DIFUZE: Interface Aware Fuzzing for Kernel Drivers

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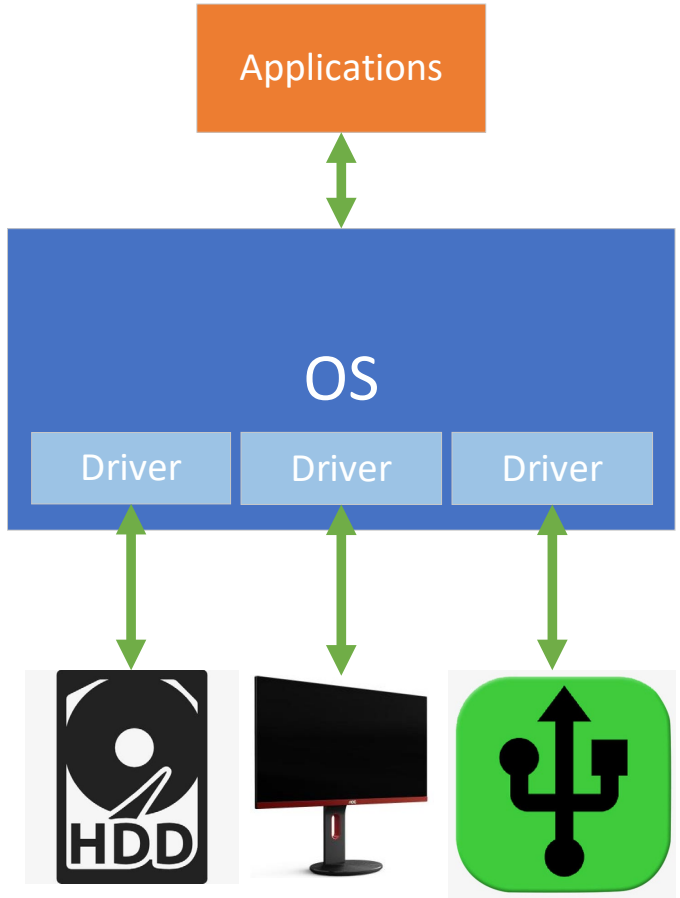
Drivers

- Part of OS kernel
- Operate or control a particular type of device that is attached to a computer



Drivers

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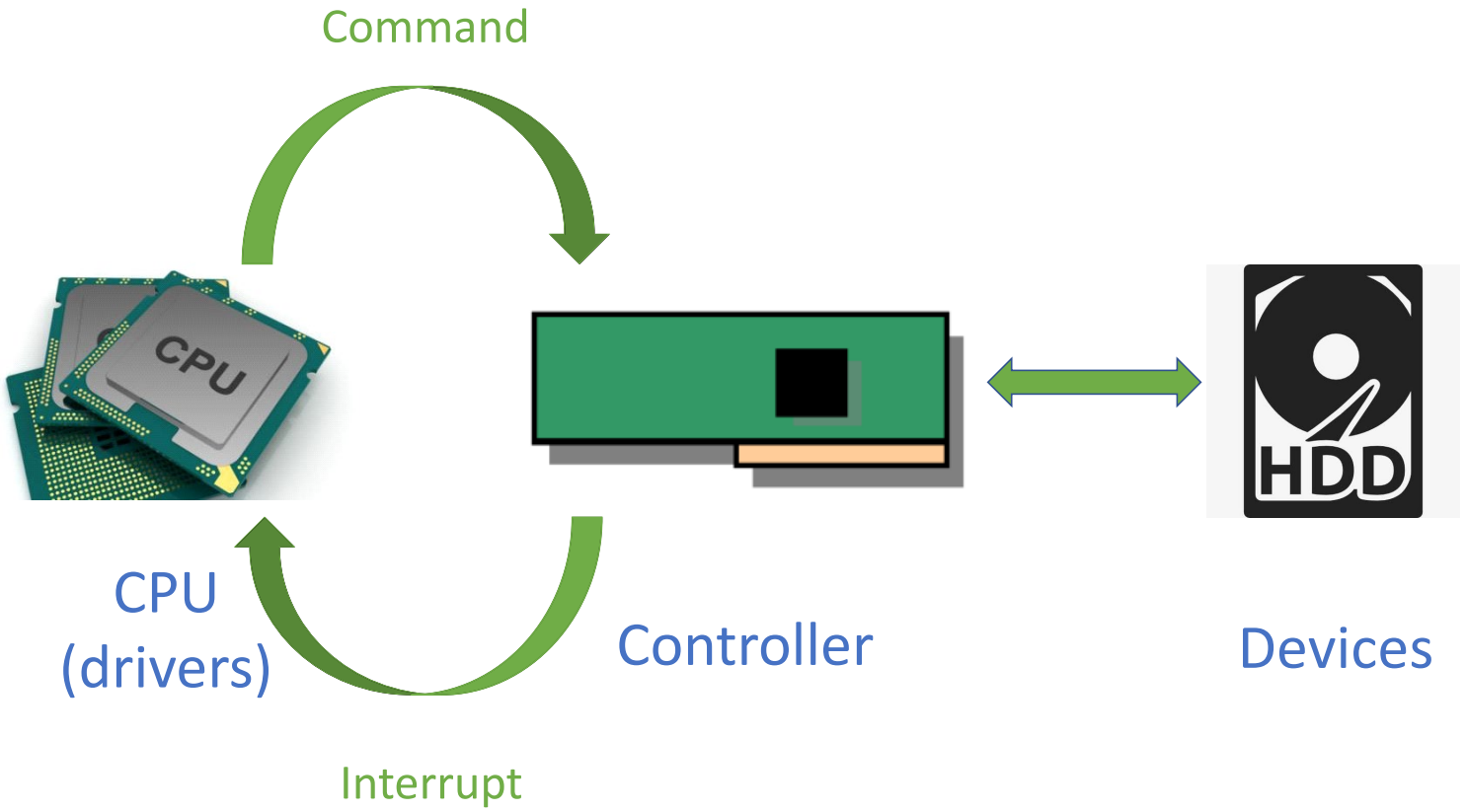
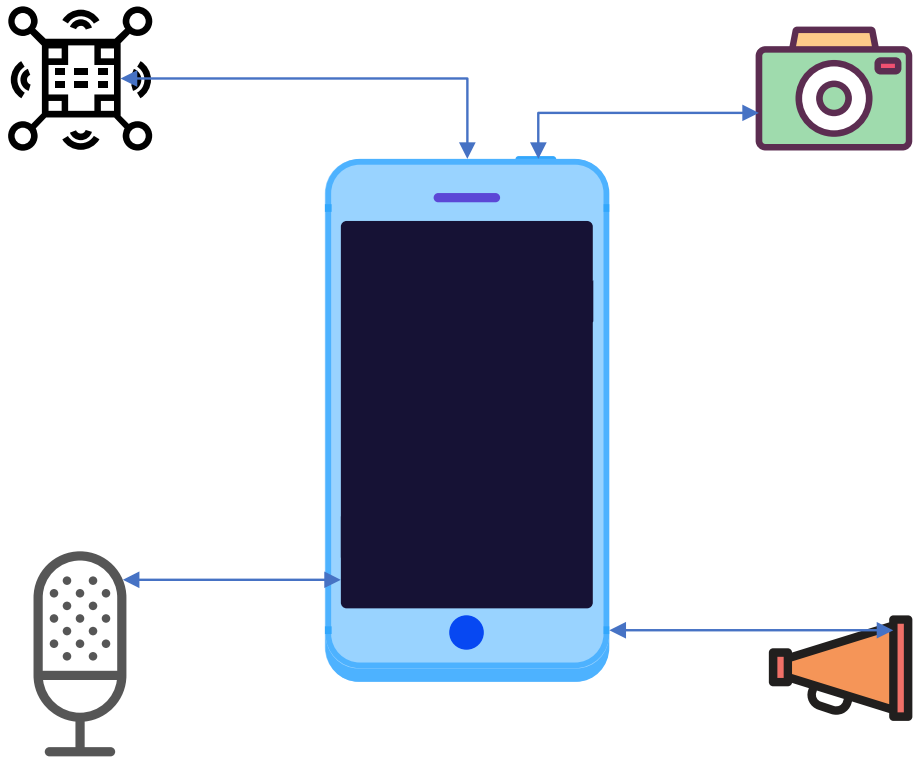


Drivers

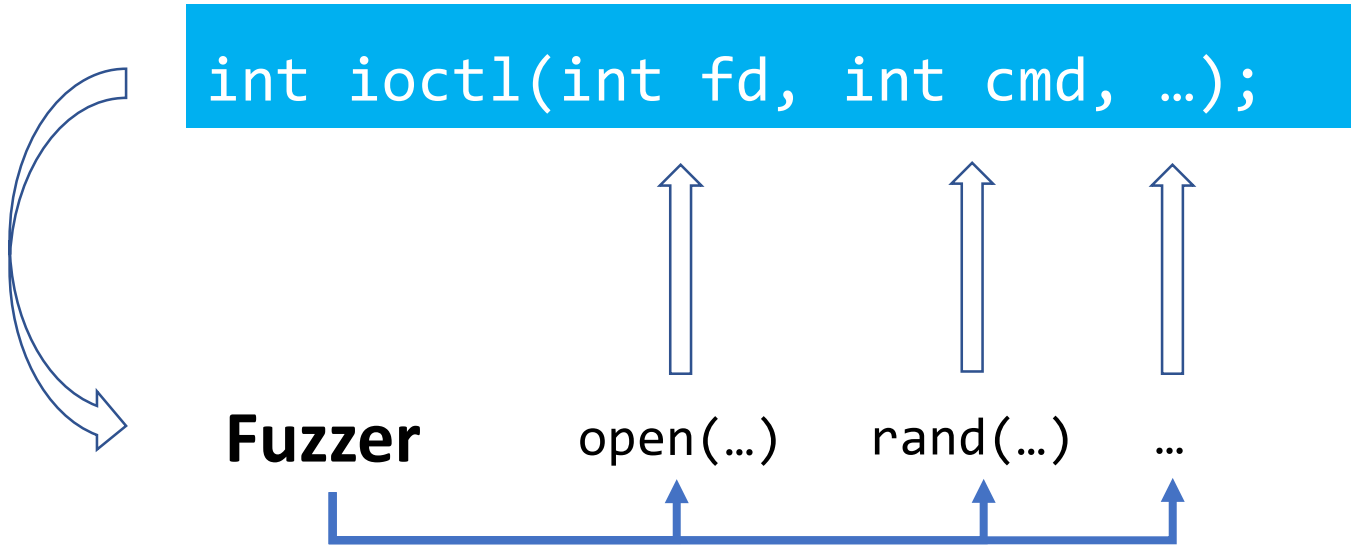
- Part of OS kernel
- Customization
- Monolithic OS

- 80% bugs of Android kernel



POSIX standard

- Portable OS Interface for Computing Systems



Issues

- Complex
- Non-structured
- Non-standard

```
int ioctl(int fd, int cmd, …);
```

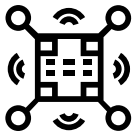
record

setting

```
struct1 {
    ……
};
```

……

```
struct2 {
    ……
};
```



……

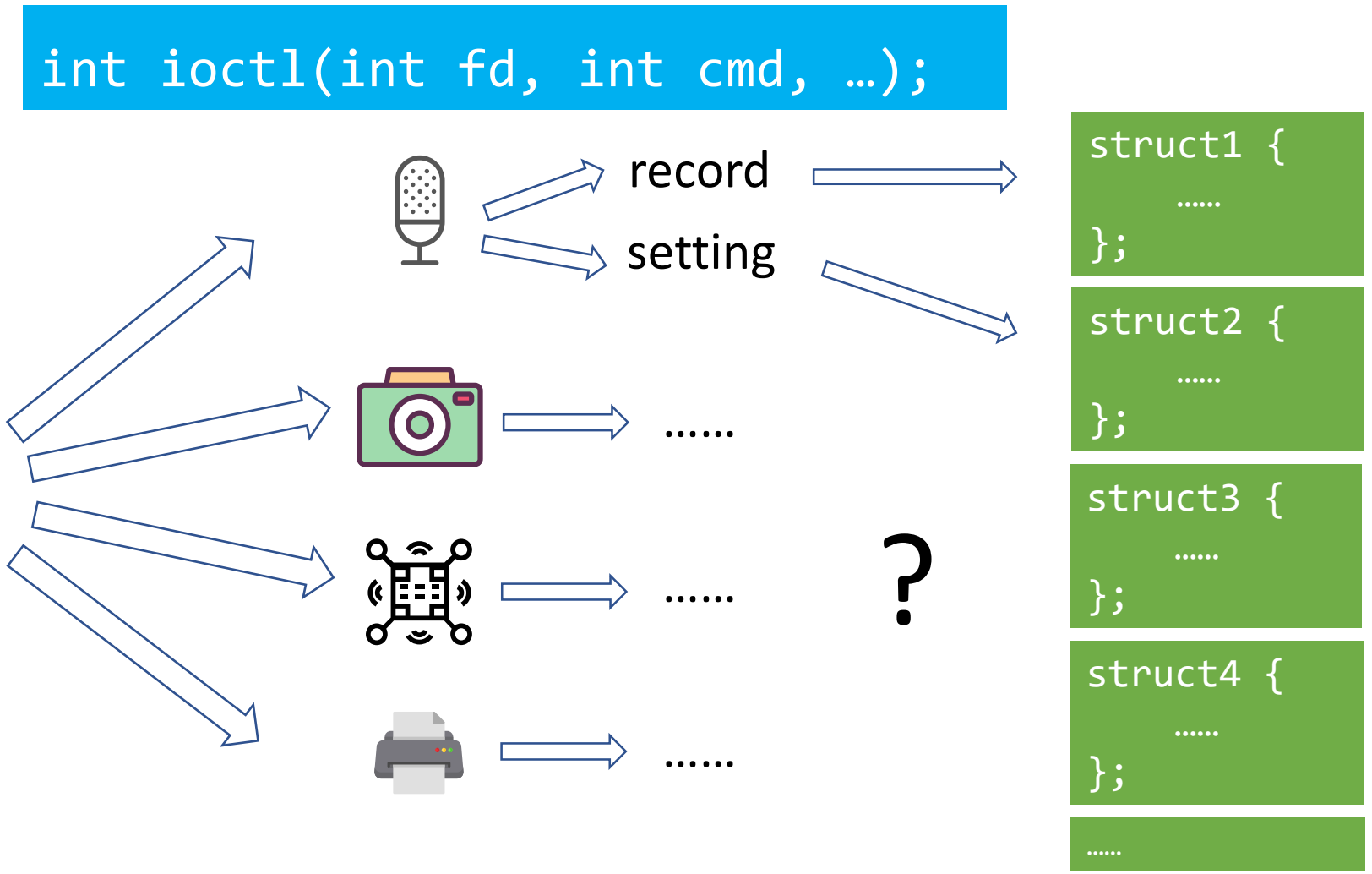
```
struct3 {
    ……
};
```

……

```
struct4 {
    ……
};
```

DIFUZE

Kernel source code

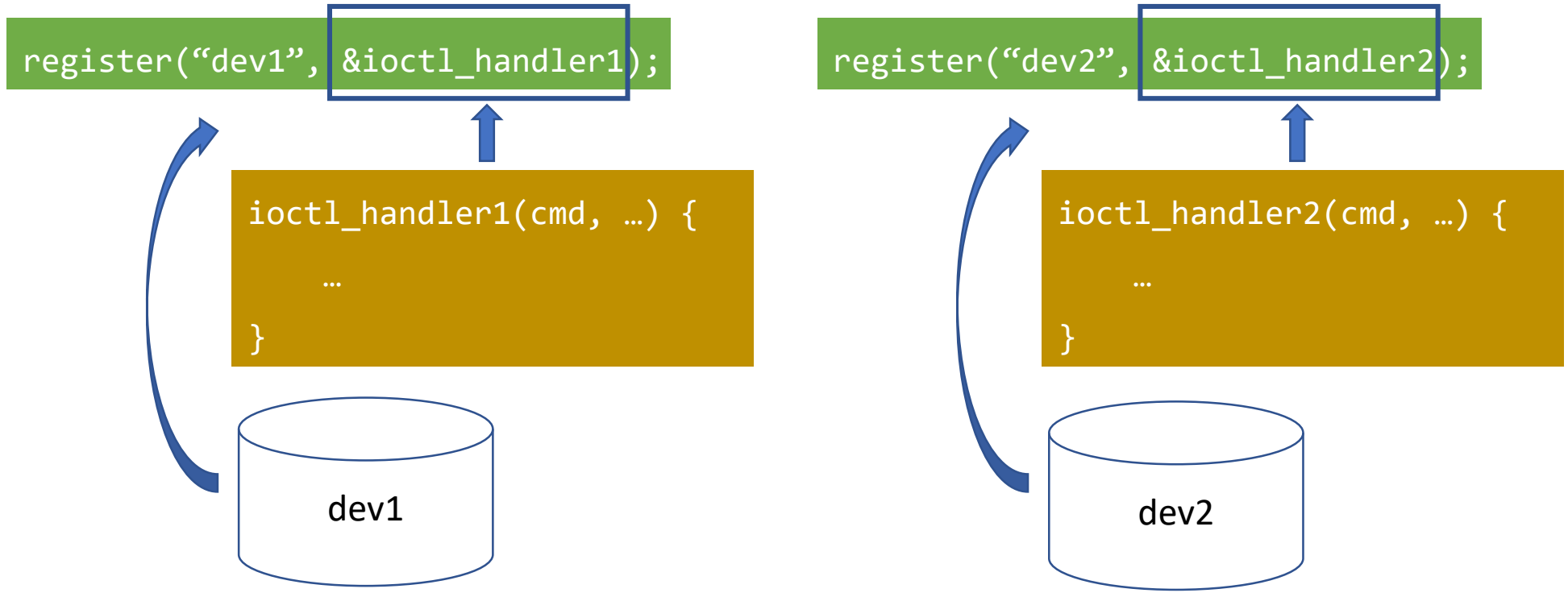


DIFUZE

User Space

```
int ioctl(int fd, int cmd, …);
```

Kernel

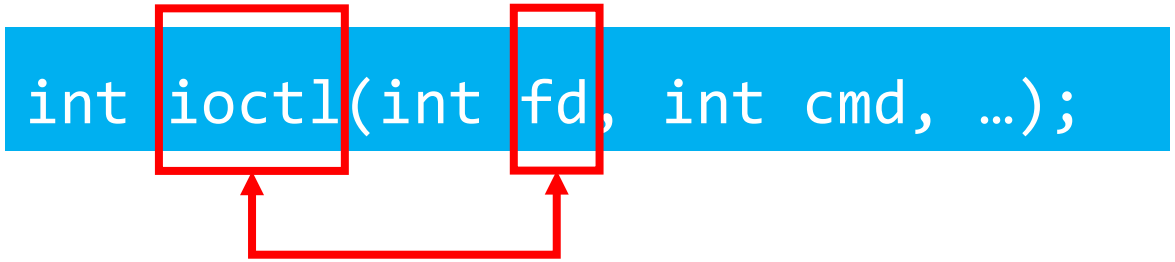


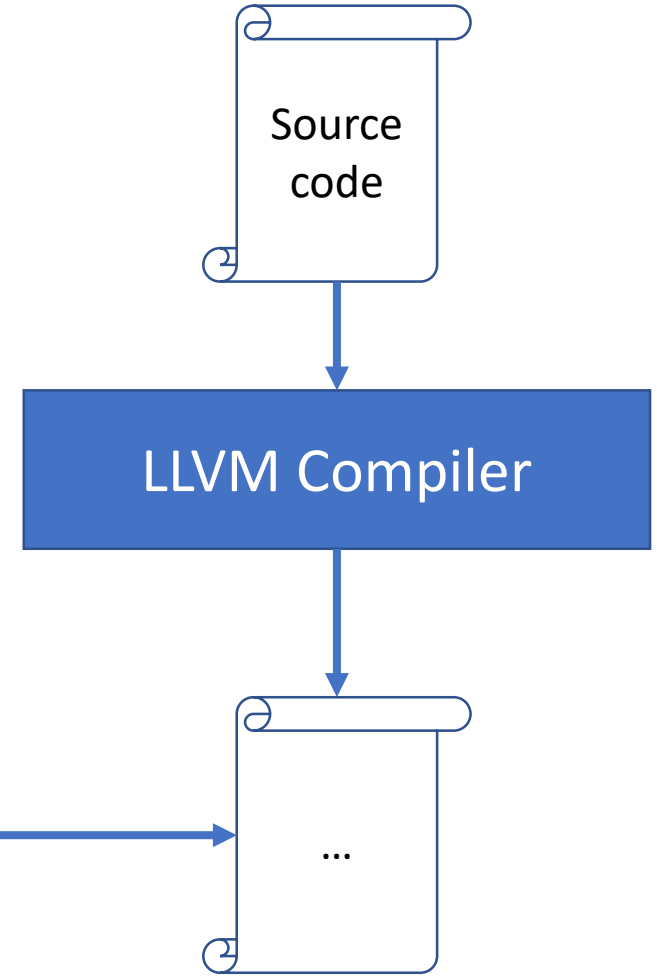
DIFUZE – Handler Identification

```
register("dev1", &ioctl_handler1);
```

- Block device
- Character device
- Proc device
- …

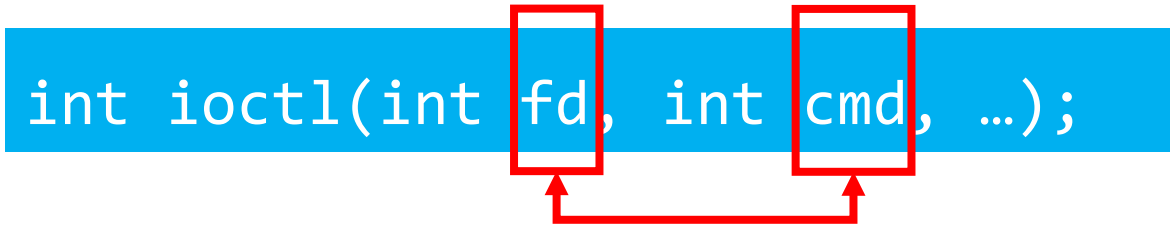
```
int ioctl(int fd, int cmd, …);
```





DIFUZE – Command Determination

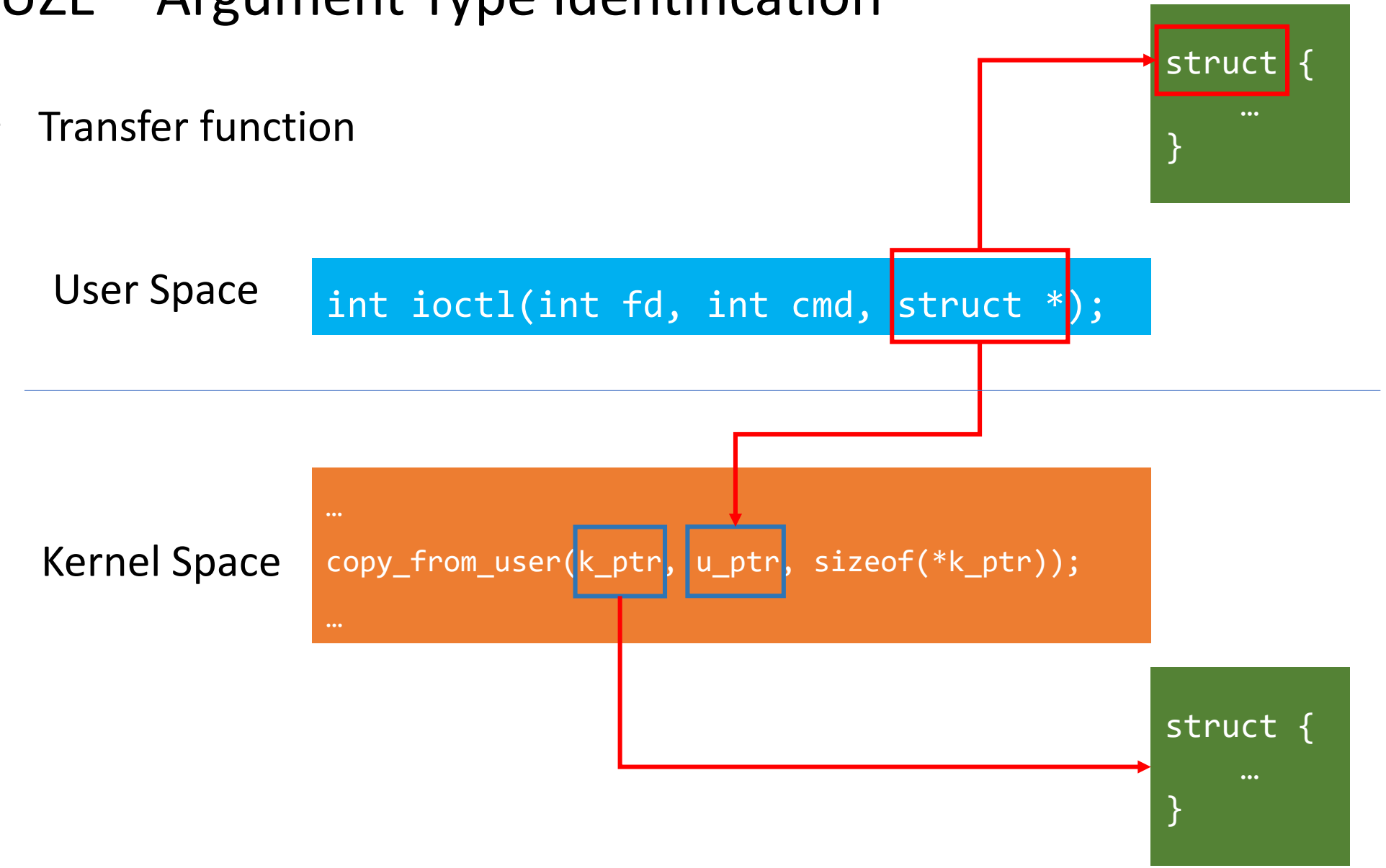
- Equality constraints




```
ioctl_handler(int cmd, …) {
    switch (cmd) {
        case 0x1001:
            …
            if (cmd == 0x1001) {
                …
            }
            …
        case 0x1002:
            …
    }
}
```

DIFUZE – Argument Type Identification

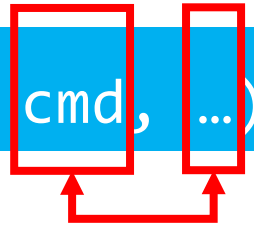
- Transfer function



DIFUZE – Argument Type Identification

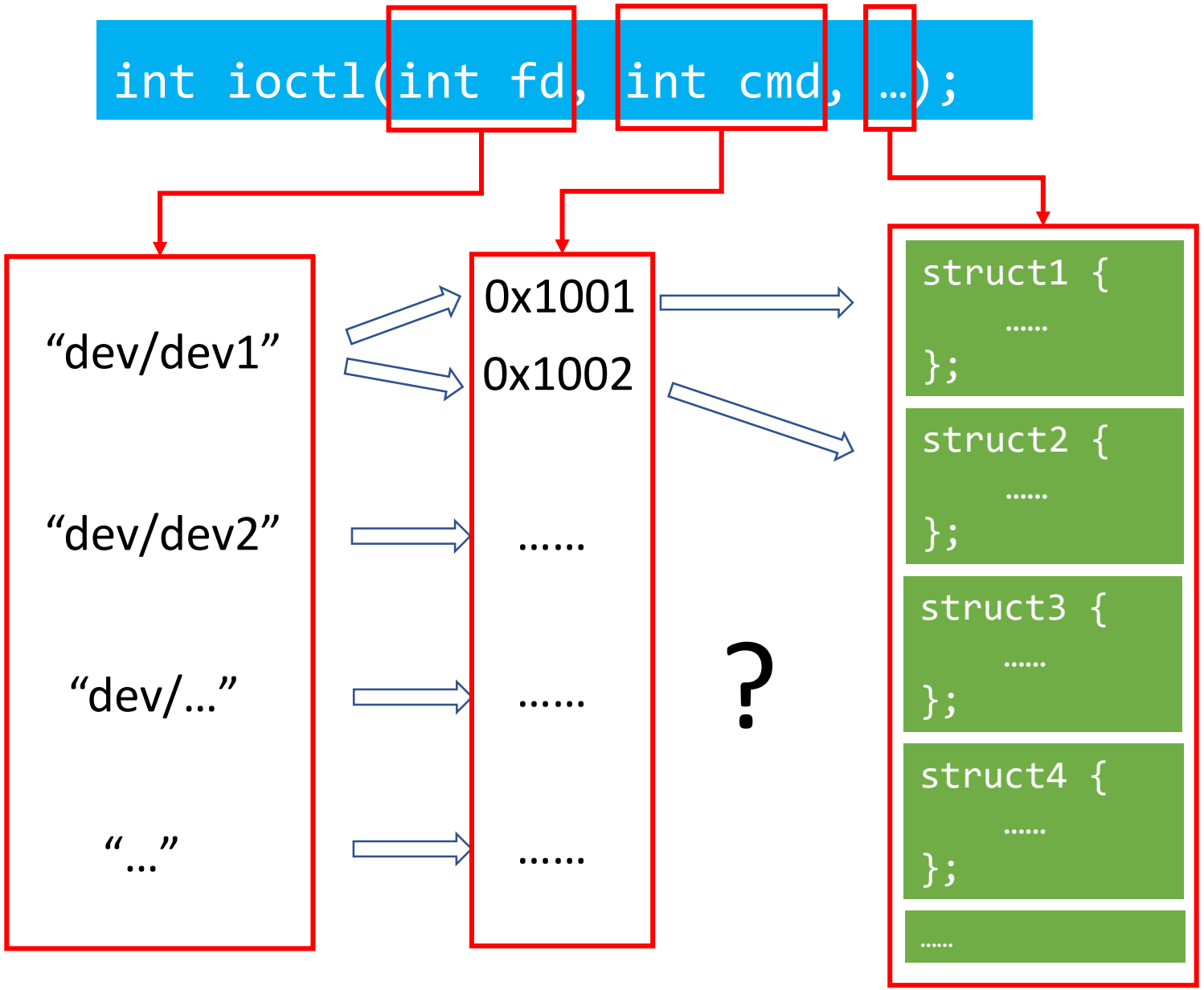
- Equal constraint on the path to transfer function

```
int ioctl(int fd, int cmd, …);
```



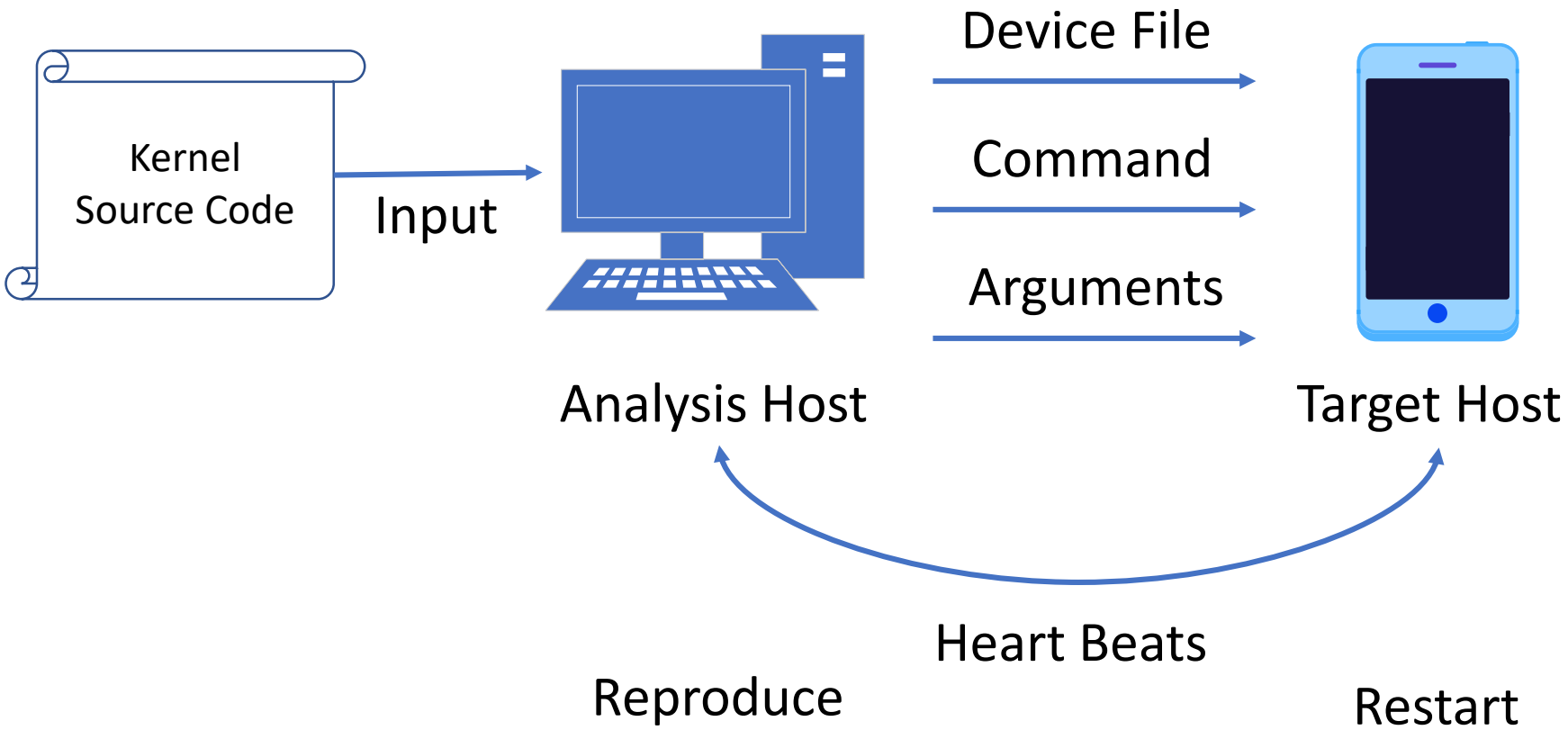
```
ioctl_handler(int cmd, …) {
    switch (cmd) {
        case 0x1001:
            …
            copy_from_user(…);
            …
        case 0x1002:
            …
    }
}
```

DIFUZE


int ioctl(int fd, int cmd, …);
“dev/dev1”
“dev/dev2”
“dev/…”
“…”
0x1001
0x1002
……
……
……
?
struct1 {
……
};
struct2 {
……
};
struct3 {
……
};
struct4 {
……
};
……

DIFUZE

```
int ioctl(int fd, int cmd, …);
```



Results

Syzkaller	DIFUZE
(without interface information)	(interface-aware)
0 bugs	36 bugs

Weaknesses

Dynamically generated device name

```
1   static struct cdev driver_devc;
2   static dev_t client_devt;
3   static struct file_operations driver_ops;
4   __init int driver_init(void)
5   {
6     // request minor number
7     alloc_chrdev_region(&driver_devt, 0, 1, "example_device");
8     // set the ioctl handler for this device
9     driver_ops.unlocked_ioctl = ioctl_handler;
10    cdev_init(&driver_devc, &driver_ops);
11    // register the corresponding device.
12    cdev_add(&driver_devc, MKDEV(MAJOR(driver_devt), 0), 1);
13  }
```

Weaknesses

Dynamically generated device name

```
1    VOS_INT __init RNIC_InitNetCard(VOS_VOID) {
2      ...
3      snprintf(pstDev->name, sizeof(pstDev->name),
4               "%s%s",
5               RNIC_DEV_NAME_PREFIX,
6               g_astRnicManageTbl[ucIndex].pucRnicNetCardName);
7      ...
8    }
```

Weaknesses

Inability to extract complex relationships between fields of structures

```
struct args {
    ……
    char *buffer;
    int buffer_len;
    ……
};
```

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Thanks.