

# CSGE602055 Operating Systems

## CSF2600505 Sistem Operasi

### Week 09: Storage, Firmware, Bootloader, & Systemd

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<https://os.vlsm.org/>

Always check for the latest revision!

REV262 10-Feb-2021

# Operating Systems 211<sup>3)</sup> — PJJ from HOME

## ZOOM: A [Mon 10] — B [Mon 15] — C [Tue 08]

Week	Schedule & Deadline <sup>1)</sup>	Topic	OSC10 <sup>2)</sup>
Week 00	2021	Overview 1, Virtualization & Scripting	Ch. 1, 2, 18.
Week 01	2021	Overview 2, Virtualization & Scripting	Ch. 1, 2, 18.
Week 02	2021	Security, Protection, Privacy, & C-language.	Ch. 16, 17.
Week 03	2021	File System & FUSE	Ch. 13, 14, 15.
Week 04	2021	Addressing, Shared Lib, & Pointer	Ch. 9.
Week 05	2021	Virtual Memory	Ch. 10.
Week 06	2021	Concurrency: Processes & Threads	Ch. 3, 4.
Week 07	2021	Synchronization & Deadlock	Ch. 6, 7, 8.
Week 08	2021	Scheduling + W06/W07	Ch. 5.
Week 09	2021	Storage, Firmware, Bootloader, & Systemd	Ch. 11.
Week 10	2021	I/O & Programming	Ch. 12.

<sup>1)</sup> The **DEADLINE** of Week 00 is XX XXX 2021, whereas the **DEADLINE** of Week 01 is XX XXX 2020, and so on...

<sup>2)</sup> Silberschatz et. al.: **Operating System Concepts**, 10<sup>th</sup> Edition, 2018.

<sup>3)</sup> This information will be on **EVERY** page two (2) of this course material.

# STARTING POINT — <https://os.vlsm.org/>

- **Text Book** — Any recent/decent OS book. Eg. (**OSC10**) Silberschatz et. al.: **Operating System Concepts**, 10<sup>th</sup> Edition, 2018. See also <http://codex.cs.yale.edu/avi/os-book/OS10/>.
- **Resources**
  - **SCELE** — <https://scele.cs.ui.ac.id/course/view.php?id=3020>. The enrollment key is **XXX**.
  - **Download Slides and Demos from GitHub.com**  
<https://github.com/UI-FASILKOM-OS/SistemOperasi/>:  
os00.pdf (W00), os01.pdf (W01), os02.pdf (W02), os03.pdf (W03),  
os04.pdf (W04), os05.pdf (W05), os06.pdf (W06), os07.pdf (W07),  
os08.pdf (W08), os09.pdf (W09), os10.pdf (W10).
  - **Problems** — <https://rms46.vlsm.org/2/>:  
195.pdf (W00), 196.pdf (W01), 197.pdf (W02), 198.pdf (W03),  
199.pdf (W04), 200.pdf (W05), 201.pdf (W06), 202.pdf (W07),  
203.pdf (W08), 204.pdf (W09), 205.pdf (W10).
- **Build your own Virtual Guest**  
<https://osp4diss.vlsm.org/>

# Agenda

- 1 Start
- 2 Schedule
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- 4 Week 09
- 5 Storage, Firmware, Bootloader, & Systemd
- 6 Storage Management
- 7 RAID
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# Week 09 Storage, Firmware, Bootloader, & Systemd: Topics<sup>1</sup>

- Storage
- Storage Arrays
- BIOS
- Loader
- Systemd

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 09 Storage, Firmware, Bootloader, & Systemd: Learning Outcomes<sup>1</sup>

- Storage [Usage]
- Storage Arrays [Usage]
- BIOS [Usage]
- Loader [Usage]
- Systemd [Usage]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Storage, Firmware, Bootloader, & Systemd

- Reference: (OSC10-ch11)
- Storage Capacity (2019)<sup>1</sup>
  - Legacy 3.5" Floppy Disk (1.4MB) – obsolete?
    - SuperDisk (up to 240 MB) — never took off.
  - 4.7" Compact Disc (700MB) – obsolete?
    - 4.7" Digital Versatile Disc (up to 9GB) – ?
    - 4.7" Blu Ray (up to 128 GB) ⇒ DVD++.
  - Tape Cartridge (up to 15TB)
    - Robotic System (up to 250 PB per unit)
    - NASA, Google, Microsoft are still using this!
    - Cheap but slow.
  - Hard Disk Drives (up to 16 TB).
    - From Perpendicular Magnetic Recording to Shingled Magnetic Recording technology (+25% – writing problems).
    - Mechanical Disk Arm Scheduling (Until When?).
  - Solid-State Disks (up to 16 TB).
    - SSD Price > HDD Price.
    - Write Speed >> Read Speed.
    - (What is a) Flash Disk?

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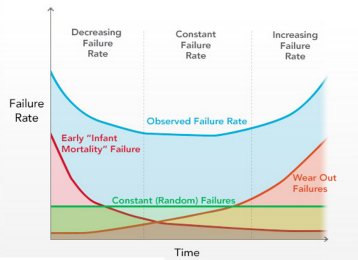
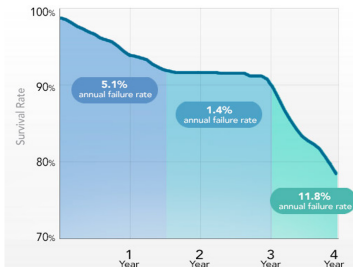
<sup>1</sup>Subject to change

# Storage Failure Rates

- MTDDL: Mean Time To Data Loss
- MTTF: Mean Time To Failure
- BackBlaze (Cloud Backup Services)

Drives Have 3 Distinct Failure Rates      General Predicted Failure Rates

Hard Drive Survival Rates - Chart 1



<https://www.extremetech.com/computing/170748-how-long-do-hard-drives-actually-live-for>



Figure: BackBlaze — Failure Rates of 25000 DISKS



# Storage Management

- Attached-Storage.
  - Host-Attached Storage: via I/O.
  - Network-Attached Storage (NAS): via distributed FileSystem.
  - Storage Area Network (SAN): dedicated Network.
- Formatting
  - Low Level (Physical)
  - High Level (FileSystem)
- Boot Block
- Disk Partition
  - "MBR"-scheme
    - upto 4 primary partition
    - upto 2 TB disk
  - "GPT"-scheme
    - "unlimited" partition
    - "unlimited" disk
    - redundancy
- Swap Space Management: On Partition or FileSystem?

# RAID: Redundant Array of In\* Disks

- RAID 0, 1, 5, 6, 10, 100
- Note (<http://www.commodore.ca/windows/raid5/raid5.htm>):
  - RAID was created to enhance data performance, reliability and availability.
  - Striping, parity checking and mirroring are three primary functions of RAID systems.
  - RAID performs its functions transparent to the operating system.
  - Systems are typically defined by ranks consisting of five disks each connected to one or two Disk Array Controllers.
  - Different RAID levels provide varying degrees of speed and data protection.
- Problems with RAID
- Stable-Storage Implementation

# BIOS, Boot, & Systemd

- Firmware
  - BIOS: Basic Input Output System.
  - UEFI: Unified Extensible Firmware Interface.
  - ACPI: Advanced Configuration and Power Interface.
- Operating System (Boot) Loader
  - BOOTMGT: Windows Bootmanager / Bootloader.
  - LILO: Linux Loader.
  - GRUB: GRand Unified Bootloader.
- Operating System Initialization
  - Init (legacy)
  - UpStart
  - Systemd

- Check Settings.
- Initialize CPU & RAM.
- POST: Power-On Self-Test.
- Initialize ports, LANS, etc.
- Load a Boot Loader.
- Handover to the Boot Loader.
- Provides "Native" (obsolete) Drivers only (not loadable).
- Provides "INT" services .
- Limitation.
  - Technology of 1970s.
  - 16 bits software.
  - 20 bits address space (1 MB).
  - 31 bits disk space (2 TB).

# BIOS

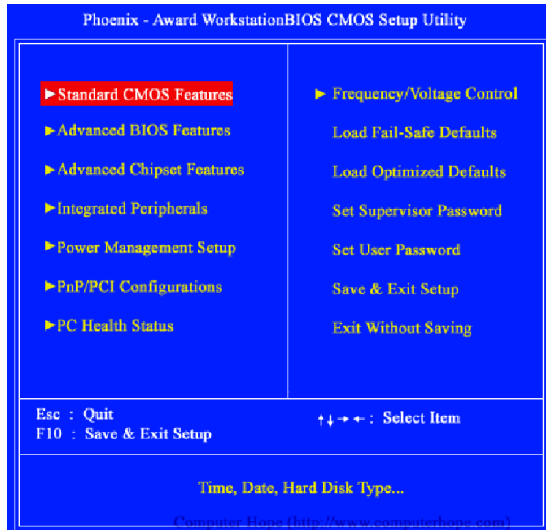


Figure: BIOS

- A Firmware Specification, not an Implementation!
- No (INT) service after boot.
- HII: Human Interface Infrastructure.
- Protected Mode.
- Flexible.
  - Technology of 2000s.
  - written in C.
  - (third party) loadable drivers and tools.
  - Emulate Legacy BIOS transition (MBR block, INT service).
  - UEFI Shell: environment shell for diagnostic (no need for DOS).
- Problems
  - Who controls the Hardware?
  - Is "Secure Boot" a good thing?
  - How about a **NASTY/LOCKING/TROJAN** UEFI implementation?
  - Different **DRIVERS**.

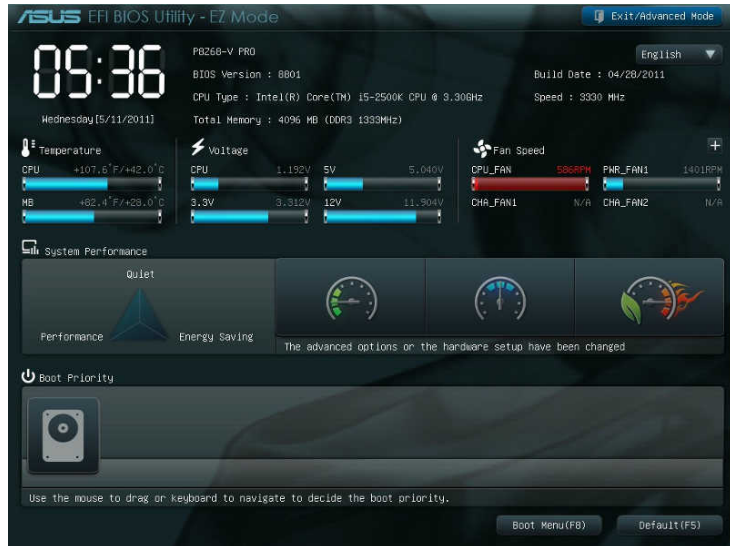


Figure: UEFI

## Platform Initialization (PI) Boot Phases

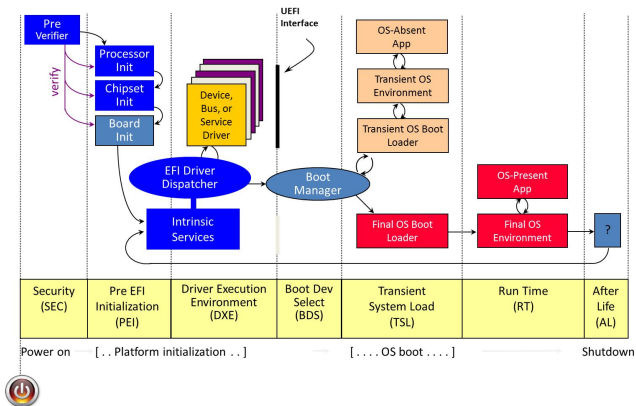


Figure: UEFI Boot Process<sup>1</sup>.

<sup>1</sup>Source Jarslstrom - 2014 - [www.tianocore.org](http://www.tianocore.org)



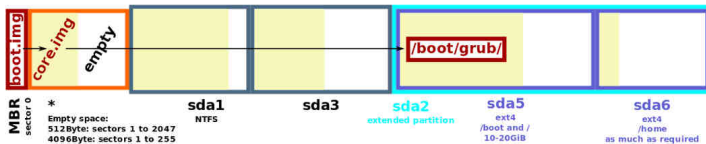
# Operating System (Boot) Loader

- General
  - How/Where to start the operating system?
  - What to do?
  - How many ways to boot?
  - How many types of OS?
- Disk Partition
  - MBR: Master Boot Record (1983).
  - GPT: GUID (Globally Unique Identifiers) Partition Table (2010s).
- GRUB: GRand Unified Boot system
  - Stage 1: a small boot.img inside the MBR.
  - Stage 1.5 (core.img): FileSystem drivers after MBR.
  - Stage 2: Kernel Selection: Windows, Linux, BSD, etc.
- GRUB2
  - More flexible than GRUB legacy.
  - More automated than GRUB legacy.
  - Accept MBR and GPT.
  - Stage 1.5 (core.img): generated from diskboot.img.
  - No 1024 cylinder restriction.

## GNU GRUB 2

Locations of *boot.img*, *core.img* and the */boot/grub* directory

Example 1: an MBR-partitioned harddisc with sector size of 512 or 4096Bytes



Example 2: a GPT-partitioned harddisc with sector size of 512 or 4096Bytes

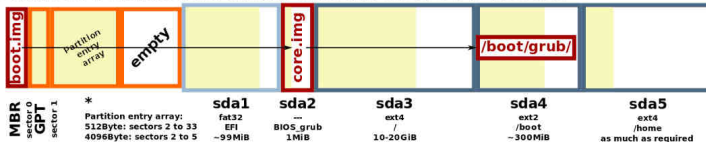


Figure: GRUB<sup>1</sup>.

<sup>1</sup>Source Shmuel Csaba Otto Traian 2013

# init (SYSV legacy)

- File: `/etc/inittab`.
- Folders: `/etc/rcX.d` — `X` = runlevel.
  - Seven (7) different runlevels:
    - 0 (shutdown).
    - 1 (single-user/admin).
    - 2 (multi-user non net).
    - 3 (standard).
    - 4 (N/A).
    - 5 (3+GUI).
    - 6 (reboot).
  - `SXX-YYY`: Start
  - `KXX-YYY`: Kill.
- One script at a time in order.
- dependency is set manually.

- Developer: Ubuntu.
- Folder: `/etc/init/`.
- Control: `initctl`.
  - `initctl list` – listing all processes managed by upstart.
- better support for hotplug devices.
- cleaner service management.
- faster service management.
- asynchronous.

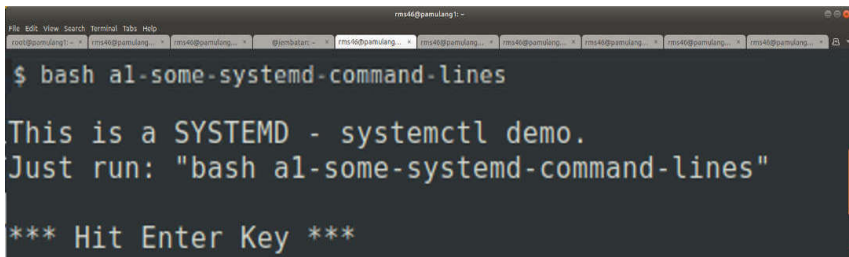
# The All New "systemd"

- Replaces (SYSV) init and UpStart.
  - better concurrency handling: Faster!
  - better dependencies handling: No more "S(tarts)" and "K(ills)".
  - better crash handling: automatic restart option.
  - better security: group protection from anyone including superusers.
  - simpler config files: reliable and clean scripts.
  - hotplug: dynamic start/stop.
  - supports legacy systems (init).
  - overhead reducing.
  - unified management way for all distros.
  - bloated: doing more with more resources.
  - linux specific: NOT portable.

# systemctl 01

```
for II in \
'systemctl list-unit-files | head -8; echo "(...)";
  systemctl list-unit-files| tail -8' \
'systemd-analyze blame | wc -l; echo "===";
  systemd-analyze blame | head -15' \
'systemctl --full | wc -l; echo "===";
  systemctl --full | head -10' \
'systemctl list-units | wc -l; echo "===";
  systemctl list-units | head -10' \
'systemctl list-units |grep .service|wc -l;echo "===";
  systemctl list-units|grep .service|head -10' \
'systemctl list-units | grep ssh.service' \
'systemctl status ssh.service' \
'systemctl is-enabled ssh' \
'journalctl' \
'journalctl -b' \
do
...
```

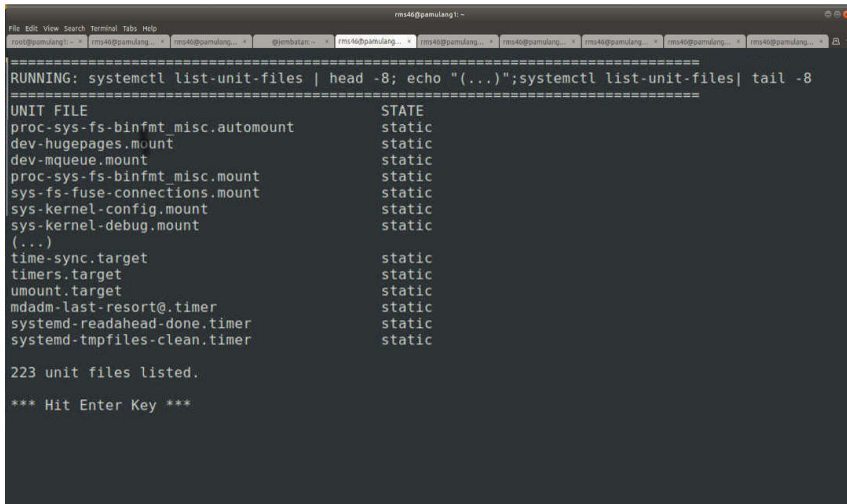
# systemctl 02

A terminal window titled 'rms46@pamulang1: ~' with multiple tabs. The active tab shows the command '\$ bash a1-some-systemd-command-lines' and its output: 'This is a SYSTEMD - systemctl demo. Just run: "bash a1-some-systemd-command-lines" \*\*\* Hit Enter Key \*\*\*'.

```
rms46@pamulang1: ~  
File Edit View Search Terminal Tabs Help  
root@pamulang1:~ * rms46@pamulang... * rms46@pamulang... * @jmbatan:~ * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... *  
$ bash a1-some-systemd-command-lines  
This is a SYSTEMD - systemctl demo.  
Just run: "bash a1-some-systemd-command-lines"  
*** Hit Enter Key ***
```

Figure: bash a1-some-systemd-command-lines

# systemctl 03



```
rms46@pamulang1: ~  
File Edit View Search Terminal Tabs Help  
root@pamulang1: ~ * rms46@pamulang... * rms46@pamulang... * @jembatan: ~ * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... *  
===== RUNNING: systemctl list-unit-files | head -8; echo "...";systemctl list-unit-files| tail -8 =====  
===== UNIT FILE STATE =====  
proc-sys-fs-binfmt_misc.automount static  
dev-hugepages.mount static  
dev-mqueue.mount static  
proc-sys-fs-binfmt_misc.mount static  
sys-fs-fuse-connections.mount static  
sys-kernel-config.mount static  
sys-kernel-debug.mount static  
(...)  
time-sync.target static  
timers.target static  
umount.target static  
mdadm-last-resort@.timer static  
systemd-readahead-done.timer static  
systemd-tmpfiles-clean.timer static  
  
223 unit files listed.  
  
*** Hit Enter Key ***
```

Figure: systemctl list-unit-files



# systemctl 04

A terminal window titled 'rms46@pamulang1: ~' with multiple tabs. The terminal shows the command 'systemd-analyze blame' being executed. The output lists various system services and their boot times. The command is repeated with a pipe to 'wc -l' and 'echo' to show the line count and a separator. The output is then piped to 'head -10' to show the first 10 lines. The output shows that 'keyboard-setup.service' is the slowest at 2.374s, followed by 'systemd-logind.service' at 963ms, and 'rsyslog.service' at 957ms. The fastest is 'systemd-tmpfiles-setup-dev.service' at 322ms. The terminal also shows a prompt '34' and a separator '==='.

```
=====  
RUNNING: systemd-analyze blame | wc -l; echo "===";systemd-analyze blame | head -10  
=====  
34  
===  
2.374s keyboard-setup.service  
963ms systemd-logind.service  
957ms rsyslog.service  
954ms ssh.service  
954ms rc-local.service  
954ms systemd-user-sessions.service  
928ms postfix.service  
589ms networking.service  
519ms snmpd.service  
322ms systemd-tmpfiles-setup-dev.service  
*** Hit Enter Key ***
```

Figure: systemd-analyze blame

# systemctl 05

```
rms40@pamulang1: ~
File Edit View Search Terminal Tabs Help
rms40@pamulang1: ~
RUNNING: systemctl --full | wc -l; echo "===";systemctl --full | head -6
=====
97
=====
UNIT
proc-sys-fs-binfmt-misc.automount                                loaded active waiting Arbitrary Executable File Formats File System Automount Point
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:0:0:0-block-sda-sda1.device loaded active plugged QEMU_HARDDISK 1
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:0:0:0-block-sda-sda2.device loaded active plugged QEMU_HARDDISK 2
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:0:0:0-block-sdb.device loaded active plugged QEMU_HARDDISK
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:1:0:0:1-block-sdb-sdb1.device loaded active plugged QEMU_HARDDISK 1
*** Hit Enter Key ***

RUNNING: systemctl list-units | wc -l; echo "===";systemctl list-units | head -6
=====
97
=====
UNIT
proc-sys-fs-binfmt-misc.automount                                loaded active waiting Arbitrary Executable File Formats File System Automount Point
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:0:0:0-block-sda-sda1.device loaded active plugged QEMU_HARDDISK 1
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:0:0:0-block-sda-sda2.device loaded active plugged QEMU_HARDDISK 2
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:0:0:0-block-sdb.device loaded active plugged QEMU_HARDDISK
sys-devices-pci0000:00:0000:00:05:0-host0-target0:0:1:0:0:1-block-sdb-sdb1.device loaded active plugged QEMU_HARDDISK 1
*** Hit Enter Key ***

RUNNING: systemctl list-units |grep .service|wc -l;echo "===";systemctl list-units|grep .service|head -6
=====
12
=====
UNIT
ssct.service                                                    loaded active exited LSB: process and login accounting
icpidd.service                                                  loaded active running ACPI event daemon
console-setup.service                                           loaded active exited Set console font and keymap
cron.service                                                    loaded active running Regular background program processing daemon
dbus.service                                                    loaded active running D-Bus System Message Bus
jetty@tty1.service                                              loaded active running Getty on tty1
*** Hit Enter Key ***
```

Figure: systemctl --full; systemctl list-units

# systemctl 06

```
rms46@pamulang1: ~
File Edit View Search Terminal Tabs Help
rms46@pamulang1 ~
=====
RUNNING: systemctl list-units | grep ssh.service
=====
ssh.service                                loaded active running    OpenBSD Secure Shell server
*** Hit Enter Key ***
=====
RUNNING: systemctl status ssh.service
=====
● ssh.service - OpenBSD Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled)
   Active: active (running) since Sun 2020-04-26 03:00:24 WIB; 3h 33min ago
   Process: 653 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
   Main PID: 686 (sshd)
   CGroup: /system.slice/ssh.service
           └─ 686 /usr/sbin/sshd -D
              3247 sshd: demo [priv]
              3253 sshd: demo@pts/0
              3254 -bash
              3391 bash a1-some-systemd-command-lines
              3550 systemctl status ssh.service
*** Hit Enter Key ***
```

Figure: systemctl status ssh.service

A terminal window titled 'rms46@pamulang1: ~' with multiple tabs open. The active tab shows the command 'systemctl status ssh' being executed. The output is displayed in a monospaced font with yellow text on a dark background. The output consists of a header line 'RUNNING: systemctl is-enabled ssh', followed by a separator line of equals signs, then the text 'enabled', another separator line of equals signs, and finally '\*\*\* Hit Enter Key \*\*\*'.

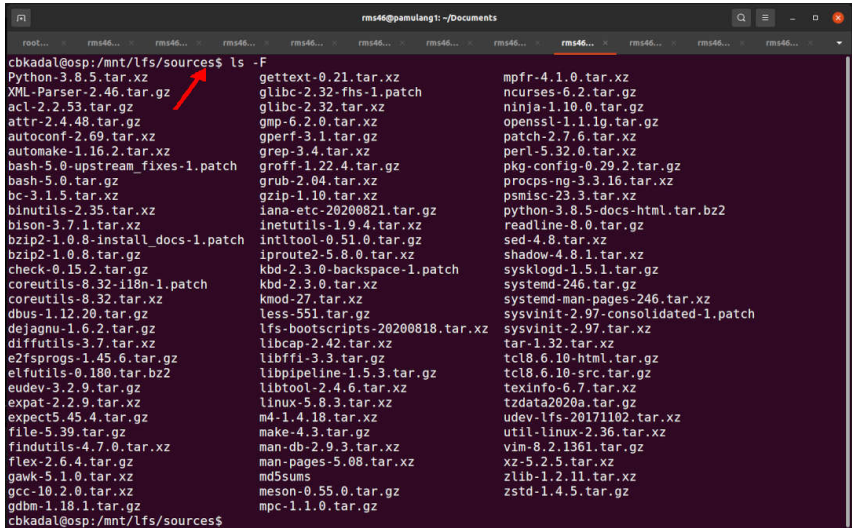
```
rms46@pamulang1: ~  
File Edit View Search Terminal Tabs Help  
root@pamulang1: ~ * rms46@pamulang... * rms46@pamulang... * @jembatan: ~ * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... *  
=====  
RUNNING: systemctl is-enabled ssh  
=====  
enabled  
=====  
*** Hit Enter Key ***
```

Figure: systemctl is-enabled ssh

# Linux From Scratch (part 02)

- Week 09 (part 02).
  - Follow the "Linux From Scratch" book, chapter 01-06 (<http://www.linuxfromscratch.org/lfs/view/stable/>).
  - Screen capture with your **OWN** account (e.g. "cbkadal"):
    - ("W09-LFS-1.jpg"): LFS source-codes /mnt/lfs/sources/.
    - ("W09-LFS-2.jpg"): Disk size /dev/sda1/ and /dev/sdb1/.
  - Save (export) the result into "LFSC.ova".
  - Sign it as: "LFSC.ova.asc" (armor, detach).
  - Deliveries: tarball "TXT/myW09.tar.bz2.txt" (signed, asymmetric-key, armor) of folder W09/ (**4 files**).
    - ❶ Blank File: "YourAccount-YourStudentID.txt" (eg. "cbkadal-2006123456.txt").
    - ❷ File: "W09-LFS-1.jpg" (page 30).
    - ❸ File: "W09-LFS-2.jpg" (page 31).
    - ❹ File: "LFSC.ova.asc" (signature, armor, detach).
- Keep but **DO NOT SUBMIT** file LFSC.ova!.
- See also <https://lfs.vlsm.org/>.

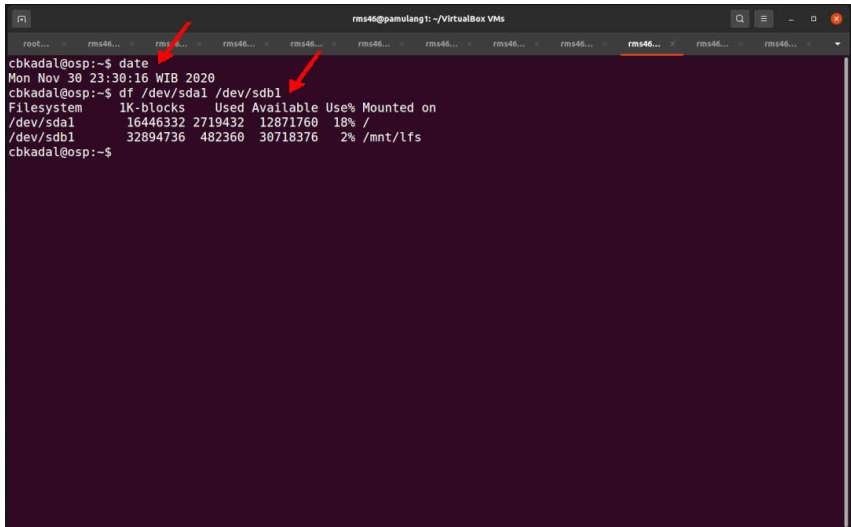
# W09-LFS-1.jpg



```
cbkadal@osp:/mnt/lfs/sources$ ls -F
Python-3.8.5.tar.xz          gettext-0.21.tar.xz        mpfr-4.1.0.tar.xz
XML-Parser-2.46.tar.gz      glibc-2.32-fhs-1.patch    ncurses-6.2.tar.gz
acl-2.2.53.tar.gz           glibc-2.32.tar.xz         ninja-1.10.0.tar.gz
attr-2.4.48.tar.gz          gmp-6.2.0.tar.xz          openssl-1.1.1g.tar.gz
autoconf-2.69.tar.xz        gperf-3.1.tar.gz          patch-2.7.6.tar.xz
automake-1.16.2.tar.xz      grep-3.4.tar.xz           perl-5.32.0.tar.xz
bash-5.0-upstream_fixes-1.patch  groff-1.22.4.tar.gz      pkg-config-0.29.2.tar.gz
bash-5.0.tar.gz             grub-2.04.tar.xz          procs-ng-3.3.16.tar.xz
bc-3.1.5.tar.xz             gzip-1.10.tar.xz          psmisc-23.3.tar.xz
binutils-2.35.tar.xz        iana-etc-20200821.tar.gz  python-3.8.5-docs-html.tar.bz2
bison-3.7.1.tar.xz          inetutils-1.9.4.tar.xz    readline-8.0.tar.gz
bzip2-1.0.8-install_docs-1.patch  intltool-0.51.0.tar.gz   sed-4.8.tar.xz
bzip2-1.0.8.tar.gz          iproute2-5.8.0.tar.xz     shadow-4.8.1.tar.xz
check-0.15.2.tar.gz         kbd-2.3.0-backspace-1.patch  sysklogd-1.5.1.tar.gz
coreutils-8.32-il8n-1.patch  kbd-2.3.0.tar.xz          systemd-246.tar.gz
coreutils-8.32.tar.xz       kmod-27.tar.xz            systemd-man-pages-246.tar.xz
dbus-1.12.20.tar.gz         less-551.tar.gz           sysvinit-2.97-consolidated-1.patch
dejagnu-1.6.2.tar.gz        lfs-bootscripts-20200818.tar.xz  sysvinit-2.97.tar.xz
diffutils-3.7.tar.xz        libcap-2.42.tar.xz        tar-1.32.tar.xz
e2fsprogs-1.45.6.tar.gz     libffi-3.3.tar.gz         tc18.6.10-html.tar.gz
elfutils-0.180.tar.bz2      libpipeline-1.5.3.tar.gz   tc18.6.10-src.tar.gz
eudev-3.2.9.tar.gz          libtool-2.4.6.tar.xz      texinfo-6.7.tar.xz
expat-2.2.9.tar.xz          linux-5.8.3.tar.xz        tzdata2020a.tar.gz
expect5.45.4.tar.gz         m4-1.4.18.tar.xz          udev-lfs-20171102.tar.xz
file-5.39.tar.gz            make-4.3.tar.gz           util-linux-2.36.tar.xz
findutils-4.7.0.tar.xz      man-db-2.9.3.tar.xz       vim-8.2.1361.tar.gz
flex-2.6.4.tar.gz           man-pages-5.08.tar.xz     xz-5.2.5.tar.xz
gawk-5.1.0.tar.xz           md5sums                   zlib-1.2.11.tar.xz
gcc-10.2.0.tar.xz          meson-0.55.0.tar.gz       zstd-1.4.5.tar.gz
gdbm-1.18.1.tar.gz         mpc-1.1.0.tar.gz
```

Figure: W09-LFS-1.jpg

# W09-LFS-2.jpg



A terminal window titled "rms46@pamulang1: ~/VirtualBox VMs" showing the output of several commands. The terminal has a dark purple background. The commands and their outputs are as follows:

```
cbkadal@osp:~$ date
Mon Nov 30 23:30:16 WIB 2020
cbkadal@osp:~$ df /dev/sda1 /dev/sdb1
Filesystem      1K-blocks    Used Available Use% Mounted on
/dev/sda1        16446332  2719432   12871760   18% /
/dev/sdb1        32894736   482360    30718376    2% /mnt/lfs
cbkadal@osp:~$
```

Two red arrows point to the terminal output: one points to the date command output, and the other points to the disk usage table.

Figure: W09-LFS-2.jpg

# Week 09: Check List (Deadline: Monday, 07-Dec-2020).

## □ Week 09: Linux From Scratch (part 2)(os09.pdf).

- ① Week 09 Token: **ROMULAN**
- ② Read: (OSC10 chapter 11)
- ③ Update your Virtual Guest.
- ④ Visit <https://os.vlsm.org/GitHubPages/>. Review **Last Week TOP 10 List** and pick at least 3 out of your 10 closest neighbors. See <https://cbkadal.github.io/os202/TXT/myrank.txt>.
- ⑤ Create your **TOP 10 List** of Week 09 (e.g. <https://cbkadal.github.io/os202/W09/>). **Do not use lecture material. Please be more creative!**
- ⑥ Run "chktoken ROMULAN" and write the result into myW09token.txt.
- ⑦ Update your log (e.g. <https://cbkadal.github.io/os202/TXT/mylog.txt>).
- ⑧ Update bash script (e.g. <https://cbkadal.github.io/os202/TXT/myscript.sh>).
- ⑨ Make SHA256SUM and sign it (detached, armor) as SHA256SUM.asc.
- ⑩ Place the assignment result into W09/ folder and "tar" it into myW09.tar.bz2.
- ⑪ GnuPG encrypt (armor) to myW09.tar.bz2.txt.



# The End

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