

OS Project 2 Report

第四組

1. 設計：

為了讓 sample code 可以跑，我們就先把 kernel 降到比較低的版本 (3.2.101)，sample code 就可以編譯成功。

設計方法：我們需要實作的是 mmap 的部分，以下分別說明四份程式碼

user_program/master.c:

```
case 'm':
    while (offset < file_size) {
        size_t length = MAP_SIZE;
        if ((file_size - offset) < length) {
            length = file_size - offset;
        }
        file_address = mmap(NULL, length, PROT_READ, MAP_SHARED, file_fd, offset);
        kernel_address = mmap(NULL, length, PROT_WRITE, MAP_SHARED, dev_fd, 0);
        memcpy(kernel_address, file_address, length);
        offset += length;
        ioctl(dev_fd, 0x12345678, length);
        int cnt;
        for(cnt = 0; 4096*cnt < length; cnt++)
            ioctl(dev_fd, 0, file_address + 4096*cnt);
        munmap(file_address, length);
        munmap(kernel_address, length);
    }
    break;
}
```

使用 mmap 以及 memcpy 傳檔案給 master device，並給予每個 Page 的 address

user_program/slave.c:

```
case 'm':
    while (1) {
        ret = ioctl(dev_fd, 0x12345678);
        if (ret == 0) {
            file_size = offset;
            break;
        }
        //fprintf(stderr, "ret = %d\n", ret);
        posix_fallocate(file_fd, offset, ret);
        file_address = mmap(NULL, ret, PROT_WRITE, MAP_SHARED, file_fd, offset);
        kernel_address = mmap(NULL, ret, PROT_READ, MAP_SHARED, dev_fd, offset);
        memcpy(file_address, kernel_address, ret);
        offset += ret;
        int cnt;
        for(cnt = 0; 4096 * cnt < ret; cnt++)
            ioctl(dev_fd, 0, file_address + 4096 * cnt);
        munmap(file_address, ret);
        munmap(kernel_address, ret);
    }
    break;
}
```

slave device 讀到檔案後，slave program 使用 mmap 以及 memcpy 寫到 output file，一樣傳 page 的 address 去 printk

```
master_device/master_device.c:
```

```
case master_IOCTL_MMAP:  
    ksend(sockfd_cli, file->private_data, ioctl_param, 0);  
    break;
```

利用 ksocket 傳送資料

```
slave_device/slave_device.c:
```

```
case slave_IOCTL_MMAP:  
    while (1) {  
        rec_n = krecv(sockfd_cli, buf, sizeof(buf), 0);  
        if (rec_n == 0) {  
            break;  
        }  
        memcpy(file->private_data + offset, buf, rec_n);  
        offset += rec_n;  
        if(offset >= MAP_SIZE){  
            break;  
        }  
    }  
    ret = offset;  
    offset = 0;  
    break;
```

讀取 ksocket 的資料到 buffer · 然後寫到 slave device

2. 執行範例測資的結果

(./test.sh 是一個執行 sample 給的執行範例的執行檔)

Testcase 1 : read/write 平均花大概 1ms · mmap 則不到 0.1ms

```
yeee@yeee-VirtualBox:~/Desktop/OS2018/project2$ sudo ./test.sh 1 f f  
Transmission time: 1.138300 ms, File size: 4 bytes  
Transmission time: 1.294900 ms, File size: 4 bytes  
[ 284.821873] blog: http://sxg.cublog.cn  
[ 285.536956] master has been registered!  
[ 285.536961] sockfd_srv = 0xfffff880114bf1180 socket is created  
[ 286.270194] slave has been registered!  
[ 298.875981] sockfd_cli = 0xfffff880114bf0c80 socket is created  
[ 298.876227] accept sockfd_cli = 0xfffff880114bf1400  
[ 298.876229] got connected from : 127.0.0.1 55778  
[ 298.876254] connected to : 127.0.0.1 2325  
yeee@yeee-VirtualBox:~/Desktop/OS2018/project2$ sudo ./test.sh 1 m m  
Transmission time: 0.033800 ms, File size: 4 bytes  
Transmission time: 0.032900 ms, File size: 4 bytes  
[ 298.876229] got connected from : 127.0.0.1 55778  
[ 298.876254] connected to : 127.0.0.1 2325  
[ 302.837019] sockfd_cli = 0xfffff880114bf1400 socket is created  
[ 302.837053] accept sockfd_cli = 0xfffff880114bf0c80  
[ 302.837055] got connected from : 127.0.0.1 55779  
[ 302.837078] master: 80000000BDA55025  
[ 302.837270] connected to : 127.0.0.1 2325  
[ 302.837301] slave: 80000000BF0AE067
```

Page Description :

```
[ 337.510301] master: 80000000AA9F6025  
[ 337.510654] slave: 80000000B0E4A067
```

Testcase 2 : read/write 花大概 0.1ms · mmap 則一樣不到 0.1ms

```
yeee@yeee-VirtualBox:~/Desktop/052018/project2$ sudo ./test.sh 2 f f  
Transmission time: 0.130800 ms, File size: 577 bytes  
Transmission time: 0.115600 ms, File size: 577 bytes  
[ 302.837055] got connected from : 127.0.0.1 55779  
[ 302.837078] master: 80000000BDA55025  
[ 302.837270] connected to : 127.0.0.1 2325  
[ 302.837301] slave: 80000000BF0AE067  
[ 337.058857] sockfd_cli = 0xffff880036834500 socket is created  
[ 337.058893] accept sockfd_cli = 0xffff880036887b80  
[ 337.058895] got connected from : 127.0.0.1 55780  
[ 337.058950] connected to : 127.0.0.1 2325  
yeee@yeee-VirtualBox:~/Desktop/052018/project2$ sudo ./test.sh 2 m m  
Transmission time: 0.031700 ms, File size: 577 bytes  
Transmission time: 0.028200 ms, File size: 577 bytes  
[ 344.235612] sockfd_cli = 0xffff880036887680 socket is created  
[ 344.235646] accept sockfd_cli = 0xffff880036886c80  
[ 344.235648] got connected from : 127.0.0.1 55781  
[ 344.235672] master: 80000000B6B3A025  
[ 344.235674] master: 80000000B6B97025  
[ 344.235806] connected to : 127.0.0.1 2325  
[ 344.235844] slave: 80000000B7DD5067  
[ 344.235845] slave: 80000000BDA19067
```

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```
[ 1306.214796] master: 80000000AF066025  
[ 1306.214797] master: 80000000A38CA025  
[ 1306.215094] slave: 80000000A5049067  
[ 1306.215096] slave: 80000000B8F77067
```

Testcase 3 : read/write 花大概 1.1ms · mmap 則大約 0.1ms

```
yeee@yeee-VirtualBox:~/Desktop/OS2018/project2$ sudo ./test.sh 3 f f
Transmission time: 1.160700 ms, File size: 9695 bytes
Transmission time: 1.179400 ms, File size: 9695 bytes
[ 344.235674] master: 80000000B6B97025
[ 344.235806] connected to : 127.0.0.1 2325
[ 344.235844] slave: 80000000B7DD5067
[ 344.235845] slave: 80000000BDA19067
[ 358.129017] sockfd_cli = 0xfffff8800b8894280 socket is created
[ 358.129075] accept sockfd_cli = 0xfffff8800b8894000
[ 358.129077] got connected from : 127.0.0.1 55782
[ 358.129119] connected to : 127.0.0.1 2325
yeee@yeee-VirtualBox:~/Desktop/OS2018/project2$ sudo ./test.sh 3 m m
Transmission time: 0.133500 ms, File size: 9695 bytes
Transmission time: 0.081800 ms, File size: 9695 bytes
[ 363.582739] slave: 80000000BDA6E067
[ 363.582740] slave: 80000000BD5A2067
[ 363.582916] slave: 80000000B643F067
[ 363.582919] slave: 80000000BD939067
[ 363.582920] slave: 80000000B68F8067
[ 363.582921] slave: 80000000B68F9067
[ 363.582923] slave: 80000000B667F067
[ 363.582924] slave: 80000000BDA2E067
```

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```
[ 2103.897979] master: 80000000AF68A025
[ 2103.897981] master: 80000000A60E9025
[ 2103.897982] master: 80000000A60E8025
[ 2103.897983] master: 80000000BEDD1025
[ 2103.897984] master: 80000000BEDD0025
[ 2103.897985] master: 80000000A5B13025
[ 2103.897985] master: 80000000A5B12025
[ 2103.897986] master: 80000000A5B15025
[ 2103.897987] master: 80000000A5B14025
[ 2103.897988] master: 80000000BEC45025
[ 2103.897989] master: 80000000BEC44025
[ 2103.897990] master: 80000000BEC55025
[ 2103.897991] master: 80000000BEC54025
[ 2103.897992] master: 80000000BEC63025
[ 2103.897992] master: 80000000BEC62025
[ 2103.897993] master: 80000000BEC91025
[ 2103.897994] master: 80000000BEC90025
[ 2103.897995] master: 80000000B7391025
[ 2103.897996] master: 80000000AF68B025
[ 2103.898221] slave: 80000000AF680067
[ 2103.898223] slave: 80000000AF681067
[ 2103.898223] slave: 80000000AF67A067
[ 2103.898224] slave: 80000000AF67B067
[ 2103.898225] slave: 80000000B9D6C067
[ 2103.898226] slave: 80000000B9D6D067
[ 2103.898227] slave: 80000000B98EA067
[ 2103.898228] slave: 80000000B98EB067
[ 2103.898229] slave: 80000000B7F2A067
[ 2103.898230] slave: 80000000B7F2B067
[ 2103.898231] slave: 80000000B9E96067
[ 2103.898231] slave: 80000000B9E97067
[ 2103.898232] slave: 80000000B9E28067
[ 2103.898233] slave: 80000000B9E29067
[ 2103.898234] slave: 80000000B95C8067
[ 2103.898235] slave: 80000000B95C9067
[ 2103.898236] slave: 80000000B95CE067
[ 2103.898237] slave: 80000000B95CF067
[ 2103.898238] slave: 80000000B97D2067
```

Testcase 4 : read/write 花大概 10ms · mmap 大概 4ms

```
yeee@yeee-VirtualBox:~/Desktop/OS2018/project2$ sudo ./test.sh 4 f f
Transmission time: 9.513700 ms, File size: 1502860 bytes
Transmission time: 10.429400 ms, File size: 1502860 bytes
[ 363.582920] slave: 80000000B68F8067
[ 363.582921] slave: 80000000B68F9067
[ 363.582923] slave: 80000000B667F067
[ 363.582924] slave: 80000000BDA2E067
[ 371.930544] sockfd_cli = 0xfffff880036887900 socket is created
[ 371.930585] accept sockfd_cli = 0xfffff880036886c80
[ 371.930588] got connected from : 127.0.0.1 55784
[ 371.930622] connected to : 127.0.0.1 2325
yeee@yeee-VirtualBox:~/Desktop/OS2018/project2$ sudo ./test.sh 4 m m
Transmission time: 3.131000 ms, File size: 1502860 bytes
Transmission time: 4.703500 ms, File size: 1502860 bytes
[ 378.850571] slave: 80000000B7F8B067
[ 378.850572] slave: 80000000B7F8A067
[ 378.850573] slave: 80000000BBCF0067
[ 378.850574] slave: 80000000BBCF1067
[ 378.850575] slave: 80000000BBCF2067
[ 378.850576] slave: 80000000BBCF3067
[ 378.850577] slave: 80000000BBCF4067
[ 378.850577] slave: 80000000BBCF5067
```

Page Description :

```
[ 1335.873890] slave: 80000000B9C22067
[ 1335.873891] slave: 80000000B9C23067
[ 1335.873893] slave: 80000000B9C24067
[ 1335.873894] slave: 80000000B9C25067
[ 1335.873895] slave: 80000000B9C26067
[ 1335.873897] slave: 80000000B9C27067
[ 1335.874204] slave: 80000000B9C3F067
[ 1335.874206] slave: 80000000B9C40067
[ 1335.874207] slave: 80000000B9C41067
[ 1335.874208] slave: 80000000B9C42067
[ 1335.874210] slave: 80000000B9C43067
[ 1335.874211] slave: 80000000B9C44067
[ 1335.874212] slave: 80000000B9C45067
[ 1335.874214] slave: 80000000B9C46067
[ 1335.874215] slave: 80000000B9C47067
[ 1335.874216] slave: 80000000B9C48067
[ 1335.874217] slave: 80000000B9C49067
[ 1335.874219] slave: 80000000B9C4A067
[ 1335.874220] slave: 80000000B9C4B067
[ 1335.874221] slave: 80000000B9C4C067
[ 1335.874223] slave: 80000000B9C4D067
[ 1335.874224] slave: 80000000B9C4E067
[ 1335.874225] slave: 80000000B9C4F067
[ 1335.874227] slave: 80000000B9C50067
[ 1335.874228] slave: 80000000B9C51067
[ 1335.874229] slave: 80000000B9C52067
[ 1335.874231] slave: 80000000B9C53067
[ 1335.874232] slave: 80000000B9C54067
[ 1335.874233] slave: 80000000B9C55067
[ 1335.874235] slave: 80000000B9C56067
[ 1335.874236] slave: 80000000B9C57067
[ 1335.874237] slave: 80000000B9C58067
[ 1335.874238] slave: 80000000B9C59067
[ 1335.874240] slave: 80000000B9C5A067
[ 1335.874241] slave: 80000000B9C5B067
[ 1335.874242] slave: 80000000B9C5C067
[ 1335.874244] slave: 80000000B9C5D067
[ 1335.874245] slave: 80000000B9C5E067
[ 1335.874246] slave: 80000000B9C5F067
[ 1335.874247] slave: 80000000B9C60067
[ 1335.874249] slave: 80000000B9C61067
[ 1335.874250] slave: 80000000B9C62067
```

3. 比較 file I/O 跟 memory-mapped I/O，並解釋造成差異的原因

理論上，由於 mmap 需要 data copy 的次數少於 fcntl，在面對同樣大小的空間時，mmap 的速度應該遠快於 fcntl。但真實運行程式下，fcntl 的運行速度顯得十分浮動，甚至有小檔案速度慢於大檔案的狀況。我認為這可能是因為我們使用虛擬機、使用降級 kernel 以符合 code 要求環境，而導致的系統不穩。

與此相對，mmap 的運行速度卻是穩定過分了，前三個 test data 的時間差異不大，第四個結果卻只和三號只相差約二十倍。一開始不太理解為何會有這樣的結果，想了一下就大概明白了。我們為了應付相對較大的檔案，將 mmap 一次映射的記憶體大小開到了約 $100*4k$ byte，在前三的 test data 中，我們都會 mmap 相同大小的記憶體，而第四個 data 大小正好是我們開的大小的 30 倍不到，所以會有這樣的時間差距是正常的，也因此在前三 case 中，fcntl 和 mmap 的差距並沒有到理論中那麼大。

4. 各組員貢獻

kernel 編譯：張凱程、張修瑞

資料查詢：梁偉傑、張修瑞、洪敦敏

code 編寫：梁偉傑、張修瑞、洪敦敏、張凱程

report 製作：張凱程、梁偉傑