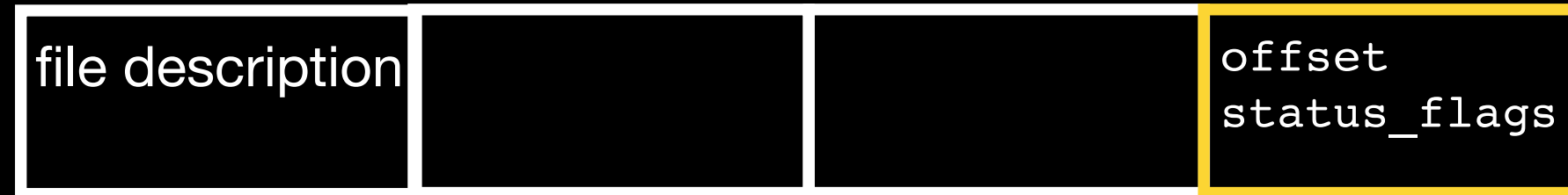
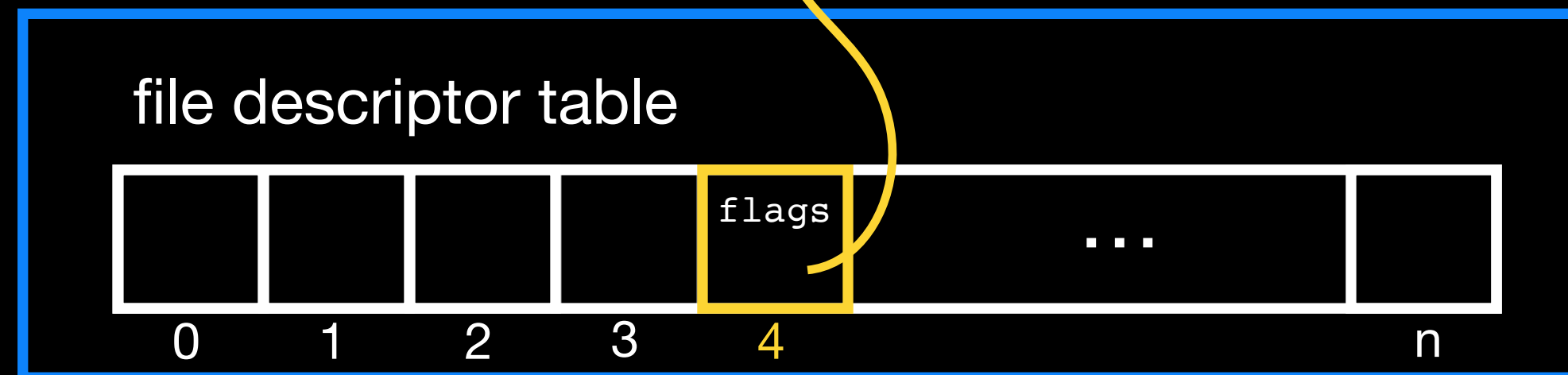


**fds, open files, and i-nodes**

open file table (system-wide)



process info



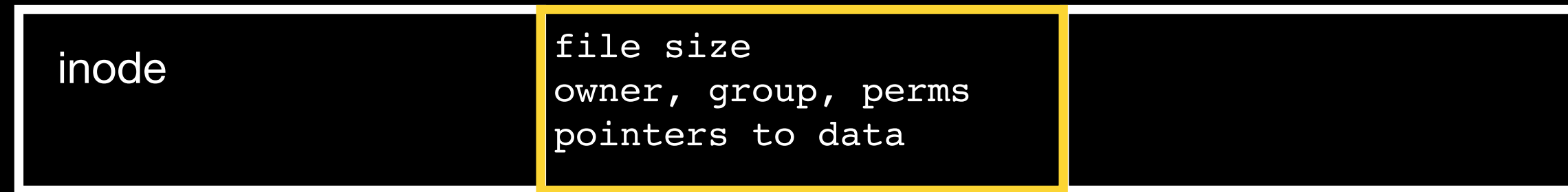
kernel space

user space

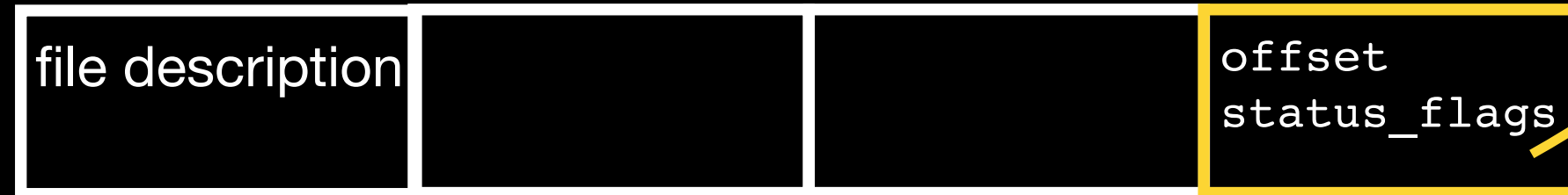
process

`open("foo.txt", flags) → 4`

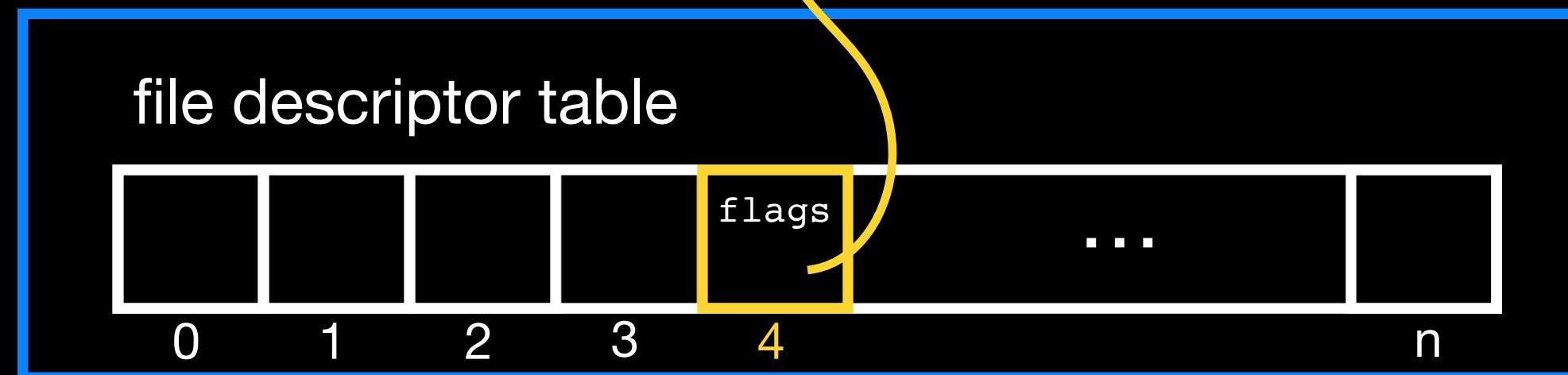
### i-node table (system-wide)



### open file table (system-wide)



### process info



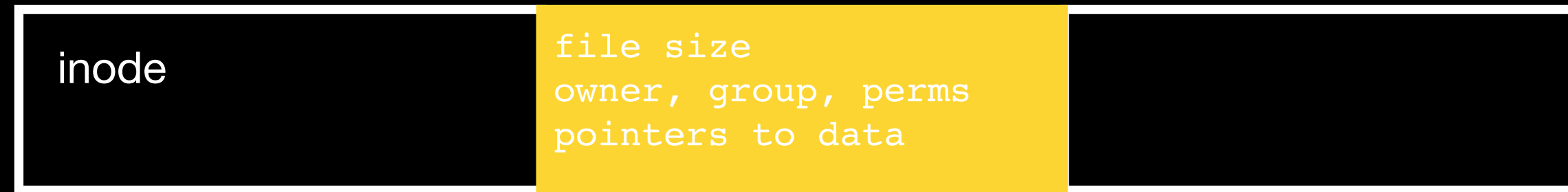
kernel space

user space

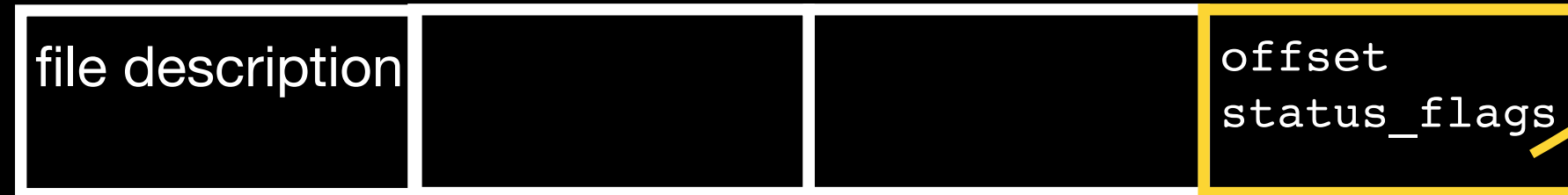
### process

`open("foo.txt", flags) → 4`

### i-node table (system-wide)



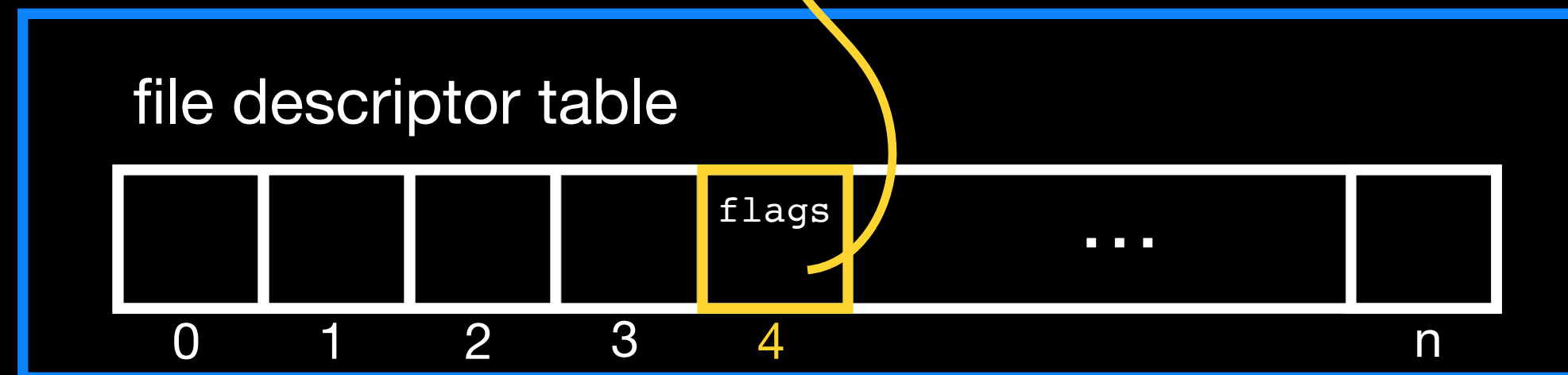
### open file table (system-wide)



syscalls to read data struct

**stat, fstat**

### process info



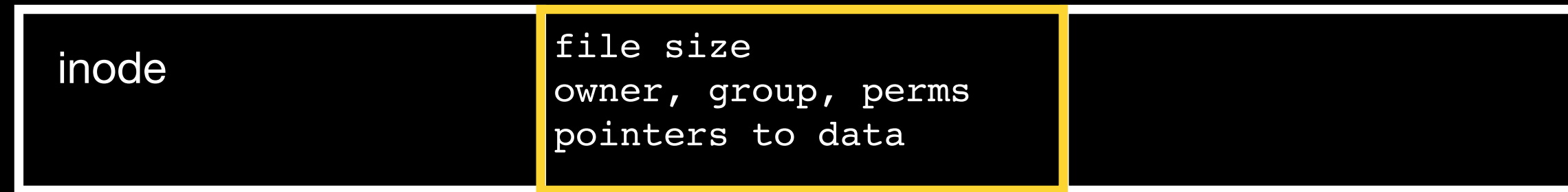
kernel space

user space

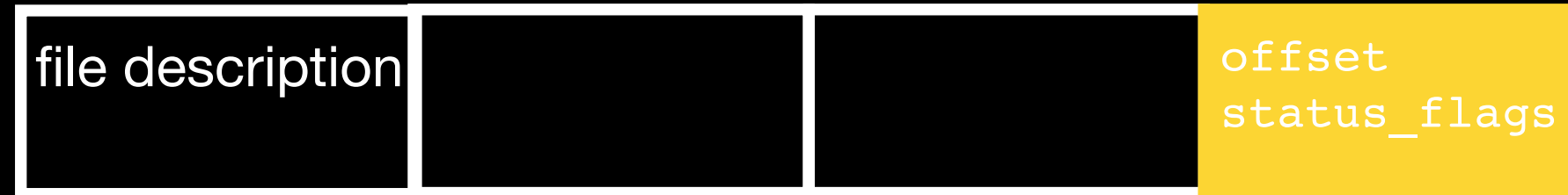
### process

`open("foo.txt", flags) → 4`

### i-node table (system-wide)

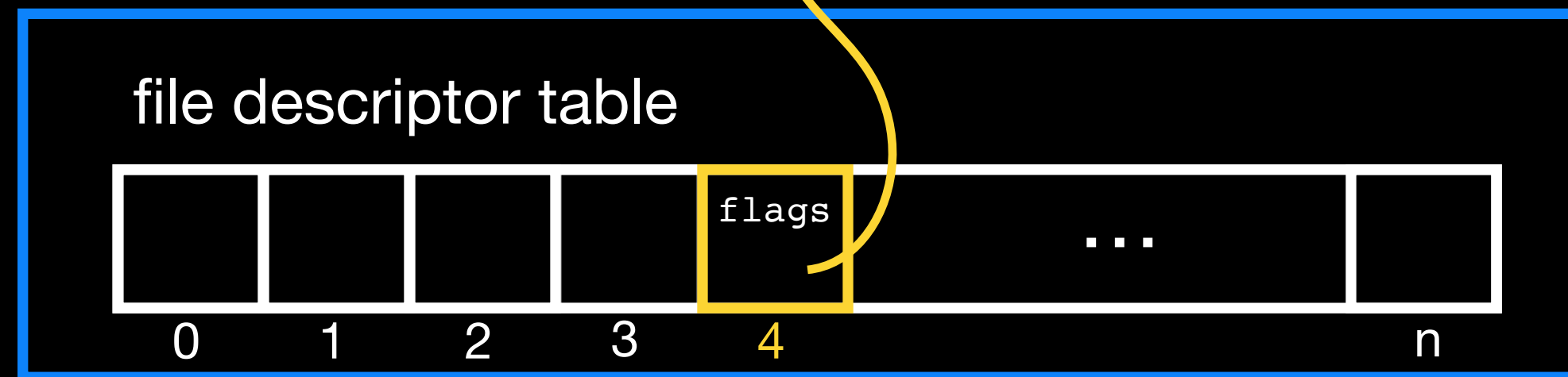


### open file table (system-wide)



syscalls to read data struct  
`fcntl(F_GETFL), lseek`

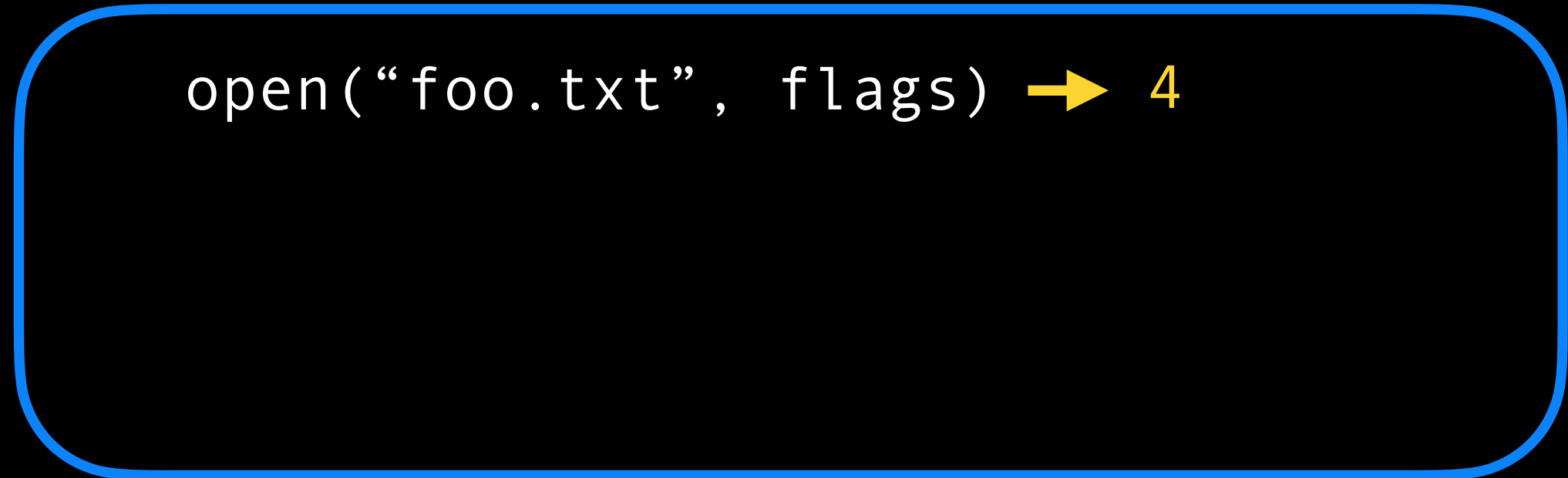
### process info



kernel space

user space

### process



### i-node table (system-wide)

|       |  |  |
|-------|--|--|
| inode | file size<br>owner, group, perms<br>pointers to data |  |
|-------|--|--|

### open file table (system-wide)

|                  |  |  |                        |
|------------------|--|--|------------------------|
| file description |  |  | offset<br>status_flags |
|------------------|--|--|------------------------|

syscalls to read data struct

`fcntl(F_GETFD)`

### process info

|                       |   |   |   |       |     |   |
|-----------------------|---|---|---|-------|-----|---|
| file descriptor table |   |   |   |       |     |   |
|                       |   |   |   | flags | ... |   |
| 0                     | 1 | 2 | 3 | 4     |     | n |

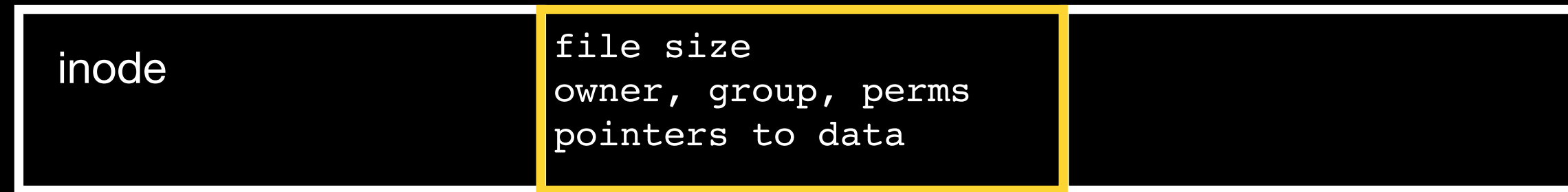
kernel space

user space

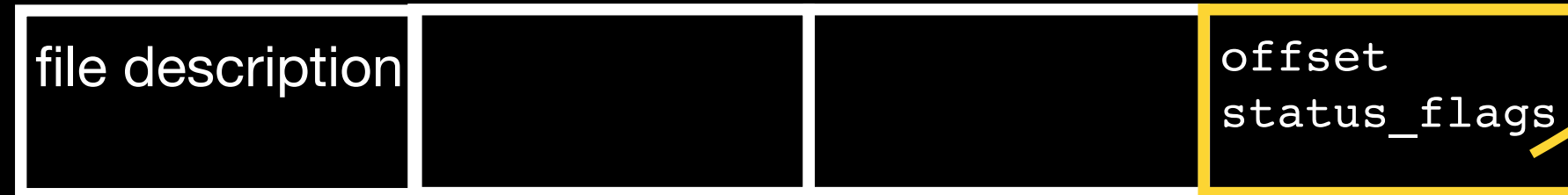
### process

`open("foo.txt", flags) → 4`

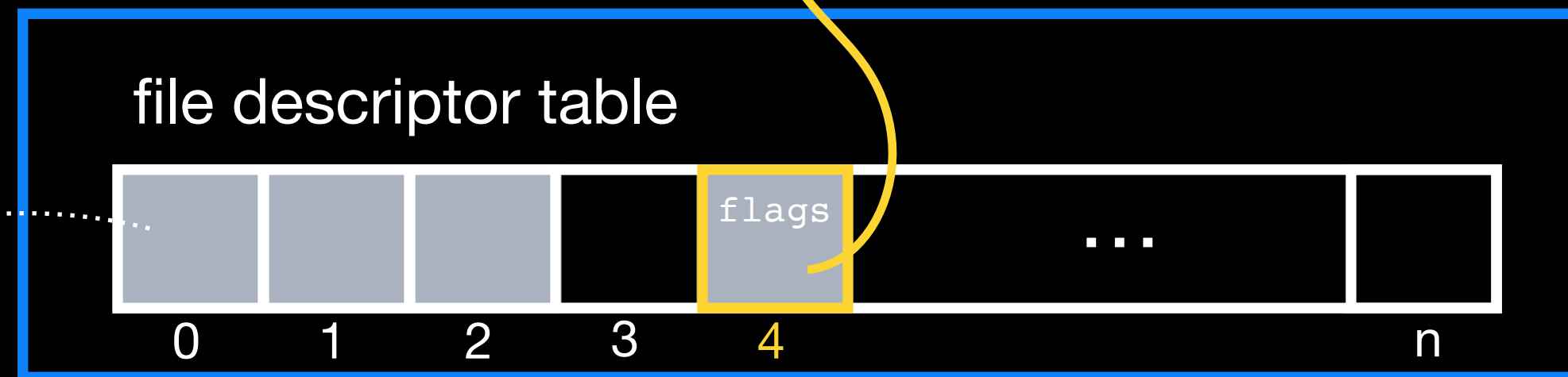
### i-node table (system-wide)



### open file table (system-wide)



### process info



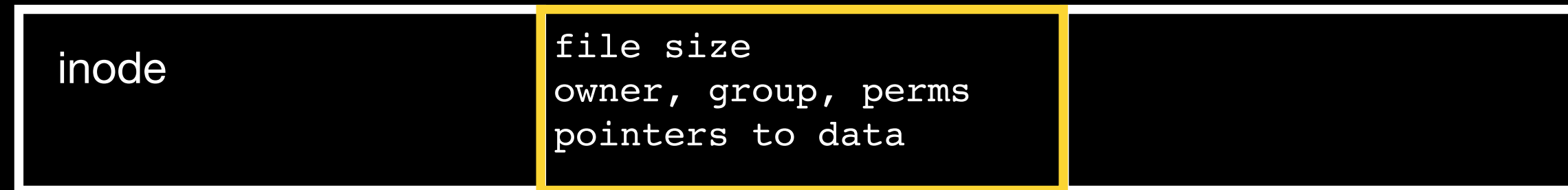
kernel space

user space

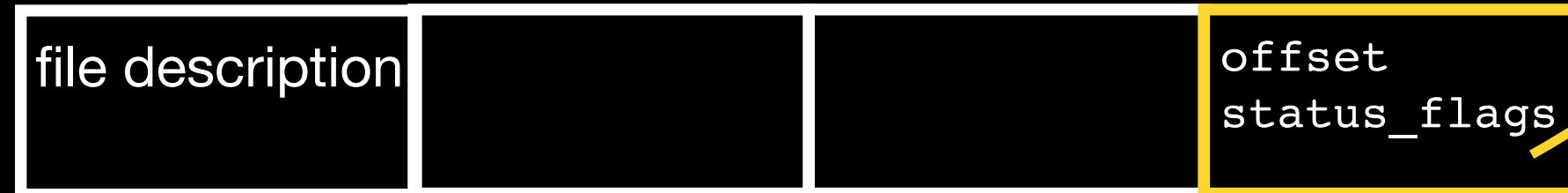
### process

```
open("foo.txt", flags) → 4
```

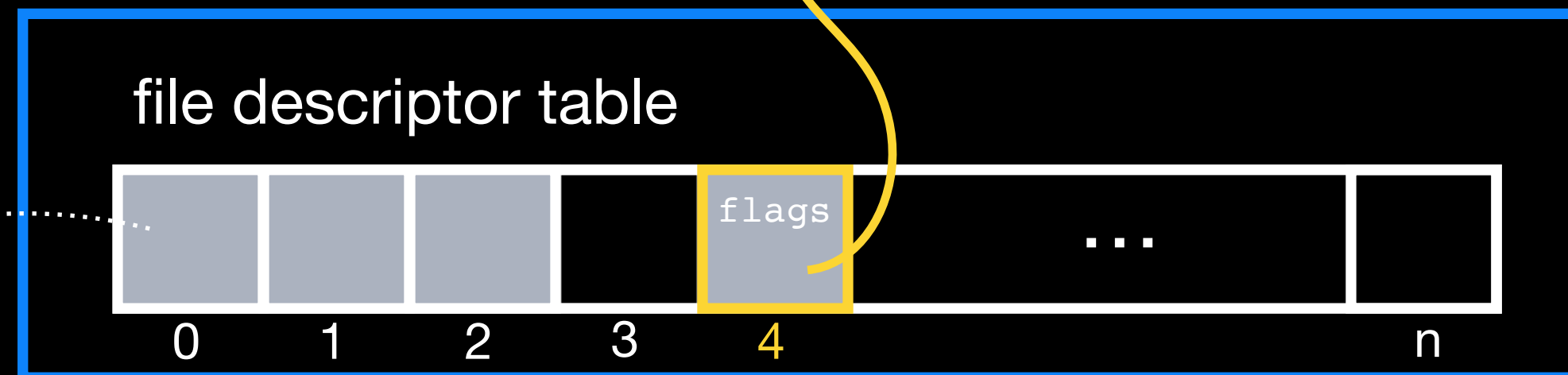
### i-node table (system-wide)



### open file table (system-wide)



### process info



kernel space

user space

### process

```
open("foo.txt", flags) → 4  
dup(4);
```



### i-node table (system-wide)

|       |  |  |
|-------|--|--|
| inode | file size<br>owner, group, perms<br>pointers to data |  |
|-------|--|--|

### open file table (system-wide)

|                  |  |                        |
|------------------|--|------------------------|
| file description |  | offset<br>status_flags |
|------------------|--|------------------------|

### syscalls to duplicate fd

**dup, dup2, dup3, fcntl**

### process info

|                       |   |   |   |       |     |  |  |  |   |
|-----------------------|---|---|---|-------|-----|--|--|--|---|
| file descriptor table |   |   |   |       |     |  |  |  |   |
| used                  |   |   |   | flags | ... |  |  |  | n |
| 0                     | 1 | 2 | 3 | 4     |     |  |  |  |   |

kernel space

user space

### process

```
open("foo.txt", flags) → 4  
dup(4); → 3
```