시스템 프로그래밍 실습 3-2 과제

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강의 시간 : 화

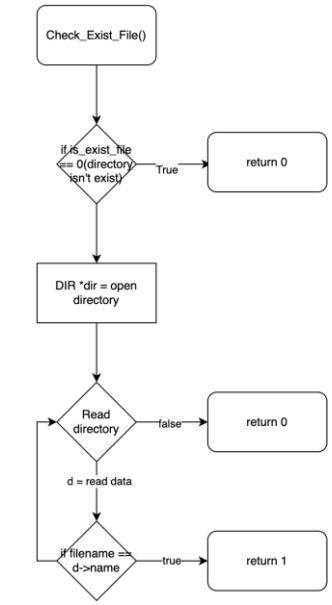
실습 분반 : 목 7, 8

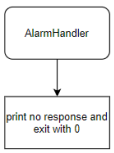
1. Introduction

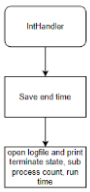
해당 과제는 기존에 3-1에서 만든 결과에서 추가적으로 덧붙어서 만들어진다. Pthread를 이용하여 Thread를 생성하고 해당 thread를 통해 logfile을 작성한다. Logfile은 기존과 같은 방식으로 출력을 한다. 기존에 사용하였던 Semaphore의 Critical zone에 thread를 추가한다. 또한 pthread_join() 함수를 이용하여 종료시점을 확인한다. Thread의 생성과 종료시에 터미널에 해당 상태를 표시한다.

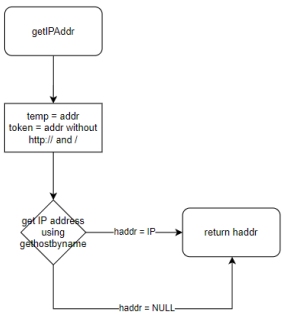
2. Flow Chart

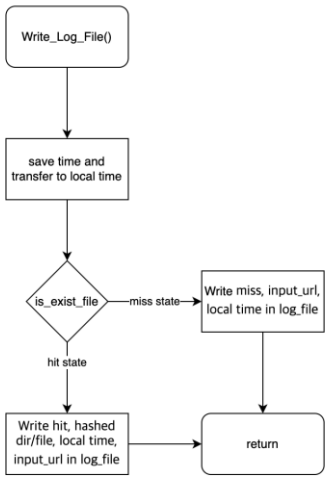
- proxy_cache.c

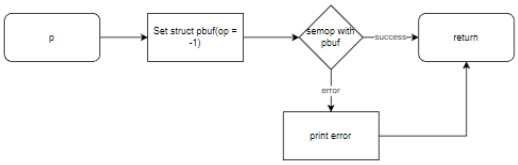


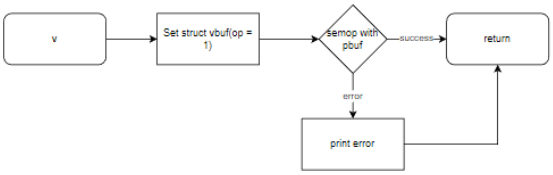


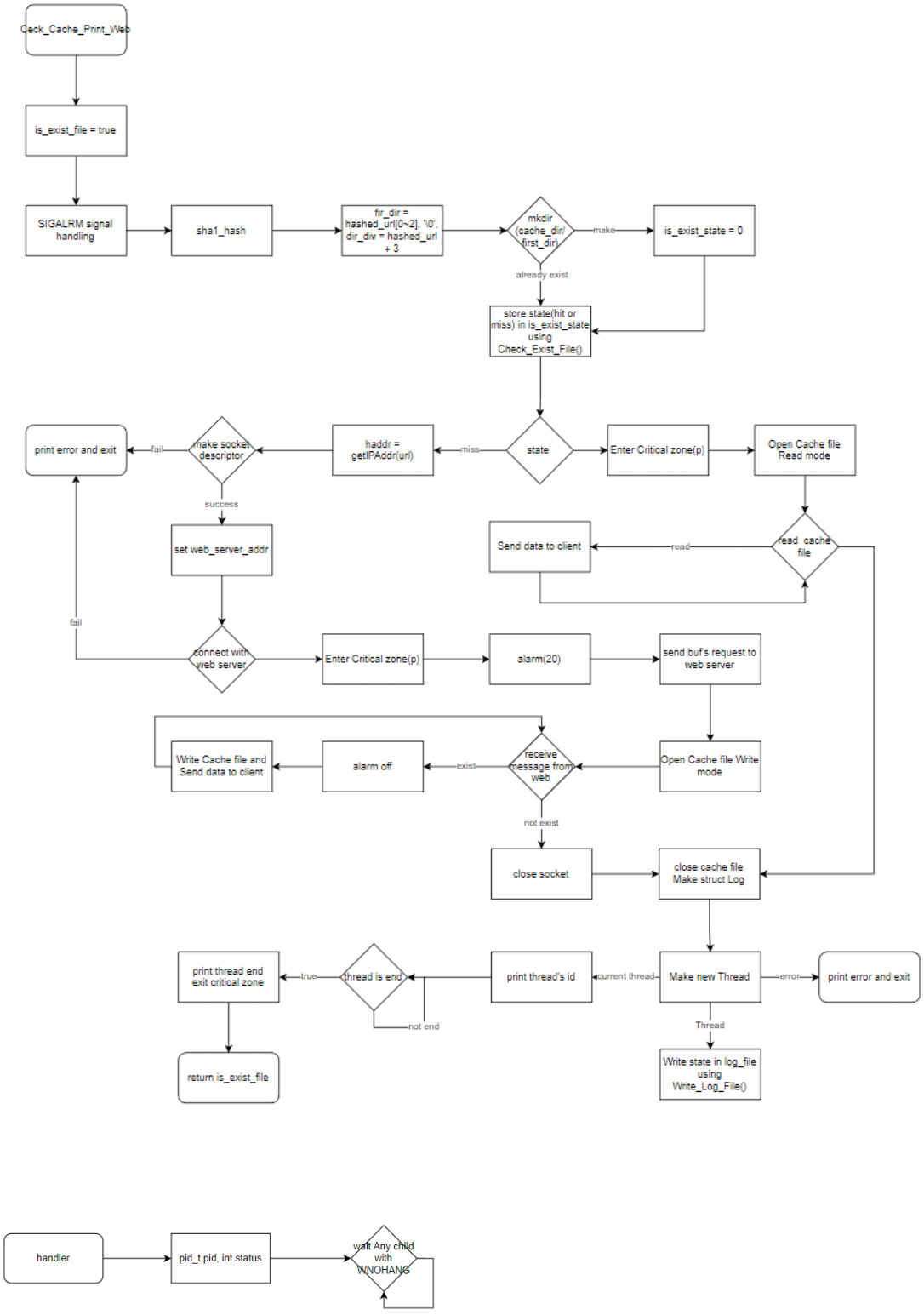


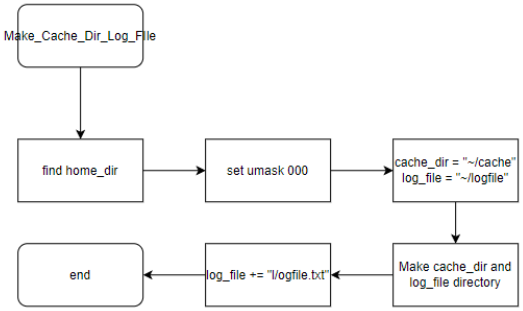

getIPAddr
temp = addr
token = addr without
http:// and /
get IP address
using
gethostbyname
haddr = IP
return haddr
haddr = NULL

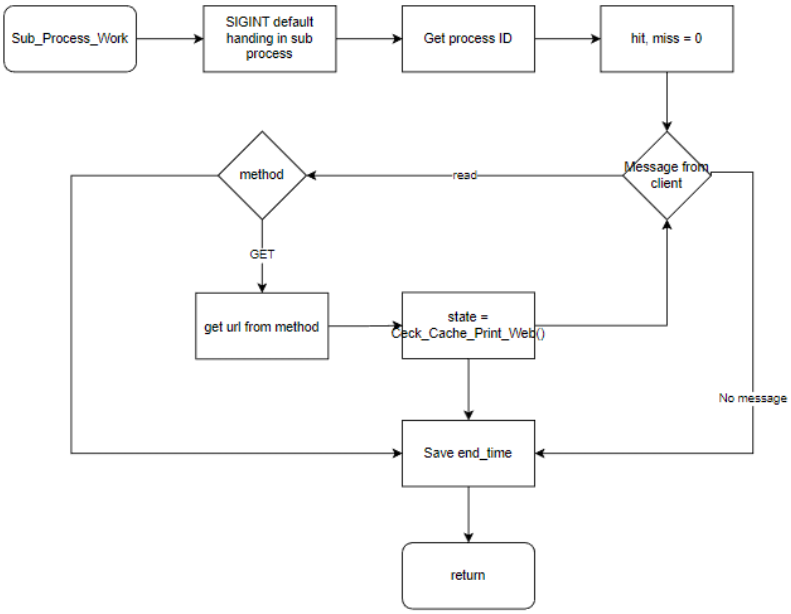

Write_Log_File()
save time and
transfer to local time
is_exist_file
miss state
Write miss, input_url,
local time in log_file
hit state
Write hit, hashed
dir/file, local time,
input_url in log_file
return

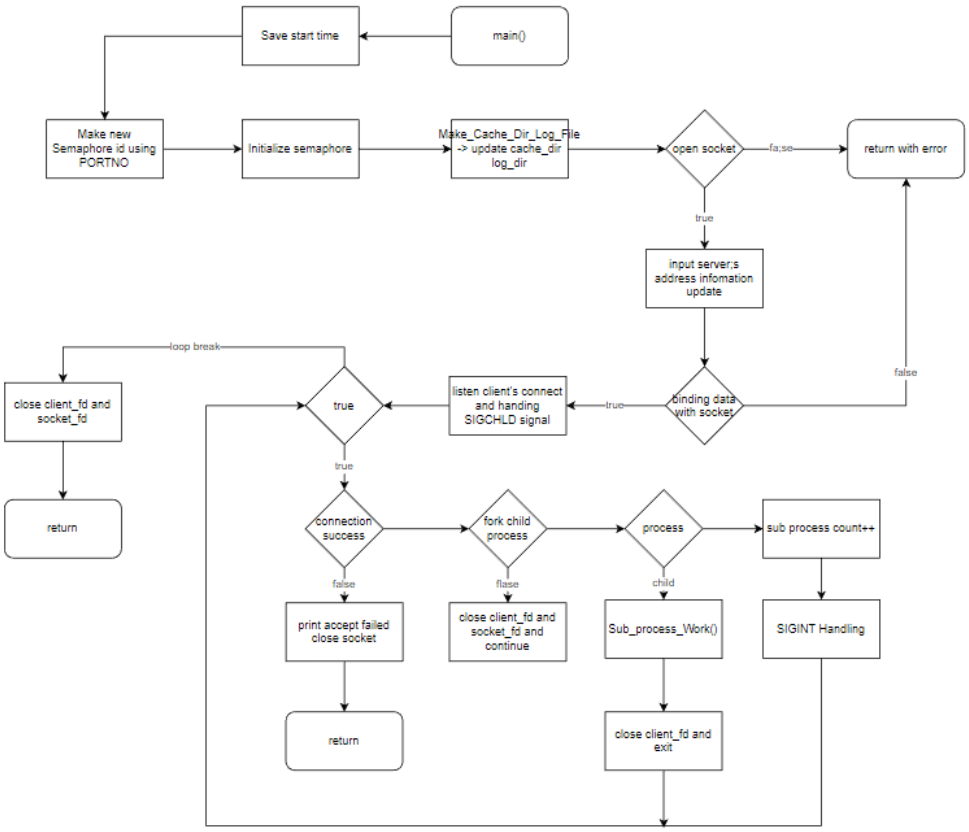

p
Set struct pbuf(op =
-1)
semop with
pbuf
success
return
error
print error


v
Set struct vbuf(op =
1)
semop with
pbuf
success
return
error
print error


Ceck_Cache_Print_Web
is_exist_file = true
SIGALRM signal handling
sha1_hash
fir_dir = hashed_url[0~2], '\0', dir_div = hashed_url + 3
mkdir (cache_dir/ first_dir)
make
is_exist_state = 0
already exist
store state(hit or miss) in is_exist_state using Check_Exist_File()
state
miss
haddr = getIPAddr(url)
make socket descriptor
fail
print error and exit
success
set web_server_addr
connect with web server
fail
Enter Critical zone(p)
alarm(20)
send buf's request to web server
Enter Critical zone(p)
Open Cache file Read mode
read_cache file
read
Send data to client
Open Cache file Write mode
receive message from web
exist
alarm off
Write Cache file and Send data to client
not exist
close socket
close cache file Make struct Log
Make new Thread
error
print error and exit
Thread
Write state in log_file using Write_Log_File()
print thread's id
current thread
thread is end
true
not end
print thread end exit critical zone
return is_exist_file
handler
pid_t pid, int status
wait Any child with WNOHANG


Make_Cache_Dir_Log_File
find home_dir
set umask 000
cache_dir = "~/cache"
log_file = "~/logfile"
end
log_file += "l/ogfile.txt"
Make cache_dir and log_file directory


Sub_Process_Work
SIGINT default handing in sub process
Get process ID
hit, miss = 0
Message from client
read
method
GET
get url from method
state = Ceck_Cache_Print_Web()
No message
Save end_time
return



3. Pseudo Code

```
static void handler(){
   pid_t pid;
   int status;
   Wait Any child with WNOHANG
}

static void AlarmHandler(){
    print No Response and exit(0);
}
```

```
Static void IntHandler(){
   Save end time;
   Open logfile and write sub process count and run time;
   Close logfile and exit;
}

void p(int semid){
   struct sembuf pbuf;
   Set pbuf(op = -1);
   If(semop of semid failed)
      Print error;
}
void v(int semid){
   struct sembuf vbuf;
   Set pbuf(op = 1);
   If(semop of semid failed)
      Print error;
}

char *getIPAddr(char *addr){
   struct hostent* hent;
   char *haddr = NULL;
   char temp[BUFFSIZE] = addr;
   token = temp(delete http://, and tokenized with /;
   if (gethostbyname(token) is exist)
      haddr = inet_ntoa(hent's h_addr_list[0]);
```

```
    return haddr;
}

Make_Cache_Dir_Log_File(char* cache_dir, char* log_file){
    getHomeDirectory();
    cache_dir = ~/cache;
    log_file = ~/logfile;
    set umask 000;
    make cache and log directory;
    log_file += /logfile.txt;
}

Check_Exist_File(char *path, char *file_name, int is_exist_file){
   if(directory isn't exist)
      return 0;

   DIR *dir = Open path directory
   While(struct dirent *d = Read path directory){
      If(d->name == file name)
         Close directory and return 1;
   }
   Close directory and return 0;
}

Struct Log{
 char *log_file;
```

```
char *input url;
char *hashed_url_dir;
char* hashed_url_file;
int is_exist_file;
int *hit;
int *miss;
}

Void Write_Log_File(void *log){
   time_t now;
   struct tm *ltp;

   ltp = current local time;
   if(log's miss state)
      Write log's miss, input_url, local time in log_file;
   Else
      Write log's hit, hashed dir/file, local time, input_url in log_file;
}

void Check_Cache_Print_Web(int client_fd, int semid, char *url, char *cache_dir, char *log_file,
char *buf int current_pid, int len, int *hit, int *miss){
   char[60] hashed_url;
   char[4] first_dir;
   char *dir_div;
   char[100] temp_dir;
   char *haddr[BUFFSIZE;
```

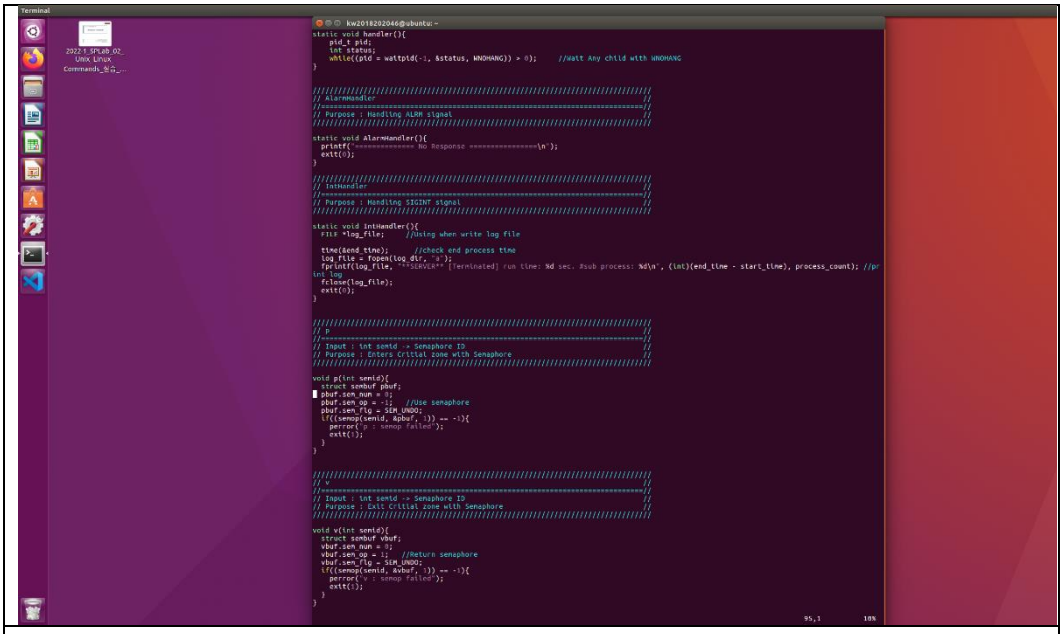
```
int h_socket_fd, cache_fd, h_len;
int is_exist_file = 1;
pthread_t tid;

struct sockaddr_in web_server_addr;

hashed_url = hashed url using sha1;
first_dir = { hashed_url[0~3], '₩0' };
dir_div = hashed_url + 3 address
temp_dir = ~/cache/first_dir;
if make temp_dir directory(permission = drwxrwxrwx)
is_exist_file = 0;
is_exist_file = hit or miss state;
temp_dir = ~/cache/first_dir/dir_div;
SIGALRM signal handling.

if(state == miss){
   haddr = getIPAddr from url;
   if (make socket fd failed)
      print error and exit();
      setting web_server_addr using haddr;
      if (connection with web failed)
         print error and exit();
      write buf's request to web server;
      alarm 20 sec;
      Enter Critical zone(p with semid);
```

```
            open temp_dir with write mode;
            while(receive response){
                alarm off;
                write response at cache file;
                write response to client_fd;
                h_buf clear;
            }
            close h_socket_fd;
        }
        else{
            Enter Critical zone(p with semid);
            open temp_dir with read mode;
            while read data is exist in cache file{
                write data to client_fd;
                h_buf clear;
            }
        }
    close fd;
    struct Log data update;
    Make new thread(thread do Write_Log_File() Function with data)
    Print made new thread;
    Wait thread end;
    Print exited thread;
    Exit Critical zone(v with semid);
    return is_exist_file;
    }
```

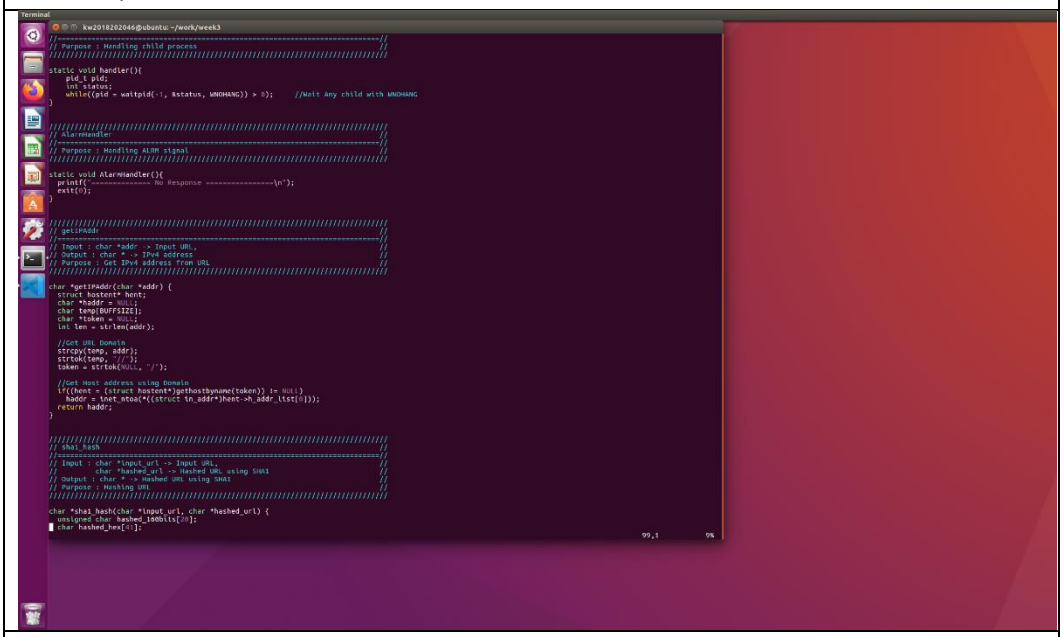
```
void Sub_Process_Work(int client_fd, struct sock_addr, int semid, char *buf, char *char_dir, FILE *log_file){
    char temp[BUFFSIZE] = { 0 };
    char method[BUFFSIZE] = { 0 };
    char url[BUFFSIZE] = { 0 };
    char h_buf[BUFFSIZE];
    char* haddr;
    char *token = NULL;
    int len, h_socket_fd;
    int state, hit = 0, miss = 0;

    struct sockaddr web_server_addr;
    pid_t current_pid = Current process ID;
    Set sub process's SIGINT handler default;
    while read data from client_fd to buf is exist{
      method = Request message's method;
      if(method == GET){
        url = Request message's url
        state = Ceck_Cache's state(Hit or Miss);
      }
    }
}

main(void){
  if Make new Semid using PORTNO failed, return;
```

```
if Semid initialize failed, return;
Make Cache and log directory and store path's information;
if open socket is failed, print error and return;
update server's address information;
if binding socket and server's address data is failed, print error and return;

Waiting Connection and Collect SIGCHID signal using handler;
while true{
   if connection didn't occur, print error and return;
   if make child process failed, close file descriptor and socket and continue;
   if child process, Do Sub_Process_Work() and exit;
   if parent process{
      sub process count++;
      SIGINT Handling;
   }
   close client file descriptor;
 }
  close socket file descriptor;
}
```

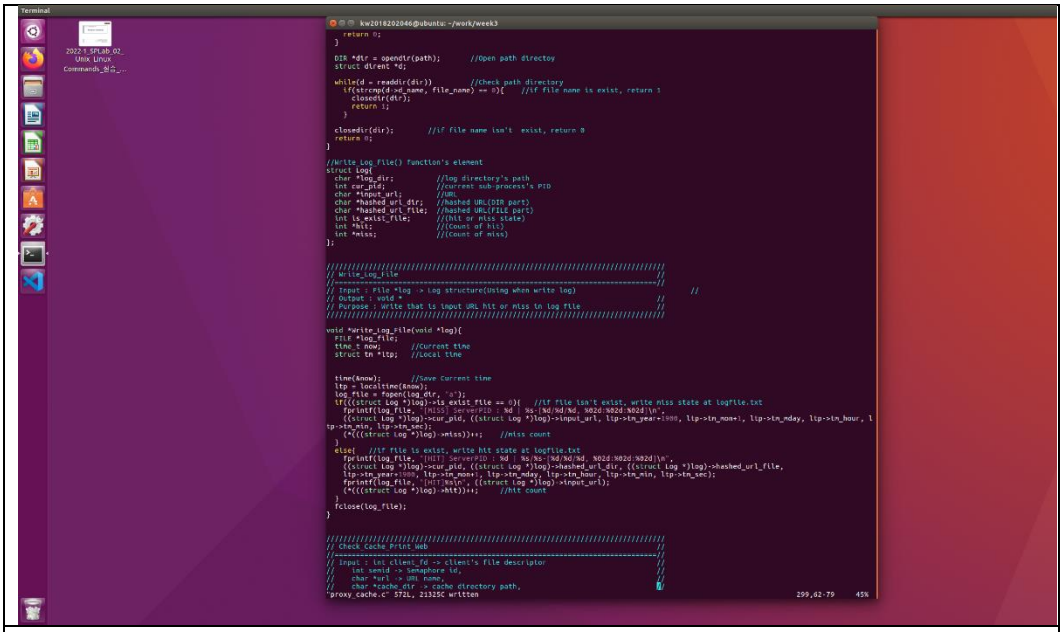
4. 결과 화면



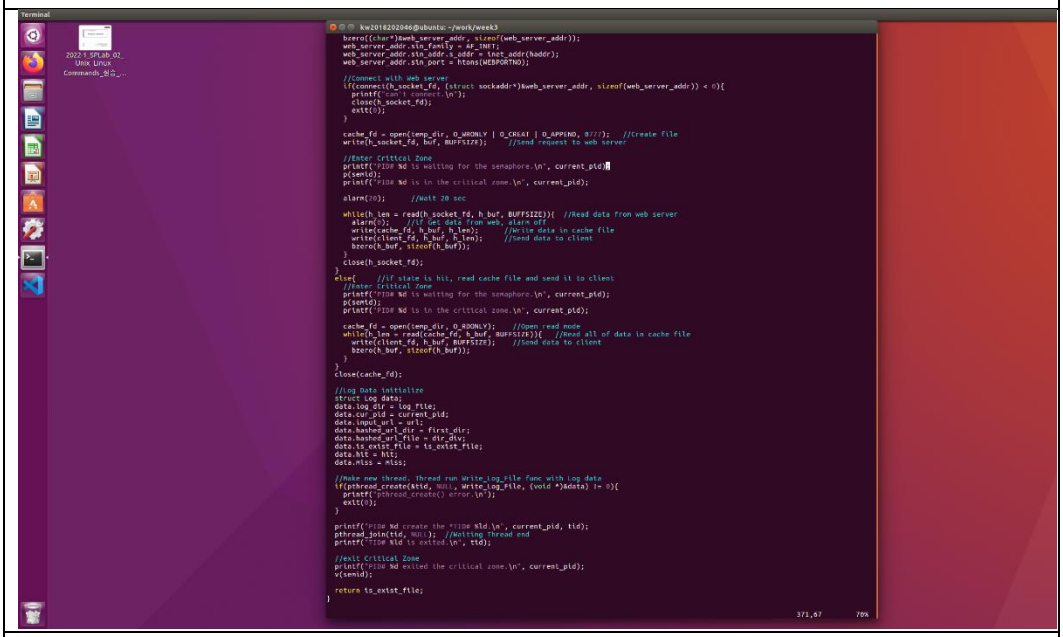
Signal 함수에서 handling을 위한 함수들과 semaphore를 위해 추가된 함수가 존재한다. Handler는 SIGCHLD, AlarmHandler는 SIGALRM, IntHandler는 SIGINT를 위한 handler이다. IntHandler는 전역변수로 선언된 sub_process_count와 log_file의 주소를 이용하여 종료 로그를 작성 후 terminate한다. P, v 함수는 각각 Critical zone 진입, 탈출 시 사용하는 함수로 segid에 해당하는 val을 컨트롤함으로써 semaphore를 조정한다.



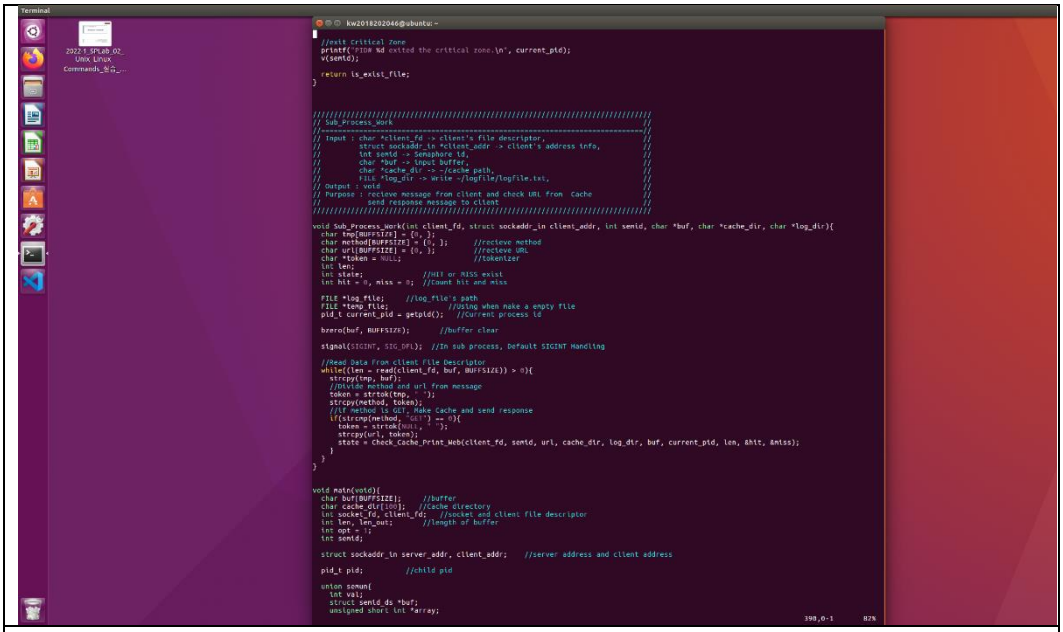
AlarmHandler()에서는 SIGALRM 에러가 왔을 경우 No response를 출력하고 exit()을 동작시킴으로써 error를 handling한다. getIPAddr()함수에서는 url을 입력으로 받으며 url에서 http://을 tokenize하고 /까지를 tokenize하여 순수한 주소를 가져온다. 이를 가지고 gethostbyname()함수를 통해 host의 정보를 가져와 IP를 추출한다.



해당 함수는 기존의 cache directory와 log directory를 생성하고 log_file과 cache_dir의 path를 저장하는 역할을 수행한다. 단 기존과 달라진 것은 위에서 선언된 구조체 struct Log를 통해 하나의 인자로 데이터를 받는다. 이는 thread에서 실행하는 함수의 인자가 1개만 가능하기 때문이다.

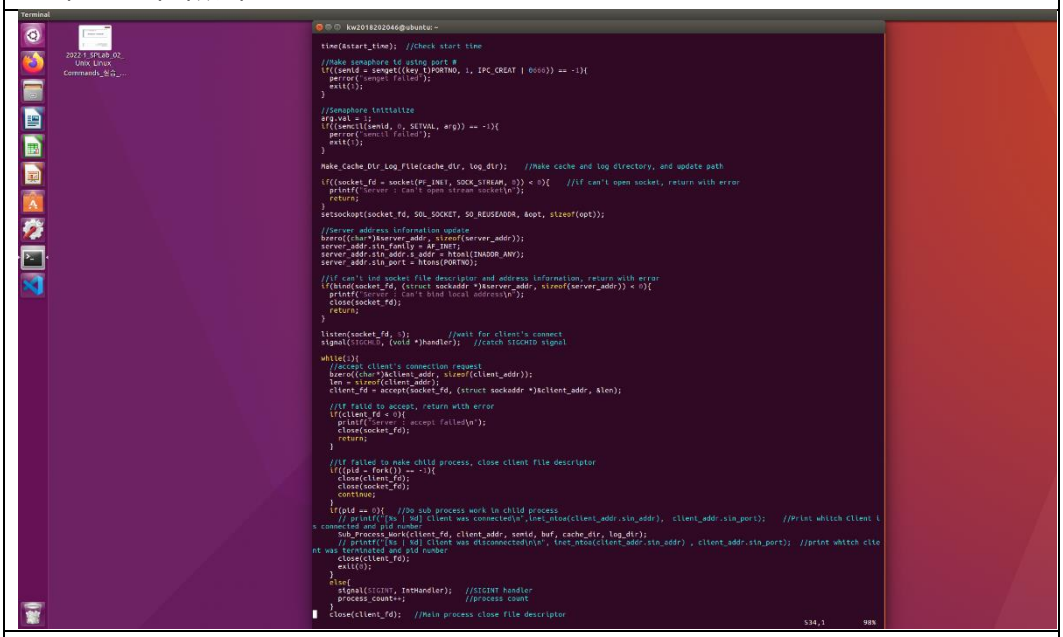


해당 함수는 이전의 함수에서 일부가 수정되었다. Critical zone에서 Logfile을 쓰는 기존 부분을 변경하여 Log로 쓸 데이터를 구조체에 담은 뒤 thread를 만들어 해당 thread에서 이를 동작시킨다. 그리고 원래 thread는 해당 thread가 끝나기를 기다린다. 이 과정은 터미널에 출력을 통해 보여진다.



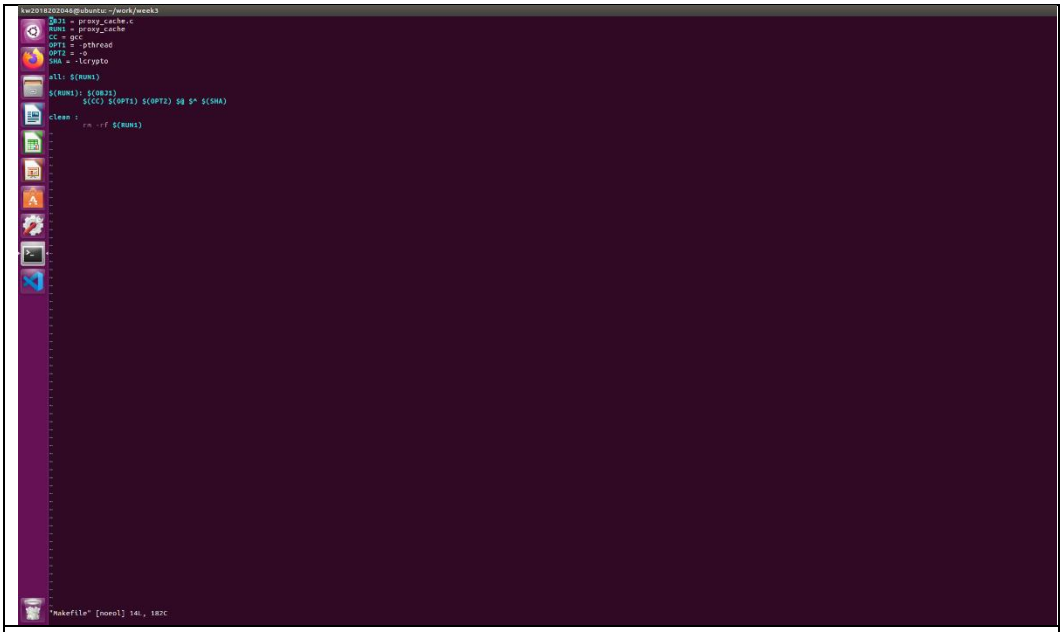
```
//exit Critical Zone
printf("PID# %d exited the critical zone.\n", current_pid);
v(semid);

return is_exist_file;
}


////////////////////////////////////////////////////////////////////////////////
// Sub_Process_Work                                                           //
//----------------------------------------------------------------------------//
// Input : char *client_fd -> client's file descriptor,                       //
//         struct sockaddr_in *client_addr -> client's address info,          //
//         int semid -> Semaphore id,                                         //
//         char *buf -> input buffer,                                         //
//         char *cache_dir -> ~/cache path,                                   //
//         FILE *log_dir -> Write ~/logfile/logfile.txt,                      //
// Output : void                                                              //
// Purpose : recieve message from client and check URL from  Cache            //
//           send response message to client                                  //
////////////////////////////////////////////////////////////////////////////////

void Sub_Process_Work(int client_fd, struct sockaddr_in client_addr, int semid, char *buf, char *cache_dir, char *log_dir){
  char tmp[BUFFSIZE] = {0, };
  char method[BUFFSIZE] = {0, };      //recieve method
  char url[BUFFSIZE] = {0, };         //recieve URL
  char *token = NULL;                 //tokenizer
  int len;
  int state;              //HIT or MISS exist
  int hit = 0, miss = 0;  //Count hit and miss

  FILE *log_file;     //log_file's path
  FILE *temp_file;            //Using when make a empty file
  pid_t current_pid = getpid();   //Current process id

  bzero(buf, BUFFSIZE);       //buffer clear

  signal(SIGINT, SIG_DFL);  //In sub process, Default SIGINT Handling

  //Read Data from client File Descriptor
  while((len = read(client_fd, buf, BUFFSIZE)) > 0){
    strcpy(tmp, buf);
    //Divide method and url from message
    token = strtok(tmp, " ");
    strcpy(method, token);
    //if method is GET, Make Cache and send response
    if(!strcmp(method, "GET") == 0){
      token = strtok(NULL, " ");
      strcpy(url, token);
      state = Check_Cache_Print_Web(client_fd, semid, url, cache_dir, log_dir, buf, current_pid, len, &hit, &miss);
    }
  }
}


void main(void){
  char buf[BUFFSIZE];     //buffer
  char cache_dir[100];    //Cache directory
  int socket_fd, client_fd;   //socket and client file descriptor
  int len, len_out;       //length of buffer
  int opt = 1;
  int semid;

  struct sockaddr_in server_addr, client_addr;    //server address and client address

  pid_t pid;          //child pid

  union semun{
    int val;
    struct semid_ds *buf;
    unsigned short int *array;
                                                                  398,0-1       82%
```

해당 함수는 2-4에서 만든 내용에서 기존 터미널 창에서의 출력을 없애서 과제의 스팩을 만족시켰다.

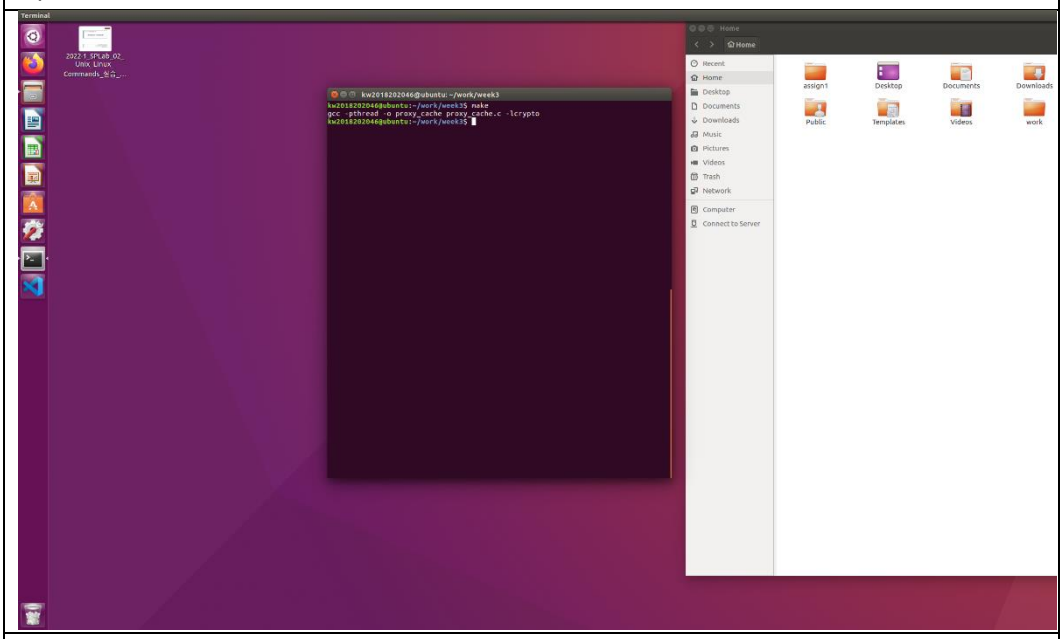


```
  time(&start_time);  //Check start time

  //Make semaphore to using port #
  if((semid = semget((key_t)PORTNO, 1, IPC_CREAT | 0666)) == -1){
    perror("semget failed");
    exit(1);
  }

  //Semaphore initialize
  arg.val = 1;
  if((semctl(semid, 0, SETVAL, arg)) == -1){
    perror("semctl failed");
    exit(1);
  }

  Make_Cache_Dir_Log_File(cache_dir, log_dir);    //Make cache and log directory, and update path

  if((socket_fd = socket(PF_INET, SOCK_STREAM, 0)) < 0){    //if can't open socket, return with error
    printf("Server : Can't open stream socket\n");
    return;
  }
  setsockopt(socket_fd, SOL_SOCKET, SO_REUSEADDR, &opt, sizeof(opt));

  //Server address information update
  bzero((char*)&server_addr, sizeof(server_addr));
  server_addr.sin_family = AF_INET;
  server_addr.sin_addr.s_addr = htonl(INADDR_ANY);
  server_addr.sin_port = htons(PORTNO);

  //if can't ind socket file descriptor and address information, return with error
  if(bind(socket_fd, (struct sockaddr *)&server_addr, sizeof(server_addr)) < 0){
    printf("Server : Can't bind local address\n");
    close(socket_fd);
    return;
  }

  listen(socket_fd, 5);             //wait for client's connect
  signal(SIGCHLD, (void *)handler);   //catch SIGCHID signal

  while(1){
    //Accept client's connection request
    bzero((char*)&client_addr, sizeof(client_addr));
    len = sizeof(client_addr);
    client_fd = accept(socket_fd, (struct sockaddr *)&client_addr, &len);

    //If faild to accept, return with error
    if(client_fd < 0){
      printf("Server : accept failed\n");
      close(socket_fd);
      return;
    }

    //If failed to make child process, close client file descriptor
    if((pid = fork()) == -1){
      close(client_fd);
      close(socket_fd);
      continue;
    }
    if(pid == 0){   //Do sub process work in child process
      // printf("%s | %d] Client was connected\n",inet_ntoa(client_addr.sin_addr),  client_addr.sin_port);    //Print whitch Client i
s connected and pid number
      Sub_Process_Work(client_fd, client_addr, semid, buf, cache_dir, log_dir);
      // printf("%s | %d] Client was disconnected\n\n", inet_ntoa(client_addr.sin_addr) , client_addr.sin_port);  //print whitch clie
nt was terminated and pid number
      close(client_fd);
      exit(0);
    }
    else{
      signal(SIGINT, IntHandler);   //SIGINT handler
      process_count++;              //process count
    }
    close(client_fd);   //Main process close file descriptor
                                                                  534,1         98%
```

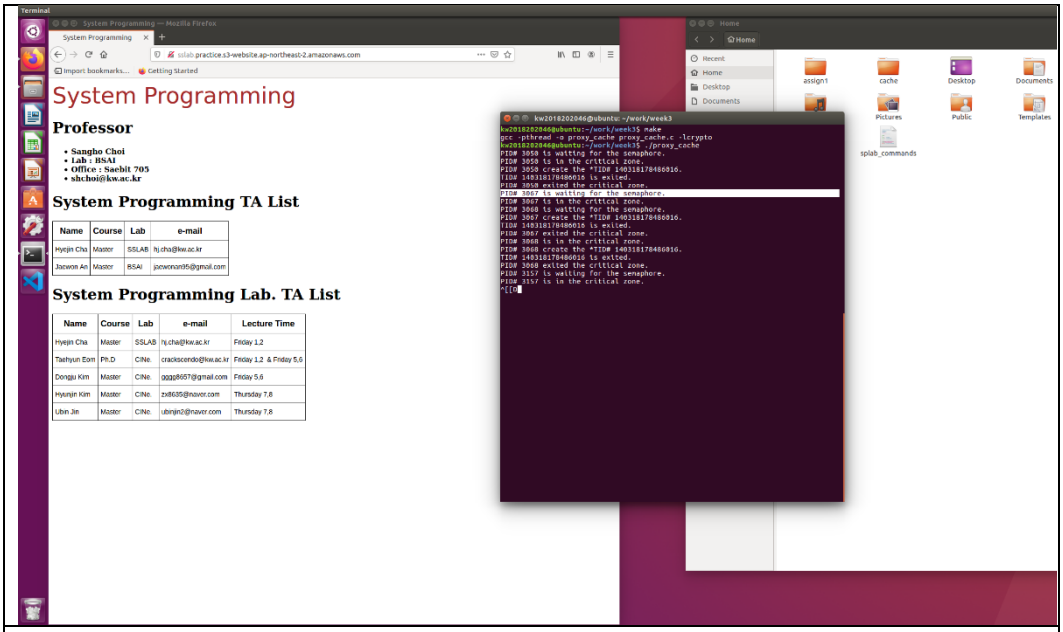
해당 그림은 메인함수다. 기존과 다른 점으로는 semaphore를 생성하고 초기화하는 부분이 추가되었으며 sub_process_work의 인자로 semid가 추가된 부분이 있다.



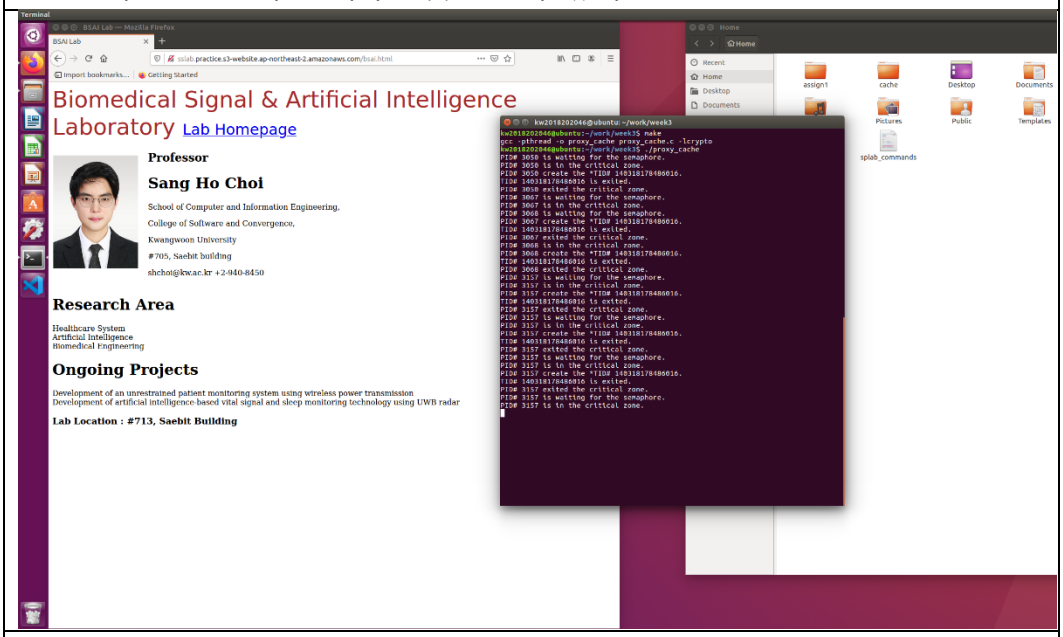
해당 파일은 Makefile이다. proxy_cache.c의 파일을 proxy_cache 실행파일로 만드는 역할을 수행한다. Thread가 만들어지기 때문에 해당 부분에 대한 옵션이 추가되었다.



해당 그림은 기존의 cache와 logfile이 없는 상태에서 시작한다.

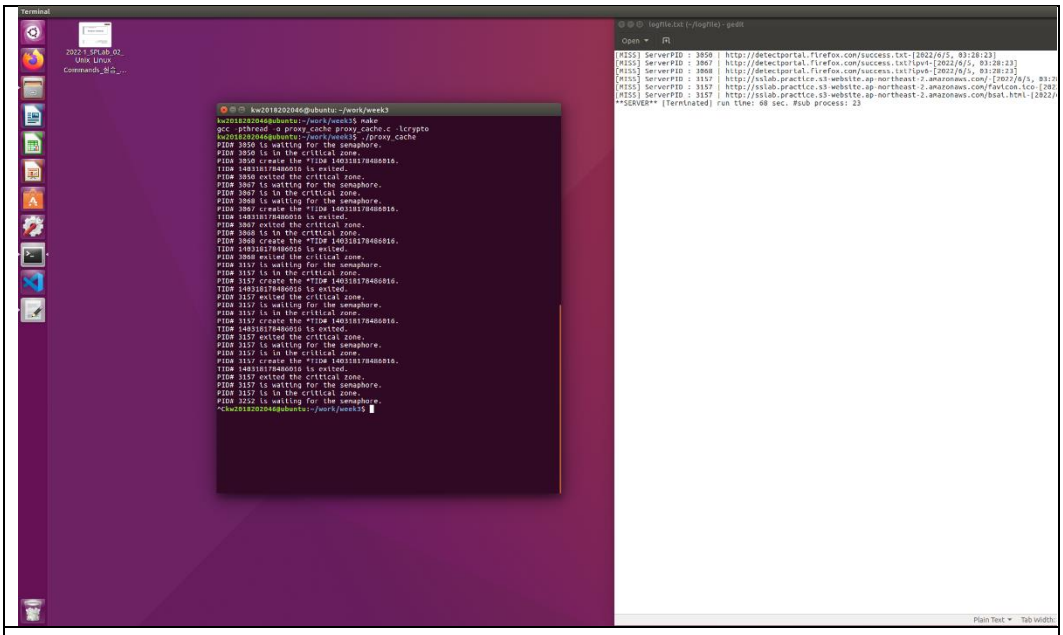


다음과 같이 기존과 같은 출력을 정상적으로 보이면서 Semaphore의 정보와 Thread의 정보를 모두 출력하는 것을 볼 수 있다.



다른 URL을 입력하였을 때에도 이전과 같이 정상적으로 출력하는 모습을 보인다.

=



Logfile을 보았을 때 기존과 같이 MISS HIT에 대한 정보가 정상적으로 존재하는 것을 확인하였다. 이를 통해 해당 과제가 완성되었음을 확인했다.

5. 고찰

해당 과제를 통해서 thread라는 생소한 개념에 대하여 공부할 수 있는 과제였다. Thread를 통해 기존에 사용하였던 fork에 비해 더욱 가볍고 자원을 공유할 수 있는 작업을 수행할 수 있다는 사실이 놀라웠다. 또한 이를 실제적으로 pthread_create, pthread_join 등의 함수를 사용하여 구현함으로써 되새김질할 시간을 가질 수 있었다. 또한 Thread에서 시작하는 함수에는 하나의 인자만이 필요하기 때문에 어떻게 하면 여러가지 인자를 줄 수 있는지 고민해볼 수 있었고, 이 과정에서 구조체를 이용함으로써 해결할 수 있었다.

6. Reference

강의 자료만을 참고