Assignment-7

Linux System and its Applications

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Assignment-7: Profiling inside the kernel

- **Profile the pxt4 module function**
  1. Find `pxt4_file_write_iter()` in `pxt4/file.c` with cscope
  2. Add calclock at `pxt4_file_write_iter()` to measure the execution time
     - Refer to [Practical Class 7-b]
  3. Printout the profiling result inside `pxt4_exit_fs()` function
  4. Build pxt4 module and mount the testing device with pxt4
     - **Free space** in the device must be larger than **3 * (RAM size)**
  5. Run Fio test with the following condition (next page)
     - Refer to [Practical Class 7-a]
  6. Unmount the device and remove pxt4 module
  7. Use `dmesg` command to check the result

Assignment-7: Profiling inside the kernel

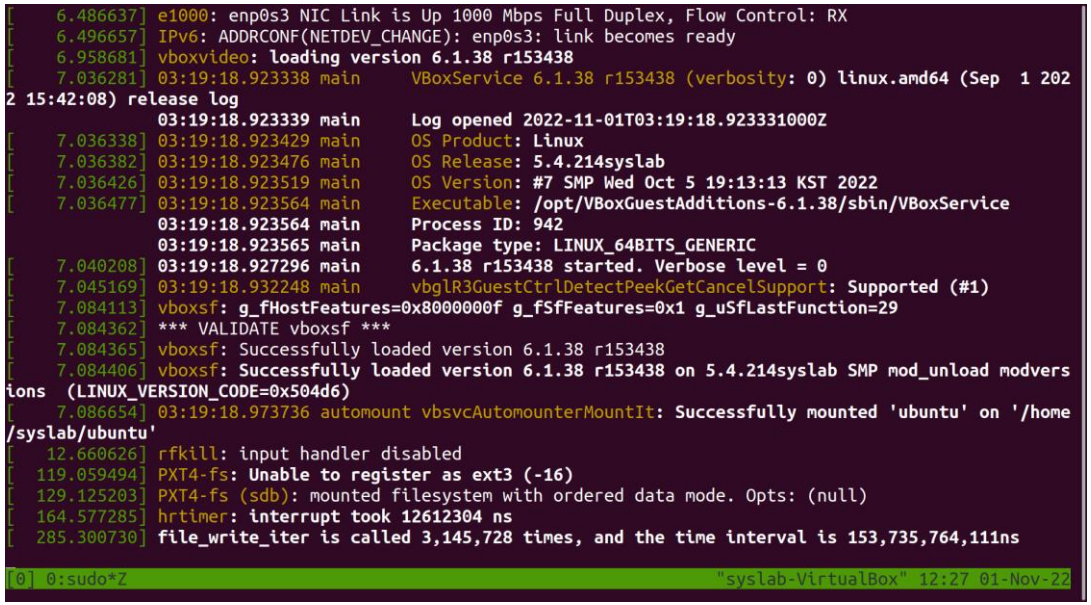
- **Test environment should satisfy the below conditions**
  - Buffered Sequential Write
  - Block Size = 4K
  - Numjobs = machine CPU cores
  - Total size = 3 times larger than your memory size
- Example Fio Script

```
; -- start job file --
[global]
name=<job name>
directory=<pxt4 filesystem mount point (e.g. /mnt/test)>
rw=write
bs=4K
direct=0
numjobs=<number of CPU cores>
verify=meta

[fio-test]
size=<(RAM size) * 3 / (numjobs)>
group_reporting
; -- end job file --
```

Assignment-7: Profiling inside the kernel

- **What to handout**
  - Take a screenshot of
    1. Fio script content used for the test
    2. The profiling result
       - ✓ Example screenshot



- **Submit within pdf format**
  - Make sure to include your name and student id

Tips

- **You can make a wrapper function with calclock**
  1. Add this code to the bottom of `pxt4/file.c`

```
unsigned long long file_write_iter_time, file_write_iter_count;

static ssize_t pxt4_file_write_iter(struct kiocb *iocb, struct iov_iter *from)
{
    ssize_t ret;
    struct timespec myclock[2];

    getrawmonotonic(&myclock[0]);
    ret = pxt4_file_write_iter_internal(iocb, from);
    getrawmonotonic(&myclock[1]);
    calclock(myclock, &file_write_iter_time, &file_write_iter_count);

    return ret;
}
```

  2. Find and rename the **existing** `pxt4_file_write_iter()` into **`pxt4_file_write_iter_internal()`**
  3. Now in the `pxt4/file.c`, there is 1 function named `pxt4_file_write_iter()` and 1 function named `pxt4_file_write_iter_internal()`

Tips

- **You can printout the profiled result when you remove the pxt4 module**

```
extern unsigned long long file_write_iter_time, file_write_iter_count;

static void __exit pxt4_exit_fs(void)
{
    ...
    pxt4_exit_pending();

    printk("pxt4_file_write_iter is called %llu times and the time interval is %llu\n",
        file_write_iter_count, file_write_iter_time);
}
```

Tips

❖ Example test environment

```
syslab@syslab-VirtualBox:~/pxt4$ sudo insmod jbd3/jbd3.ko
[sudo] password for syslab:
syslab@syslab-VirtualBox:~/pxt4$ sudo insmod pxt4.ko
syslab@syslab-VirtualBox:~/pxt4$ sudo mount -t pxt4 /dev/sdb /mnt/test
syslab@syslab-VirtualBox:~/pxt4$ sudo fio seq-write.fio
fio-test: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=psync
, iodepth=1
...
fio-3.16
Starting 4 processes
Jobs: 4 (f=4): [W(4)][24.4%][w=267MiB/s][w=68.5k IOPS][eta 01m:05s]
```

```
                03:19:18.923339 main     Log opened 2022-11-01T03:19:18.923331000Z
[    7.036338] 03:19:18.923429 main     OS Product: Linux
[    7.036382] 03:19:18.923476 main     OS Release: 5.4.214syslab
[    7.036426] 03:19:18.923519 main     OS Version: #7 SMP Wed Oct 5 19:13:13 KST 2022
[    7.036477] 03:19:18.923564 main     Executable: /opt/VBoxGuestAdditions-6.1.38/sbin/VBoxSe
rvice
                03:19:18.923564 main     Process ID: 942
                03:19:18.923565 main     Package type: LINUX_64BITS_GENERIC
[    7.040208] 03:19:18.927296 main     6.1.38 r153438 started. Verbose level = 0
[    7.045169] 03:19:18.932248 main     vbglR3GuestCtrlDetectPeekGetCancelSupport: Supported (
#1)
[    7.084113] vboxsf: g_fHostFeatures=0x8000000f g_fSfFeatures=0x1 g_uSfLastFunction=29
[    7.084362] *** VALIDATE vboxsf ***
[    7.084365] vboxsf: Successfully loaded version 6.1.38 r153438
[    7.084406] vboxsf: Successfully loaded version 6.1.38 r153438 on 5.4.214syslab SMP mod_unl
oad modversions  (LINUX_VERSION_CODE=0x504d6)
[    7.086654] 03:19:18.973736 automount vbsvcAutomounterMountIt: Successfully mounted 'ubuntu
' on '/home/syslab/ubuntu'
[   12.660626] rfkill: input handler disabled
[  119.059494] PXT4-fs: Unable to register as ext3 (-16)
[  129.125203] PXT4-fs (sdb): mounted filesystem with ordered data mode. Opts: (null)
[  164.577285] hrtimer: interrupt took 12612304 ns
```

```
  6   5  85   4   0|    0     0 |   0     0 |   0     0 | 957  1048
 12  32  12  43   0|  628k  285M|   0     0 |   0     0 |2484  8047
  7  19   2  71   0|  408k  404M|   0     0 |   0     0 |1812  4709
  5   9  28  58   0|  272k  335M|   0     0 |   0     0 |1368  2504
 13  25  10  52   0|  432k  352M|   0     0 |   0    36k|2110  5405
  7  11  11  71   0|  236k  342M|   0     0 |  24k   24k|1363  3262
 15  24  19  42   0|  360k  314M|   0     0 |   0    20k|1544  2500
  6  13  16  66   0|  220k  278M|   0     0 |   0  8192B|1310  2654
  8  15  21  55   0|  340k  278M|   0     0 |   0    40k|1581  3281
 10  17  21  53   0|  340k  297M|   0     0 |   0    32k|1425  2766
 24  46   4  26   0|  452k  334M|   0     0 |   0    32k|1953  3899
--total-cpu-usage-- --dsk/sdb-- -net/total- ---paging-- ---system--
usr sys idl wai stl| read  writ| recv  send|  in   out | int   csw
 14  20   4  62   0|  240k  309M|   0     0 |   0    32k|1387  2680
  6  10  27  56   0|  200k  254M|   0     0 |   0    12k|1204  1739
  8  13   9  70   0|  204k  230M|   0     0 |   0    44k|1213  2725
 11  16   7  66   0|  252k  278M|   0     0 |   0    44k|1244  2920
  8  10  21  62   0|  220k  248M|   0     0 |   0    48k| 982  1628
  6  10  17  67   0|  220k  274M|   0     0 |   0    40k|1056  2346
  6   9  30  54   0|  244k  272M|   0     0 |   0    60k|1253  2476
 10  18   4  67   0|  220k  244M|   0     0 |   0    60k|1364  2395
 10  19  10  61   0|  300k  271M|   0     0 |   0    84k|1540  2899
 13  22   1  63   0|  312k  252M|   0     0 |   0   128k|1200  2481
```

```
  1 [||||||||||                          27.9%]   Tasks: 124, 252 thr; 1 running
  2 [||||||||||                          29.6%]   Load average: 1.64 0.50 0.18
  3 [||||||||||||                        35.3%]   Uptime: 00:03:12
  4 [||||||||||                          32.1%]
  Mem[||||||||||||||||||||||||1.33G/3.84G]
  Swp[|                        1.26M/923M]

    PID USER      PRI  NI  VIRT   RES   SHR S CPU% MEM%   TIME+  Command
   1870 root       20   0  765M 41292  1160 D 26.9  1.0  0:03.64 fio seq-write.fio
   1869 root       20   0  768M 45252  1156 D 26.1  1.1  0:03.69 fio seq-write.fio
   1871 root       20   0  765M 42084  1160 D 20.6  1.0  0:03.62 fio seq-write.fio
   1868 root       20   0  769M 46044  1148 D 20.6  1.1  0:03.40 fio seq-write.fio
   1318 syslab     20   0 4930M  388M  118M S  5.5  9.9  0:10.87 /usr/bin/gnome-shell
   1571 syslab     20   0  307M 11316  7852 S  4.8  0.3  0:00.79 /usr/libexec/gvfsd-trash --sp
   1578 syslab     20   0  307M 11316  7852 S  4.0  0.3  0:00.74 /usr/libexec/gvfsd-trash --sp
   1008 syslab     20   0  285M 97692 51116 S  3.2  2.4  0:05.46 /usr/lib/xorg/Xorg vt2 -displ
   1862 root       20   0  793M  415M  411M S  2.4 10.6  0:00.85 fio seq-write.fio
   1709 syslab     20   0  941M 50676 37268 S  1.6  1.3  0:02.50 /usr/libexec/gnome-terminal-s
   1235 syslab     20   0  153M  1440  1068 S  1.6  0.0  0:01.85 /usr/bin/VBoxClient --dragand
   1266 syslab     20   0  153M  1440  1068 S  1.6  0.0  0:01.83 /usr/bin/VBoxClient --dragand
   1335 syslab     20   0 4930M  388M  118M S  0.8  9.9  0:01.07 /usr/bin/gnome-shell
F1Help  F2Setup F3Search F4Filter F5Tree  F6SortBy F7Nice -F8Nice +F9Kill  F10Quit
[0] 0:sudo*                                                  "syslab-VirtualBox" 12:22 01-Nov-22
```