

CSGE602055 Operating Systems

CSF2600505 Sistem Operasi

Week 03: File System & FUSE

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

Always check for the latest revision!

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Operating Systems 211³⁾ — PJJ from HOME

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

| Week | Schedule & Deadline ¹⁾ | Topic | OSC10 ²⁾ |
|---------|-----------------------------------|--|---------------------|
| 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 | 15 Mar - 21 Mar 2021 | Security, Protection, Privacy, & C-language. | Ch. 16, 17. |
| Week 03 | 22 Mar - 28 Mar 2021 | File System & FUSE | Ch. 13, 14, 15. |
| Week 04 | 29 Mar - 04 Apr 2021 | Addressing, Shared Lib, & Pointer | Ch. 9. |
| Week 05 | 05 Apr - 11 Apr 2021 | Virtual Memory | Ch. 10. |
| Week 06 | 26 Apr - 02 May 2021 | Concurrency: Processes & Threads | Ch. 3, 4. |
| Week 07 | 03 May - 09 May 2021 | Synchronization & Deadlock | Ch. 6, 7, 8. |
| Week 08 | 24 May - 30 May 2021 | Scheduling + W06/W07 | Ch. 5. |
| Week 09 | 24 May - 06 Jun 2021 | Storage, Firmware, Bootloader, & Systemd | Ch. 11. |
| Week 10 | 07 Jun - 13 Jun 2021 | I/O & Programming | Ch. 12. |

¹⁾ The **DEADLINE** of Week 00 is 28 Feb 2021, whereas the **DEADLINE** of Week 01 is 07 Mar 2020, and so on...

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

³⁾ 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**, 10th 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=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).
- **Build your own Virtual Guest**
<https://osp4diss.vlsm.org/>
- **Linux From Scratch**
<http://www.linuxfromscratch.org/lfs/view/stable/>

Agenda

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Week 03 File System & FUSE: Topics¹

- Files: data, metadata, operations, organization, buffering, sequential, nonsequential
- Directories: contents and structure
- File systems: partitioning, mount/unmount, virtual file systems
- Standard implementation techniques
- Memory-mapped files
- Special-purpose file systems
- Naming, searching, access, backups
- Journaling and log-structured file systems

¹Source: ACM IEEE CS Curricula 2013

Week 03 File System & FUSE: Learning Outcomes¹

- Describe the choices to be made in designing file systems.
[Familiarity]
- Compare and contrast different approaches to file organization, recognizing the strengths and weaknesses of each. [Usage]
- Summarize how hardware developments have led to changes in the priorities for the design and the management of file systems.
[Familiarity]
- Summarize the use of journaling and how log-structured file systems enhance fault tolerance. [Familiarity]

¹Source: ACM IEEE CS Curricula 2013

File System Interface

- File Concept

- File Attributes: Name, Id, Type, Location, Size, Protection, Time Stamp: create, last modified, last accessed.
- File Operation
 - Create/Delete/Truncate
 - Open/Close
 - Read/Write
- File Types: Executable, Object, Source Code, Library, Markup, Markdown, Archive, Compressed.
- File Structure: No Structure (just a string).
- Access Methods: Sequential vs Direct Access

- Directory and Disk Structure

- Three-Structured Directories
- Directory Operation: create/delete, search/list, rename, traverse
- Path Name: Absolute vs. Relative
- FS Mounting vs. Volume Based System

- File Sharing

- Protection: Access Control (eg. -rwx-x-x)

File System Organization

- Disk Partition
 - One Disk — Many Partitions
 - Many Disks — One Partitions
 - Many Disks — Many Partitions
 - One Partition — One File System (Volume)
- Mounting vs. Volumes

```
demo@badak:~$ df
```

| Filesystem | 1K-blocks | Used | Available | Use% | Mounted on |
|------------|-----------|----------|-----------|------|----------------|
| /dev/sda2 | 9515660 | 1435776 | 7573468 | 16% | / |
| /dev/sdb1 | 32895760 | 12156672 | 19045036 | 39% | /usr |
| /dev/sdc1 | 412322216 | 79695252 | 311639116 | 21% | /home |
| udev | 10240 | 0 | 10240 | 0% | /dev |
| tmpfs | 16508828 | 0 | 16508828 | 0% | /dev/shm |
| tmpfs | 6603532 | 8880 | 6594652 | 1% | /run |
| tmpfs | 5120 | 0 | 5120 | 0% | /run/lock |
| tmpfs | 16508828 | 0 | 16508828 | 0% | /sys/fs/cgroup |
| tmpfs | 3301768 | 0 | 3301768 | 0% | /run/user/1002 |

```
demo@badak:~$
```


FHS: Filesystem Hierarchy Standard

- Source (URL) http://refspecs.linuxfoundation.org/FHS_3.0/fhs-3.0.pdf
- A file placement guidelines/requirements for GNU/Linux-like OS.

| FILES | shareable (multiple hosts) | unshareable (single hosts) |
|---------------------------------------|----------------------------|----------------------------|
| static (read only, except for update) | /usr, /opt | /etc, /boot |
| variable (r/w) | /var/mail, /var/spool/news | /var/run, /var/lock |

● The Root File System (Required)

| Directory | Description |
|-----------|---|
| /bin | Essential command binaries |
| /boot | Static files of the boot loader |
| /dev | Device files |
| /etc | Host-specific system configuration |
| /lib | Essential shared libraries and kernel modules |
| /media | Mount point for removable media |
| /mnt | Mount point for mounting a filesystem temporarily |
| /opt | Add-on application software packages |
| /run | Data relevant to running processes |
| /sbin | Essential system binaries |
| /srv | Data for services provided by this system |
| /tmp | Temporary files |
| /usr | Secondary hierarchy |
| /var | Variable data |

- Specific Options

| Directory | Description |
|------------|---|
| /home | User home directories (optional) |
| /lib<qual> | Alternate format essential shared libraries(optional) |
| /root | Home directory for the root user (optional) |

- The /usr Hierarchy

| Directory | Description |
|----------------|---|
| /usr/bin | Most user commands (required) |
| /usr/lib | Libraries (required) |
| /usr/local | Local hierarchy (empty after main installation) (required) /usr/local/{bin etc games include lib man sbin share src} (required) |
| /usr/sbin | Non-vital system binaries (required) |
| /usr/share | Architecture-independent data (required) /usr/share/{man misc} (required) /usr/share/{color dict doc games info locale} (optional) /usr/share/{nls ppd sgml terminfo tmac xml zoneinfo} (optional) |
| /usr/games | Games and educational binaries (optional) |
| /usr/include | Header files included by C programs (optional) |
| /usr/libexec | Binaries run by other programs (optional) |
| /usr/lib<qual> | Alternate Format Libraries (optional) |
| /usr/src | Source code (optional) |

• The /var Hierarchy

| Directory | Description |
|---------------|---|
| /var/cache | Application cache data (required) |
| /var/lib | Variable state information (required) /var/lib/misc (required) |
| /var/local | Variable data for /usr/local (required) |
| /var/lock | Lock filesLog files and directories (required) |
| /var/opt | Variable data for /opt (required) |
| /var/run | Data relevant to running processes (required) |
| /var/spool | Application spool data (required) |
| /var/tmp | Temporary files preserved between system reboots (required) |
| /var/backups | (reserved names, do not use) |
| /var/cron | (reserved names, do not use) |
| /var/msgs | (reserved names, do not use) |
| /var/preserve | (reserved names, do not use) |
| /var/account | Process accounting logs (optional) |
| /var/crash | System crash dumps (optional) |
| /var/games | Variable game data (optional) |
| /var/mail | User mailbox files (optional) |
| /var/yp | Network Information Service (NIS) database files(optional) |

- (Mostly) Linux

| Directory | Description |
|-----------------|---|
| /proc | Kernel and process information virtual filesystem |
| /sys | Kernel and system information virtual filesystem |
| /usr/include | Header files included by C programs |
| /usr/src | Source code |
| /var/spool/cron | cron and at jobs |

- the `/dev/` directory
 - `/etc/fstab`: configuration of filesystems
 - `/etc/mtab` → `/proc/mounts`: mounted filesystems
 - `/proc/swaps`: swap filesystems
 - `df`: checking disk space and filesystems
 - Device Major and Minor Numbers
 - UUID - Universally Unique Identifier (128 bits)
 - GUID - Globally Unique Identifiers: `ls -al /dev/disk/by-uuid`
 - practically is NOT guaranteed unique
 - FUSE: Filesystem in Userspace
 - BBFS: Big Brother File System
- More Storage Structure
 - `tmpfs`
 - `objfs`
 - `ctfs`
 - `lofs`
 - `procfs`
 - `ufs`
 - `zfs`

A Typical Ubuntu 18.04 Work Station

```
rms46@rmsbase:~$ df
```

| Filesystem | 1K-blocks | Used | Available | Use% | Mounted on |
|-------------|-----------|-----------|-----------|------|------------------------------|
| /dev/sda1 | 511996 | 31772 | 480224 | 7% | /otr/ntfs1 |
| /dev/sda2 | 250823676 | 167941776 | 82881900 | 67% | /otr/ntfs2 |
| /dev/sda5 | 31588496 | 9181304 | 20779532 | 31% | / |
| /dev/sda6 | 123866100 | 39281464 | 78269476 | 34% | /home |
| /dev/sda7 | 490099792 | 270878316 | 194302800 | 59% | /extra |
| /dev/sda8 | 778472088 | 538257360 | 200647612 | 73% | /arsip |
| /dev/sda9 | 197809844 | 66848396 | 120890188 | 36% | /u1904 |
| /dev/sda10 | 51851620 | 7784424 | 41410236 | 16% | /u1810 |
| udev | 8159412 | 0 | 8159412 | 0% | /dev |
| tmpfs | 8189664 | 142196 | 8047468 | 2% | /dev/shm |
| tmpfs | 1637936 | 2108 | 1635828 | 1% | /run |
| tmpfs | 5120 | 4 | 5116 | 1% | /run/lock |
| tmpfs | 1637932 | 16 | 1637916 | 1% | /run/user/121 |
| tmpfs | 1637932 | 44 | 1637888 | 1% | /run/user/1000 |
| tmpfs | 1637932 | 0 | 1637932 | 0% | /run/user/0 |
| tmpfs | 8189664 | 0 | 8189664 | 0% | /sys/fs/cgroup |
| /dev/sdc1 | 259103 | 8 | 259096 | 1% | /media/rms46/FAT32 |
| /dev/sdc2 | 60360796 | 4694276 | 52600360 | 9% | /media/rms46/FLASHDISK |
| /dev/sdd1 | 7799912 | 331988 | 7467924 | 5% | /media/rms46/OS |
| /dev/loop0 | 93312 | 93312 | 0 | 100% | /snap/core/6259 |
| /dev/loop1 | 14976 | 14976 | 0 | 100% | /snap/gnome-logs/45 |
| /dev/loop2 | 35712 | 35712 | 0 | 100% | /snap/gtk-common-themes/1122 |
| /dev/loop3 | 13312 | 13312 | 0 | 100% | /snap/gnome-characters/103 |
| /dev/loop4 | 93184 | 93184 | 0 | 100% | /snap/core/6350 |
| /dev/loop5 | 13312 | 13312 | 0 | 100% | /snap/gnome-characters/139 |
| /dev/loop6 | 35456 | 35456 | 0 | 100% | /snap/gtk-common-themes/818 |
| /dev/loop7 | 35584 | 35584 | 0 | 100% | /snap/gtk-common-themes/319 |
| /dev/loop8 | 144128 | 144128 | 0 | 100% | /snap/gnome-3-26-1604/74 |
| /dev/loop9 | 93184 | 93184 | 0 | 100% | /snap/core/6405 |
| /dev/loop10 | 14848 | 14848 | 0 | 100% | /snap/gnome-logs/37 |

File Systems Implementation

- File System Layers / Structure
 - Application Programs
 - Logical File Systems
 - File-Organization Module
 - Basic File Systems
 - I/O Control
 - Hardware Device
- File System Implementation
- File Control Block
- FS In Memory Structure
- VFS: Virtual File Systems
 - How to support multiple File Systems
 - I.e. How to support multiple `open()/close()` `read()/write()` operations

Implementation and Allocation Method

- Directory Implementation
 - Linear List
 - Hash Table
- Allocation Method
 - Contiguous
 - Linked
 - Indexed
 - Combined Scheme
- Free Space Management
- Performance & Efficiency
- Unified Buffer Cache
- Recovery
- Log Structured File System

- File Systems
- File-System Mounting
- Partitions and Mounting
- File Sharing
- Virtual File Systems
- Remote File Systems
- Consistency Semantics
- NFS

```
demo@badak:~/mydemo/W03-demos$ ls -al
total 20
drwxr-xr-x  4 demo demo 4096 Feb 27 19:32 .
drwx----- 14 demo demo 4096 Feb 27 19:32 ..
-rw-r--r--  1 demo demo  672 Feb 27 19:32 1-READ-THIS-FIRST.txt
drwxr-xr-x  2 demo demo 4096 Feb 27 19:32 Files
drwxr-xr-x  2 demo demo 4096 Feb 27 19:32 FUSE
demo@badak:~/mydemo/W03-demos$ cat 1-READ-THIS-FIRST.txt
```

[...etc...]

Folder Name:

Week03/

To copy the folder to your home directory:

```
cp -r /extra/Demos/W03-demos/ W03-demos/
```

=====

File Listing:

* 1-READ-THIS-FIRST.txt (this file)

* Files

[...etc...]

FUSE (2)

```
demo@badak:~/mydemo/W03-demos$ cd FUSE/
demo@badak:~/mydemo/W03-demos/FUSE$ ls -al
total 164
drwxr-xr-x 2 demo demo 4096 Feb 27 19:32 .
drwxr-xr-x 4 demo demo 4096 Feb 27 19:32 ..
-rw-r--r-- 1 demo demo 2321 Feb 27 19:32 1-READ-ME.txt
-rw-r--r-- 1 demo demo 151814 Feb 27 19:32 fuse-tutorial.tgz
demo@badak:~/mydemo/W03-demos/FUSE$ cat 1-READ-ME.txt
[...etc...]
```

FUSE DEMO STEP by STEP

=====

ATTN: This does not work for WSL! See also

<http://www.secfs.net/winfsp/blog/files/winfsp-2017.html>

<https://wpdev.uservoice.com/forums/266908-command-prompt-console-windows-subsystem-for-l/suggestions/13522>

1. UBUNTU's deb packages (privilege):

```
sudo apt-get install autoconf automake build-essential \
fuse libfuse-dev lynx pkg-config sshfs
```
2. Get a NEW tarball with

```
wget http://www.cs.nmsu.edu/~pfeiffer/fuse-tutorial.tgz
```

OR use the current fuse-tutorial.tgz
3. List and open the tarball with

```
tar tfz fuse-tutorial.tgz
tar xfz fuse-tutorial.tgz
```
4. Enter the directory (yours may be a different version)

```
cd fuse-tutorial-2018-02-04/
ls -al
```

FUSE (3)

5. Read the manual with
lynx index.html

Writing a FUSE Filesystem: a Tutorial

Joseph J. Pfeiffer, Jr., Ph.D. (pfeiffer@cs.nmsu.edu)
Emeritus Professor
Department of Computer Science, New Mexico State University

Version of 2018-02-04

One of the real contributions of Unix has been the view that "everything is a file". A tremendous number of radically different sorts of objects, from data storage to file format conversions to internal operating system data structures, have been mapped to the file abstraction.

One of the more recent directions this view has taken has been Filesystems in User Space, or FUSE (no, the acronym really doesn't work. Oh well). The idea here is that if you can envision your interaction with an object in terms of a directory structure and filesystem operations, you can write a FUSE file system to provide that interaction. You just write code that implements file operations like `open()`, `read()`, and `write()`; when your filesystem is mounted, programs are able to access the data using the standard file operation system calls, which call your code.

FUSE filesystems have been written to do everything from providing remote access to files on a different host without using NFS or CIFS (see SSHFS at [2]<https://github.com/libfuse/sshfs>) to implementing a filesystem to talk to devices using the Media Transfer protocol (see

[.....])

FUSE (4)

```
6. Run
   ./configure
   make
```

```
7 cd example
```

TO TRY:

```
$ ls -al rootdir
$ ls -al mountdir
$ df
$ ../src/bbfs rootdir/ mountdir/
$ df
$ ls -al rootdir
$ ls -al mountdir
```

TO PLAY:

```
$ cd mountdir
$ touch blah-blah-blah.txt
$ ls -al
$ cd ..
$ ls -al rootdir
```

TO FINISH:

```
$ fusermount -u mountdir
```

EXTRA:

```
# /etc/fstab: configuration of filesystems
# /etc/mtab --> /proc/mounts: mounted filesystems
# /proc/swaps: swap filesystems
# df: checking disk space and filesystems
# GUID (Globally Unique Identifiers) ls -al /dev/disk/by-uuid
RMS
```

FUSE (5)

```
>>>> $ ./configure
checking for a BSD-compatible install... /usr/bin/install -c
checking whether build environment is sane... yes
checking for a thread-safe mkdir -p... /bin/mkdir -p
checking for gawk... gawk
checking whether make sets $(MAKE)... yes
checking whether make supports nested variables... yes
checking for gcc... gcc
checking whether the C compiler works... yes
checking for C compiler default output file name... a.out
checking for suffix of executables...
checking whether we are cross compiling... no
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking whether gcc understands -c and -o together... yes
checking for style of include used by make... GNU
checking dependency style of gcc... gcc3
checking how to run the C preprocessor... gcc -E
checking for grep that handles long lines and -e... /bin/grep
checking for egrep... /bin/grep -E
checking for ANSI C header files... yes
[...]
checking for fdatasync... yes
checking that generated files are newer than configure... done
configure: creating ./config.status
config.status: creating Makefile
config.status: creating html/Makefile
config.status: creating src/Makefile
config.status: creating src/config.h
config.status: executing depfiles commands
```

FUSE (6)

```
>>>>> $ make
Making all in example
make[1]: Entering directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/example'
mkdir -p mountdir
mkdir -p rootdir
echo "bogus file" > rootdir/bogus.txt
make[1]: Leaving directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/example'
Making all in html
make[1]: Entering directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/html'
make[1]: Nothing to be done for 'all'.
make[1]: Leaving directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/html'
Making all in src
make[1]: Entering directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/src'
make all-am
make[2]: Entering directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/src'
gcc -DHAVE_CONFIG_H -I. -D_FILE_OFFSET_BITS=64 -I/usr/include/fuse -g -O2 -MT bbfs.o -MD -MP -MF
.deps/bbfs.Tpo -c -o bbfs.o bbfs.c
mv -f .deps/bbfs.Tpo .deps/bbfs.Po
gcc -DHAVE_CONFIG_H -I. -D_FILE_OFFSET_BITS=64 -I/usr/include/fuse -g -O2 -MT log.o -MD -MP -MF
.deps/log.Tpo -c -o log.o log.c
mv -f .deps/log.Tpo .deps/log.Po
gcc -D_FILE_OFFSET_BITS=64 -I/usr/include/fuse -g -O2 -o bbfs bbfs.o log.o -lfuse -pthread
make[2]: Leaving directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/src'
make[1]: Leaving directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04/src'
make[1]: Entering directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04'
make[1]: Nothing to be done for 'all-am'.
make[1]: Leaving directory '/home/demo/mydemo/W09-demos/fuse-tutorial-2018-02-04'
>>>>> $
```

FUSE (7)

```
>>>> $ cd example/
>>>> $ ls -al rootdir/
total 12
drwxr-xr-x 2 demo demo 4096 Apr 25 18:23 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:23 ..
-rw-r--r-- 1 demo demo 11 Apr 25 18:23 bogus.txt
>>>> $ ls -al mountdir/
total 8
drwxr-xr-x 2 demo demo 4096 Apr 25 18:23 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:23 ..
>>>> $ df
Filesystem      1K-blocks      Used Available Use% Mounted on
udev              10240          0       10240   0% /dev
tmpfs            1639412      103116    1536296   7% /run
/dev/vda2        9515660     1677648    7331596  19% /
/dev/vdc1        32895760    12093508    19108200  39% /usr
tmpfs            4098528          0     4098528   0% /dev/shm
tmpfs            5120          0        5120   0% /run/lock
tmpfs            4098528          0     4098528   0% /sys/fs/cgroup
/dev/vdb1        515929528   38454128   451244668   8% /home
tmpfs            819708          0      819708   0% /run/user/1002
>>>> $ ../src/bbfs rootdir/ mountdir/
Fuse library version 2.9
about to call fuse_main
>>>> $ df
Filesystem      1K-blocks      Used Available Use% Mounted on
udev              10240          0       10240   0% /dev
[...]
tmpfs            819708          0      819708   0% /run/user/1002
bbfs            515929528   38454136   451244660   8% /home/demo/mydemo/W09-demos/
                                     fuse-tutorial-2018-02-04/example/mountdir
>>>> $
```


FUSE (8)

```
>>>> $ ls -al rootdir/
total 12
drwxr-xr-x 2 demo demo 4096 Apr 25 18:23 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:26 ..
-rw-r--r-- 1 demo demo 11 Apr 25 18:23 bogus.txt
>>>> $ ls -al mountdir/
total 12
drwxr-xr-x 2 demo demo 4096 Apr 25 18:23 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:26 ..
-rw-r--r-- 1 demo demo 11 Apr 25 18:23 bogus.txt
>>>> $ cd mountdir/
>>>> $ touch blah-blah-blah.txt
>>>> $ ls -al
total 12
drwxr-xr-x 2 demo demo 4096 Apr 25 18:30 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:26 ..
-rw-r--r-- 1 demo demo 0 Apr 25 18:30 blah-blah-blah.txt
-rw-r--r-- 1 demo demo 11 Apr 25 18:23 bogus.txt
>>>> $ cd ..
>>>> $ ls -al rootdir/
total 12
drwxr-xr-x 2 demo demo 4096 Apr 25 18:30 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:26 ..
-rw-r--r-- 1 demo demo 0 Apr 25 18:30 blah-blah-blah.txt
-rw-r--r-- 1 demo demo 11 Apr 25 18:23 bogus.txt
>>>> $ fusermount -u mountdir
>>>> $ ls -al mountdir/
total 8
drwxr-xr-x 2 demo demo 4096 Apr 25 18:23 .
drwxr-xr-x 4 demo demo 4096 Apr 25 18:26 ..
>>>> $
```

Week 03: Check List (Deadline: Monday, 12-Oct-2020).

- ☐ Week 03 Token: **OS202**
- ☐ **Starting Points:** <https://os.vlsm.org/>, CBKadal, and OSP4DISS.
- ☐ Week 03: Assignment (Details in <https://osp4diss.vlsm.org/W03.html>).
 - ① Read: (OSC10 chapter 13 + chapter 14 + chapter 15)
 - ② Try Demos Week 03 (and Week 02).
 - ③ Visit your Virtual Guest, and update file ".bash_aliases" (See OSP4DISS).
 - 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 03 (e.g. <https://cbkadal.github.io/os211/W03/>). Do not use lecture material. Please be more creative!
 - ⑥ Run "chktoken OS202" and write the result into myW03token.txt.
 - ⑦ Download TLPI Code and write the "disk usage" (du) into myW03disk.txt.
 - ⑧ Update your log (e.g. <https://cbkadal.github.io/os211/TXT/mylog.txt>).
 - ⑨ Update bash script (e.g. <https://cbkadal.github.io/os211/TXT/myscript.sh>).
 - ⑩ Make SHA256SUM and sign it (detached, armor) as SHA256SUM.asc.

The End

- ☐ This is the end of the presentation.
- ☒ This is the end of the presentation.
 - This is the end of the presentation.