System Programming & OS 실습
7. File I/O

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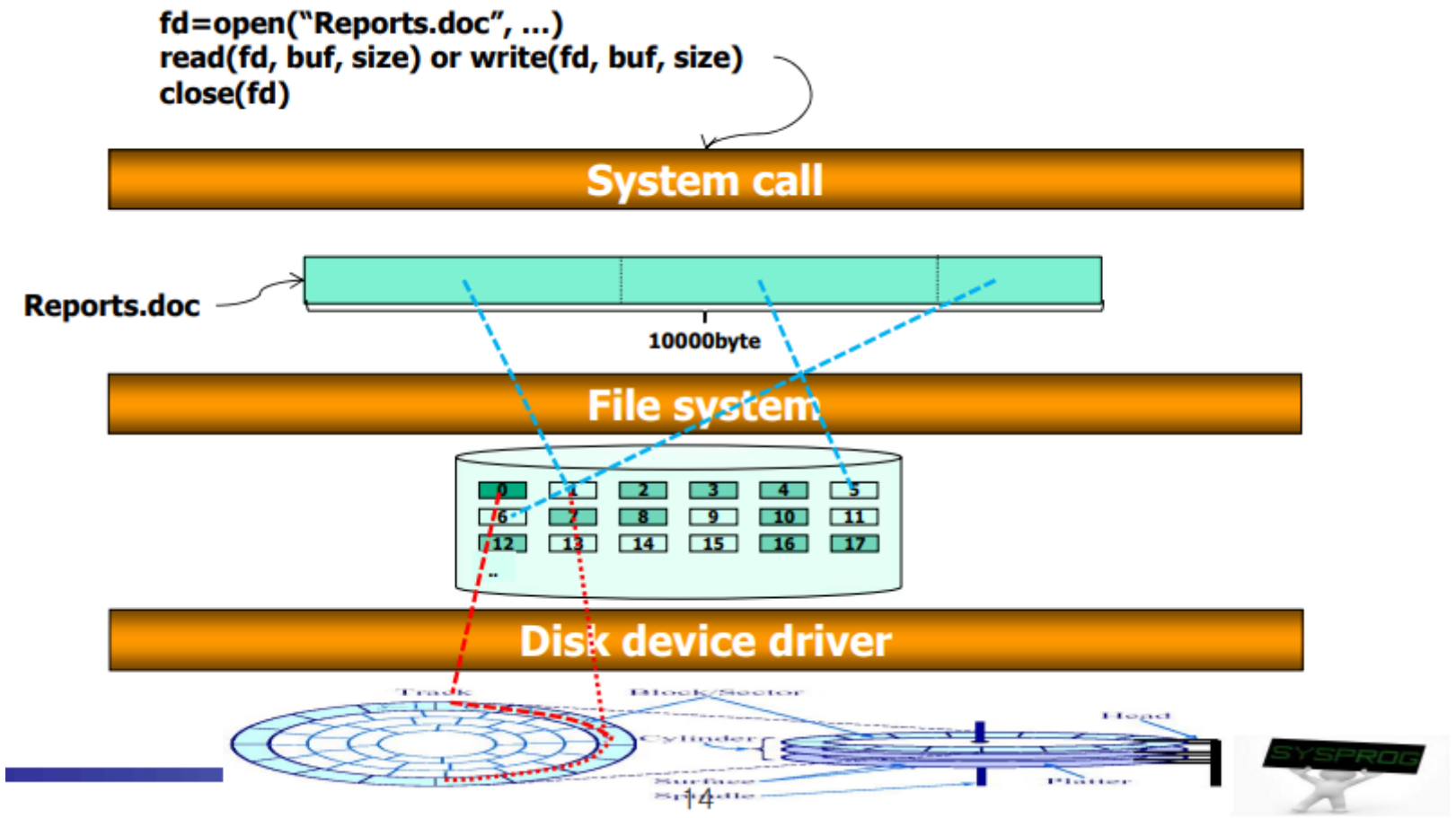
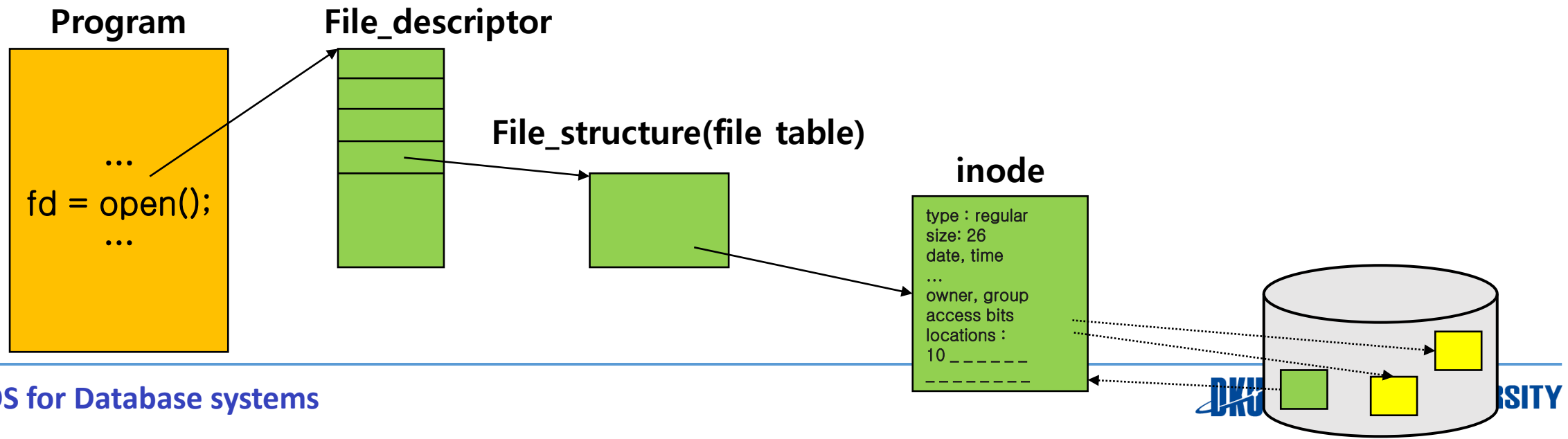
요약: 파일입출력 과정


fd=open("Reports.doc", ...)
read(fd, buf, size) or write(fd, buf, size)
close(fd)
System call
Reports.doc
10000byte
File system
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Disk device driver
Track
Block/Sector
Cylinder
Head
Surface
Platter
SYSPROG

System call

- System call
  - Use fd (file descriptor) instead of file name (for efficiency)
  - fd: object to point out a file in kernel
  - Return value of the open() system call
  - Used by the following read(), write(), …, close() system calls
  - fd is connected into inode through various kernel objects (file table)



실습1: open(),read()


```
[centos@localhost ~]$ vim open.c
```

```c
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
#include <errno.h>
#define MAX_BUF 5
char fname[]="alphabet.txt";

int main(){
        int fd,size;
        char buf[MAX_BUF];

        fd = open(fname,O_RDONLY);
        if(fd<0){
                printf("Can't open %sfile with errno %d\n",fname,errno);
                exit(-1);
        }
        size = read(fd,buf,MAX_BUF);
        if(size < 0){
                printf("Can't read from file %s,size= %d\n",fname,size);
        }
        else
                printf("size of read data is %d\n",size);
        close(fd);
}
```

실습1: open(),read()


```
[centos@localhost ~]$ gcc -o open open.c
[centos@localhost ~]$ ls
Desktop    Downloads  open      Pictures  Templates
Documents  Music      open.c    Public    Videos
[centos@localhost ~]$ ./open
Can't open alphabet.txtfile with errno 2
```

오류코드: 파일 및 디렉토리 X

실습1: open(),read()


```
[centos@localhost ~]$ vim alphabet.txt
```

실습1: open(),read()


```
[centos@localhost ~]$ ./open
size of read data is 5
```

실습1: open(),read()

int open(const char *pathname, int flags, [mode_t mode])

- ✓ pathname : absolute path or relative path
- ✓ flags (see: /usr/include/asm/fcntl.h or Chapter 4.3 in the LPI)
  - O_RDONLY, O_WRONLY, O_RDWR
  - O_CREAT, O_EXCL
  - O_TRUNC, O_APPEND
  - O_NONBLOCK, O_SYNC
  - …
- ✓ mode
  - meaningful with the O_CREAT flag
  - file access mode (S_IRUSR, S_IWUSR, S_IXUSR, S_IRGRP, …, S_IROTH, …)
- ✓ return value
  - file descriptor if success
  - -1 if fail

int read(int fd, char *buf, int size) // same as the write(fd, buf, size)

- ✓ fd: file descriptor (return value of open())
- ✓ buf: memory space for keeping data
- ✓ size: request size
- ✓ return value
  - read size
  - -1 if fail

실습2: write()


```
[centos@localhost ~]$ vim write.c
```

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
#include <errno.h>
#define MAX_BUF 5
char fname[]="alphabet.txt";

int main(){
        int fd,read_size,write_size;
        char buf[MAX_BUF];

        fd = open(fname,O_RDONLY);
        if(fd<0){
                printf("Can't open %sfile with errno %d\n",fname,errno);
                exit(-1);
        }
        read_size = read(fd,buf,MAX_BUF);
        if(read_size < 0){
                printf("Can't read from file %s,size= %d\n",fname,write_size);
        }
        write_size = write(STDOUT_FILENO,buf,MAX_BUF);
        close(fd);
}
~
~
~
"write.c" 24L, 506B                                   22,33-40      All
```

```
#define STDIN_FILENO    0   // Standard input
#define STDOUT_FILENO   1   // Standard output
#define STDERR_FILENO   2   // Standard error
```

실습2: write()


```
[centos@localhost ~]$ gcc -o write write.c
[centos@localhost ~]$ ./write
abcde[centos@localhost ~]$
```

실습3: mycat


```
[centos@localhost ~]$ vim mycat.c
```

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
#include <errno.h>
#define MAX_BUF 64

int main(int argc, char *argv[]){
        int fd,read_size,write_size;
        char buf[MAX_BUF];

        if(argc != 2){
                printf("USAGE: %S file_name\n",argv[0]);
                exit(-1);
        }
        fd = open(argv[1], O_RDONLY);
        if(fd<0){
                //open error handling
        }
        while(1){
                read_size=read(fd,buf,MAX_BUF);
                if(read_size == 0)
                        break;
                write_size=write(STDOUT_FILENO,buf,read_size);
        }
        close(fd);
}
"mycat.c" 27L, 489B                                          18,4-18       All
```

실습3: mycat


```
[centos@localhost ~]$ gcc -o mycat mycat.c
[centos@localhost ~]$ ./mycat alphabet.txt
abcdefgh
```

실습4: create new file


```
[centos@localhost ~]$ vim creat.c
```

```c
#include <fcntl.h>
#include <errno.h>
#define MAX_BUF 64
char fname[]="newfile.txt";
char dummy_data[]="abcdefg\n";


int main(){
        int fd,read_size,write_size;
        char buf[MAX_BUF];

        fd = open(fname,O_RDWR | O_CREAT | O_EXCL, 0664);
        if(fd<0){
                printf("Can't create %s file with errno %d\n",fname,errno);
                exit(1);
        }
        write_size=write(fd,dummy_data,sizeof(dummy_data));
        printf("write_size = %d\n",write_size);
        close(fd);

        fd=open(fname,O_RDONLY);
        read_size = read(fd,buf,MAX_BUF);
        printf("read_size = %d\n",read_size);
        write_size= write(STDOUT_FILENO,buf,read_size);

        close(fd);
}
```

```
                                                              30,1          Bot
```

실습4: create new file


```
[centos@localhost ~]$ gcc -o creat creat.c
[centos@localhost ~]$ ./creat
Can't create newfile.txt file with errno 17
[centos@localhost ~]$ rm -rf newfile.txt
[centos@localhost ~]$ ./creat
write_size = 9
read_size = 9
abcdefg
```

실습5: lseek()

- Using lseek()

off_t lseek(int fd, off_t offset, int whence)

- fd : file descriptor
- offset : offset position
- whence (/usr/include/unistd.h)
  - SEEK_SET : New offset is set to offset bytes.
  - SEEK_CUR: New offset is set to its current location plus offset bytes.
  - SEEK_END: New offset is set to the size of the file plus offset bytes
- return value
  - new offset if success
  - -1 if fail

Negative value is allowed

실습5: lseek()


```
[centos@localhost ~]$ vim lseek.c
```

```c
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
#include <errno.h>
#define MAX_BUF 64
char fname[]="newfile.txt";
char dummy_data[]="abcdefg\n";

int main(){
        int fd,read_size,write_size,new_offset;
        char buf[MAX_BUF];

        fd = open(fname,O_RDWR | O_CREAT | O_EXCL, 0664);
        if(fd<0){
                printf("Can't create %s file with errno %d\n",fname,errno);
                exit(1);
        }
        write_size=write(fd,dummy_data,sizeof(dummy_data));
        close(fd);

        fd=open(fname,O_RDONLY);
        new_offset = lseek(fd,3,SEEK_SET);
        read_size = read(fd,buf,MAX_BUF);
        printf("read_size = %d\n",read_size);
        write_size = write(STDOUT_FILENO,buf,read_size);

        close(fd);
}
```

```
                                                              9,0-1         All
```

Read and write

O_CREAT 또는create()

파일이 존재하는지 확인

접근 권한

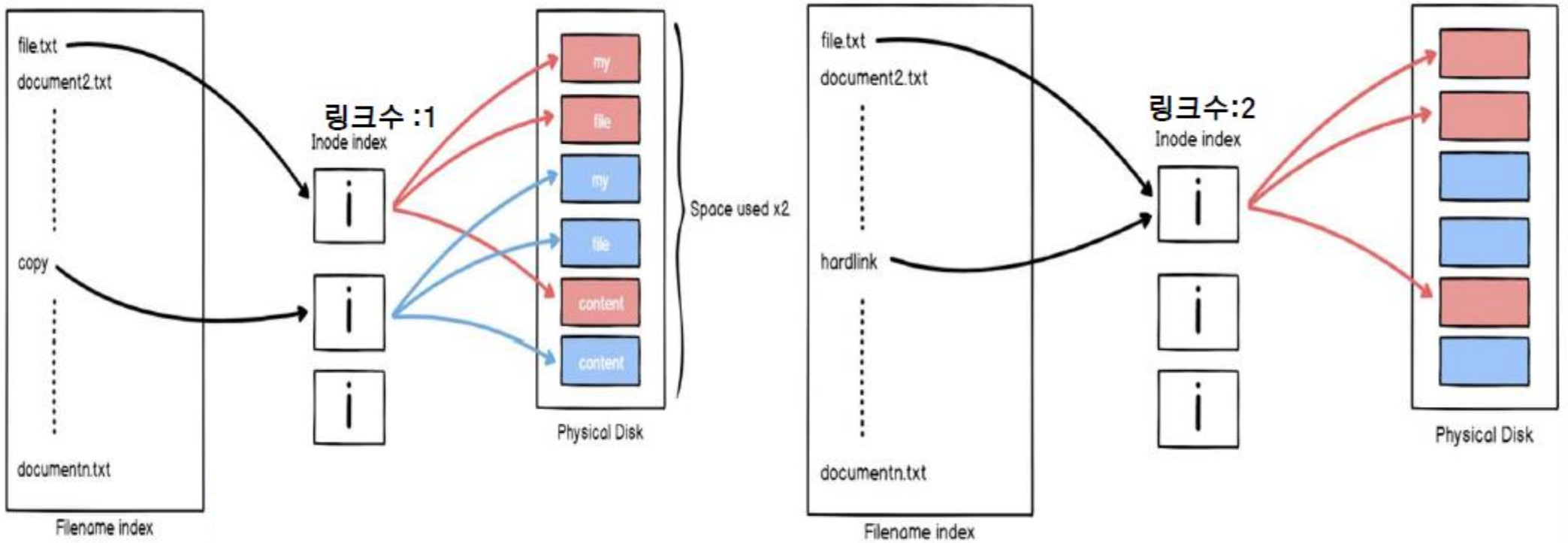
실습5: lseek()


```
[centos@localhost ~]$ gcc -o lseek lseek.c
[centos@localhost ~]$ ./lseek
Can't create newfile.txt file with errno 17
[centos@localhost ~]$ rm -rf newfile.txt
[centos@localhost ~]$ ./lseek
read_size = 6
defg
[centos@localhost ~]$
```

그 이외 파일 입출력 관련 시스템콜

- creat() - 파일을 생성하고 오픈
- mkdir(), readdir(), rmdir() - 새 디렉터리를 생성, 디렉토리 읽기, 삭제
- pipe() - 파이프를 생성
- mknod() - 특수 파일 또는 파일 시스템 노드를 생성
- link(),unlink() - 새로운 하드 링크를 생성, 삭제
- dup(),dup2() - file descriptor를 복사, 다른 file descriptor로 복사
- stat(),fstat() - 파일의 정보, 열려 있는 file descriptor 에 대한 정보
- chmod(), fchmod() - 파일의 권한을 변경, 열려 있는 …
- Ioctl(), fcntl() - I/O 제어 연산을 수행
- Sync(), fsync() - 동기화

link()


file.txt
document2.txt
copy
documentn.txt
Filename index
링크수 :1
Inode index
my
file
my
file
content
content
Physical Disk
Space used x2
file.txt
document2.txt
hardlink
documentn.txt
Filename index
링크수:2
Inode index
Physical Disk

dup()

Figure 10.11
Typical kernel data structures for open files. In this example, two descriptors reference distinct files. There is no sharing.

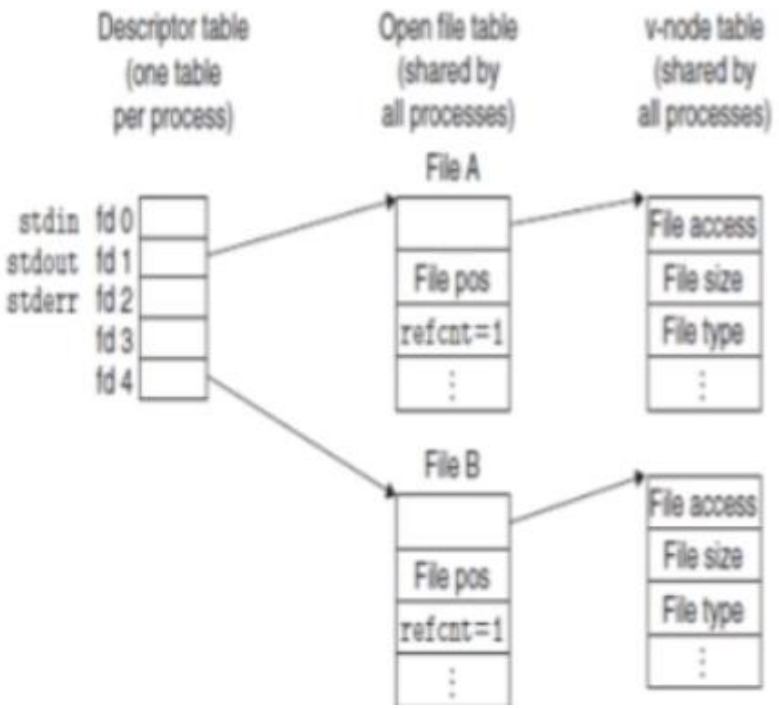


Figure 10.14
Kernel data structures after redirecting standard output by calling dup2(4,1). The initial situation is shown in Figure 10.11.