2021 FALL OS
Project 4 Help Document

ZGUEM SARA
JEONGEUN LEE

Distributed Computing Systems Laboratory
Department of Computer Science and Engineering
Seoul National University, Korea

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NOTE

- 과제 **#0** Set up development environment

  기한: 09/18 midnight
  방법: etl 제출

- 과제 **#1**

  기한: 10/08 midnight
  방법: 팀별 repository에 proj1 branch 생성 / 발표자료는 대표 한 명이 etl 제출

- 과제 **#2**

  기한: 11/06 midnight
  방법: 팀별 repository에 proj2 branch 생성 / 발표자료는 대표 한 명이 etl 제출

- 과제 **#3**

  기한: 11/27 midnight
  방법: 팀별 repository에 proj3 branch 생성 / 발표자료는 대표 한 명이 etl 제출

- 과제 **#4**

  기한: 12/15 midnight
  방법: 팀별 repository에 proj4 branch 생성 / 발표자료는 대표 한 명이 etl 제출

Project 4 Overview

- **Geo-tagged file system** (based on `ext2`)
    - Attach a GPS tag to each regular file
- **Access control** with the tags
    - Files are accessible from the location where they are recently created/modified

Key Challenges

(1) Modify physical representation of **inode**
  - to embed GPS coordinates

(2) Add **GPS-related inode operations** and **implement them for `ext2` regular files**
  - `set_gps_location`
  - `get_gps_location`

(3) Modify **access control mechanism** to realize location-based access control

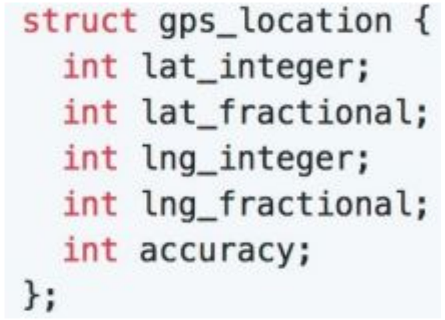
(1) Add GPS-related fields to inode structure

- `fs/ext2/ext2.h`

- There are two structs for `ext2` inode.
    - **inode in the memory**
    - **inode on the disk**

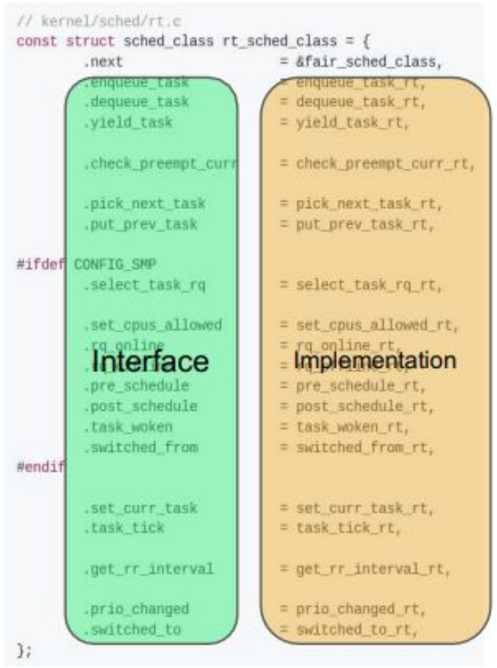
- Add 5 fields.

- Pay attention to endianness of the fields of the physical inode
    - You may get a hint from other fields in the structures.

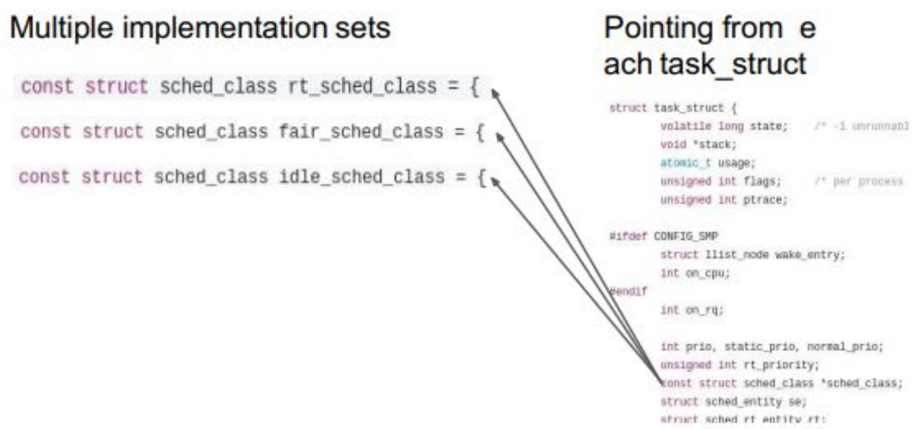


```
struct gps_location {
  int lat_integer;
  int lat_fractional;
  int lng_integer;
  int lng_fractional;
  int accuracy;
};
```

(cf) Recall from Project 2 (WRR) ...



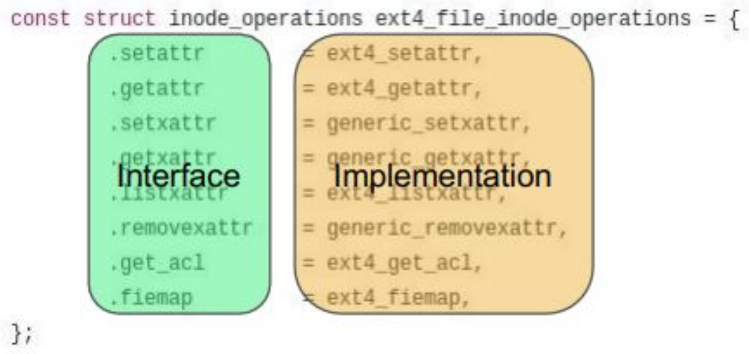
```
// kernel/sched/rt.c
const struct sched_class rt_sched_class = {
        .next                   = &fair_sched_class,
        .enqueue_task           = enqueue_task_rt,
        .dequeue_task           = dequeue_task_rt,
        .yield_task             = yield_task_rt,

        .check_preempt_curr     = check_preempt_curr_rt,

        .pick_next_task         = pick_next_task_rt,
        .put_prev_task          = put_prev_task_rt,

#ifdef CONFIG_SMP
        .select_task_rq         = select_task_rq_rt,

        .set_cpus_allowed       = set_cpus_allowed_rt,
        .rq_online              = rq_online_rt,
        .rq_offline             = rq_offline_rt,
        .pre_schedule           = pre_schedule_rt,
        .post_schedule          = post_schedule_rt,
        .task_woken             = task_woken_rt,
        .switched_from          = switched_from_rt,
#endif

        .set_curr_task          = set_curr_task_rt,
        .task_tick              = task_tick_rt,

        .get_rr_interval        = get_rr_interval_rt,

        .prio_changed           = prio_changed_rt,
        .switched_to            = switched_to_rt,
};
```



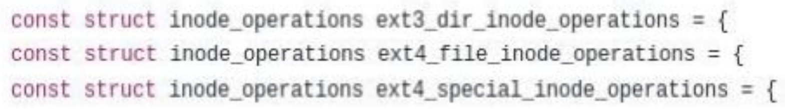
```
const struct sched_class rt_sched_class = {
const struct sched_class fair_sched_class = {
const struct sched_class idle_sched_class = {
```

```
struct task_struct {
        volatile long state;    /* -1 unrunnabl
        void *stack;
        atomic_t usage;
        unsigned int flags;     /* per process
        unsigned int ptrace;

#ifdef CONFIG_SMP
        struct llist_node wake_entry;
        int on_cpu;
#endif
        int on_rq;

        int prio, static_prio, normal_prio;
        unsigned int rt_priority;
        const struct sched_class *sched_class;
        struct sched_entity se;
        struct sched_rt_entity rt;
```

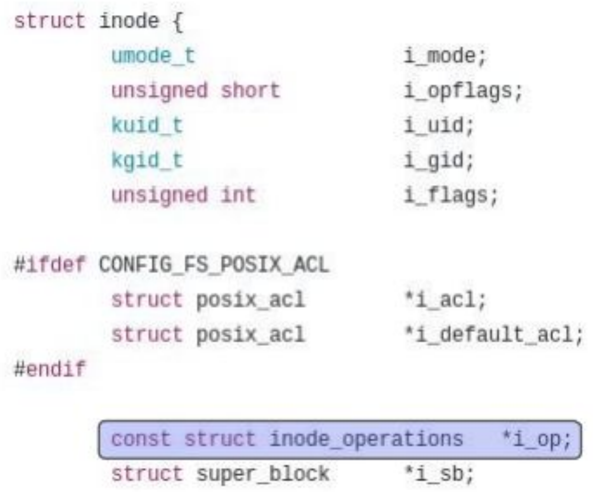
(cf) Similar for inode_operations



```
const struct inode_operations ext4_file_inode_operations = {
        .setattr        = ext4_setattr,
        .getattr        = ext4_getattr,
        .setxattr       = generic_setxattr,
        .getxattr       = generic_getxattr,
        .listxattr      = ext4_listxattr,
        .removexattr    = generic_removexattr,
        .get_acl        = ext4_get_acl,
        .fiemap         = ext4_fiemap,
};
```



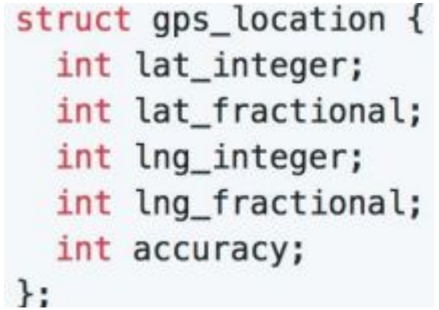
```
const struct inode_operations ext3_dir_inode_operations = {
const struct inode_operations ext4_file_inode_operations = {
const struct inode_operations ext4_special_inode_operations = {
```



```
struct inode {
        umode_t                 i_mode;
        unsigned short          i_opflags;
        kuid_t                  i_uid;
        kgid_t                  i_gid;
        unsigned int            i_flags;

#ifdef CONFIG_FS_POSIX_ACL
        struct posix_acl        *i_acl;
        struct posix_acl        *i_default_acl;
#endif

        const struct inode_operations   *i_op;
        struct super_block      *i_sb;
```

(2) Make a new syscall

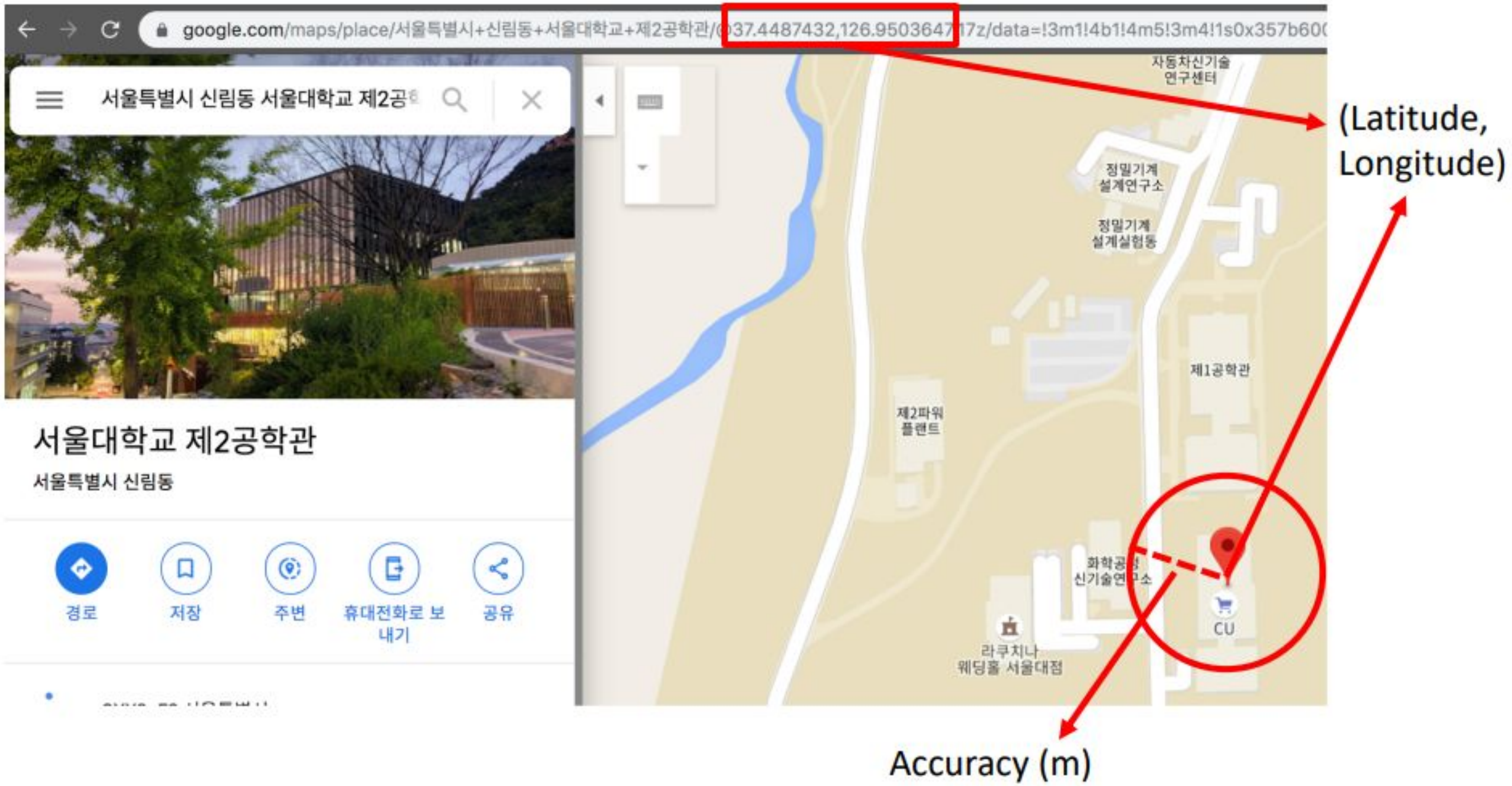
- `int set_gps_location(struct gps_location user *loc)`



```
struct gps_location {
  int lat_integer;
  int lat_fractional;
  int lng_integer;
  int lng_fractional;
  int accuracy;
};
```

- `Latitude = lat_integer + lat_frac*10^-6`
- `Longitude = lng_integer+lng_frac*10^-6`
- `0 <= lat_frac, lng_frac <= 999,999`
- `-90 <=latitude <= 90`
- `-180 <= longitude <= 180`
- `Accuracy (meter): non-negative integer`

DCSLAB


google.com/maps/place/서울특별시+신림동+서울대학교+제2공학관/@37.4487432,126.9503647,17z/data=!3m1!4b1!4m5!3m4!1s0x357b60

(2) Define GPS-related inode operations

- Add the following two function pointer fields to the **`struct inode_operations`** structure in **`include/linux/fs.h`**
    - `int (*set_gps_location)(struct inode *);`
    - `int (*get_gps_location)(struct inode *, struct gps_location *);`

(2) And implement them for ext2

- Implement the set/get functions for `ext2`.
    - `set_gps_location`: copy the current device location to the inode
    - `get_gps_location`: copy the inode location to the buffer

- Register the functions with `ext2` file inode operations.

(2) Update location info

- GPS info of **regular files** should be updated whenever they are **created or modified**
  - Use `set_gps_location` operation

  *** You may assume that any GPS related operations are performed after properly setting the device location.

- look at
  - `fs/` – for file system code
  - `fs/ext2/` – for ext2 specific code

(3) Access control

● Files of the modified `ext2` can be only **accessible** from the location where they are **recently created/modified**.
● There is an **inode operation related to access control.** You can use it.
● Compare the geo-tag and current location.
  ○ You cannot use float or double operations.
  *** Note that the kernel does not have any floating point or double precision support.
  ○ You should consider accuracy of the geo-tag
  ○ Compare the values with your own algorithm. Document any assumptions or approximations on `README.md`

Be careful!

- Current **device location** is shared mutable state, so you should use **proper synchronization mechanism** when accessing the state.

- Never access the memory by user-space addresses directly. Refer to guides and provided links in Project 1 help document(Linux Kernel Exploration Guide for OS projects).

- For parameters in `struct gps_location` in **`set_gps_location`** syscall, make sure they are **in appropriate range**.

Testing with the modified file system

- To test your code, you should create a your modified ext2 file system. You will use **`mke2fs`** `(in e2fsprogs).`

- You need to modify ext2 inode structure to make mke2fs use your modified ext2.
    - `e2fsprogs/lib/ext2fs/ext2_fs.h`
    - **There is a structure you should modify**.

About submission

Same rules as previous projects

- Make sure your branch name: proj4

- Check for format : slides title / demo name / test file names / branch name
  and directory name
- Please aggregate your demo videos (=submit only one video!)

- Deadline
  - Due:12/15 midnight + 3 days of late submission allowed (10% will be deducted for every day)