

# CSGE602055 Operating Systems

## CSF2600505 Sistem Operasi

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

Rahmat M. Samik-Ibrahim (ed.)

University of Indonesia

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

Always check for the latest revision!

REV271 28-Feb-2021

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

## ZOOM: A [Mon (or Wed) 10:00] — B [Mon (or Wed) 15:40] — C [Tue (or Thu) 08:00]

Week	Schedule & Deadline <sup>1)</sup>	Topic	OSC10 <sup>2)</sup>
Week 00	22 Feb - 28 Feb 2021	Overview 1, Virtualization & Scripting	Ch. 1, 2, 18.
Week 01	01 Mar - 07 Mar 2021	Overview 2, Virtualization & Scripting	Ch. 1, 2, 18.
Week 02	08 Mar - 16 Mar 2021	Security, Protection, Privacy, & C-language.	Ch. 16, 17.
Week 03	17 Mar - 23 Mar 2021	File System & FUSE	Ch. 13, 14, 15.
Week 04	24 Mar - 30 Mar 2021	Addressing, Shared Lib, & Pointer	Ch. 9.
Week 05	31 Mar - 06 Apr 2021	Virtual Memory	Ch. 10.
Week 06	07 Apr - 25 Apr 2021	Concurrency: Processes & Threads	Ch. 3, 4.
Week 07	26 Apr - 02 May 2021	Synchronization & Deadlock	Ch. 6, 7, 8.
Week 08	03 May - 09 May 2021	Scheduling + W06/W07	Ch. 5.
Week 09	17 May - 23 May 2021	Storage, Firmware, Bootloader, & Systemd	Ch. 11.
Week 10	24 May - 06 Jun 2021	I/O & Programming	Ch. 12.

<sup>1)</sup> The **DEADLINE** of Week 00 is 28 Feb 2021, whereas the **DEADLINE** of Week 01 is 07 Mar 2021, 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 OS211** — <https://scele.cs.ui.ac.id/course/view.php?id=3134>.  
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).
  - ❑ **LFS** — <http://www.linuxfromscratch.org/lfs/view/stable/>
  - ❑ **OSP4DISS** — <https://osp4diss.vlsm.org/>
  - ❑ **DOIT** — <https://doit.vlsm.org/001.html>

# Agenda

- 1 Start
- 2 Schedule
- 3 Agenda
- 4 Week 09
- 5 Storage, Firmware, Bootloader, & Systemd
- 6 Storage Management
- 7 RAID
- 8 Legacy BIOS
- 9 UEFI
- 10 Operating System (Boot) Loader
- 11 GRUB Map
- 12 init (SYSV legacy)
- 13 UpStart - Ubuntu
- 14 The All New "systemd"
- 15 systemctl
- 16 Linux From Scratch (part 02)
- 17 Week 09: Check List

# 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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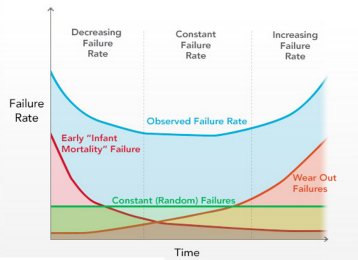
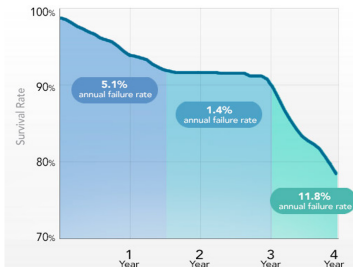
<sup>1</sup>Subject to change

# 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

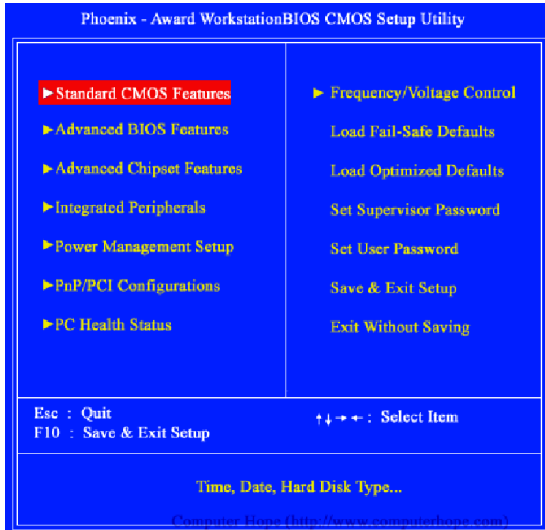


Figure: BIOS

- 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**.

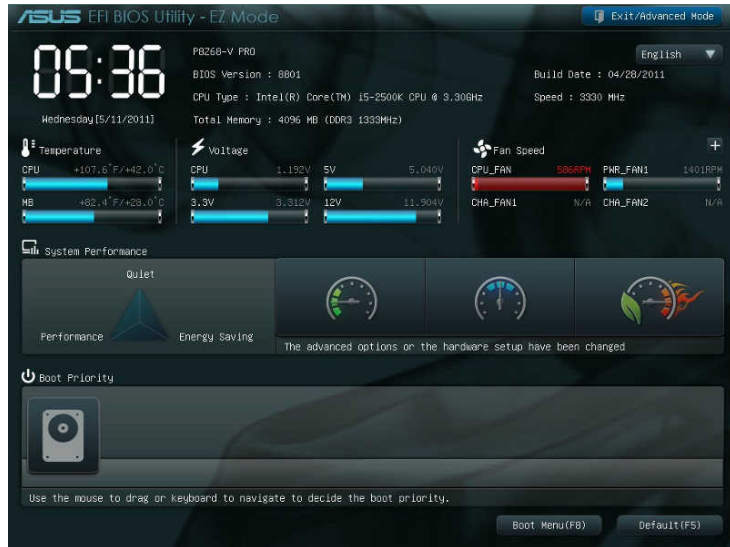


Figure: UEFI

## Platform Initialization (PI) Boot Phases

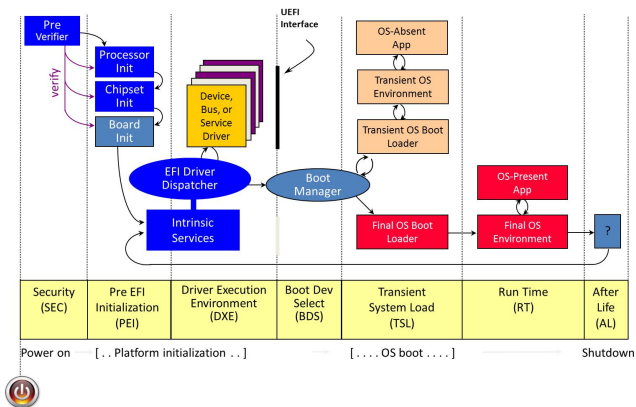


Figure: UEFI Boot Process<sup>1</sup>.

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



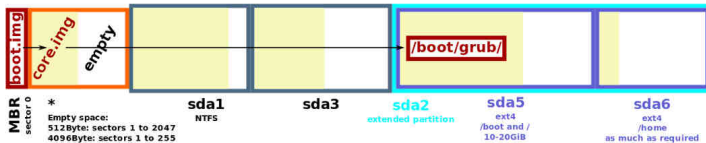
# Operating System (Boot) Loader

- 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

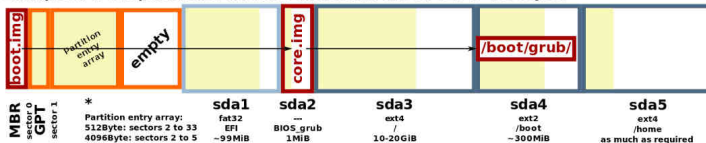


Figure: GRUB<sup>1</sup>.

<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.

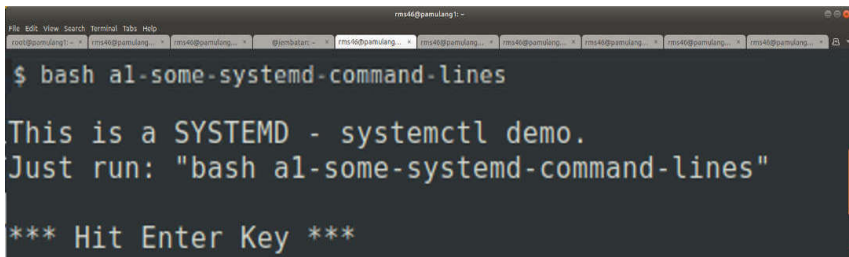
# The All New "systemd"

- 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
...
```

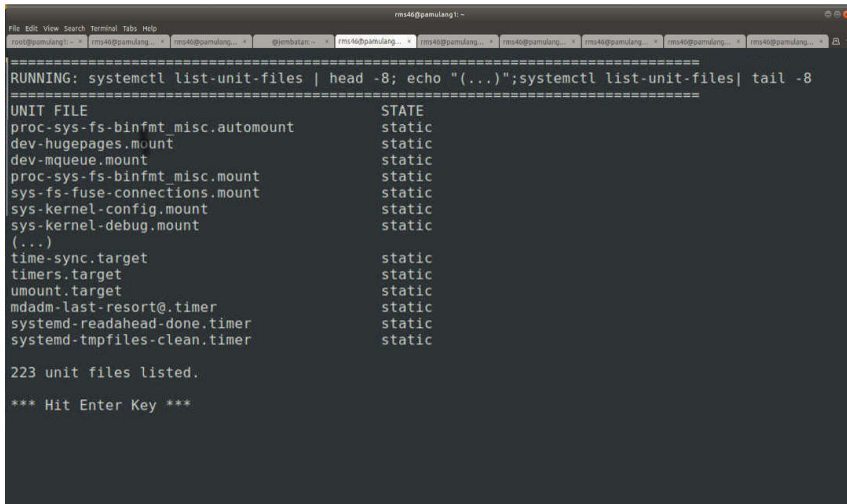
# systemctl 02

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: -  
root@pamulang1:~$ 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

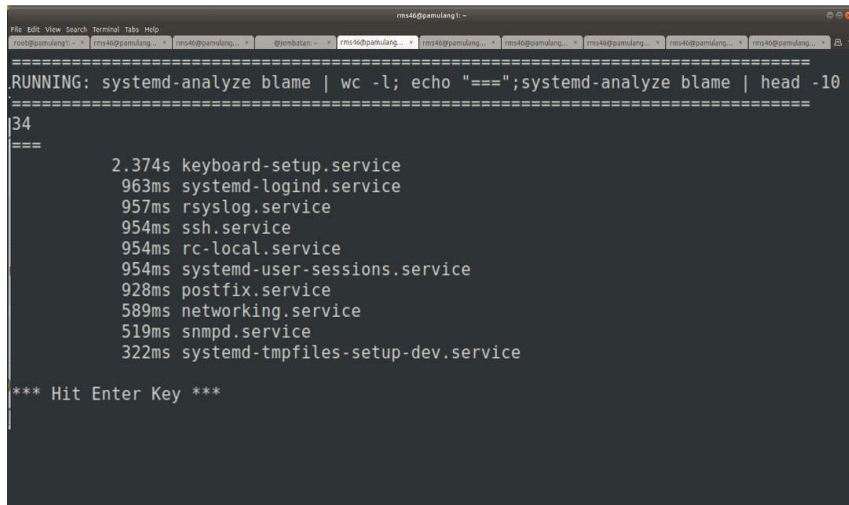


```
rms46@pamulang1: ~  
File Edit View Search Terminal Tabs Help  
root@pamulang1: ~ * rms46@pamulang... * rms46@pamulang... * @jembatan: ~ * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... *  
=====   
RUNNING: systemctl list-unit-files | 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



```
rms46@pamulang1: ~  
File Edit View Search Terminal Tabs Help  
root@pamulang1: ~ * rms46@pamulang... * rms46@pamulang... * @jembar: ~ * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... *  
=====  
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 ***

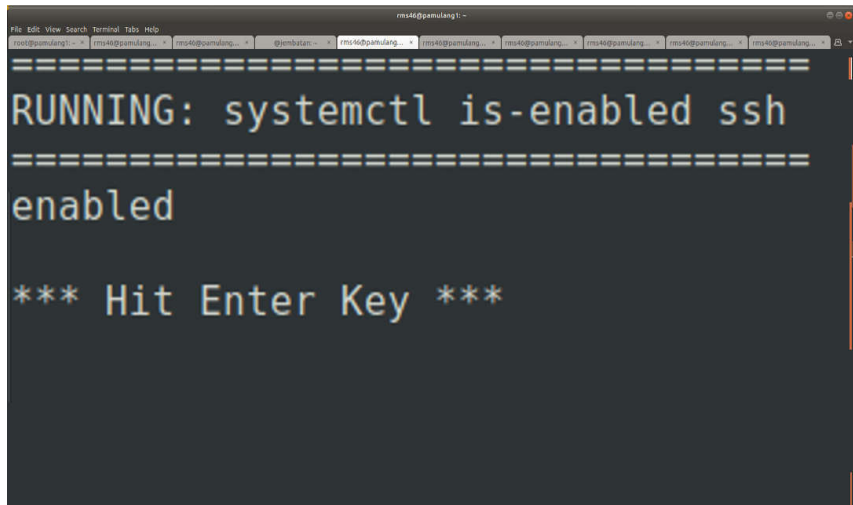
RUNNING: systemctl list-units | grep .service | wc -l; echo "===";systemctl list-units | grep .service | head -6
=====
12
UNIT
ssct.service                                                    loaded active exited LSB: process and login accounting
icpidd.service                                                  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. 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 includes a separator line of equals signs, the status 'RUNNING: systemctl is-enabled ssh', another separator line, the word 'enabled', and a prompt '\*\*\* Hit Enter Key \*\*\*'.

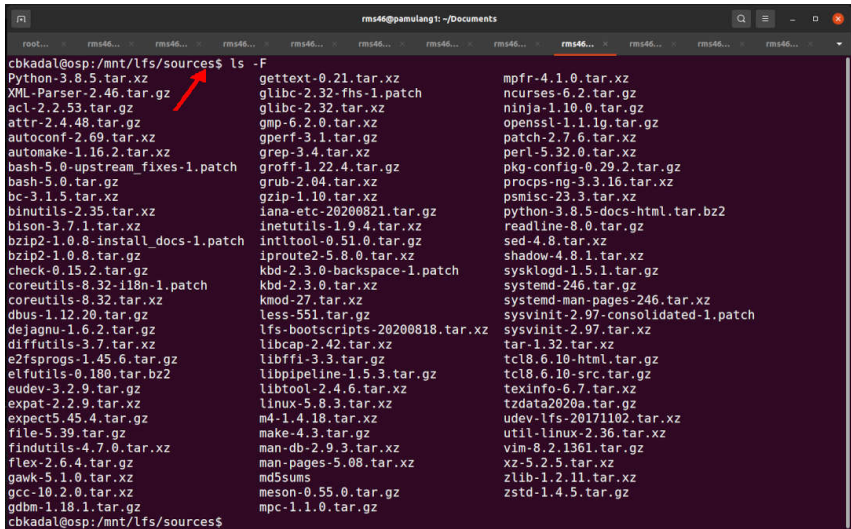
```
rms46@pamulang1: ~  
File Edit View Search Terminal Tabs Help  
root@pamulang1: ~ * rms46@pamulang... * rms46@pamulang... * @jembaran: ~ * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... * rms46@pamulang... *  
=====  
RUNNING: systemctl is-enabled 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/>.

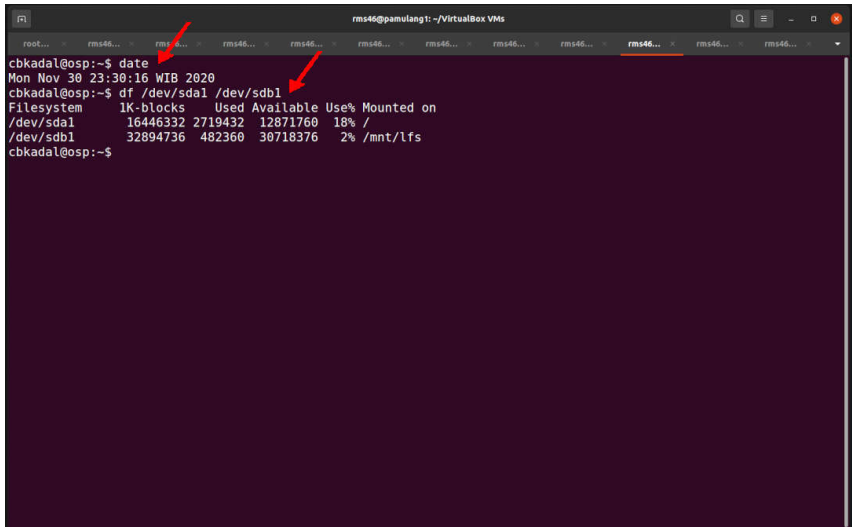
# W09-LFS-1.jpg



```
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       tcl8.6.10-html.tar.gz
elfutils-0.180.tar.bz2  libpipeline-1.5.3.tar.gz  tcl8.6.10-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
cbkadal@osp:/mnt/lfs/sources$
```

Figure: W09-LFS-1.jpg

# W09-LFS-2.jpg



A terminal window titled "rms46@pamulang1: ~/VirtualBox VMs" showing the output of several commands. The window has multiple tabs, with the active one labeled "rms46...". Two red arrows point to the first two tabs. The terminal output is 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:~$
```

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/os211/TXT/myrank.txt>.
- ⑤ Create your **TOP 10 List** of Week 09 (e.g. <https://cbkadal.github.io/os211/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/os211/TXT/mylog.txt>).
- ⑧ Update bash script (e.g. <https://cbkadal.github.io/os211/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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