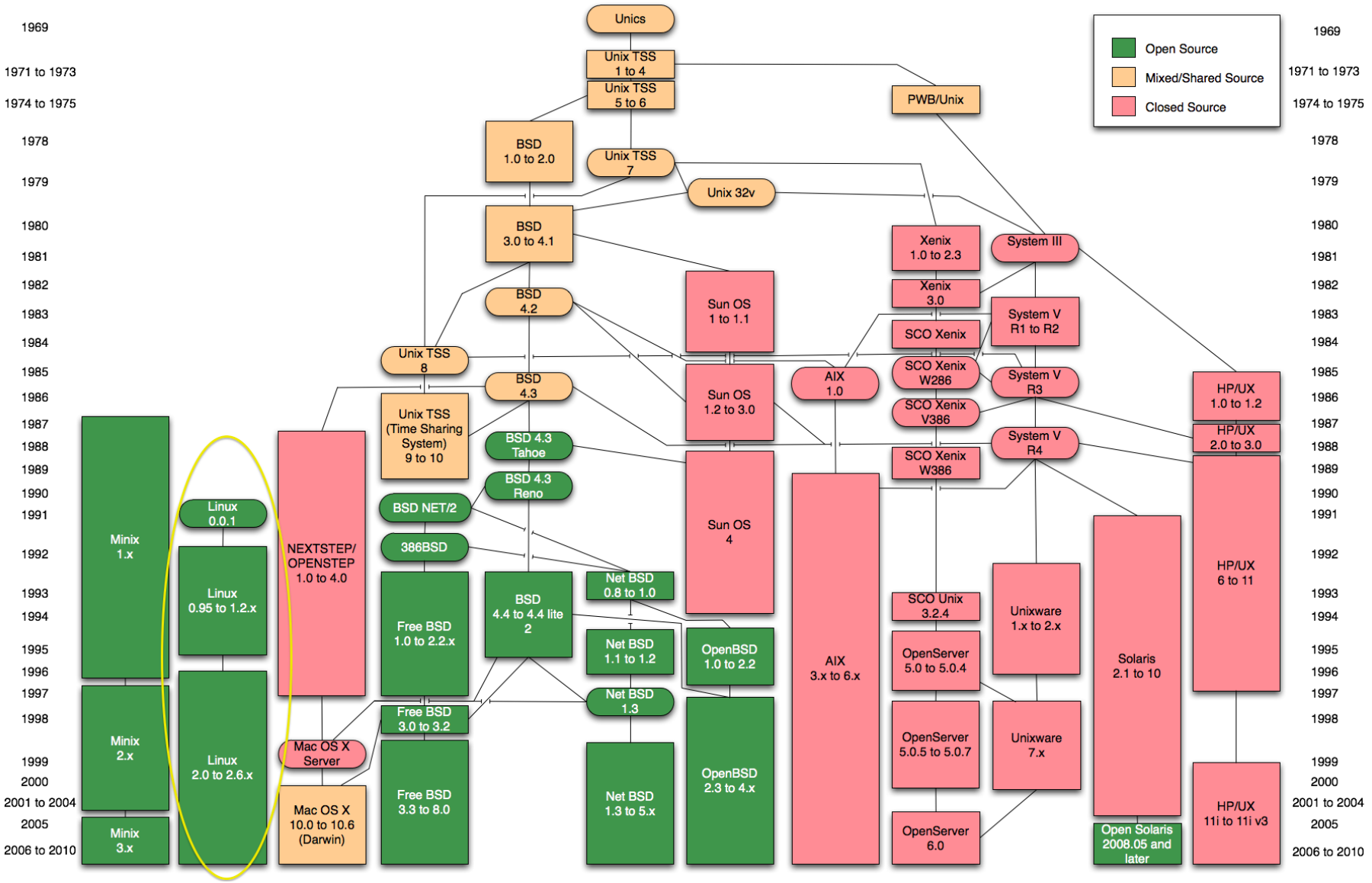
Kernel Design Goal

- **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


Applications
System Libraries (libc)
Modules
System Call Interface
I/O Related
File Systems
Networking
Device Drivers
Process Related
Scheduler
Memory Management
IPC
Architecture-Dependent Code
Hardware

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**

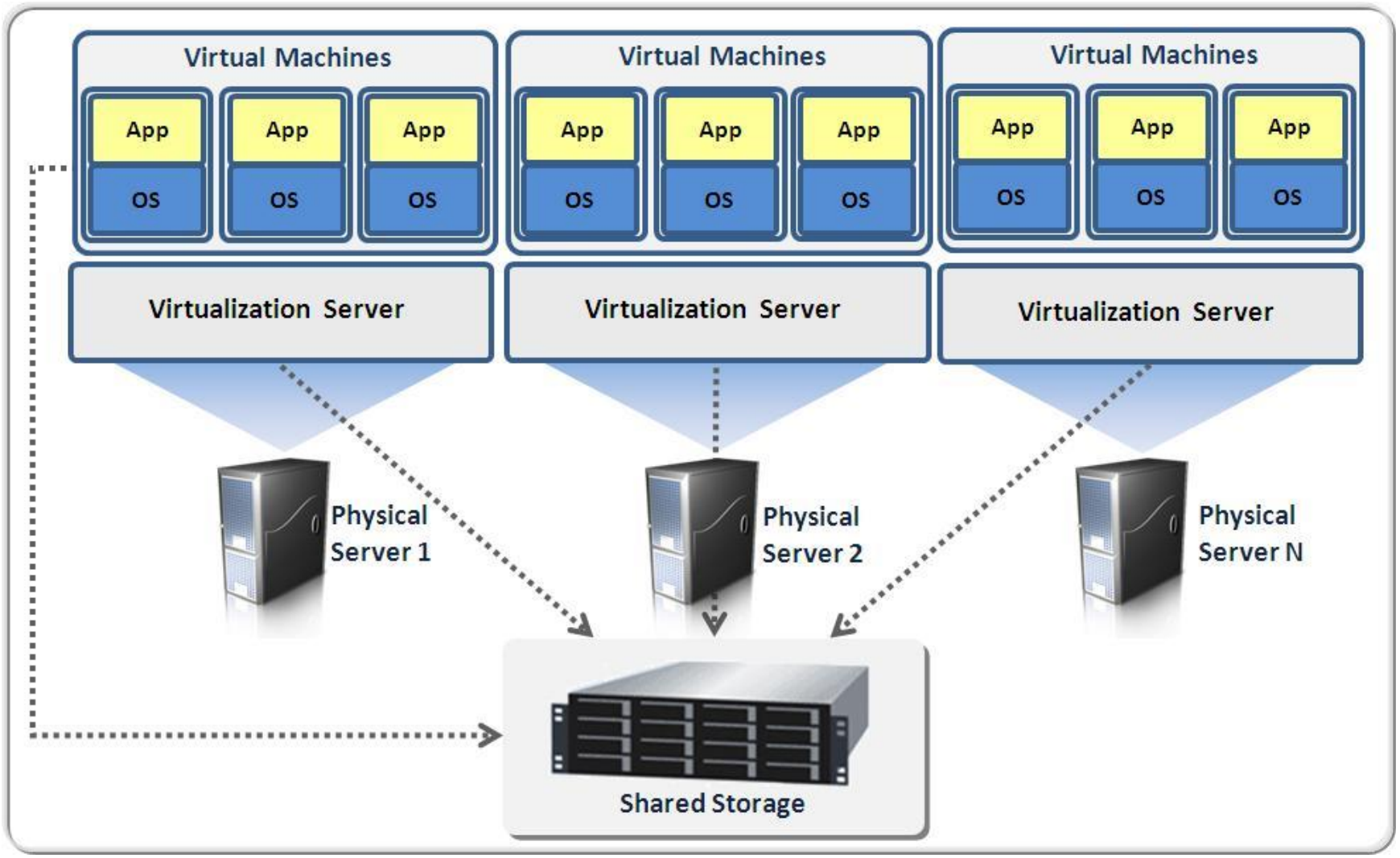
Linux Distribution

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.**

Installing Linux

Virtualization



Installing Virtualbox

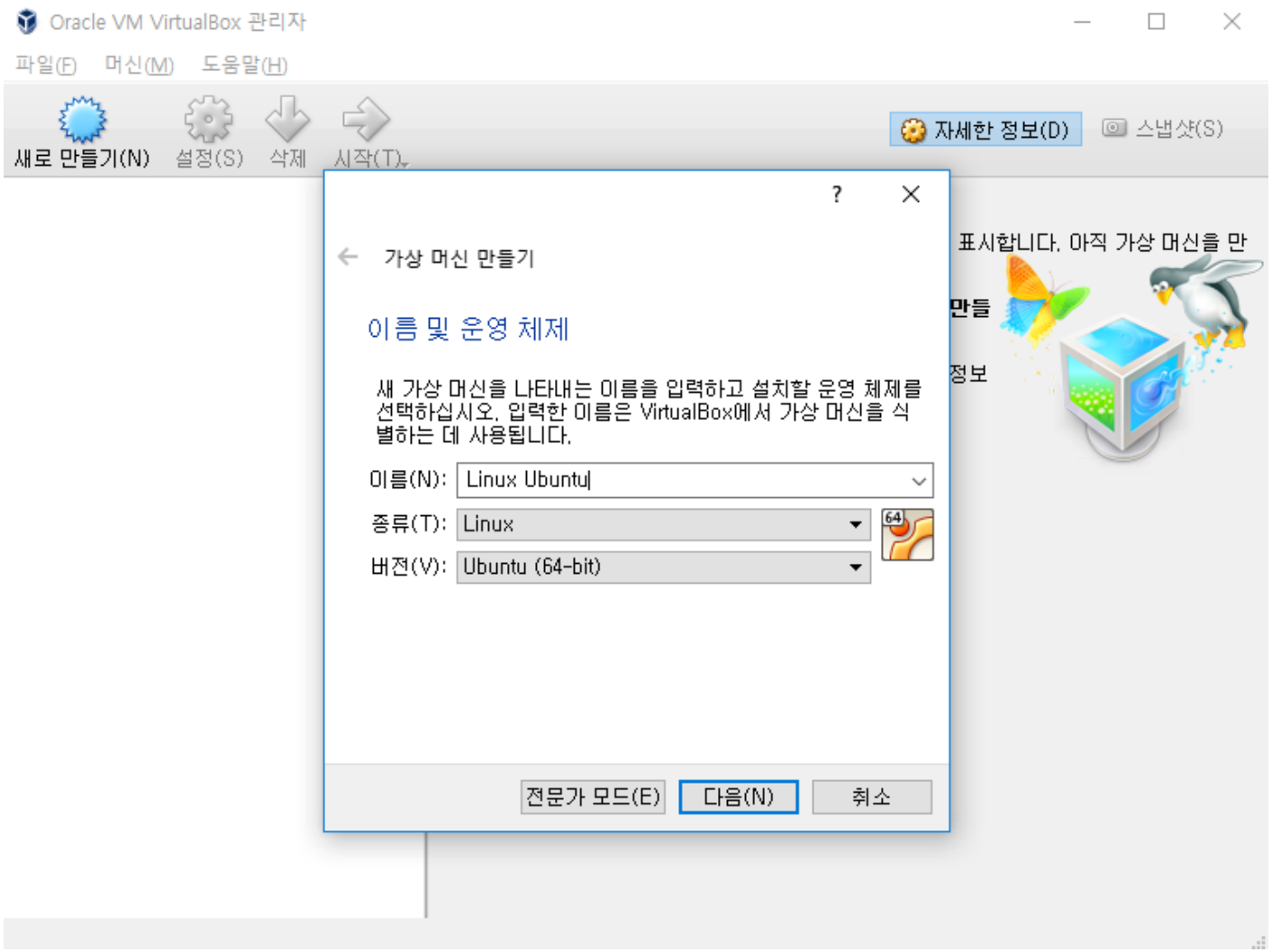
- Oracle VM VirtualBox
  - a free and open-source hypervisor for x86 computers
  - Supported Platform : Linux, OS X, Windows, Solaris, and OpenSolaris
- Creation and management of guest virtual machines
  - Windows, Linux, BSD, OS/2, Solaris, Haiku, OSx86 and others

- Download
  - http://download.virtualbox.org/virtualbox/5.2.0/VirtualBox-5.2.0-118431-Win.exe
  - Next, Next, Next…

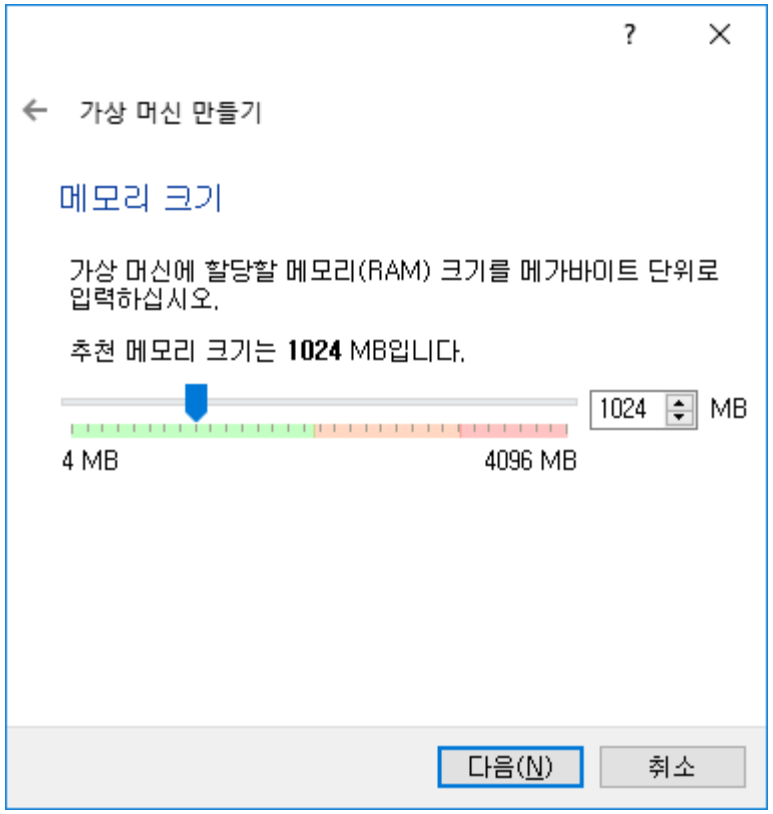
Download Ubuntu Image

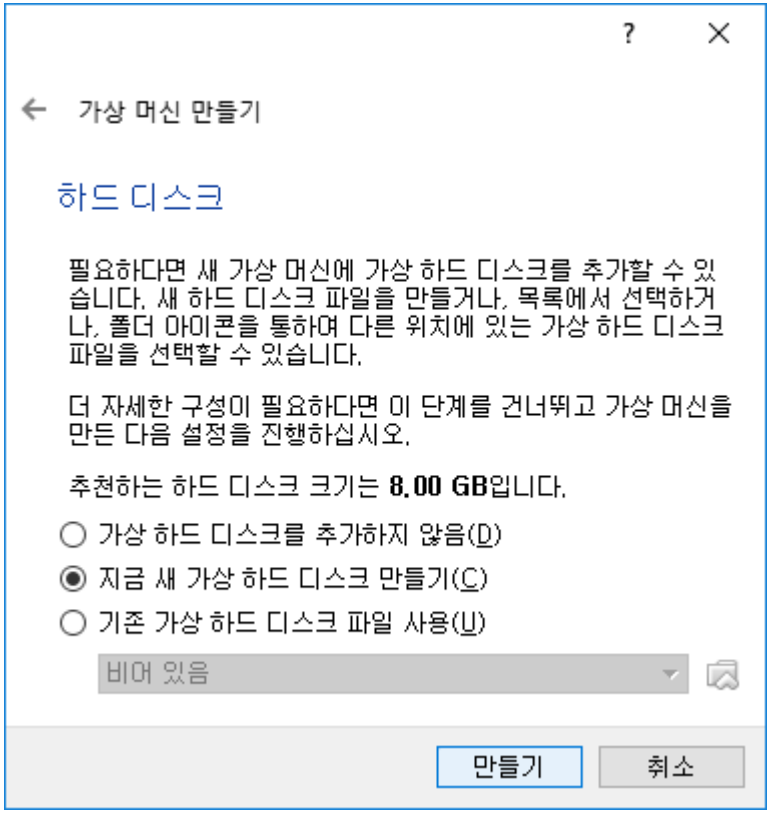
- Direct Download
  - http://ftp.daumkakao.com/ubuntu-releases/16.04.3/ubuntu-16.04.3-desktop-amd64.iso
  - http://ftp.neowiz.com/ubuntu-releases/16.04.3/ubuntu-16.04.3-desktop-amd64.iso

Create Virtual Machine

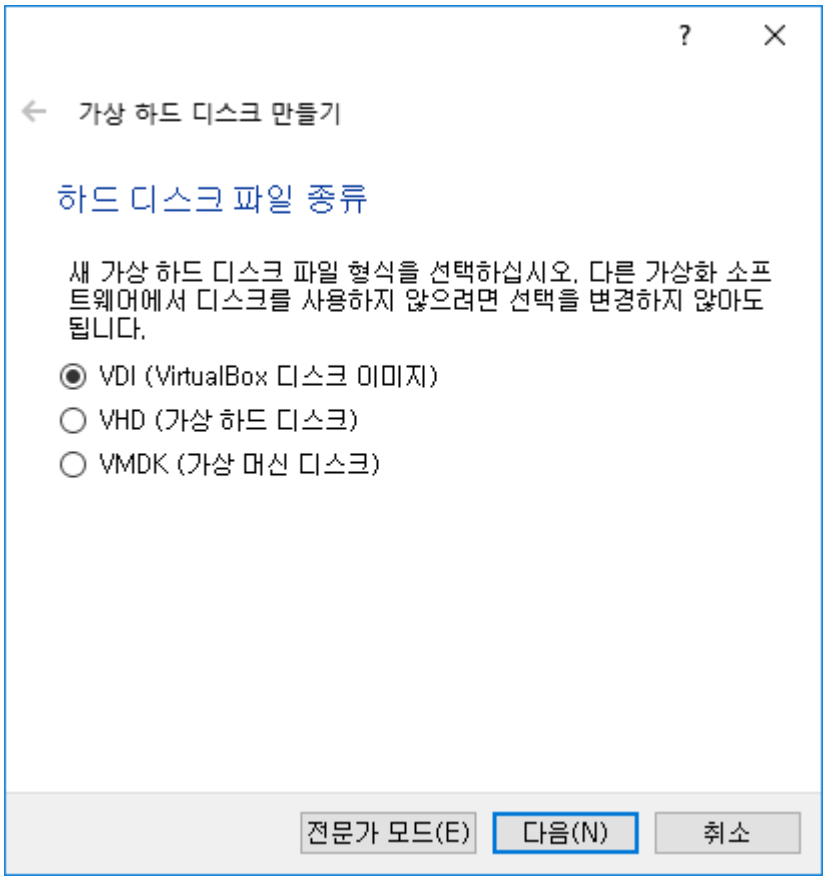


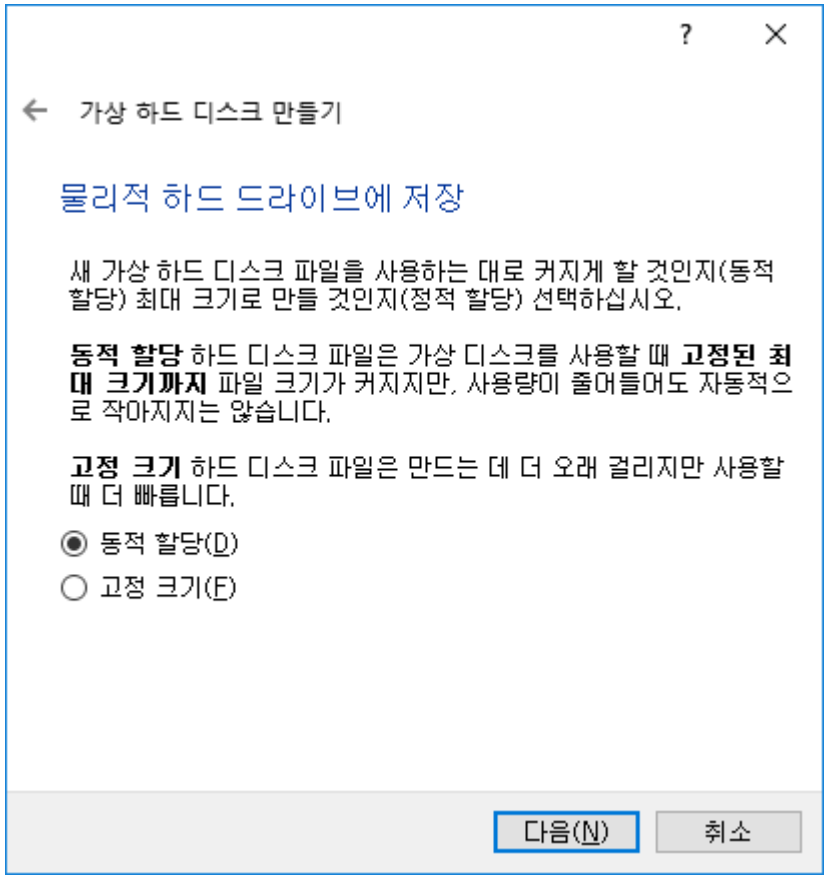
Create Virtual Machine



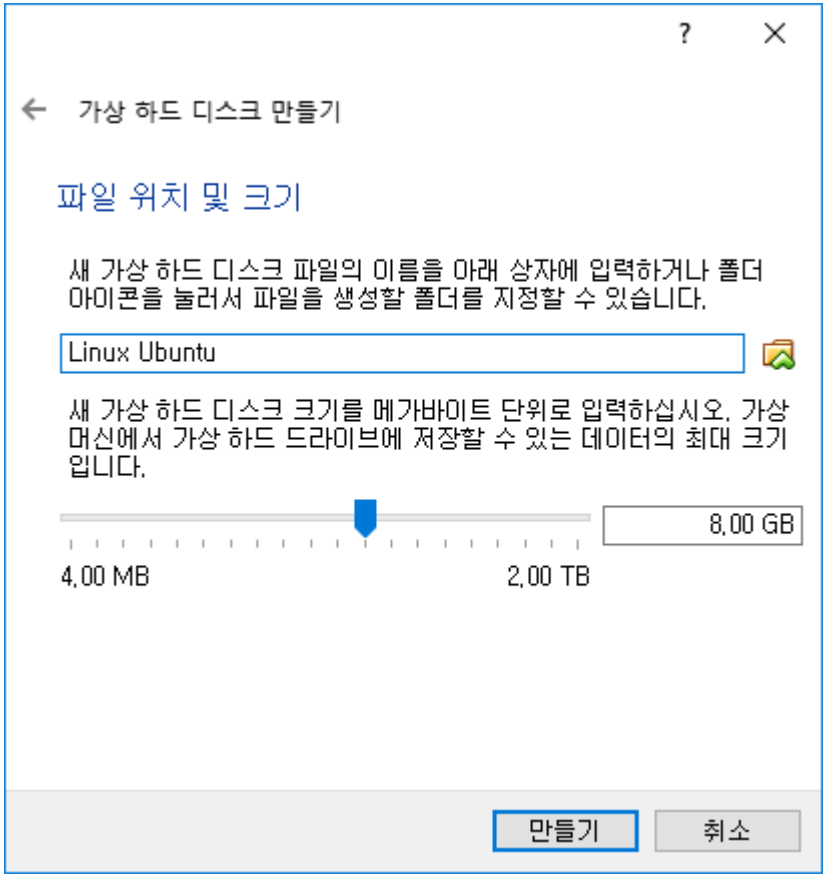


Create Virtual Machine



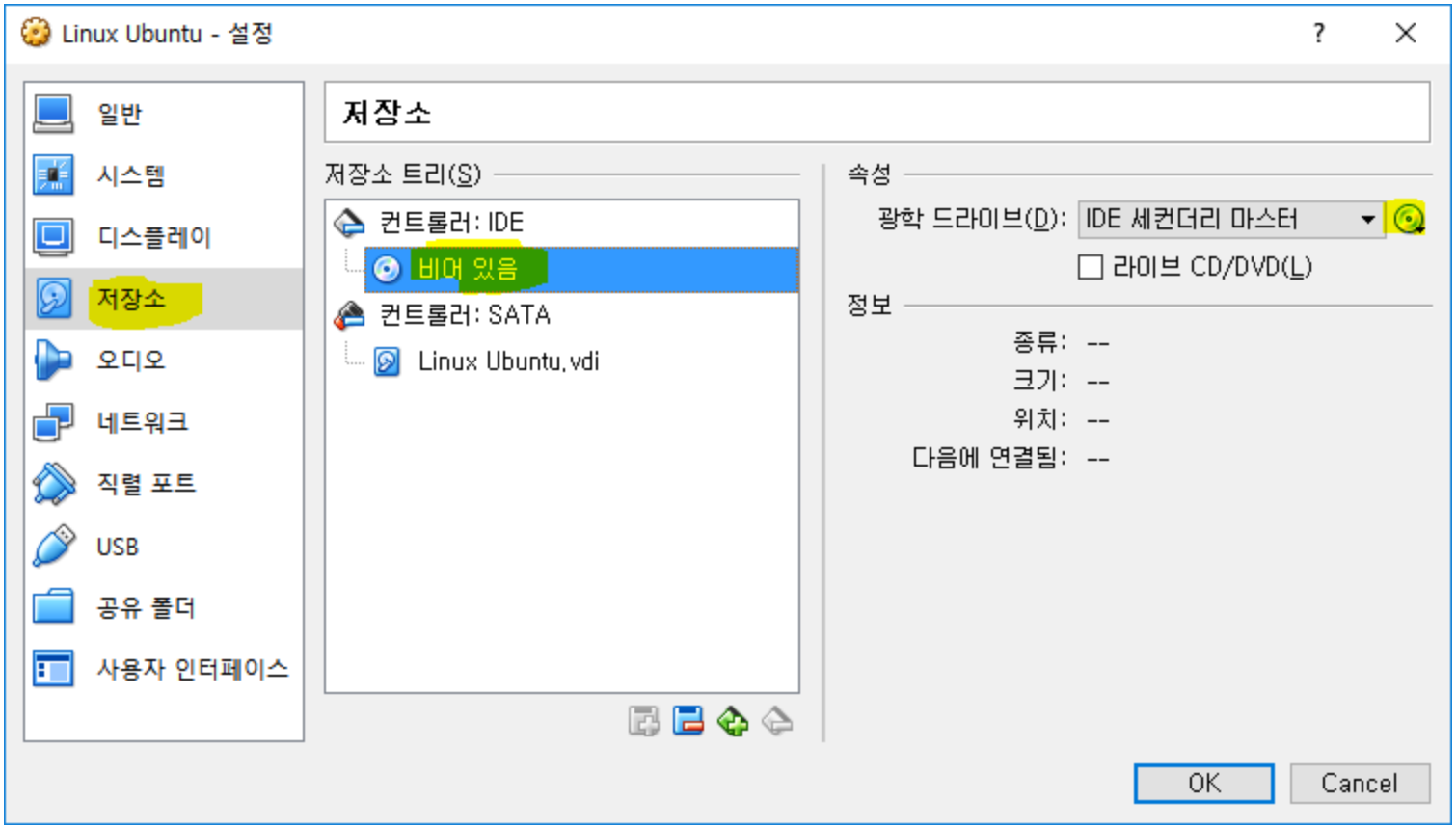


Create Virtual Machine

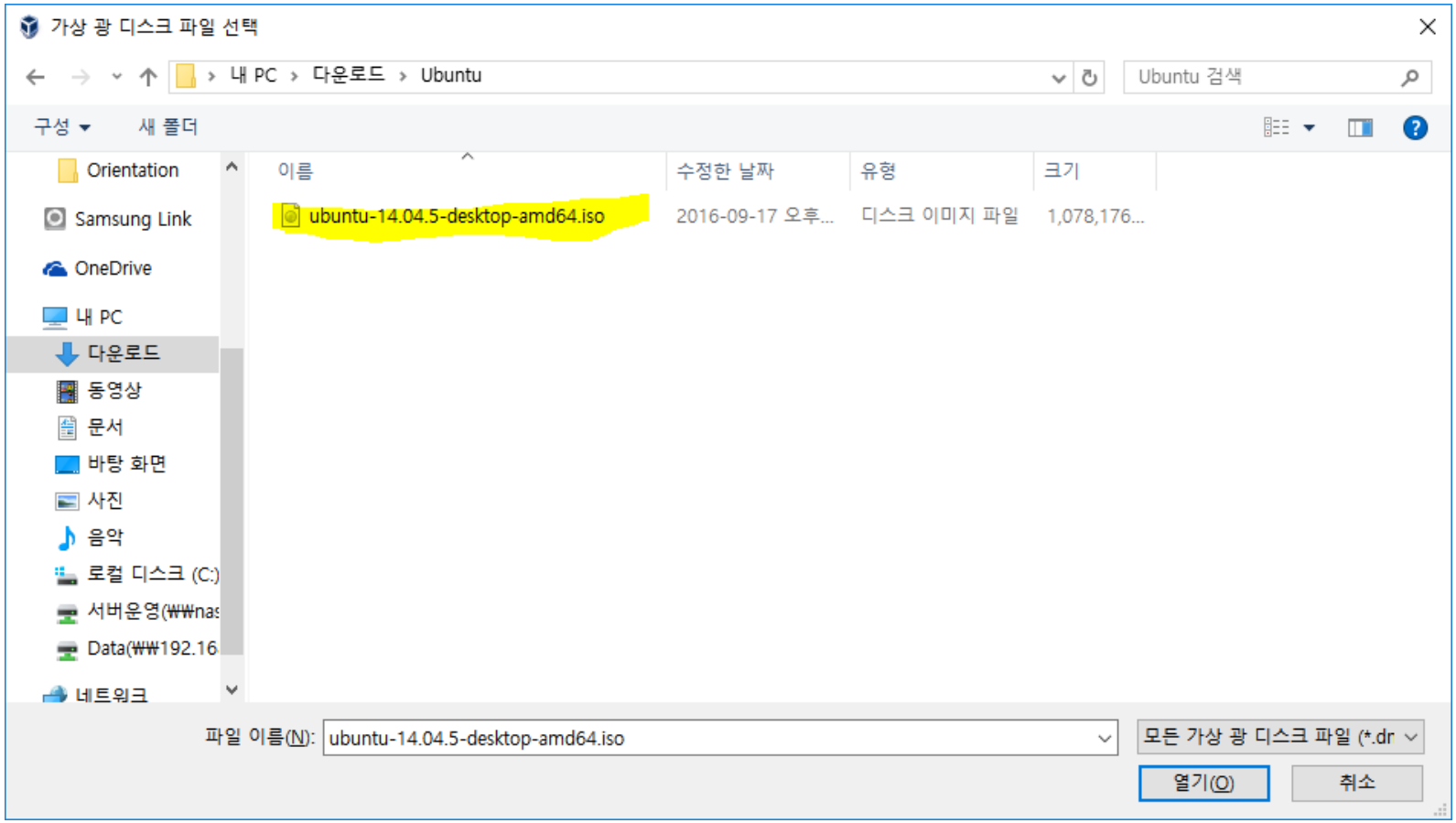


Create Virtual Machine

Create Virtual Machine



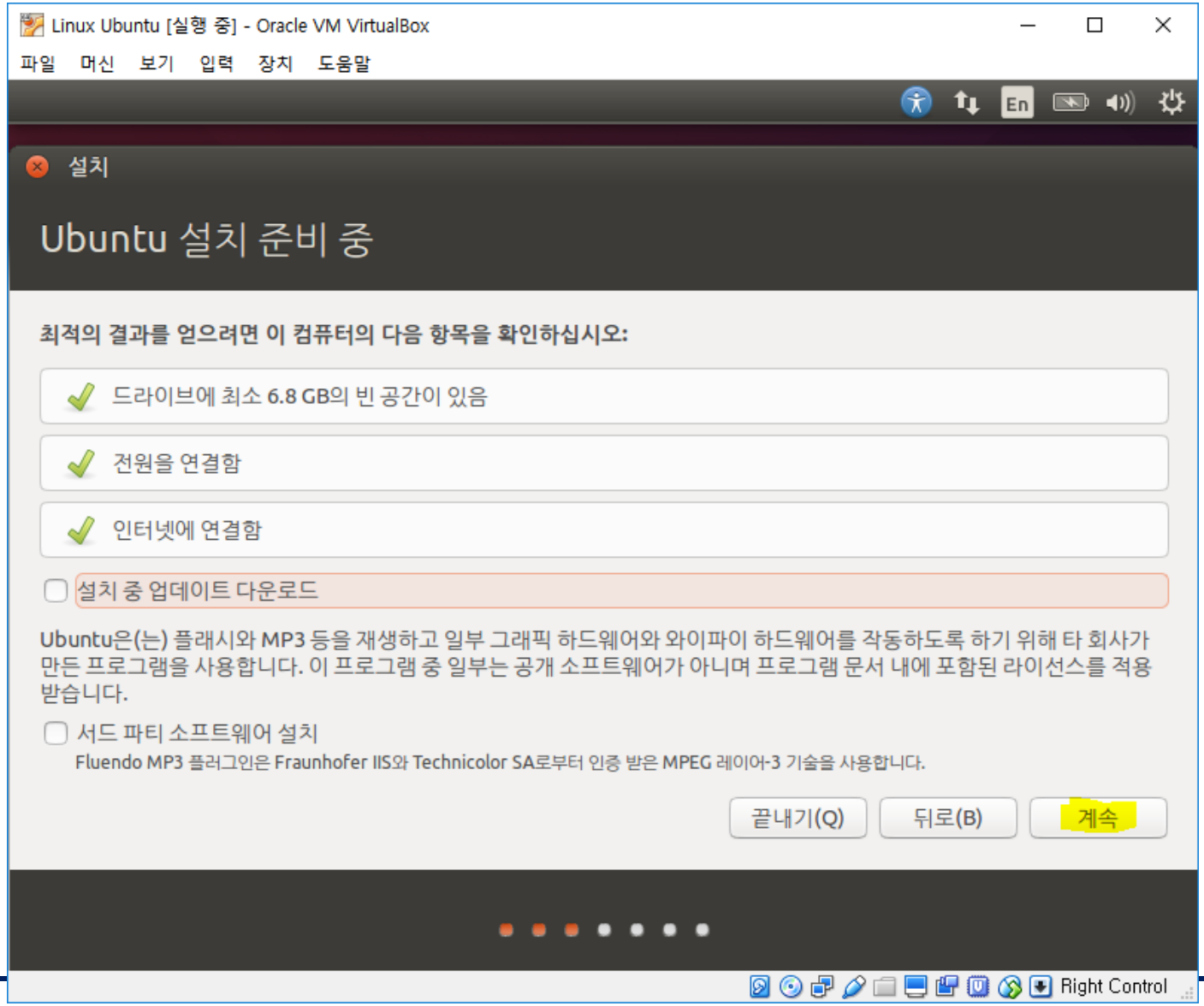
Create Virtual Machine



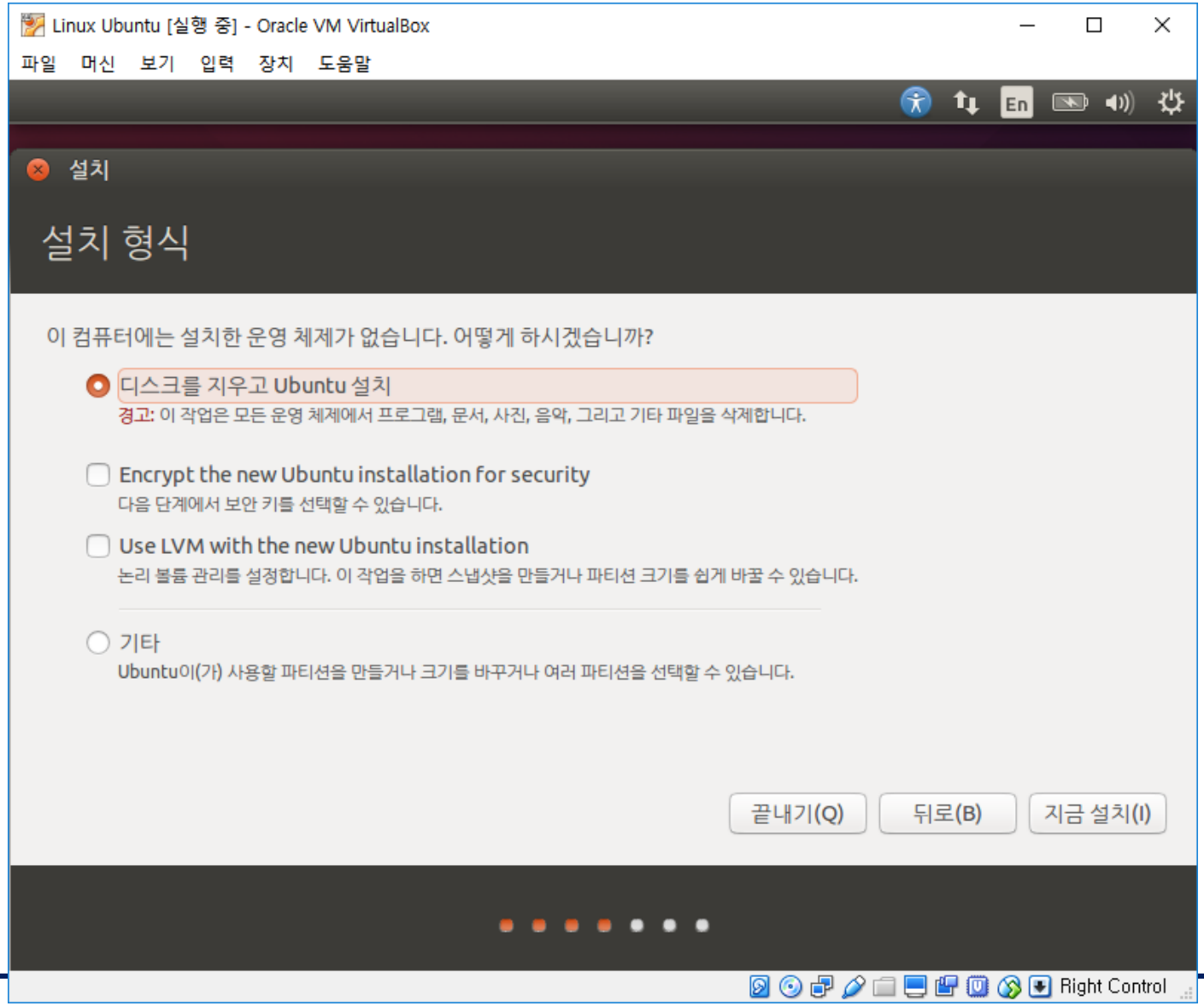
Create Virtual Machine

Installing Linux

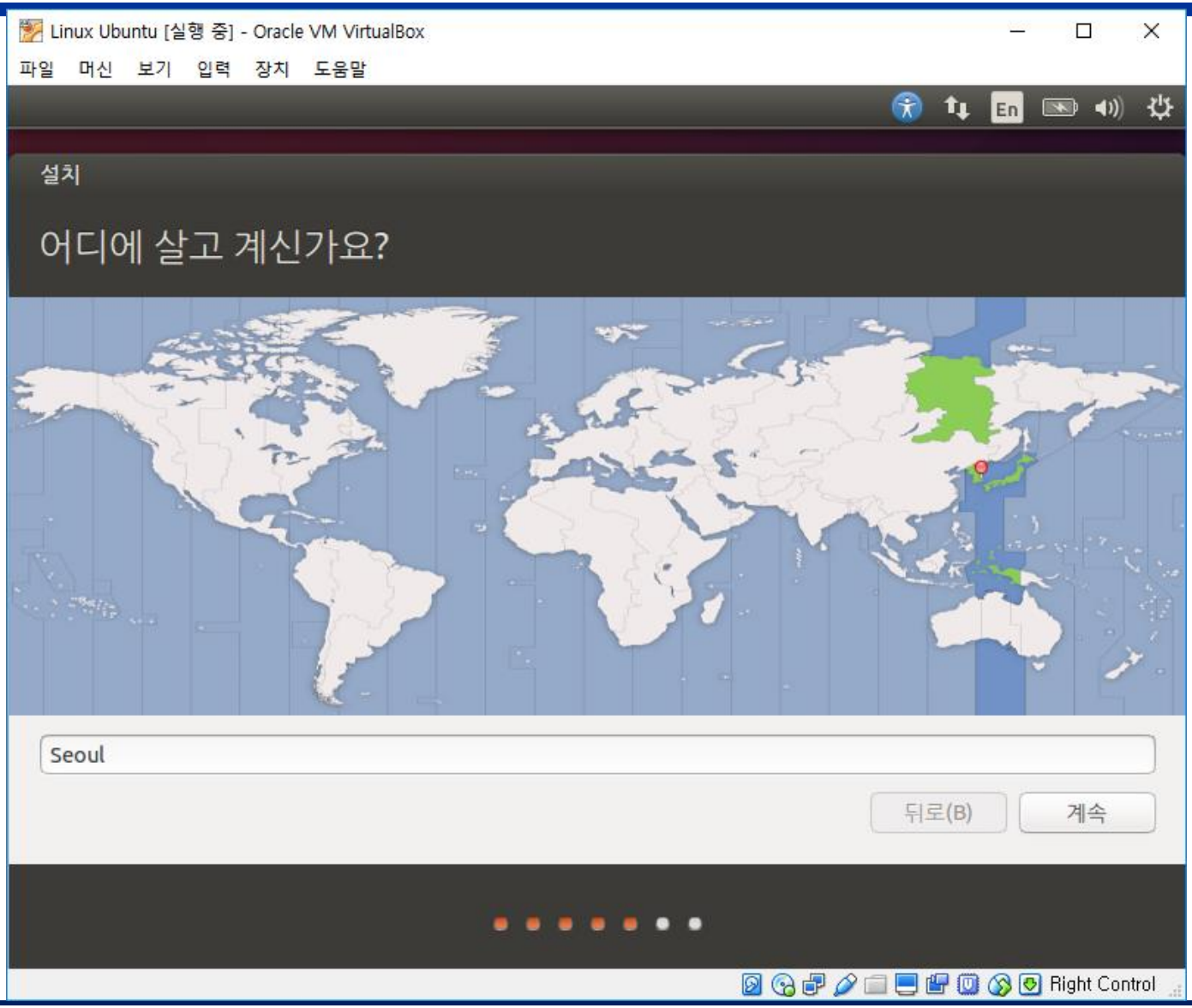
Installing Linux



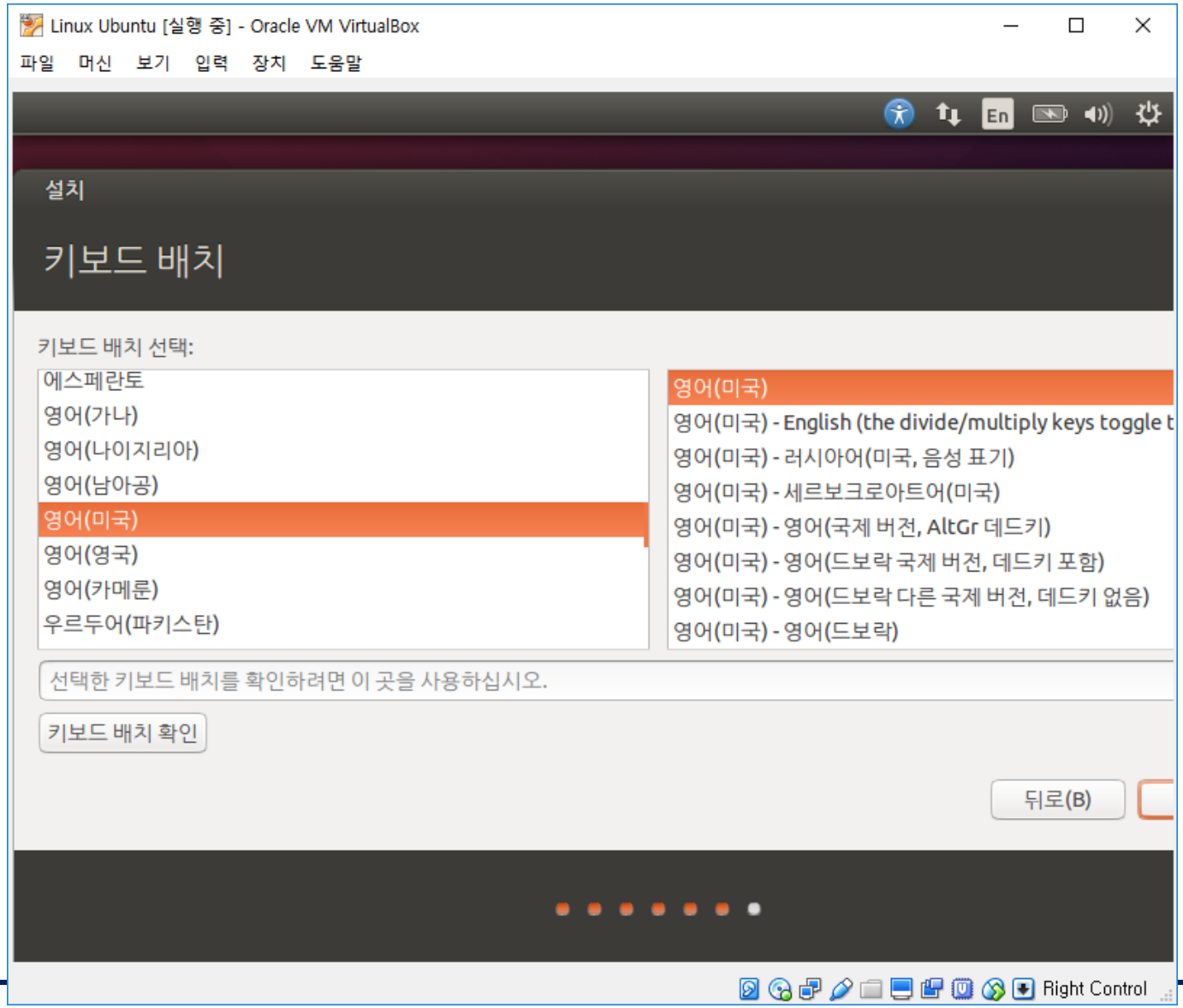
Installing Linux



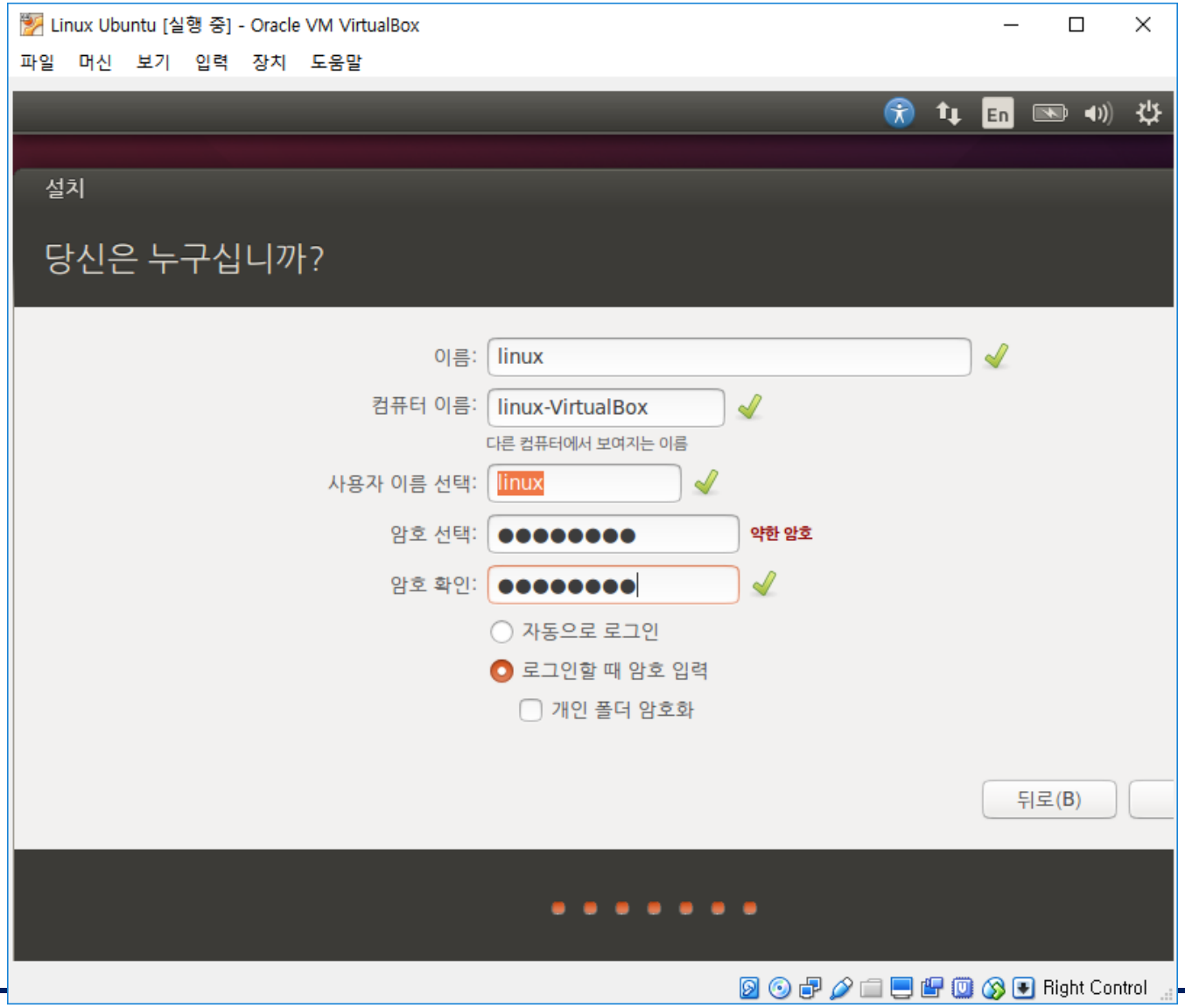
Installing Linux



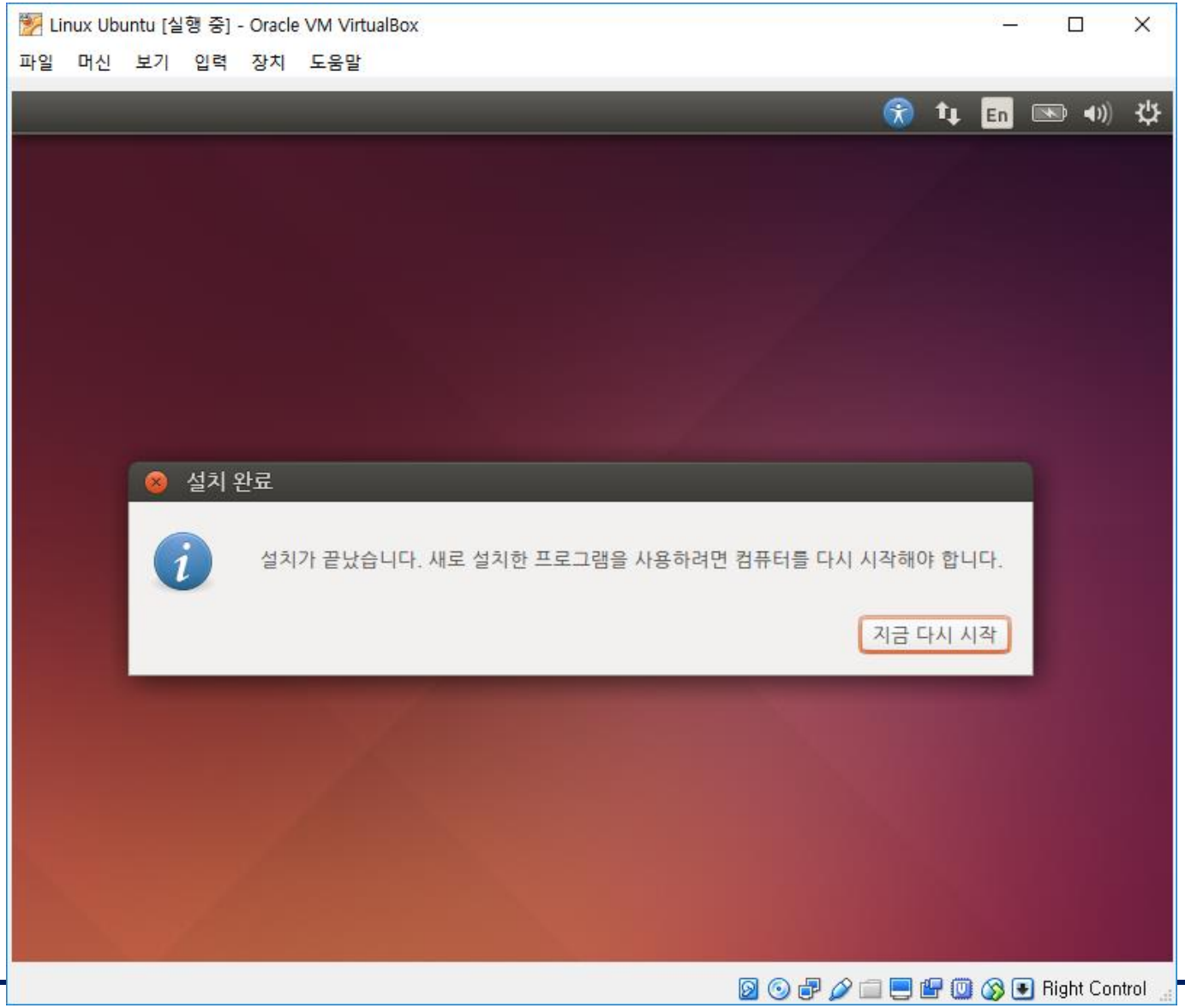
Installing Linux



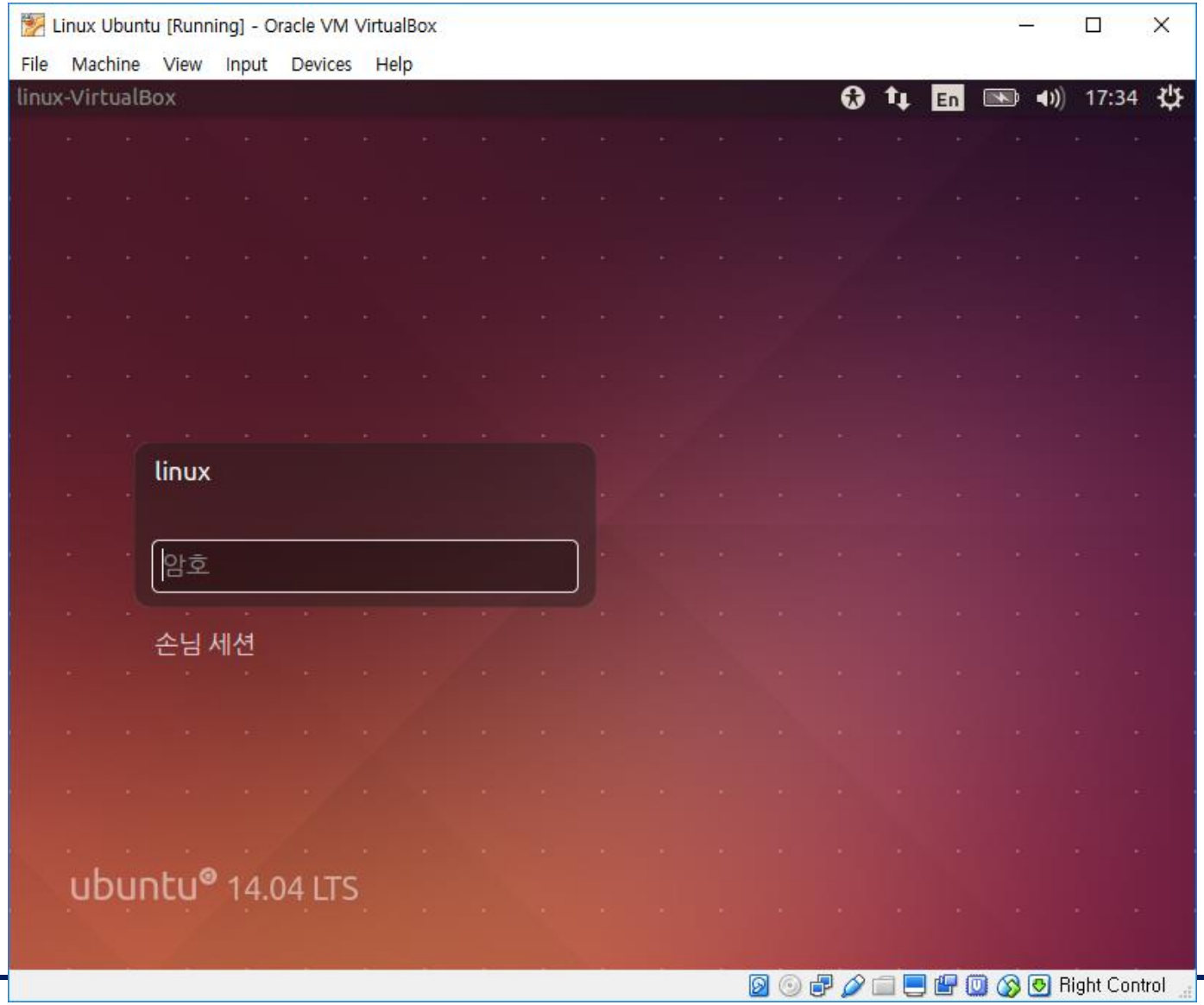
Installing Linux



Installing Linux

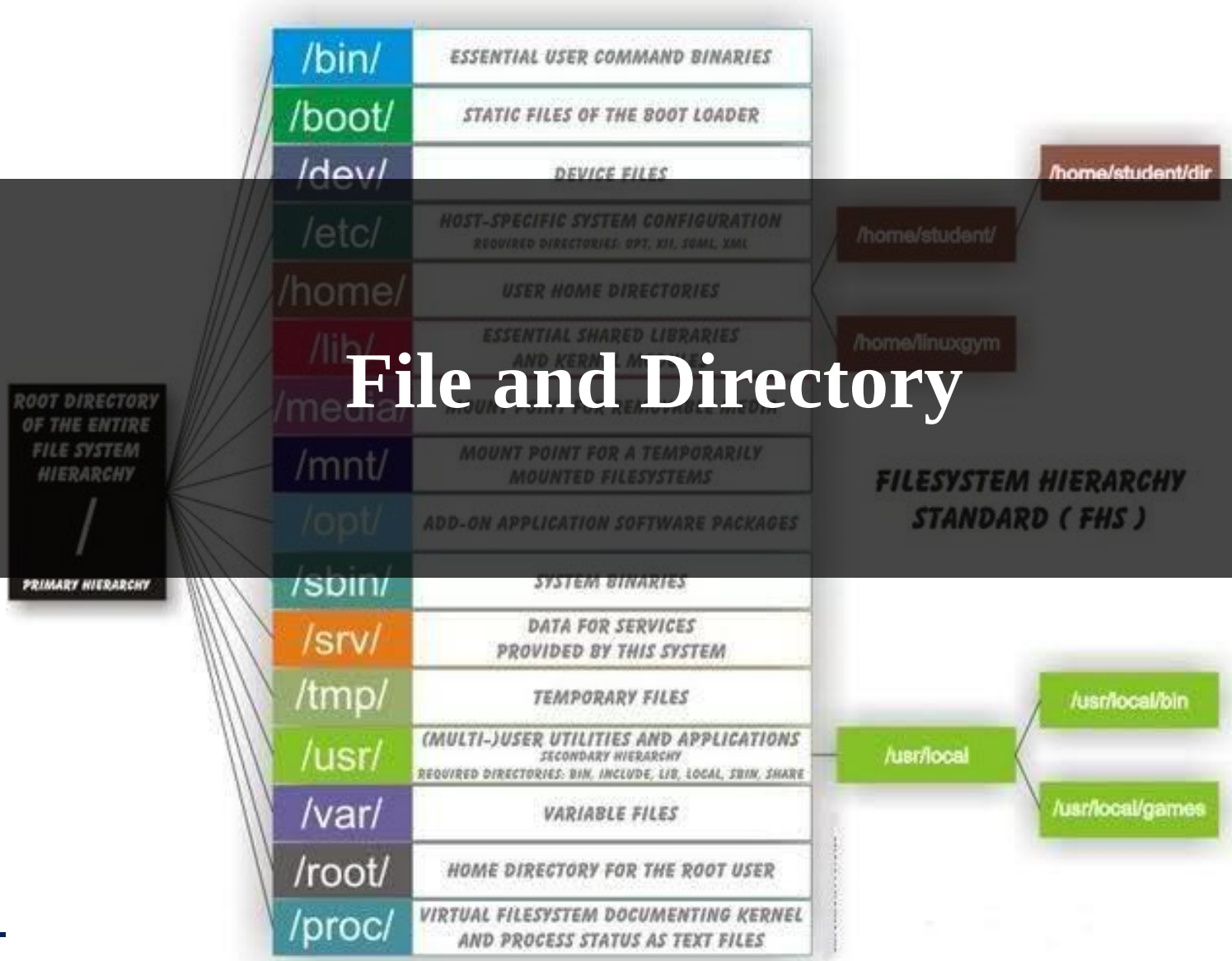


Installing Linux



Installing Linux

File and Directory



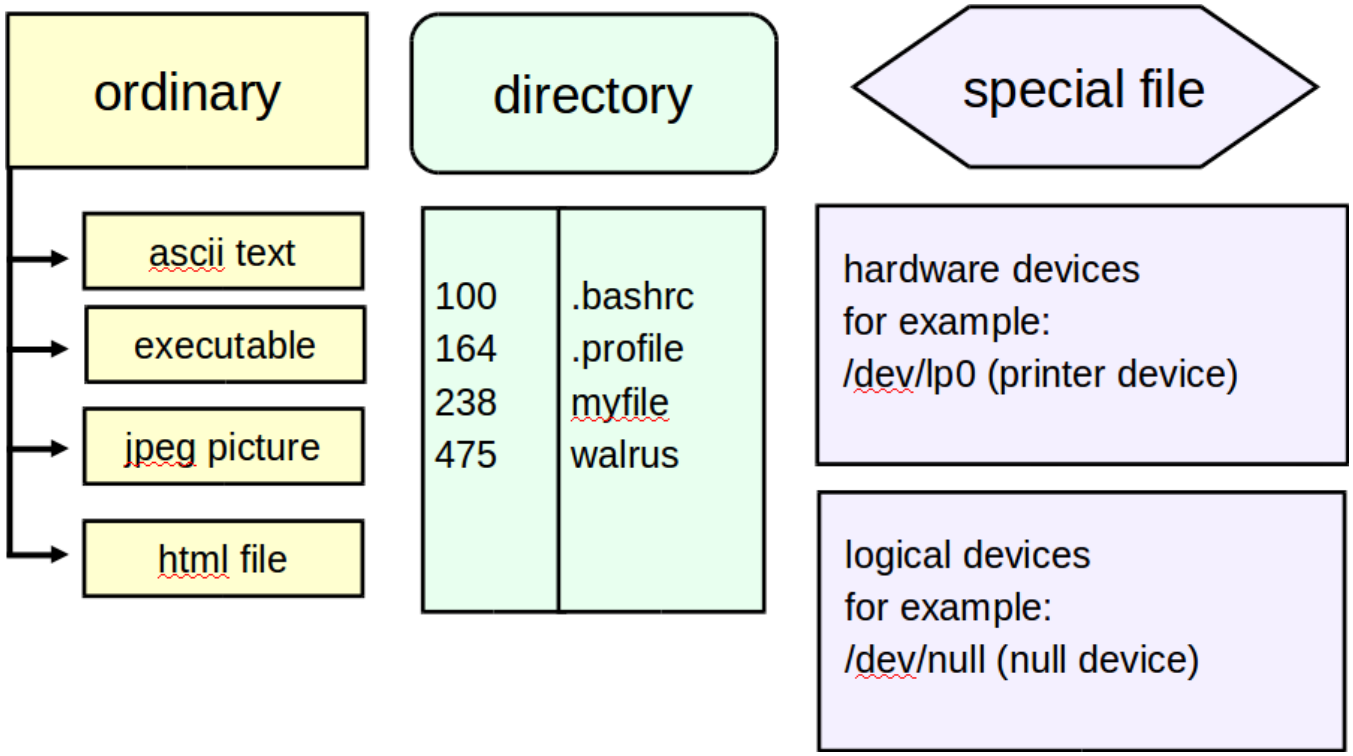
Filesystem

- **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”**



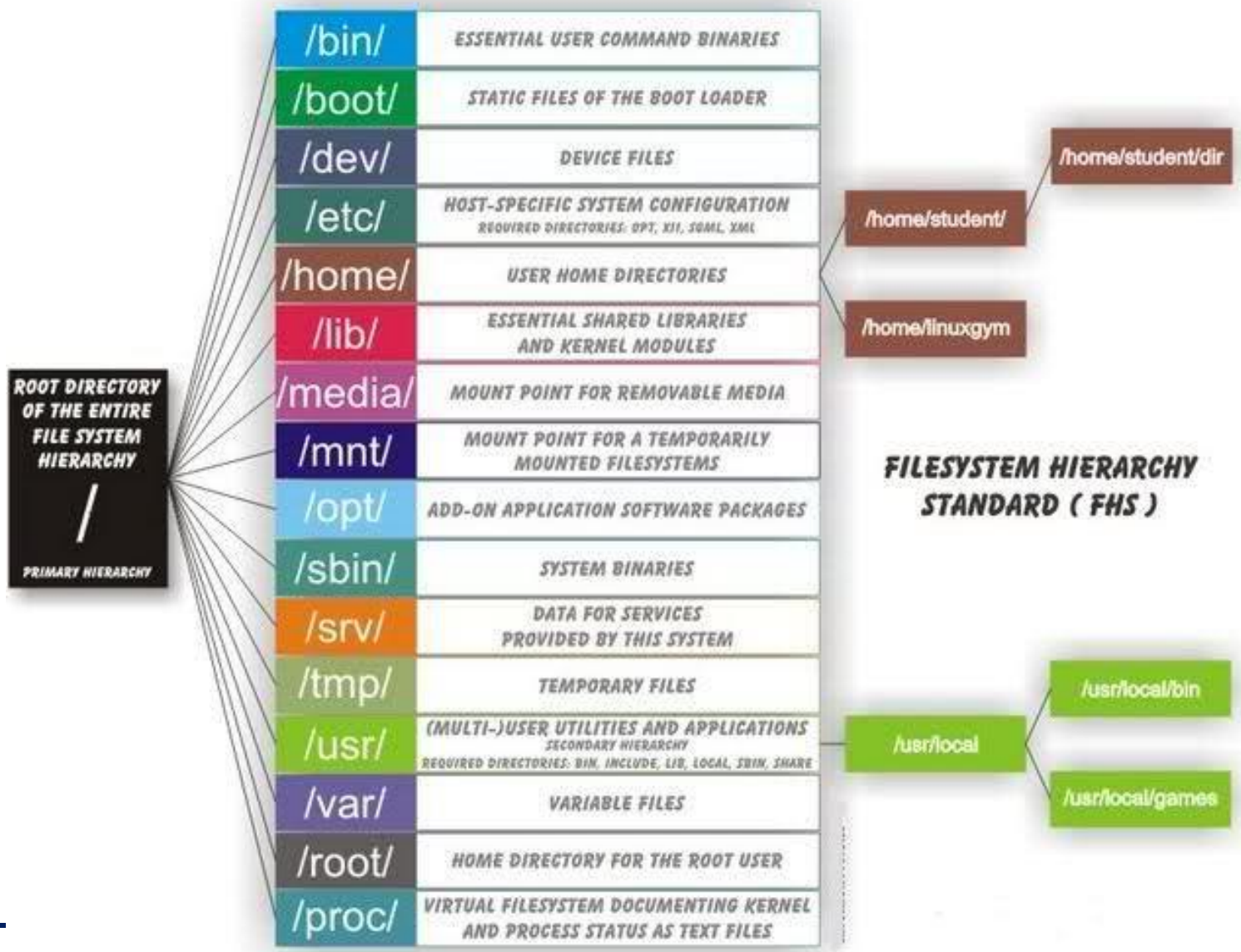
Filenames

- **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

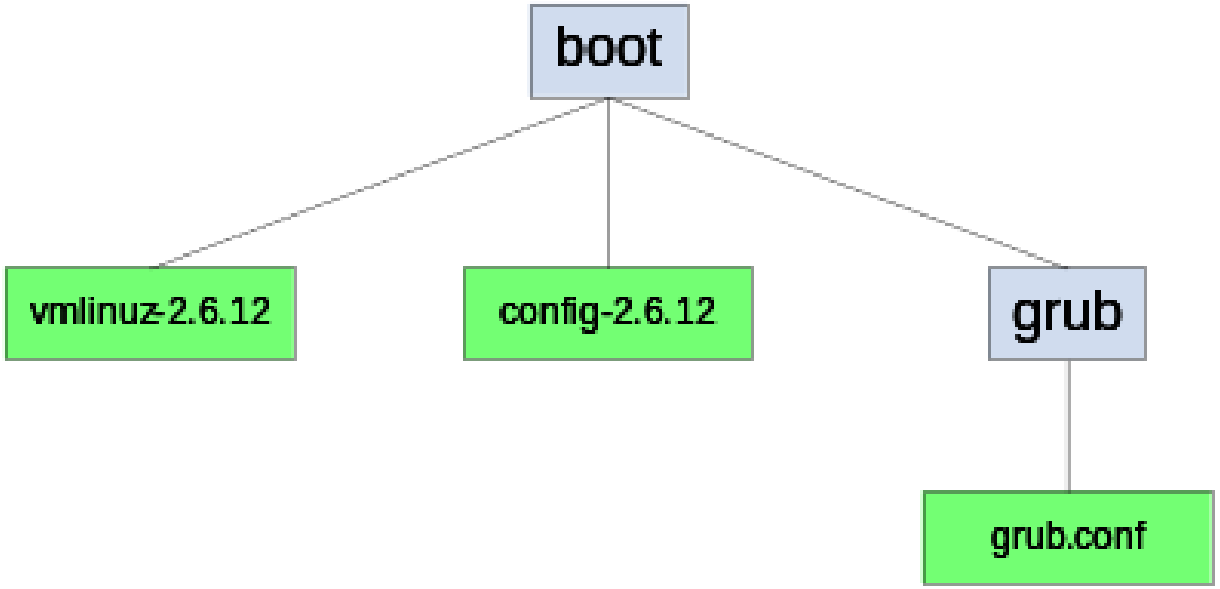
- **All Linux directories are contained in one, virtual, unified filesystem.**
- **Physical devices are mounted on mount points:**
  - **Floppy disks**
  - **Hard disk partitions**
  - **CD-ROM drives**
- **No drive letters like A:, C:, ...**

Linux Directory



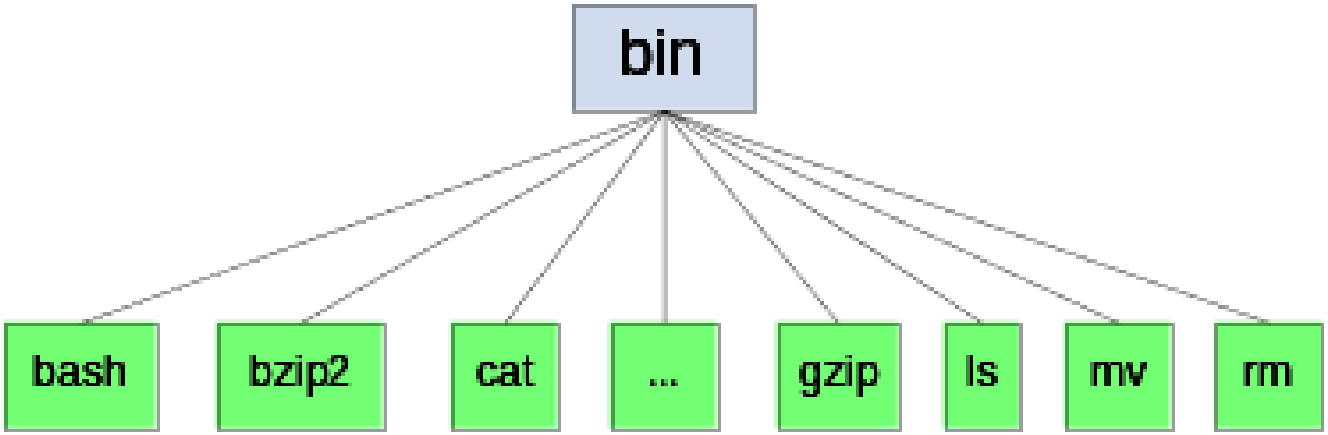
Directory : Boot

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



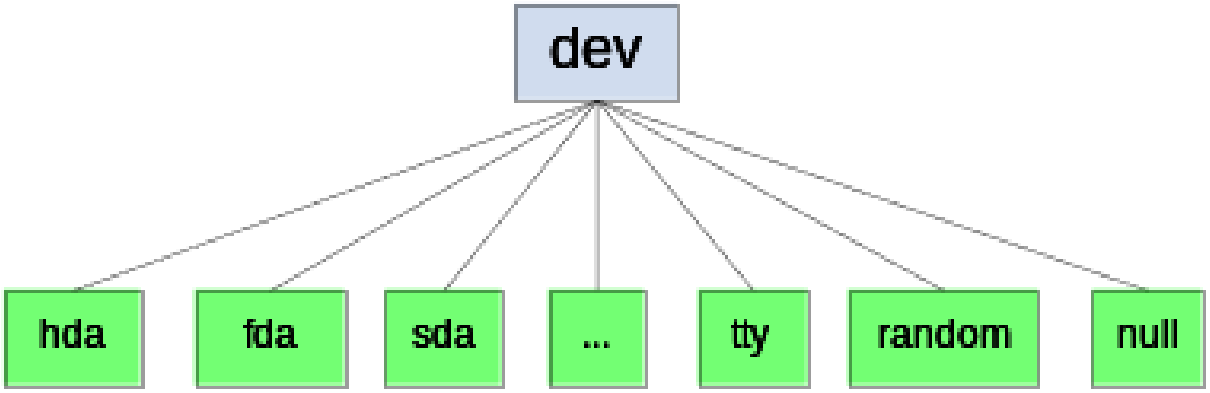
Directory : Bin

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



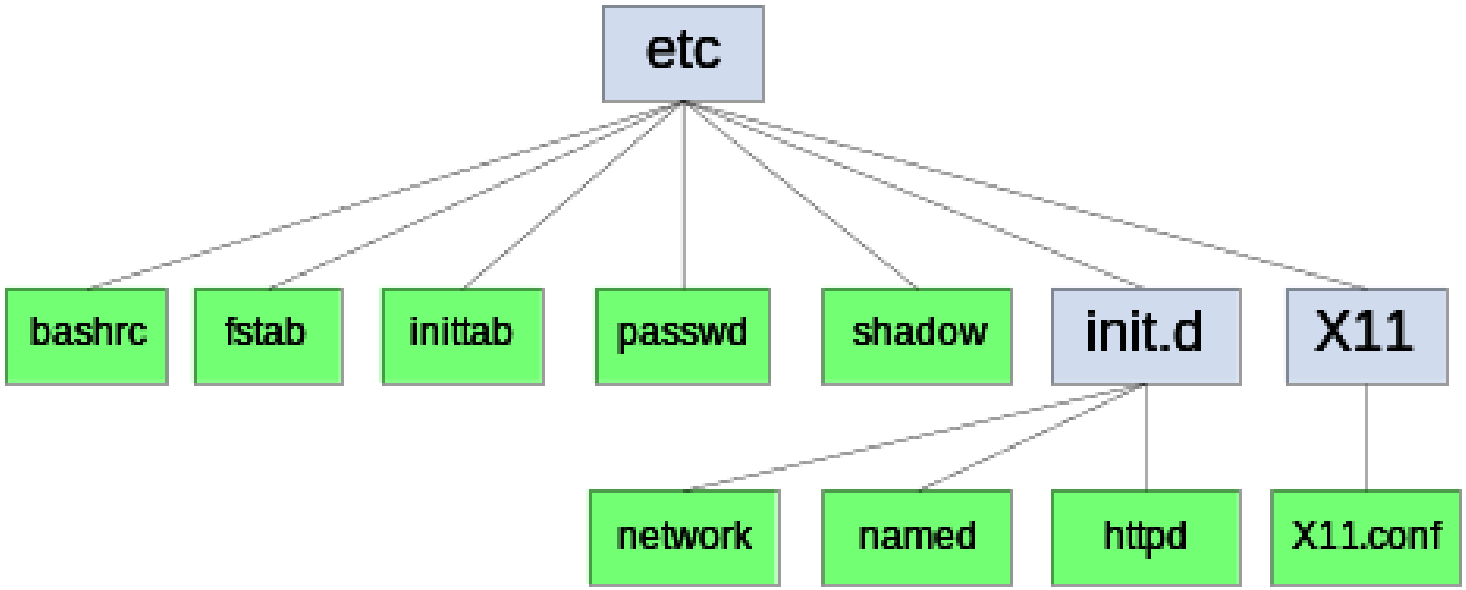
Directory : dev

- **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**

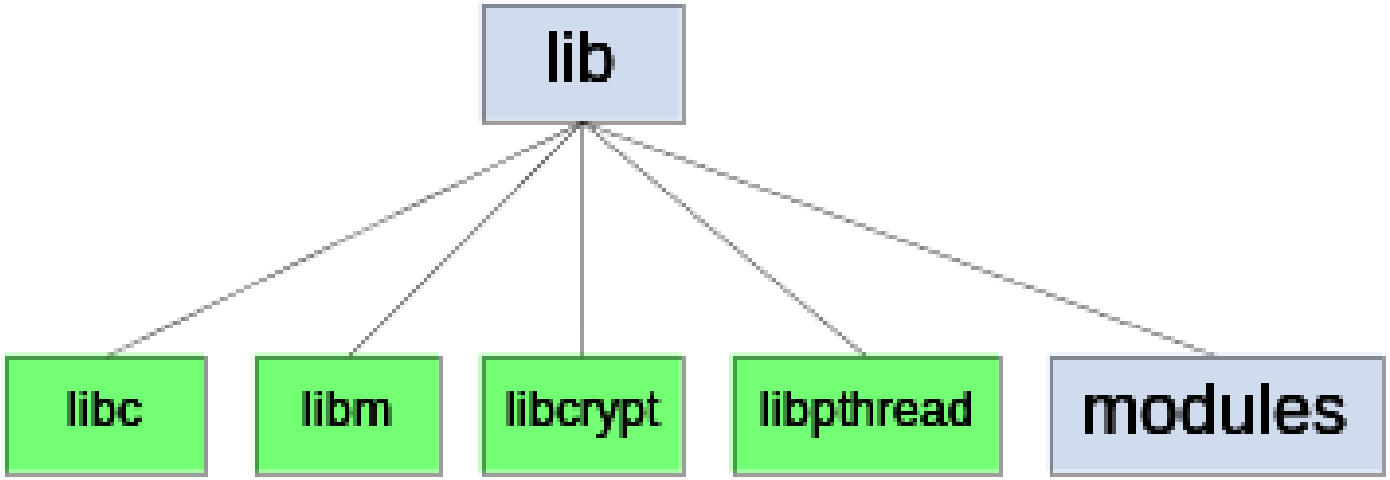


Directory : home

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

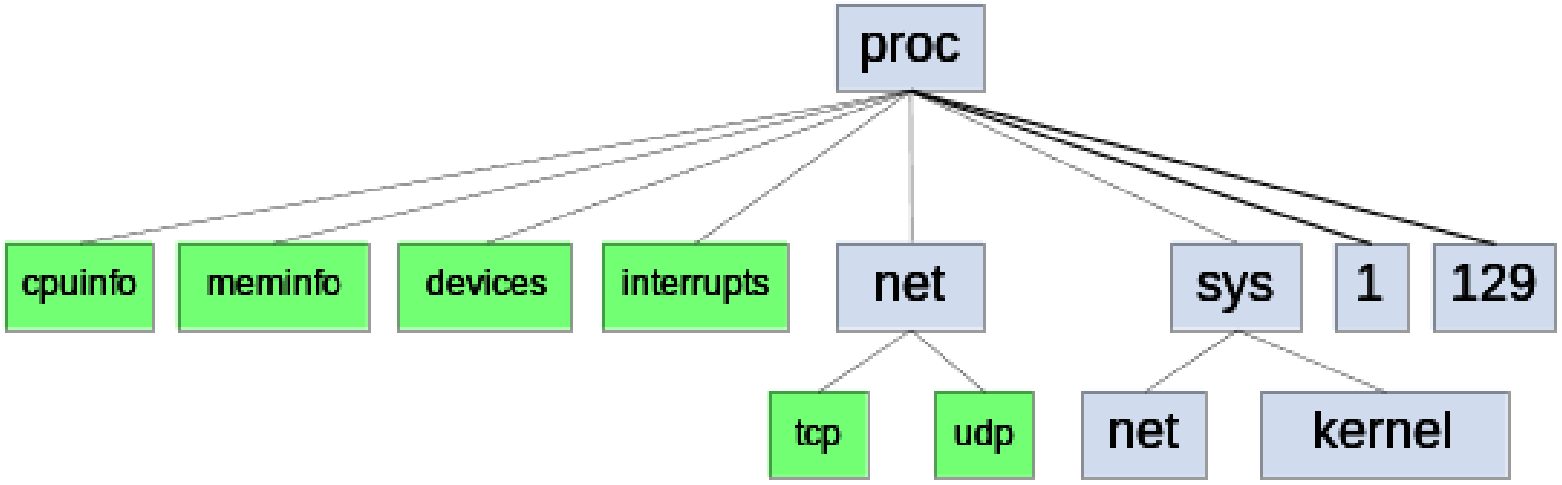
Directory : lib

- **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**

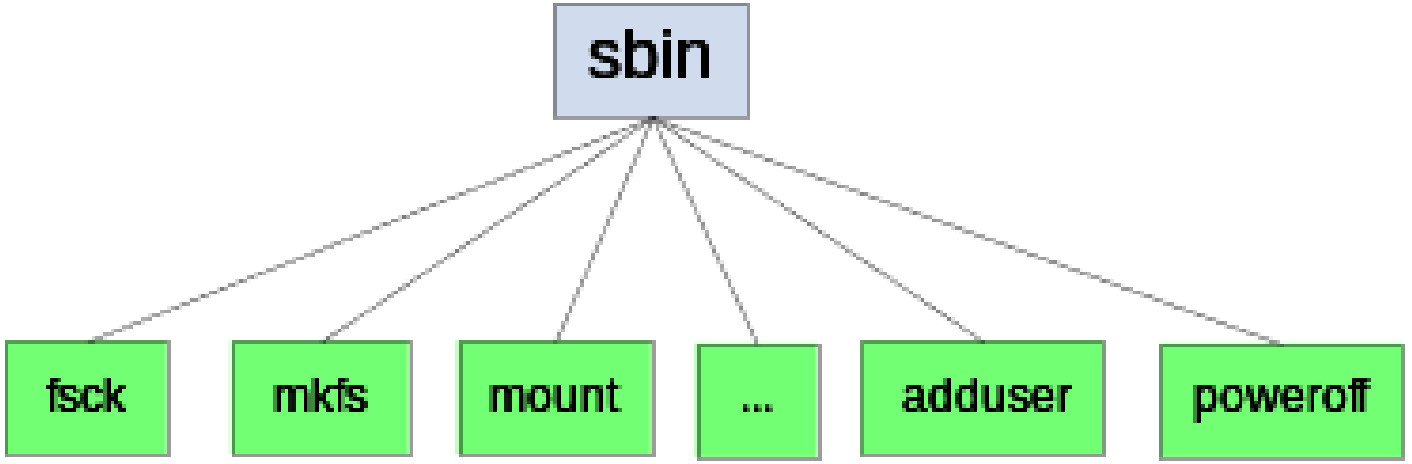


Directory : root

- **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

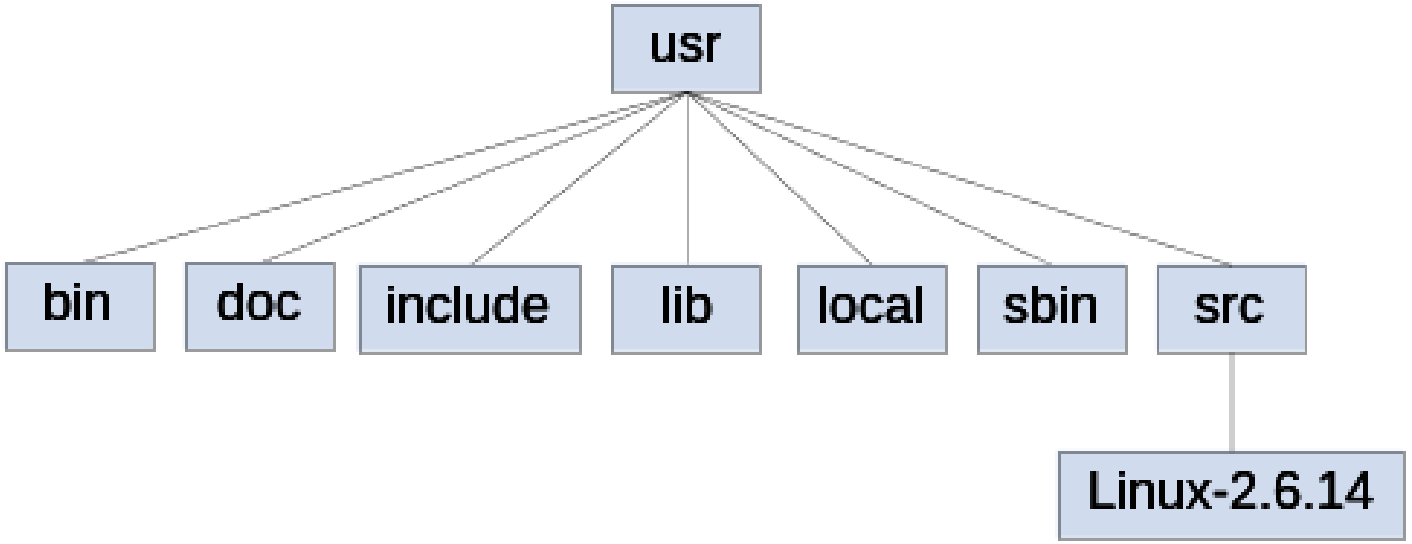


Directory : tmp

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

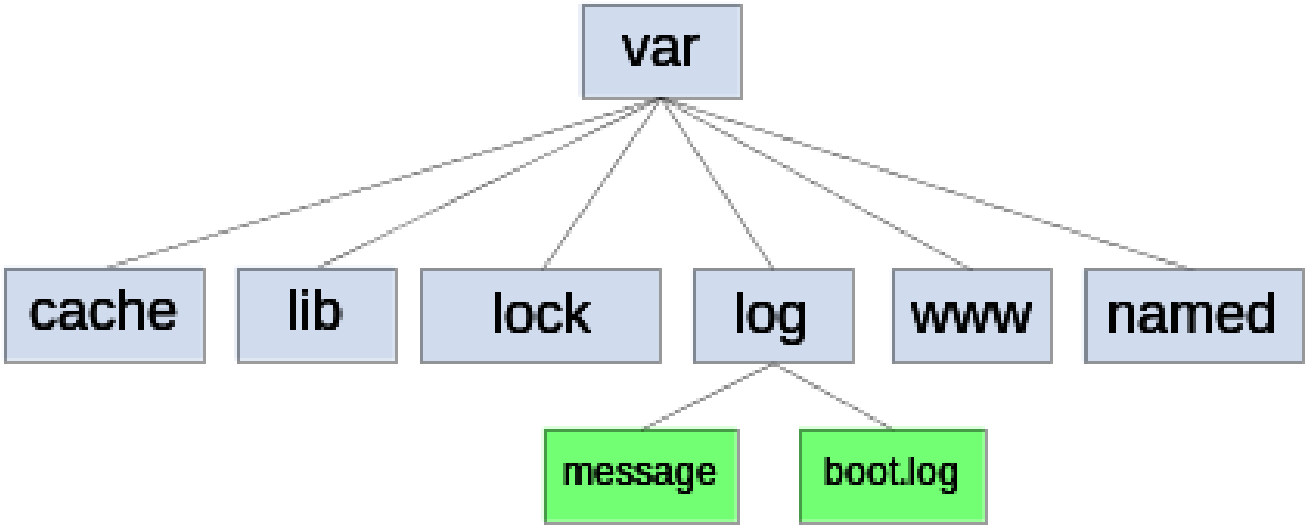
Directory : usr

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

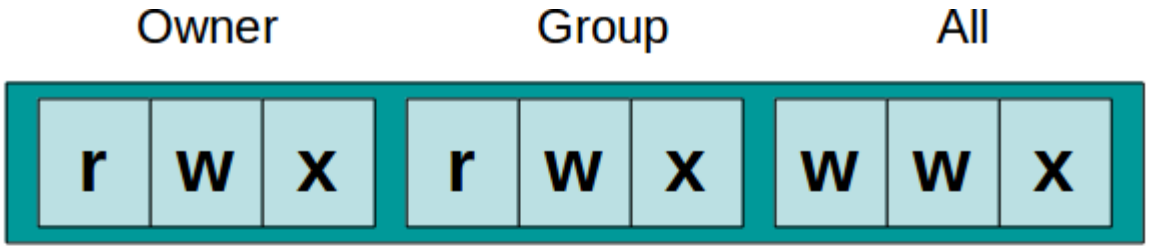


Directory : var

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



Permission



Legend

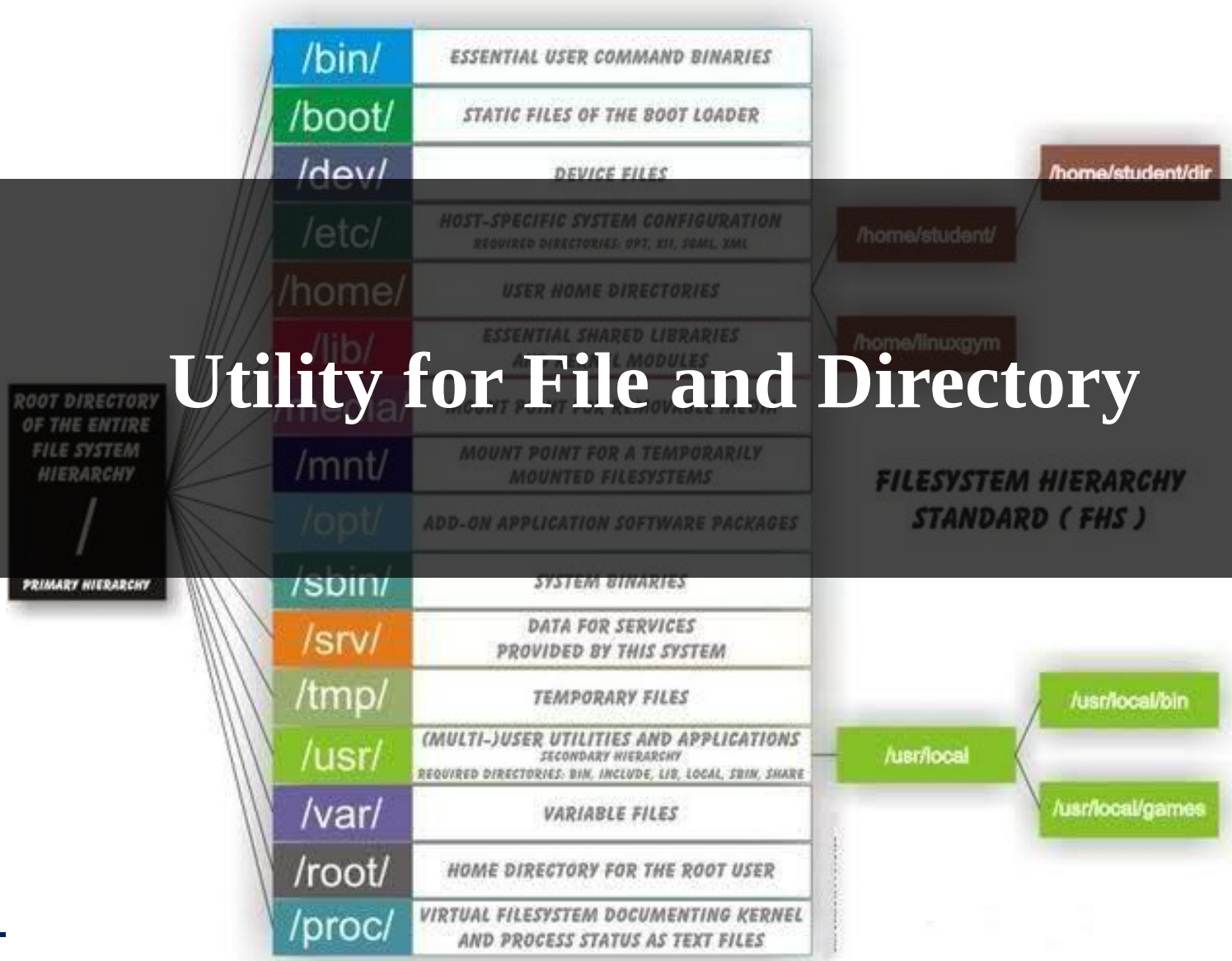
r = ‘read access’ (1 = yes, 0 = no)

w = ‘write access’ (1 = yes, 0 = no)

x = ‘execute access’ (1 = yes, 0 = no)

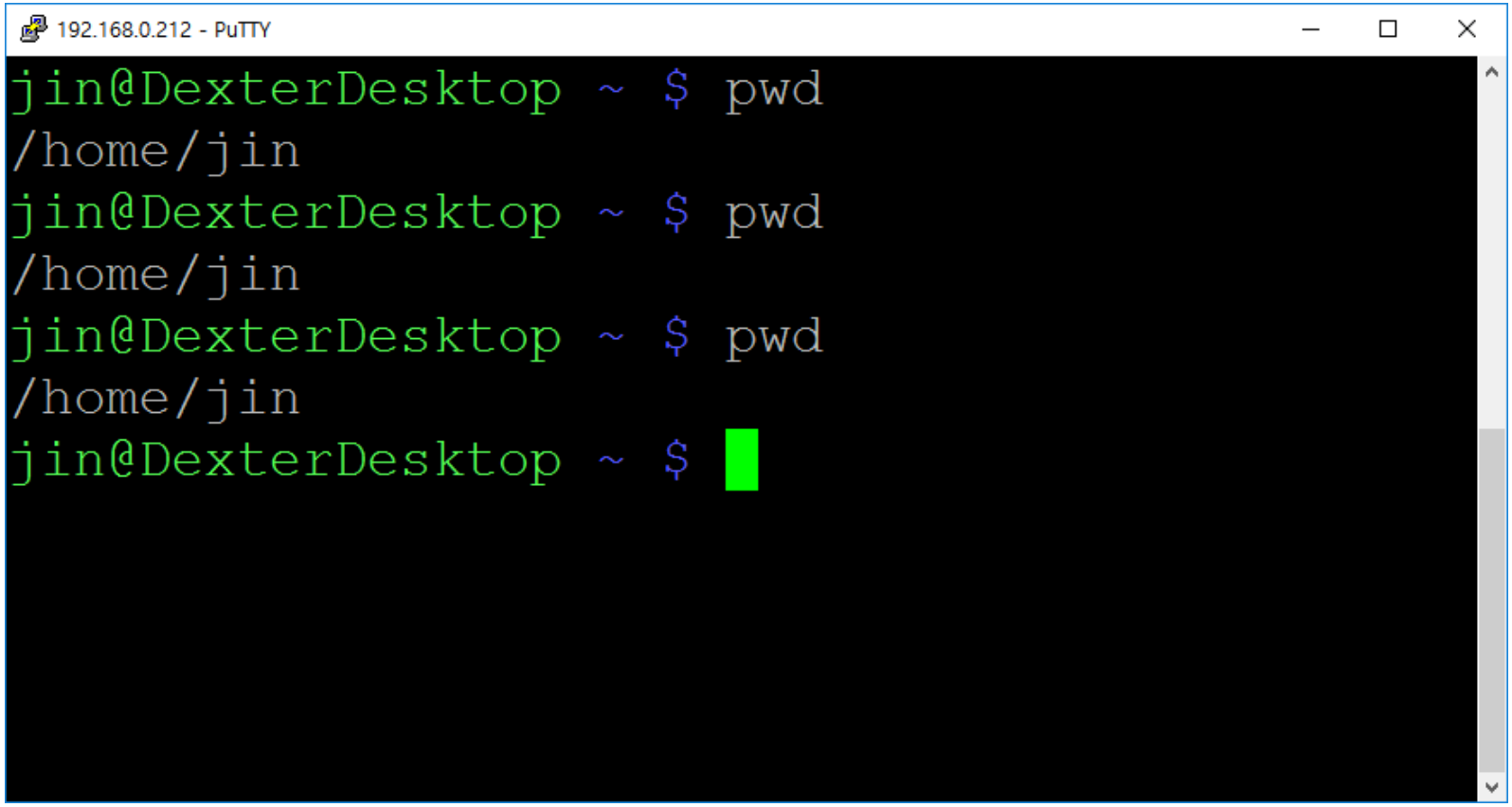
Bitmap-example: 110-100-100
Octal representation: 0644
ASCII-representation: rw-r--r--

Utility for File and Directory



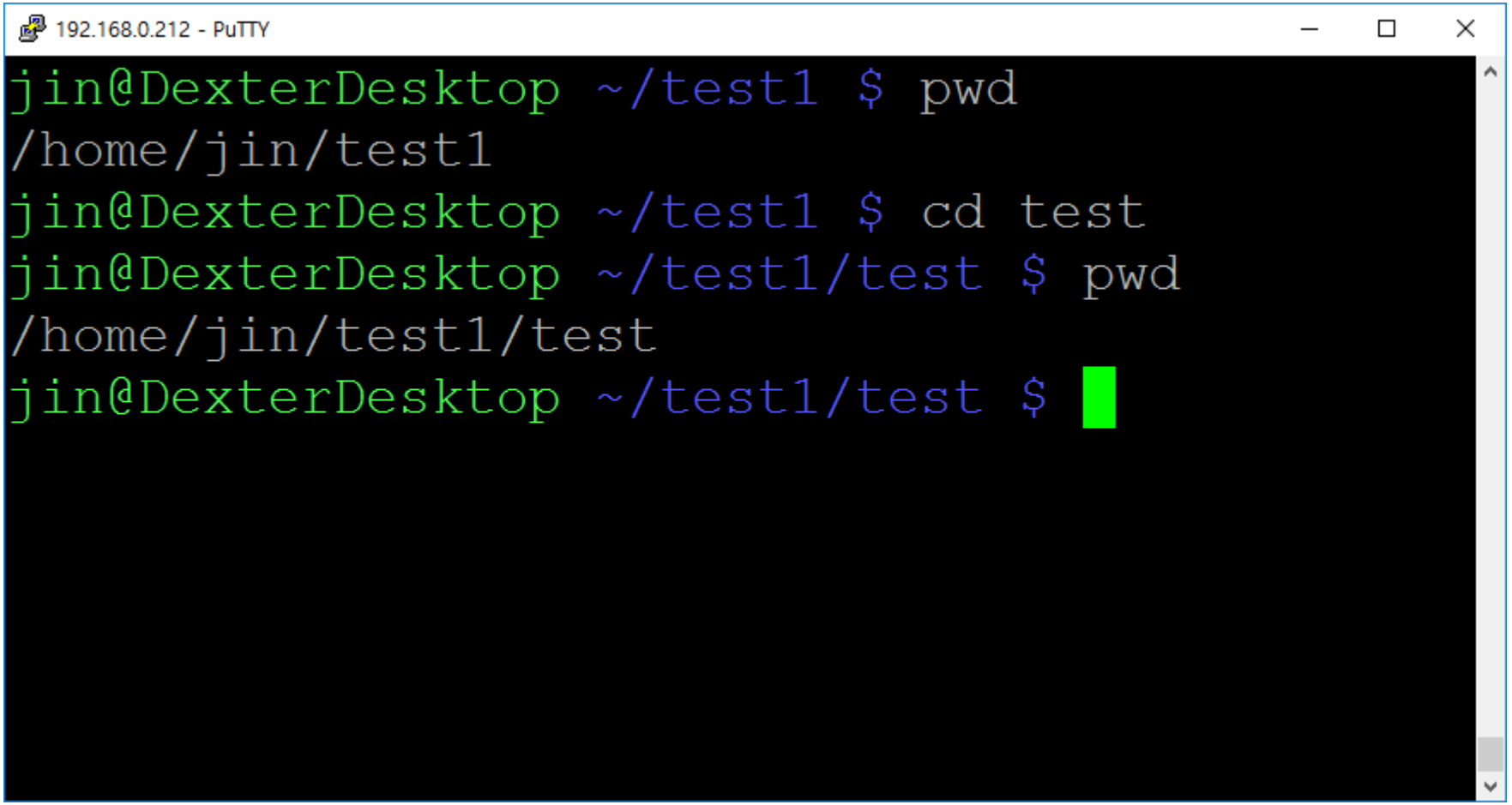
Utility : pwd

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



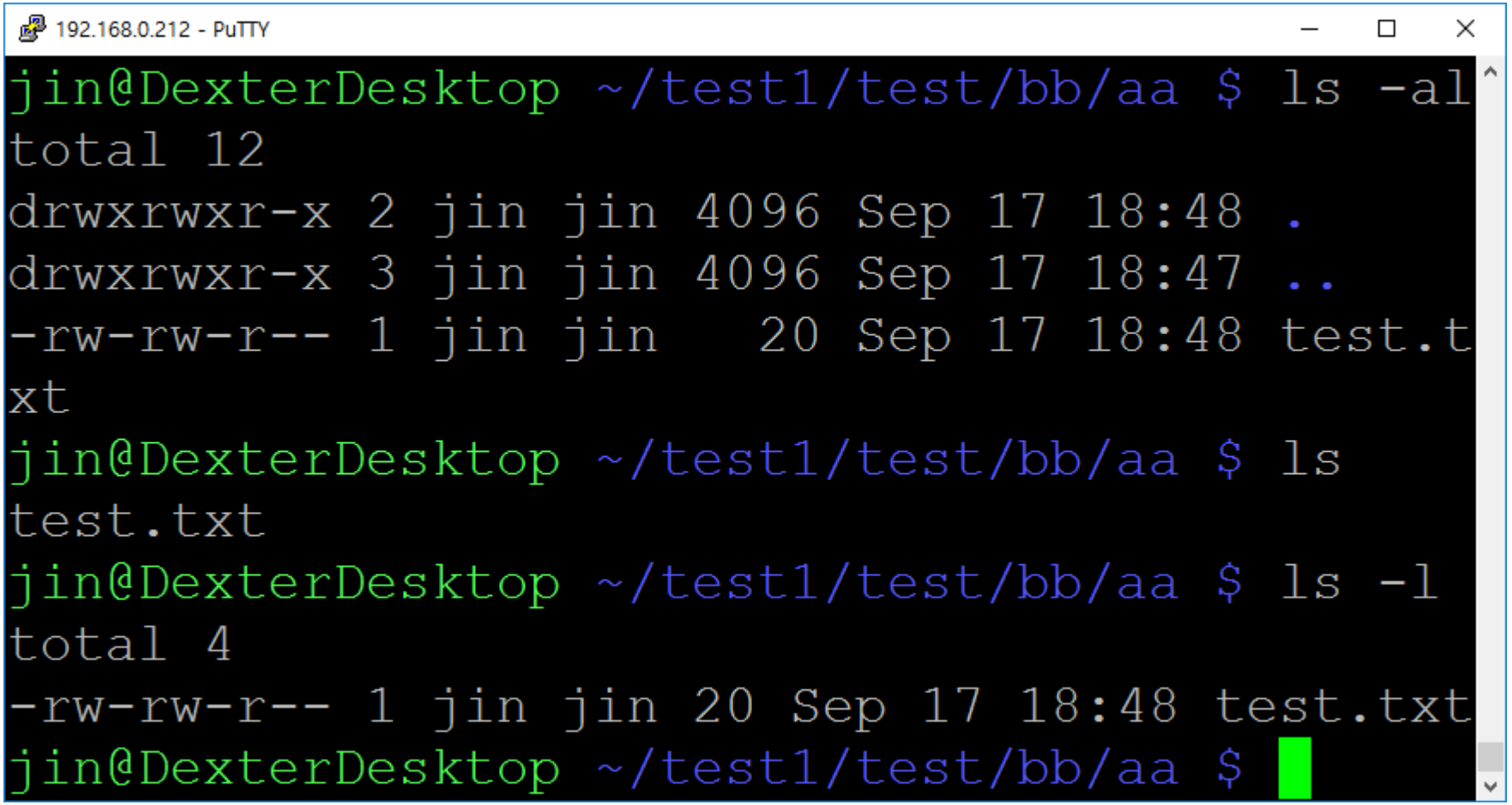
Utility : cd

- **Change Directory**



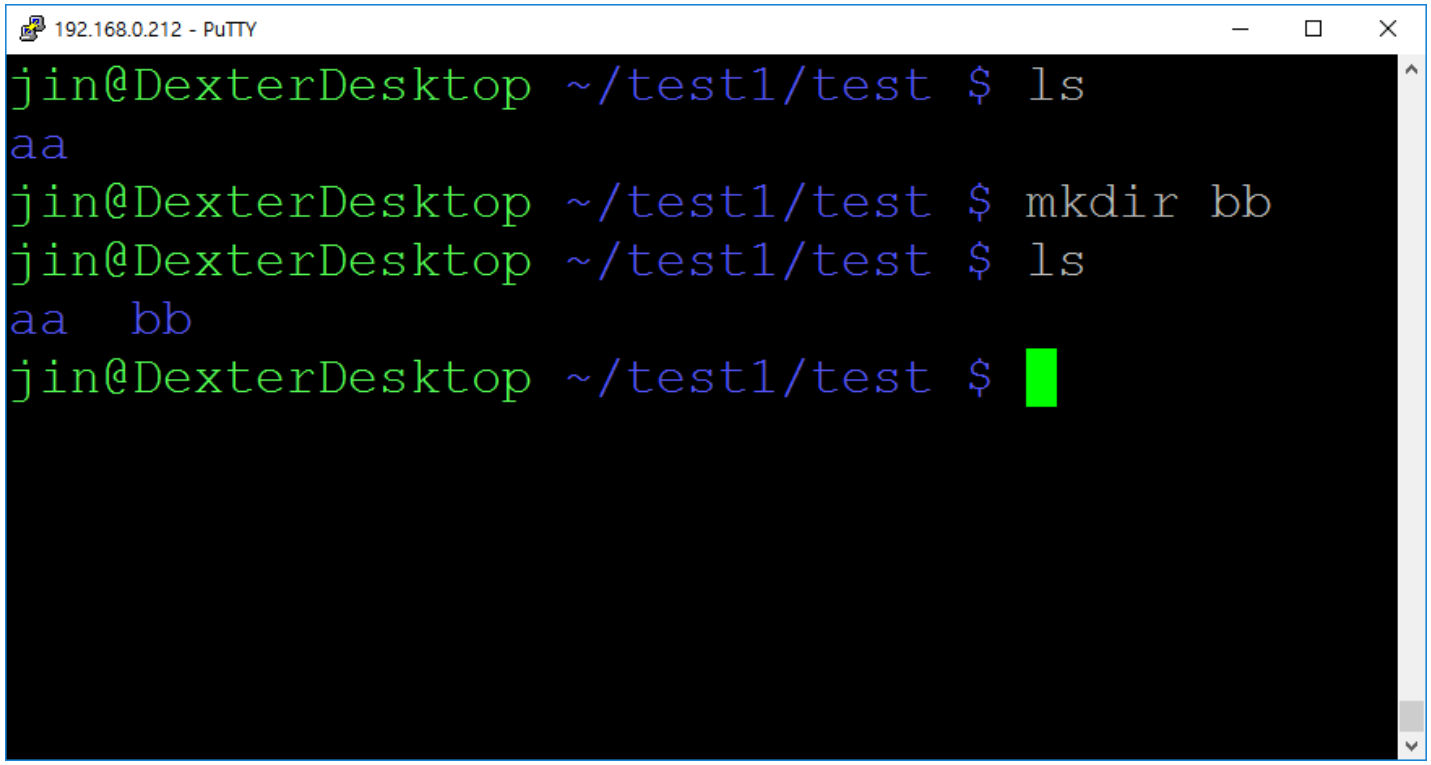
Utility : ls

- **List contents of a directory**



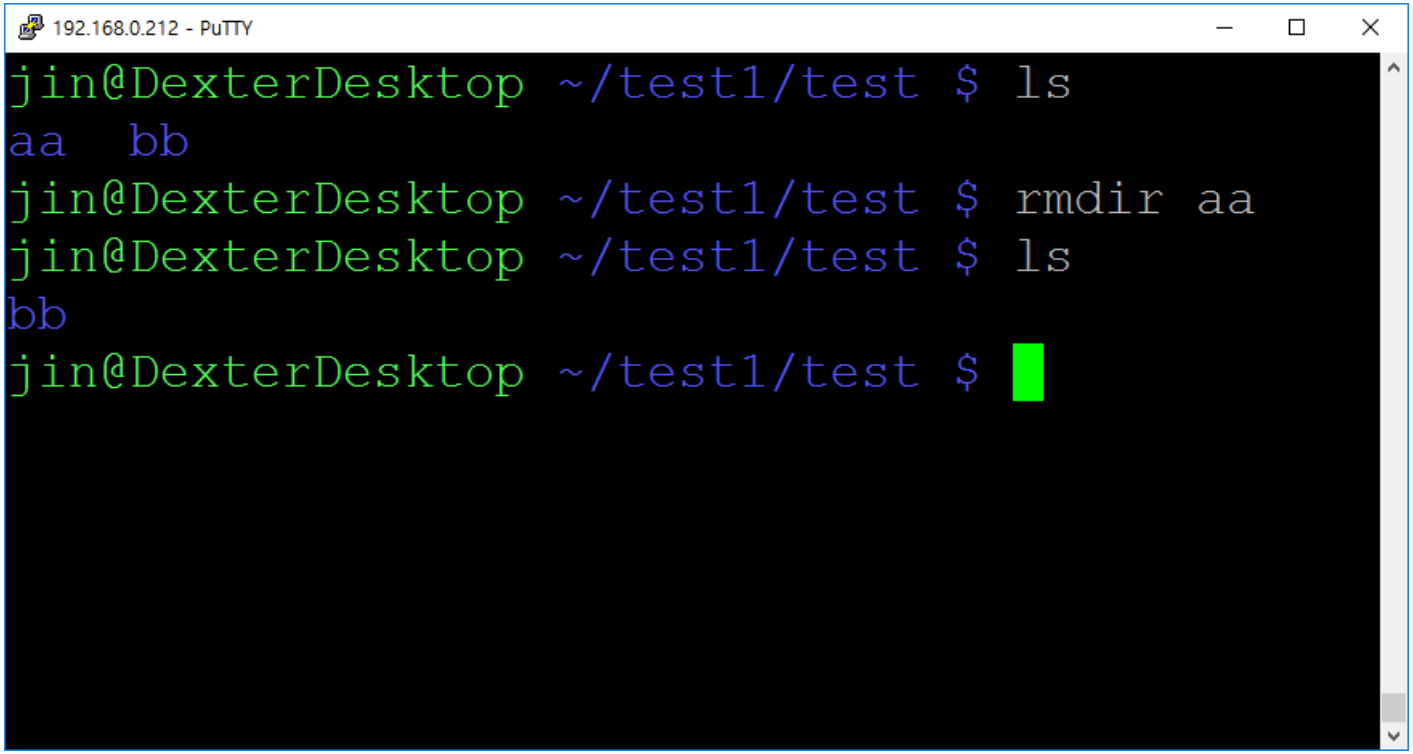
Utility : mkdir

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



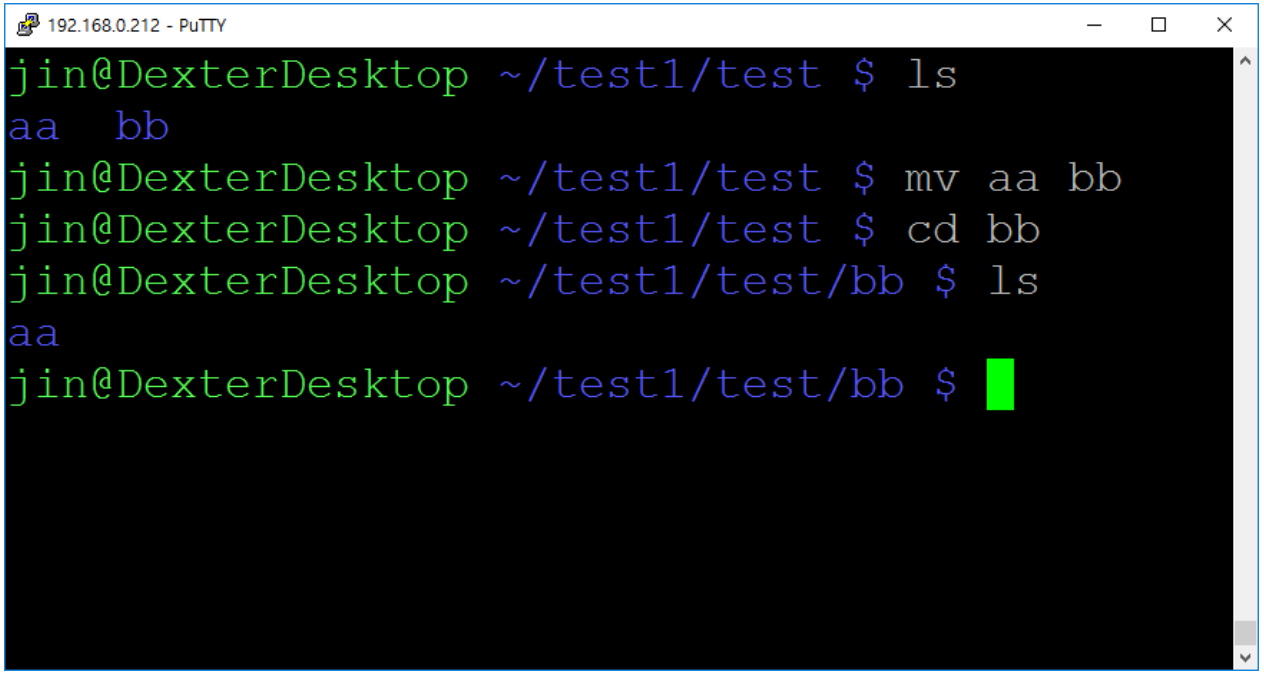
Utility : rmdir

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



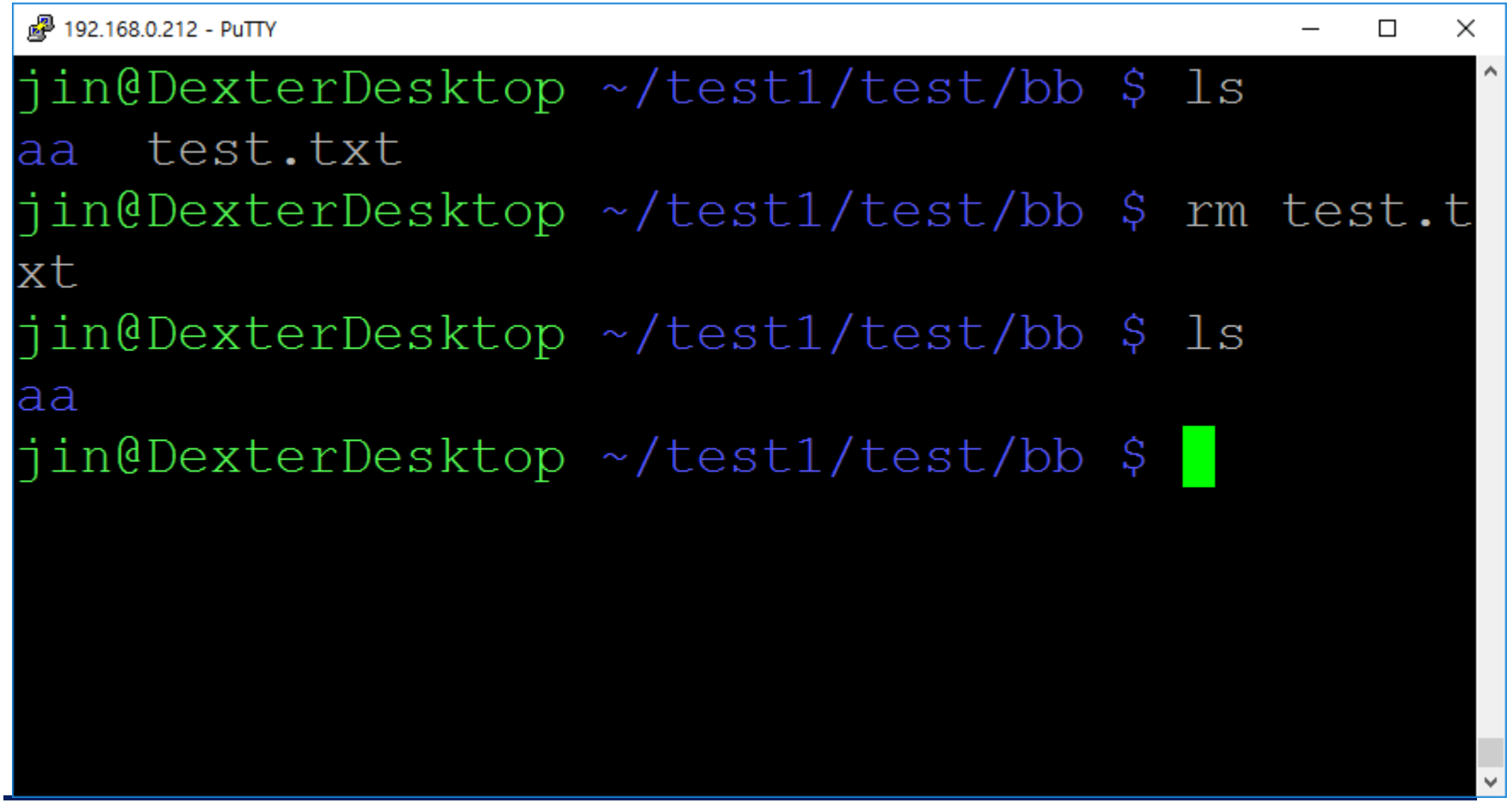
Utility : mv

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



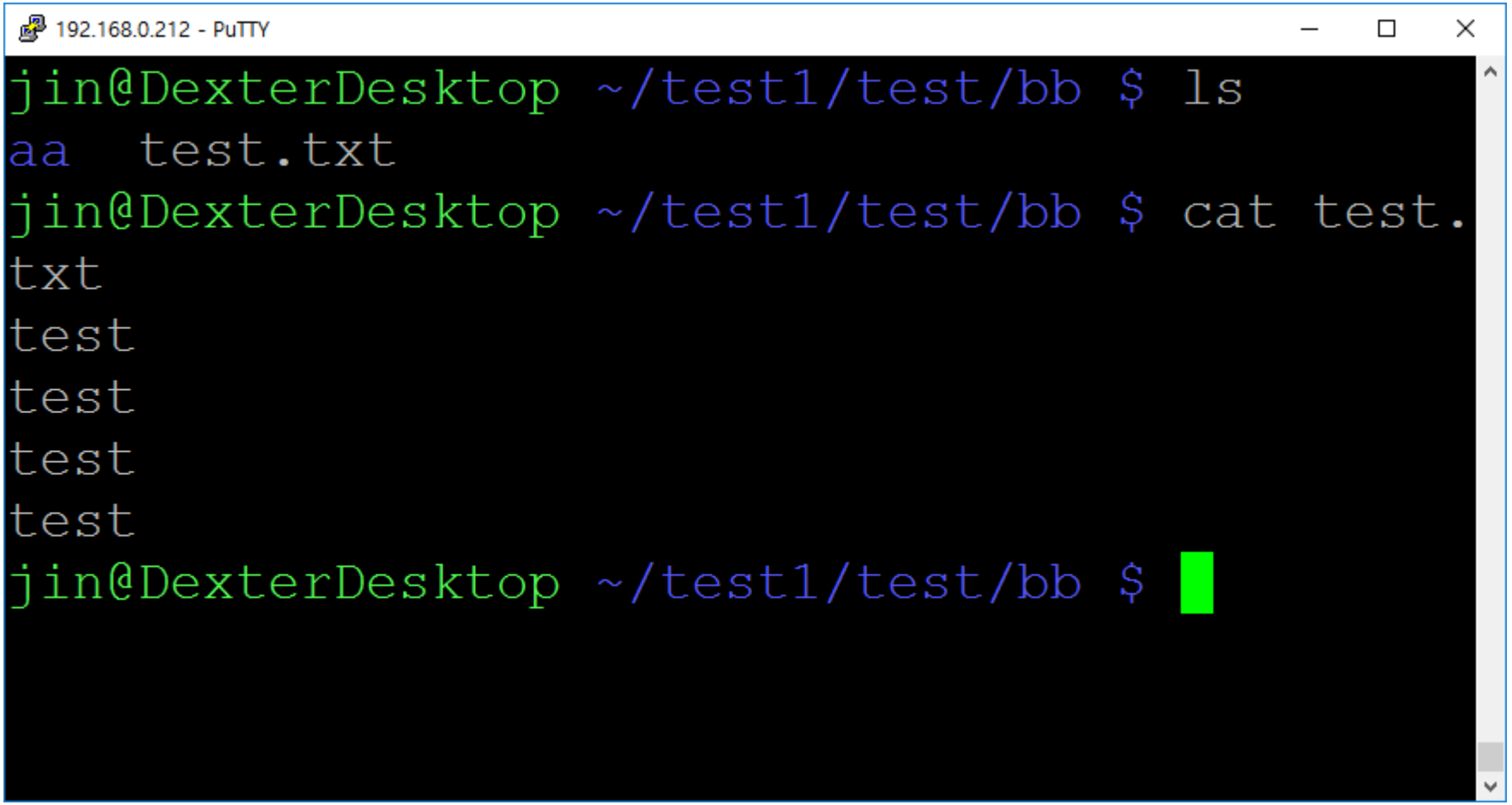
Utility : rm

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



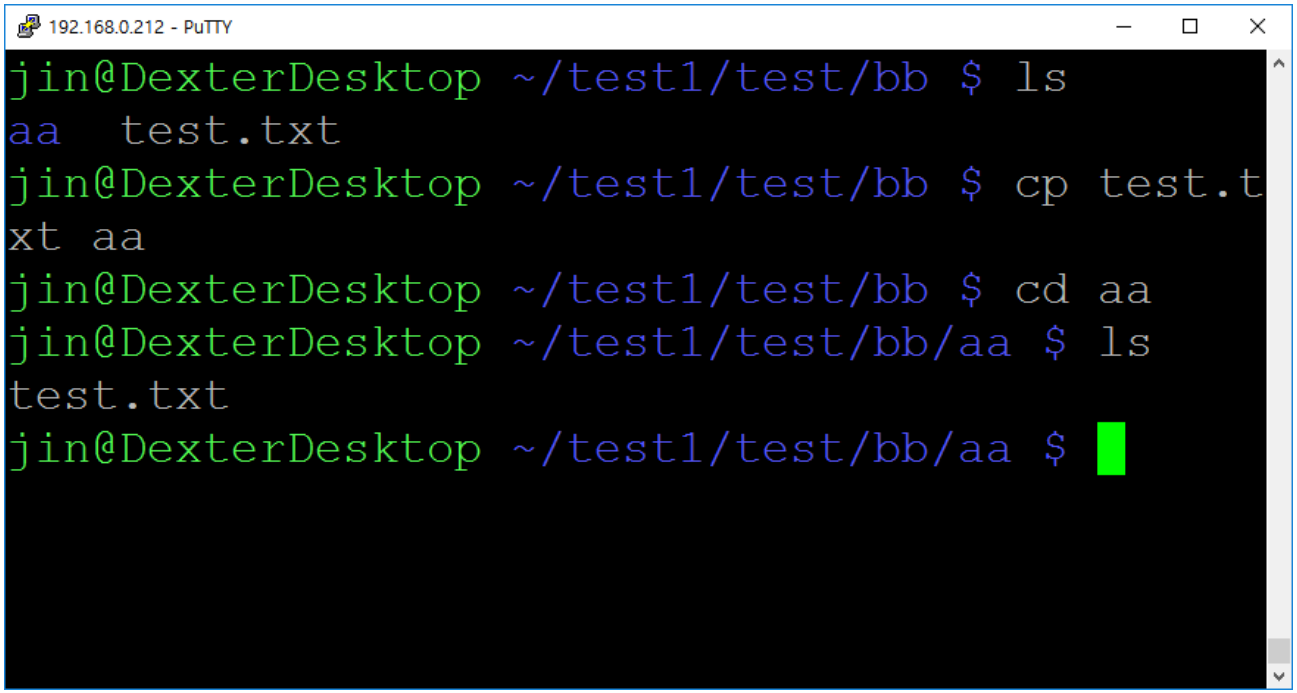
Utility : cat

- **Prints contents of file**



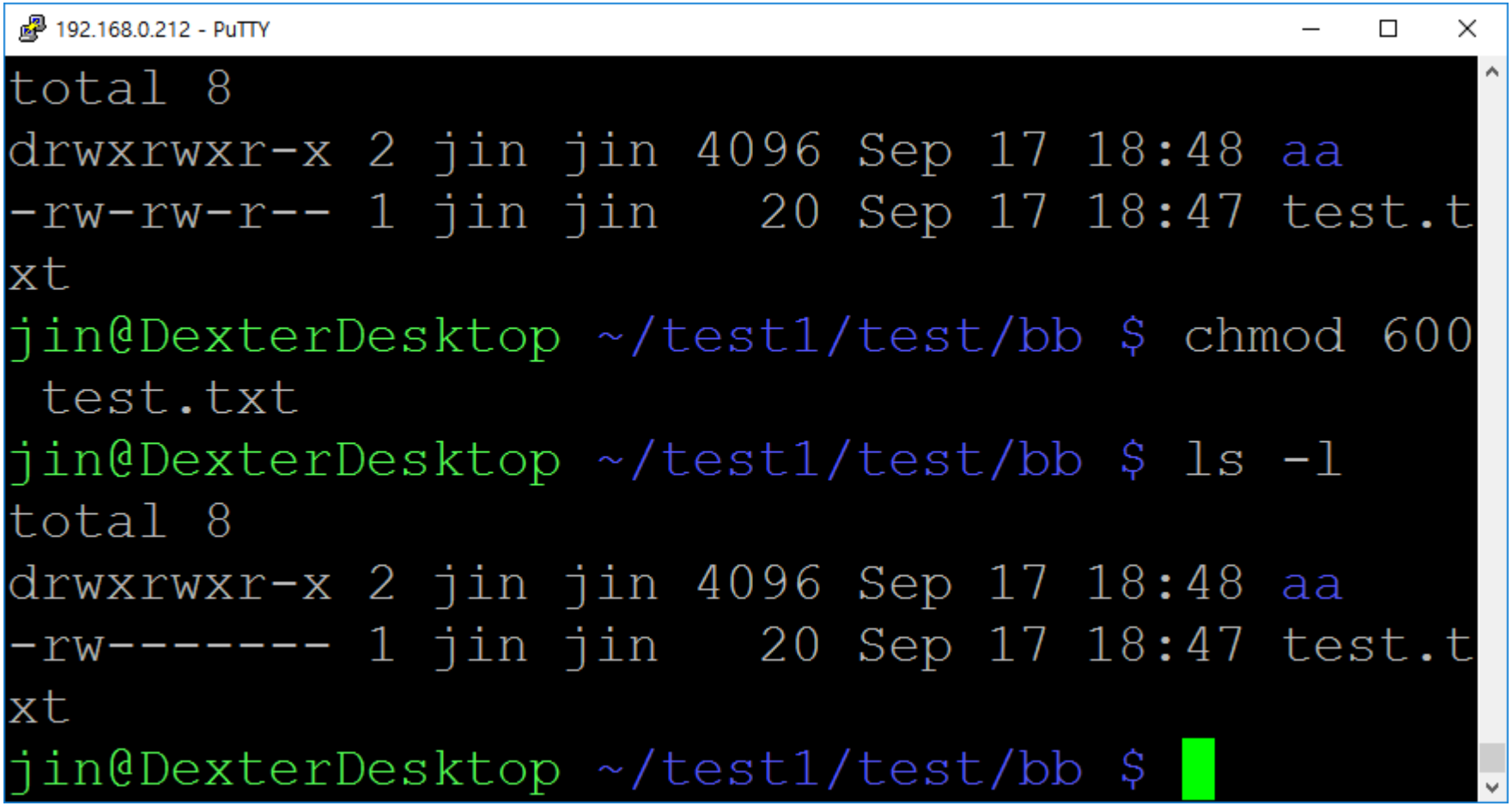
Utility : cp

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



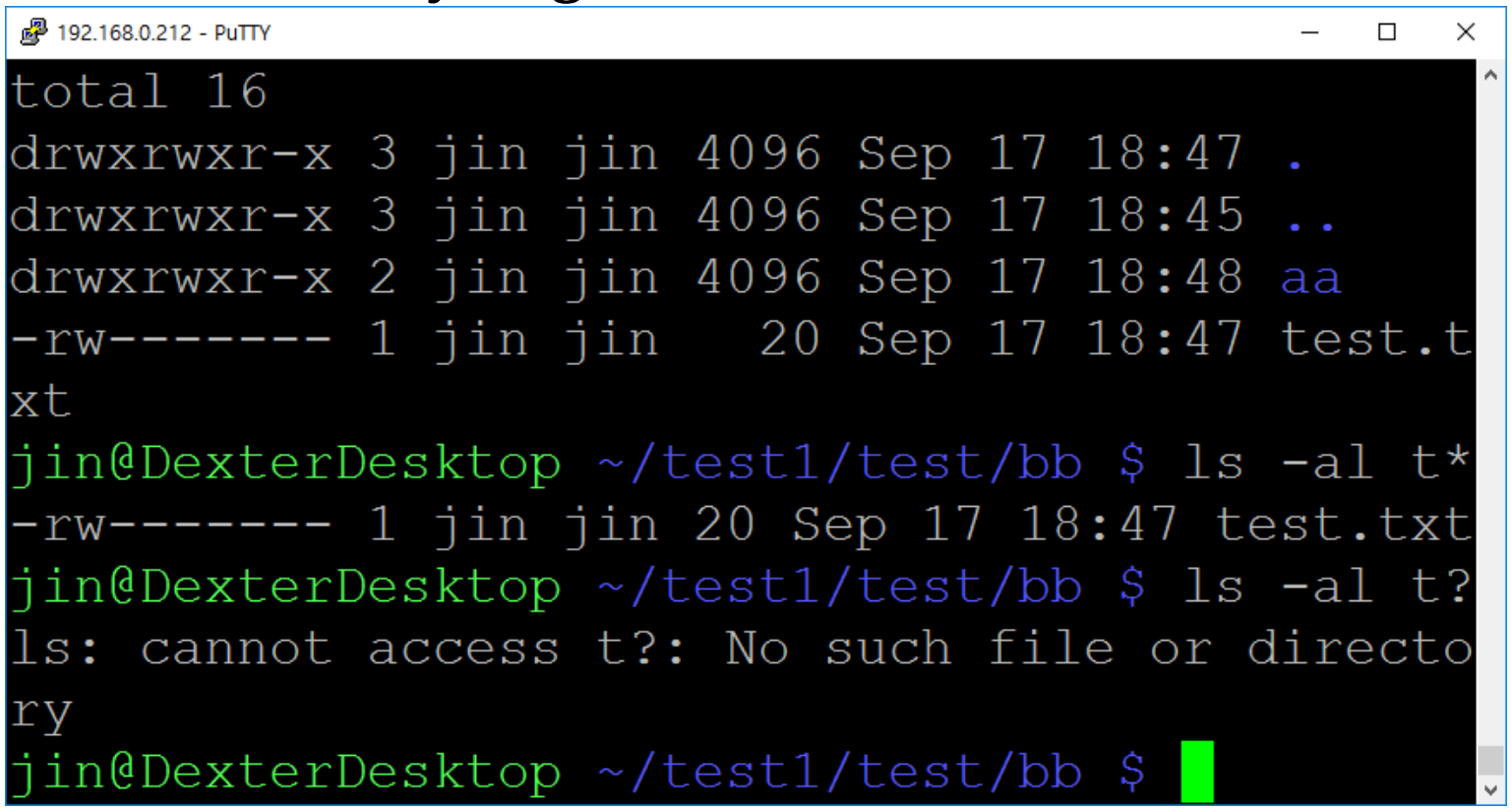
Utility : chmod

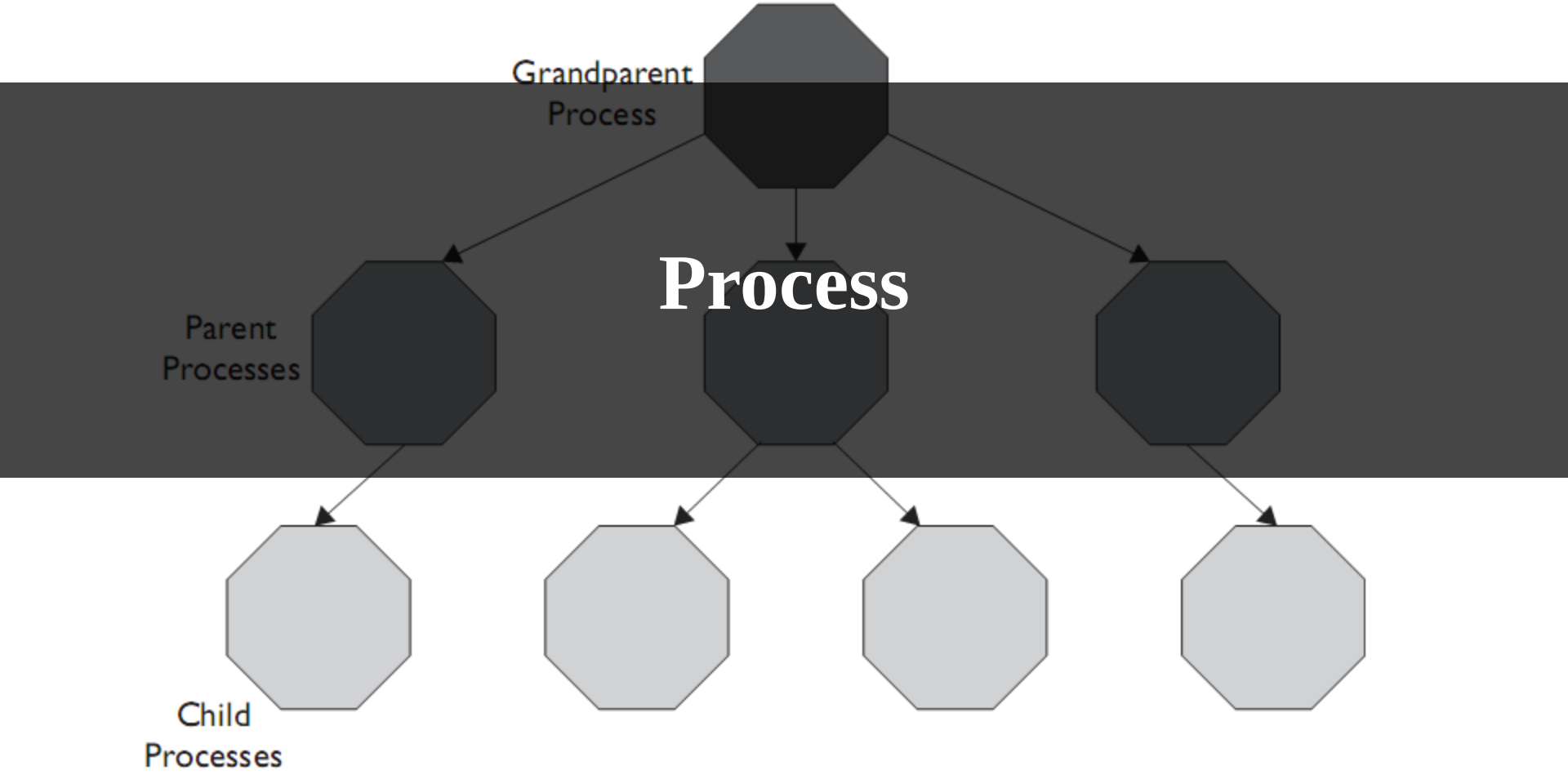
- **Change the file permission**



Metacharacter

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




Grandparent
Process
Process
Parent
Processes
Child
Processes

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)**

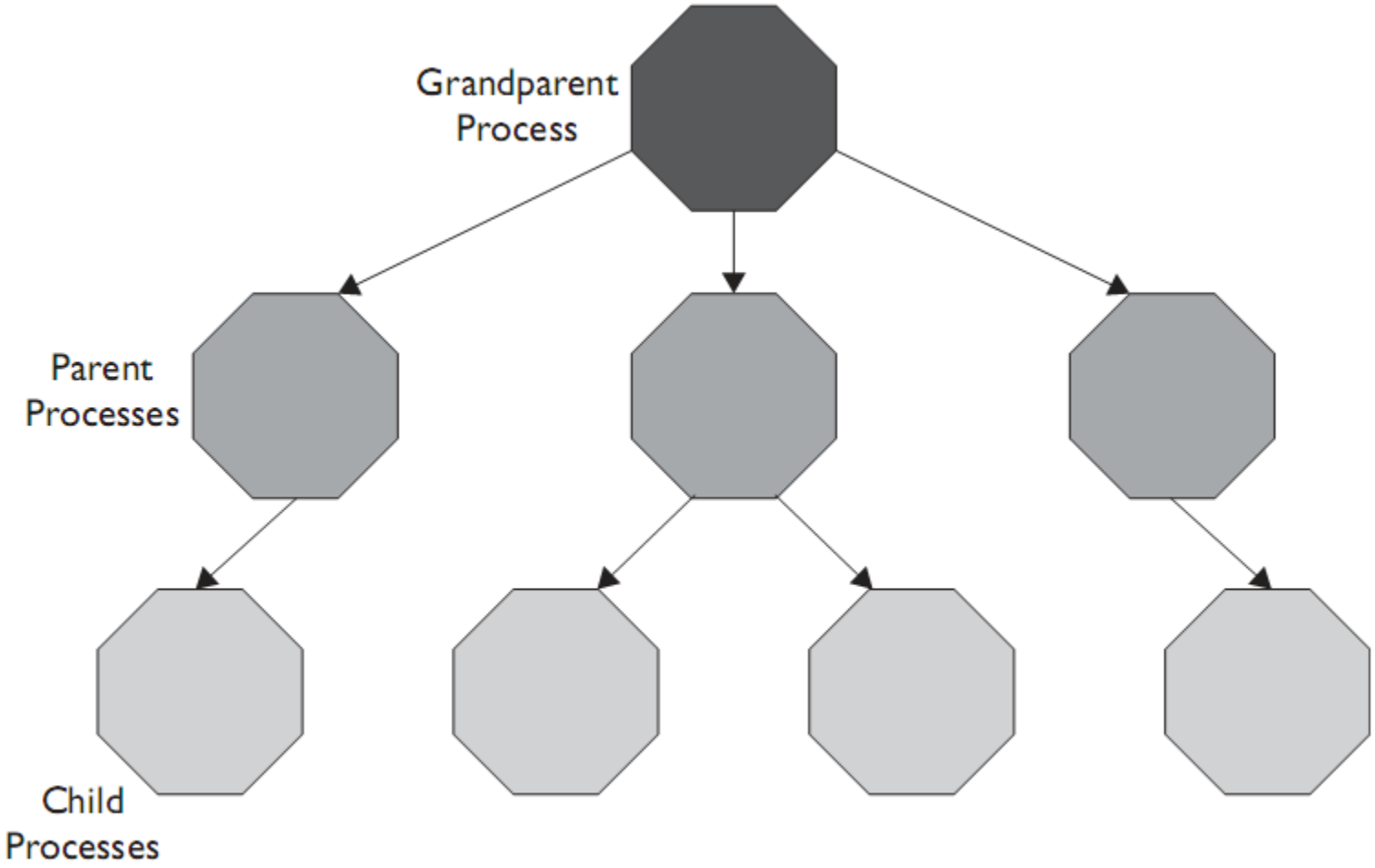
Type of Process

- **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.**

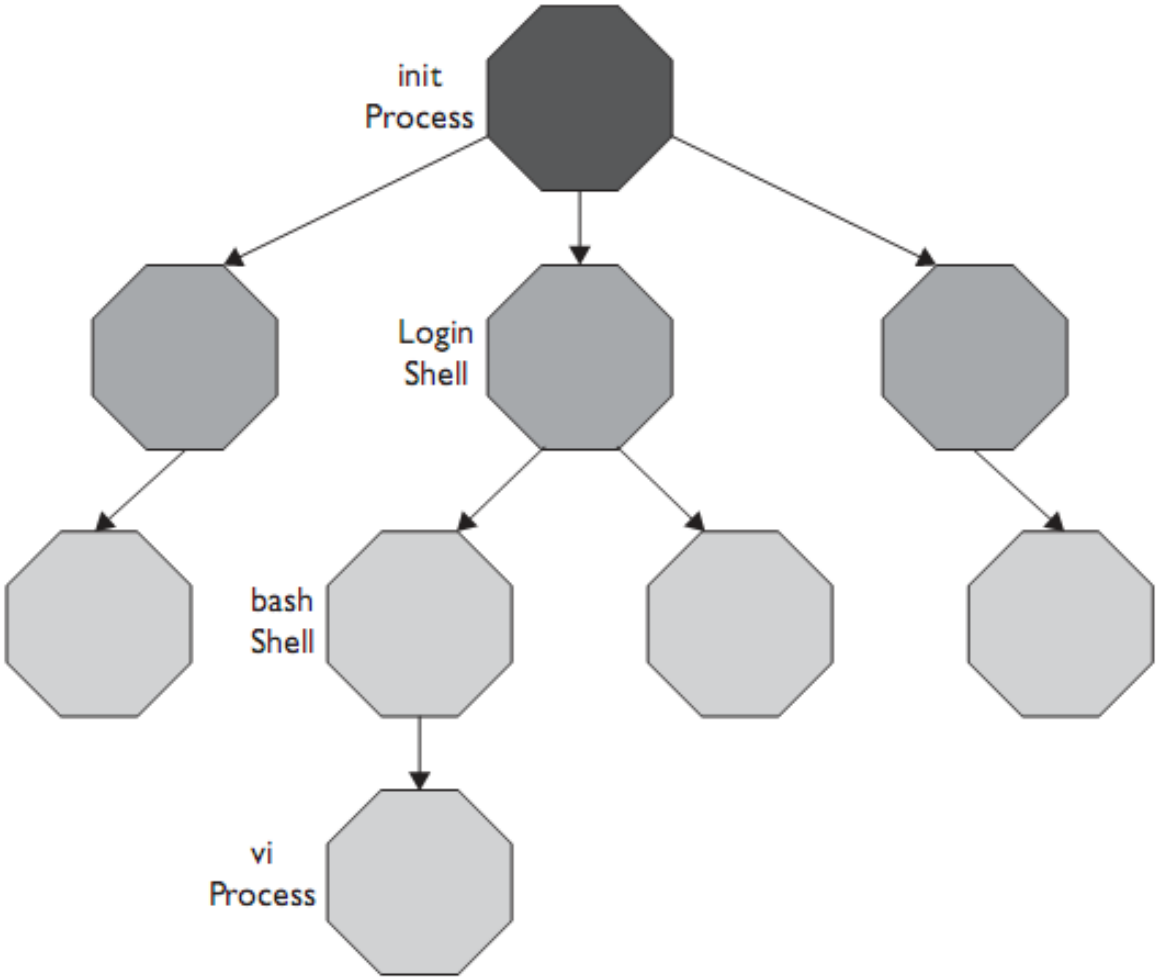
Attribute of Process

- **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**

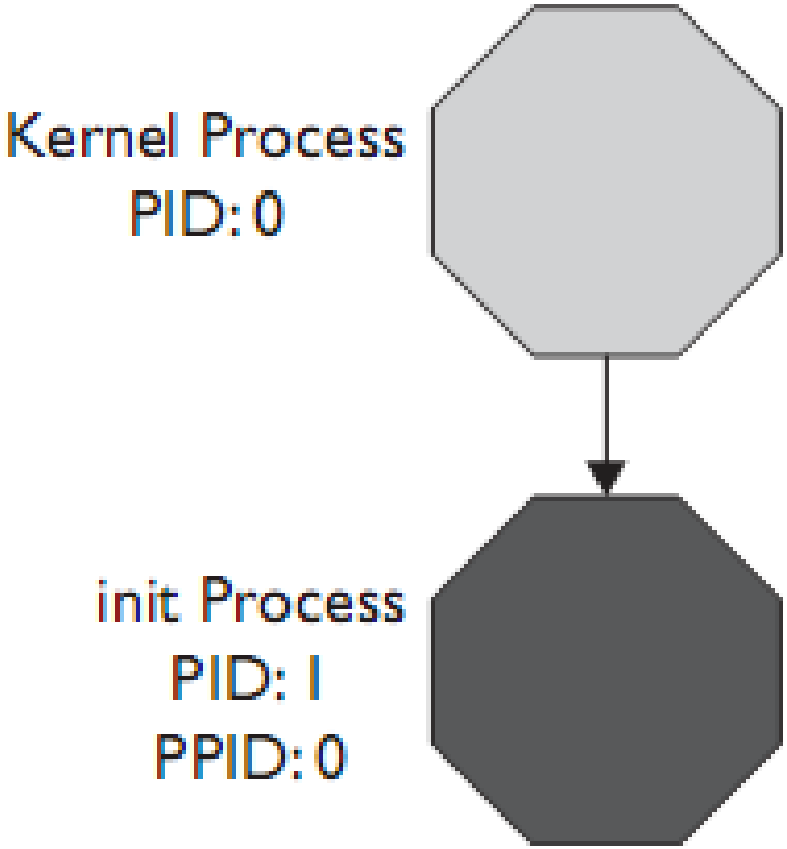
The Heredity of Linux Processes



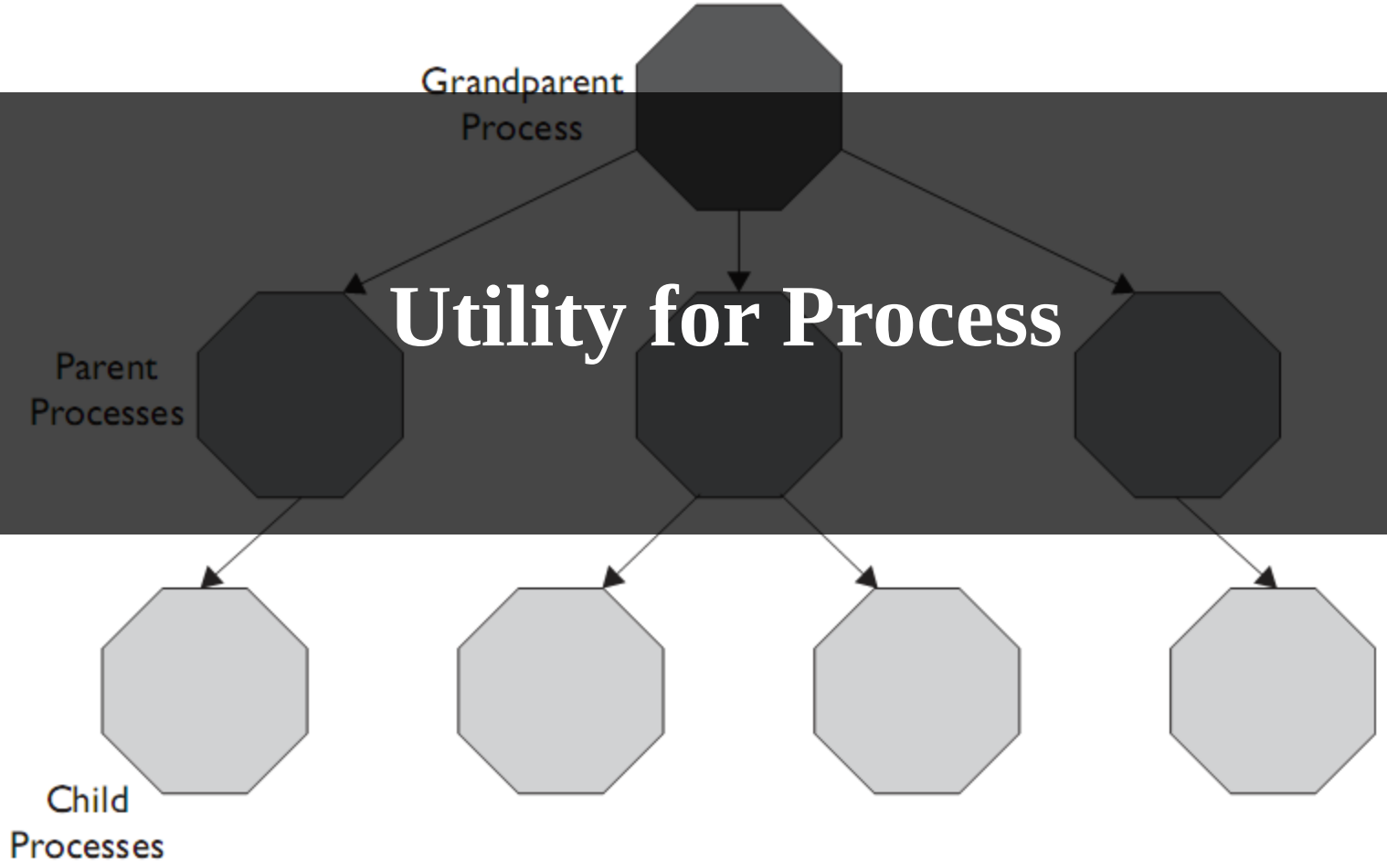
The Heredity of Linux Processes



Parent Process ID

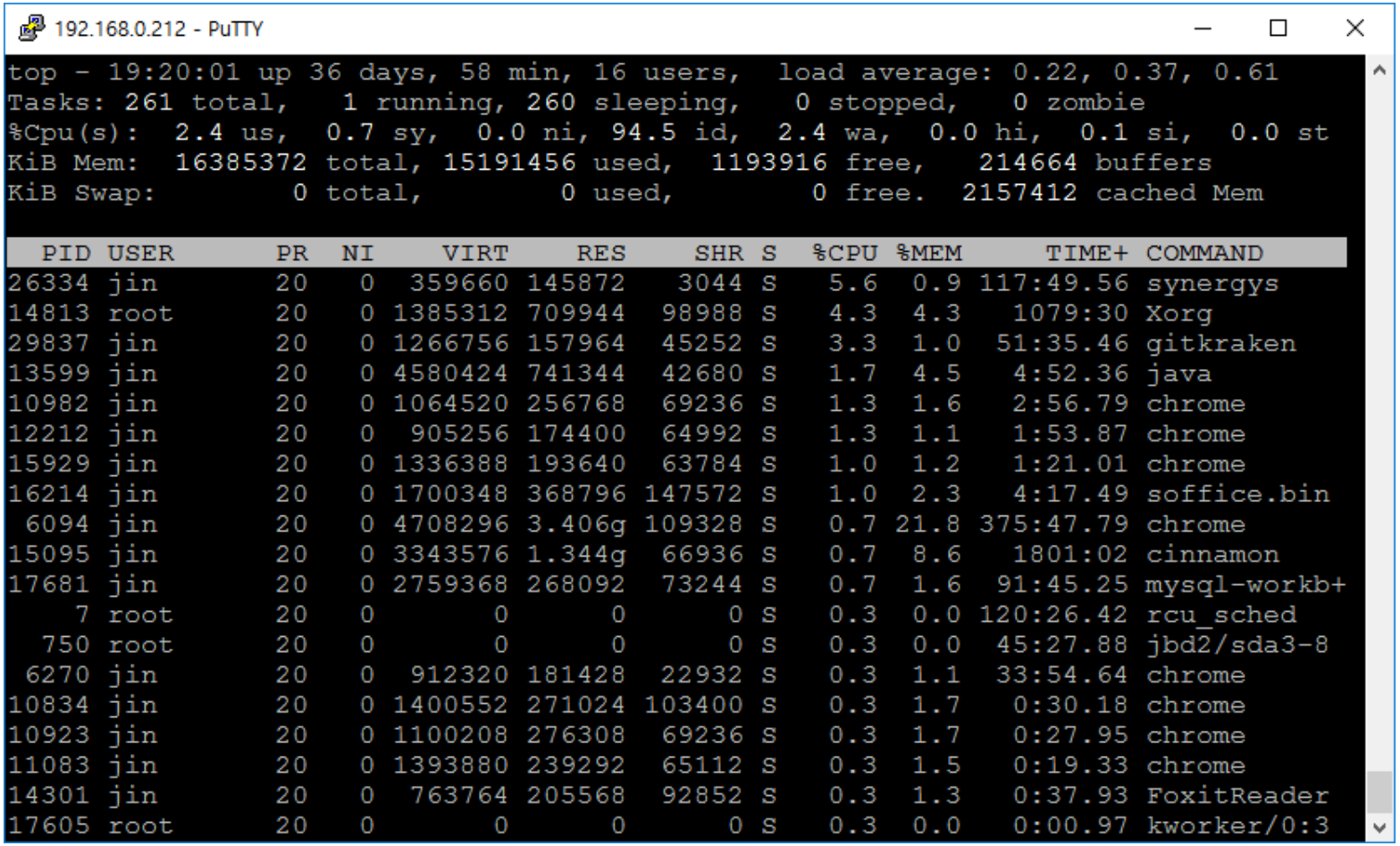


Utility for Process



Utility : top

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



Utility : ps

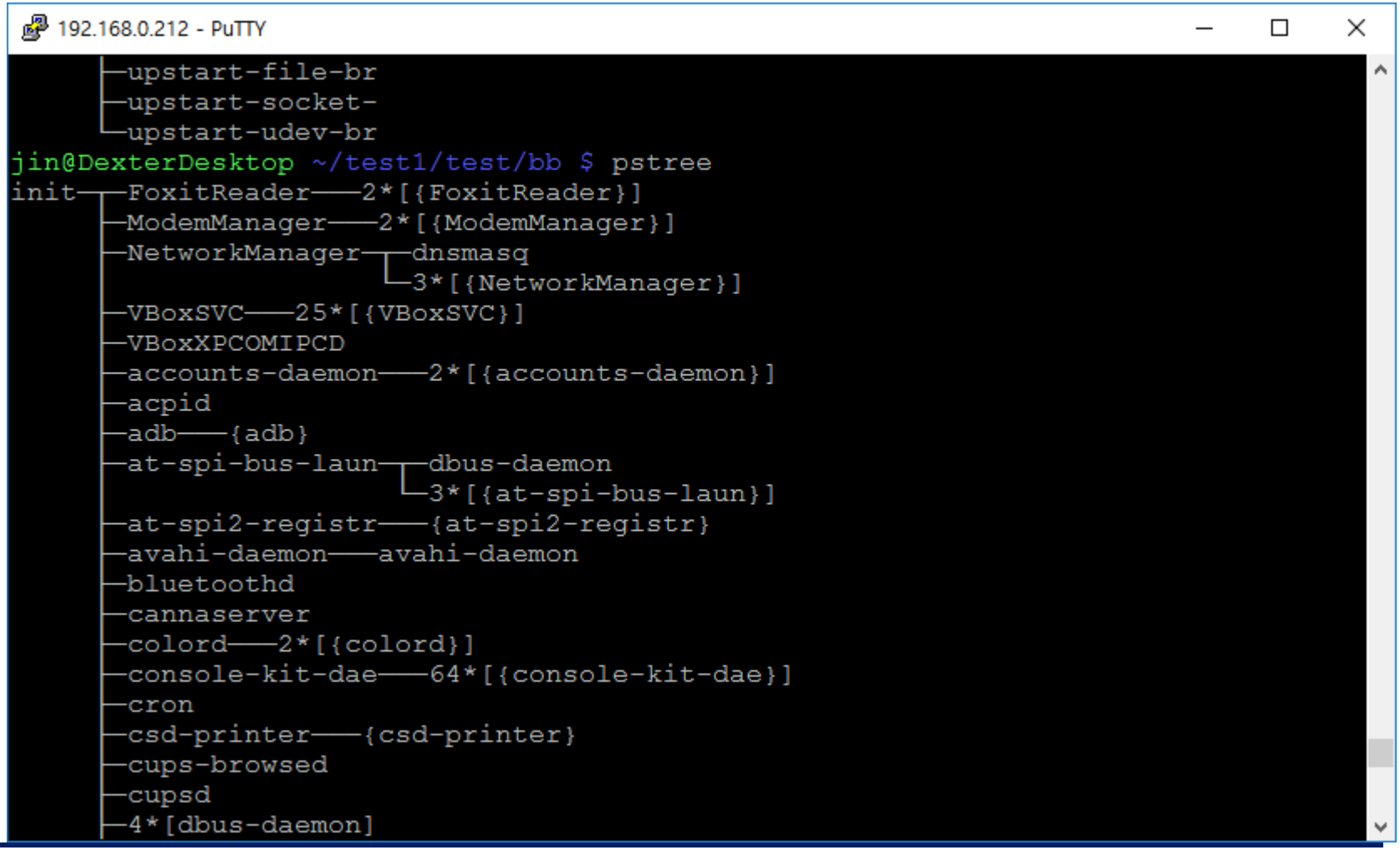
- **Report a snapshot of the current processes.**

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 $
```

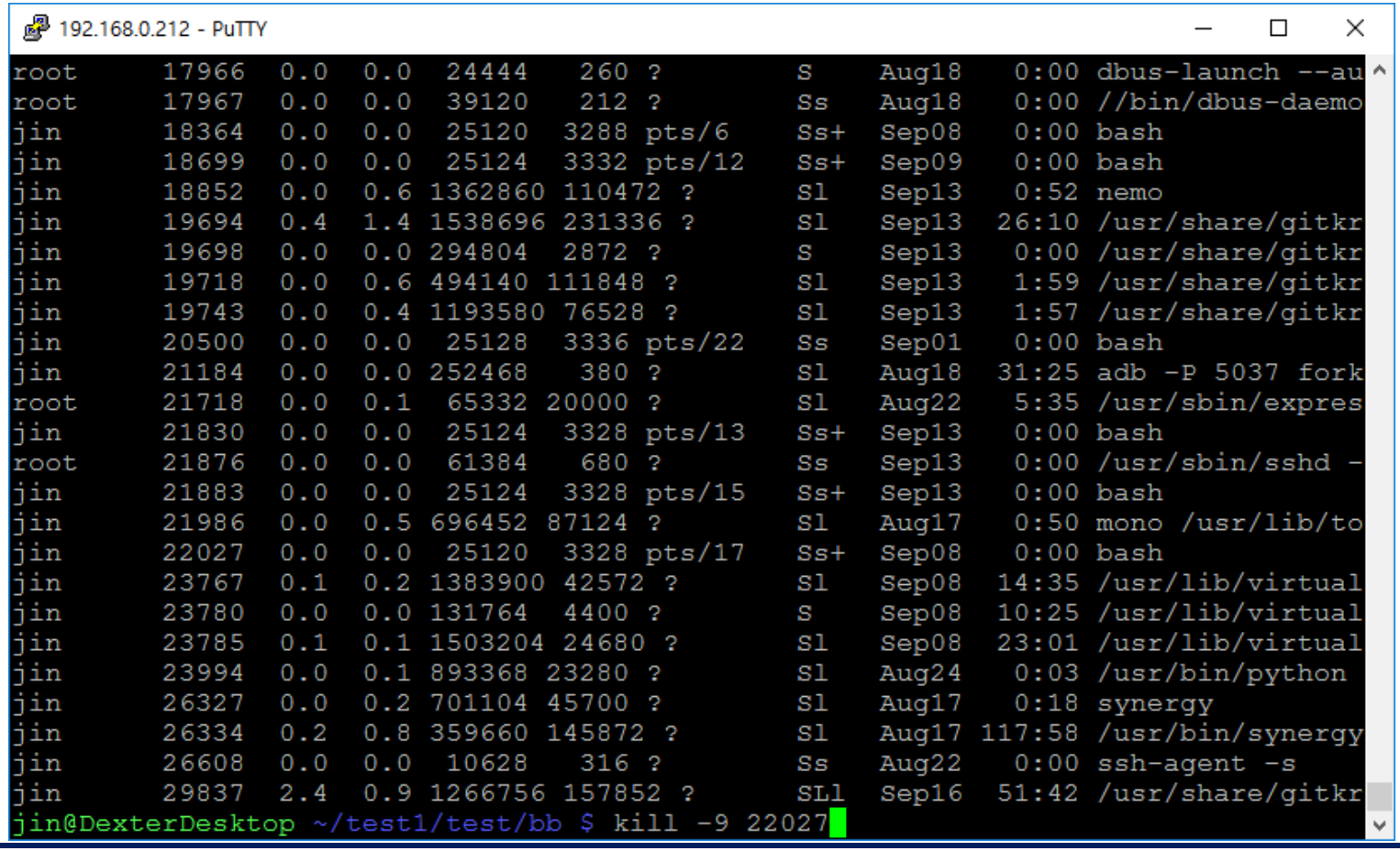
Utility : pstree

- **Display a tree of processes**



Utility : kill

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

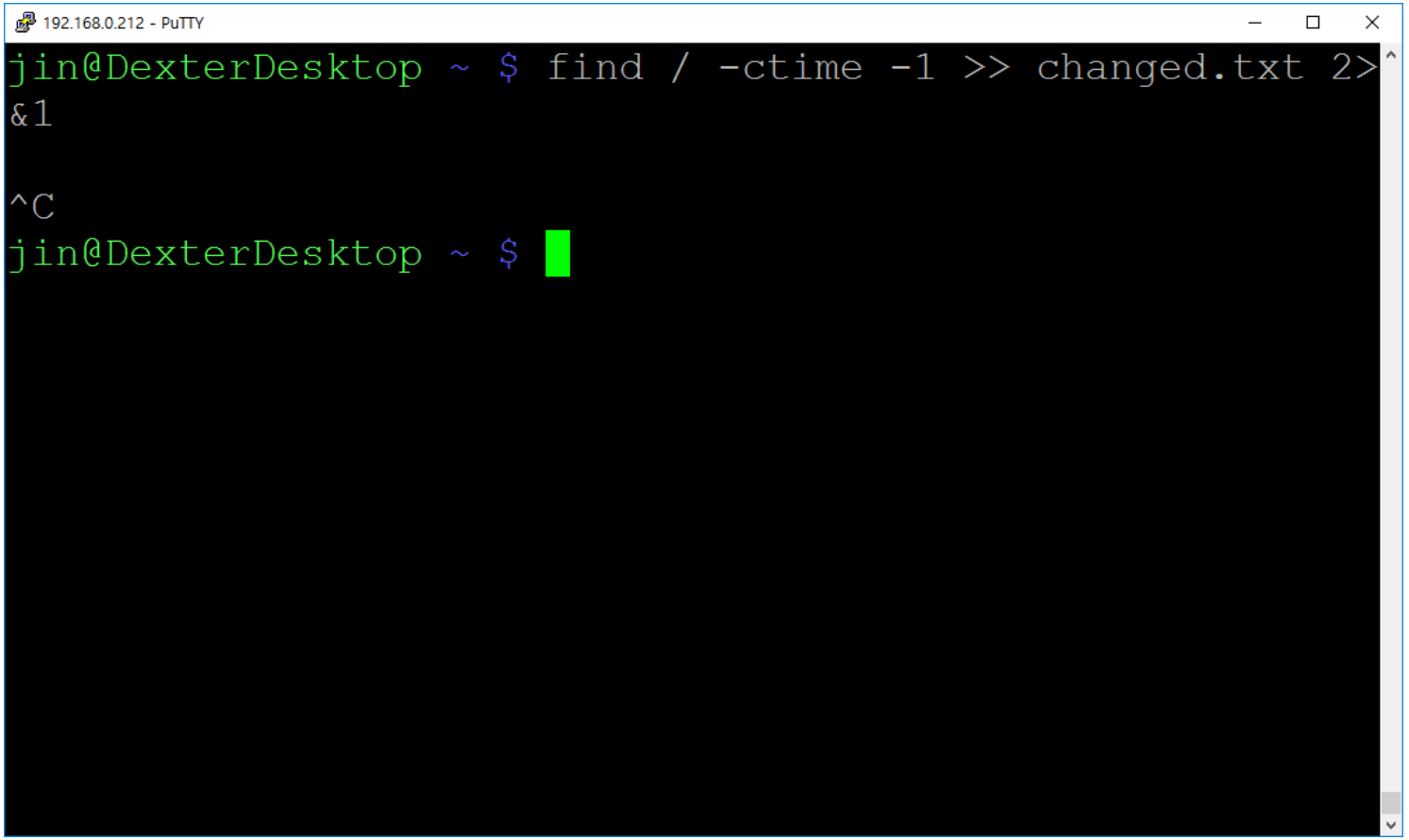


Utility : command &

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

Utility : Ctrl + C

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

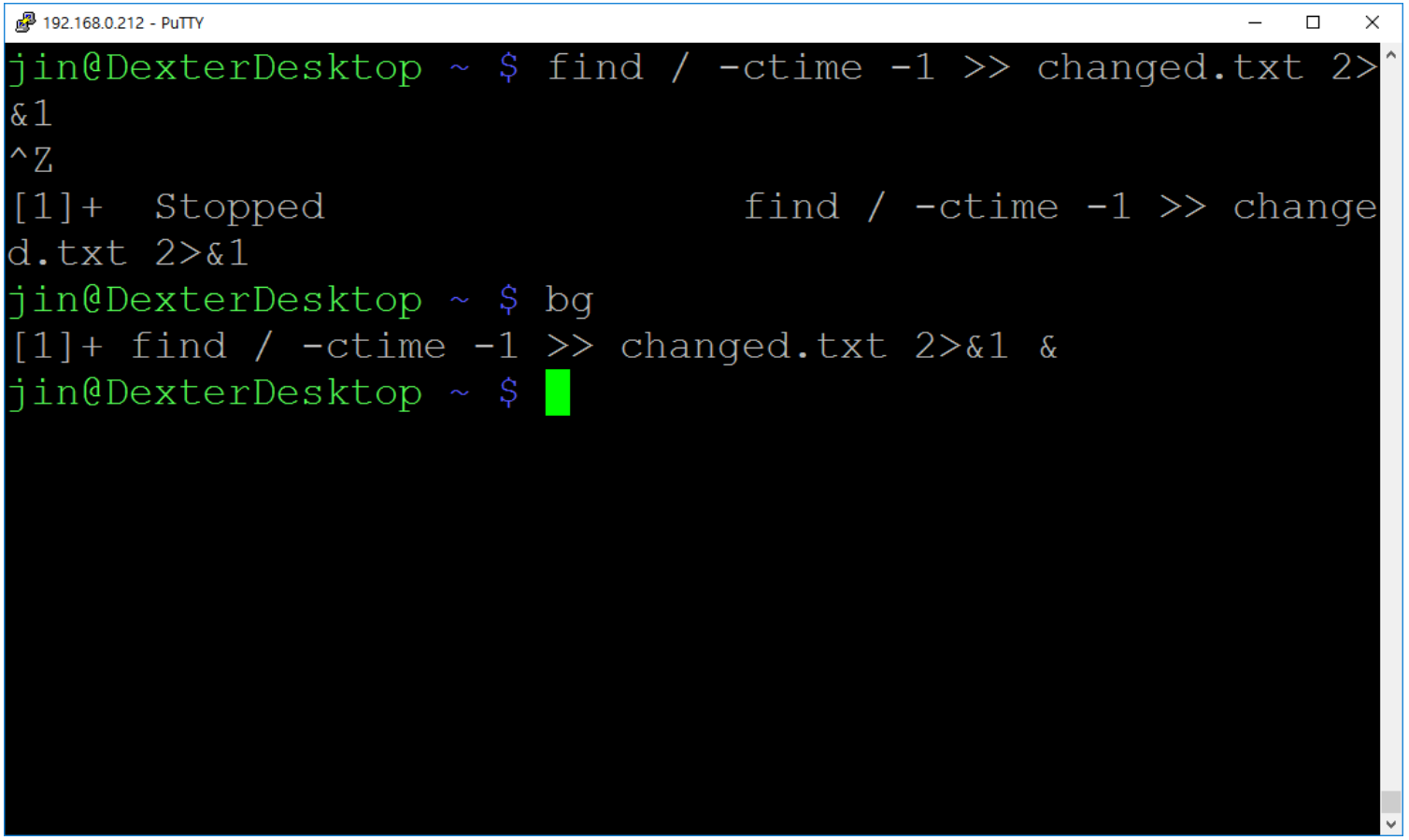


Utility : Ctrl + Z

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

Utility : bg

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



Utility : fg

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