lab8_oom 实验说明

本实验是为了学习 oom killer 机制。

书上说，写一个用户空间的 app 来触发 oom 机制，这个可能不太容易触发 OOM 机制。为此，我们写一个简单的内核驱动来触发，更加直观一些。

基本实验步骤

1. 编译 lab8 的内核模块，并且拷贝到 Qemu 虚拟机里面。
   运行内核模块，过一会就会出现 OOM Kill 的现象了。

```
/mnt # insmod alloc-oom.ko
insmod invoked oom-killer: gfp_mask=0xd0, order=0, oom_score_adj=0
insmod cpuset=/ mems_allowed=0
CPU: 0 PID: 705 Comm: insmod Tainted: G           O    4.0.0+ #2
Hardware name: ARM-Versatile Express
[<c002475c>] (unwind_backtrace) from [<c001d640>] (show_stack+0x2c/0x38)
[<c001d640>] (show_stack) from [<c05956e4>] (__dump_stack+0x1c/0x24)
[<c05956e4>] (__dump_stack) from [<c05957bc>] (dump_stack+0xd0/0xf8)
[<c05957bc>] (dump_stack) from [<c01a81b4>] (dump_header+0x104/0x158)
[<c01a81b4>] (dump_header) from [<c01a87a4>] (oom_kill_process+0x208/0xa48)
[<c01a87a4>] (oom_kill_process) from [<c01a99a8>] (__out_of_memory+0x410/0x43c)
[<c01a99a8>] (__out_of_memory) from [<c01a9a38>] (out_of_memory+0x64/0x88)
[<c01a9a38>] (out_of_memory) from [<c01b08b4>] (__alloc_pages_nodemask+0xed8/0x1208)
[<c01b08b4>] (__alloc_pages_nodemask) from [<bf00209c>] (my_init+0x9c/0xf0 [alloc_oom])
[<bf00209c>] (my_init [alloc_oom]) from [<c0008dc8>] (do_one_initcall+0x68/0x190)
[<c0008dc8>] (do_one_initcall) from [<c0119af8>] (do_init_module+0xb4/0x278)
[<c0119af8>] (do_init_module) from [<c011a4ac>] (load_module+0x3ec/0x570)
[<c011a4ac>] (load_module) from [<c011a6d8>] (SyS_init_module+0xa8/0xc0)
[<c011a6d8>] (SyS_init_module) from [<c0014d40>] (ret_fast_syscall+0x0/0x34)
Mem-info:
Normal per-cpu:
CPU    0: hi:  186, btch:  31 usd:  69
CPU    1: hi:  186, btch:  31 usd: 160
CPU    2: hi:  186, btch:  31 usd:  10
CPU    3: hi:  186, btch:  31 usd: 154
```

进阶思考

本实验重点是希望读者可以对照代码来分析 oom killer 的 log。

比如：

```
/mnt # insmod alloc-oom.ko
insmod invoked oom-killer: gfp_mask=0xd0, order=0, oom_score_adj=0
insmod cpuset=/ mems_allowed=0
```

这句话是在 oom_kill_process()->dump_header()函数里打印出来的，告诉你那个进程触发的这次 oom killer，这里显示是 insmod 进程，它在分配多少的物理页面的时候触发的，分配的掩码是啥，当时的 oom_score_adj 的值是啥。

接下来。

```
CPU: 0 PID: 705 Comm: insmod Tainted: G           O    4.0.0+ #2
Hardware name: ARM-Versatile Express
[<c002475c>] (unwind_backtrace) from [<c001d640>] (show_stack+0x2c/0x38)
[<c001d640>] (show_stack) from [<c05956e4>] (__dump_stack+0x1c/0x24)
[<c05956e4>] (__dump_stack) from [<c05957bc>] (dump_stack+0xd0/0xf8)
[<c05957bc>] (dump_stack) from [<c01a81b4>] (dump_header+0x104/0x158)
[<c01a81b4>] (dump_header) from [<c01a87a4>] (oom_kill_process+0x208/0xa48)
[<c01a87a4>] (oom_kill_process) from [<c01a99a8>] (__out_of_memory+0x410/0x43c)
[<c01a99a8>] (__out_of_memory) from [<c01a9a38>] (out_of_memory+0x64/0x88)
[<c01a9a38>] (out_of_memory) from [<c01b08b4>] (__alloc_pages_nodemask+0xed8/0x1208)
[<c01b08b4>] (__alloc_pages_nodemask) from [<bf00209c>] (my_init+0x9c/0xf0 [alloc_oom]
[<bf00209c>] (my_init [alloc_oom]) from [<c0008dc8>] (do_one_initcall+0x68/0x190)
[<c0008dc8>] (do_one_initcall) from [<c0119af8>] (do_init_module+0xb4/0x278)
[<c0119af8>] (do_init_module) from [<c011a4ac>] (load_module+0x3ec/0x570)
[<c011a4ac>] (load_module) from [<c011a6d8>] (SyS_init_module+0xa8/0xc0)
[<c011a6d8>] (SyS_init_module) from [<c0014d40>] (ret_fast_syscall+0x0/0x34)
```

这是在 oom_kill_process()->dump_header()->dump_stack()函数里打印的，这也是打印触发这次 oom killer 的函数调用栈的关系。

接下来：

```
Mem-info:
Normal per-cpu:
CPU    0: hi:  186, btch:  31 usd:  69
CPU    1: hi:  186, btch:  31 usd: 160
CPU    2: hi:  186, btch:  31 usd:  10
CPU    3: hi:  186, btch:  31 usd: 154
HighMem per-cpu:
CPU    0: hi:   90, btch:  15 usd:  15
CPU    1: hi:   90, btch:  15 usd:  27
CPU    2: hi:   90, btch:  15 usd:   4
CPU    3: hi:   90, btch:  15 usd:   8
active_anon:559 inactive_anon:1065 isolated_anon:0
 active_file:0 inactive_file:0 isolated_file:0
 unevictable:0 dirty:0 writeback:0 unstable:0
 free:66636 slab_reclaimable:584 slab_unreclaimable:986
 mapped:343 shmem:1596 pagetables:10 bounce:0
 free_cma:0
Normal free:3348kB min:3468kB low:4332kB high:5200kB active_anon:92kB inactive_anon:0kB active_file:0kB inactiv
e_file:0kB unevictable:0kB isolated(anon):0kB isolated(file):0kB present:778240kB managed:755144kB mlocked:0kB
dirty:0kB writeback:0kB mapped:0kB shmem:4kB slab_reclaimable:2336kB slab_unreclaimable:3944kB kernel_stack:384
kB pagetables:40kB unstable:0kB bounce:0kB free_cma:0kB writeback_tmp:0kB pages_scanned:0 all_unreclaimable? ye
s
lowmem_reserve[]: 0 2112 2112
HighMem free:263196kB min:264kB low:572kB high:884kB active_anon:2144kB inactive_anon:4260kB active_file:0kB in
active_file:0kB unevictable:0kB isolated(anon):0kB isolated(file):0kB present:270336kB managed:270336kB mlocked
:0kB dirty:0kB writeback:0kB mapped:1372kB shmem:6380kB slab_reclaimable:0kB slab_unreclaimable:0kB kernel_stac
k:0kB pagetables:0kB unstable:0kB bounce:0kB free_cma:0kB writeback_tmp:0kB pages_scanned:0 all_unreclaimable?
yes
lowmem_reserve[]: 0 0 0
Normal: 1*4kB (R) 0*8kB 1*16kB (R) 0*32kB 0*64kB 0*128kB 1*256kB (R) 0*512kB 1*1024kB (R) 1*2048kB (R) 0*4096kB
 = 3348kB
HighMem: 1*4kB (U) 1*8kB (M) 1*16kB (M) 2*32kB (UM) 1*64kB (U) 1*128kB (U) 1*256kB (U) 1*512kB (M) 2*1024kB (UM
) 1*2048kB (U) 63*4096kB (MR) = 263196kB
1596 total pagecache pages
0 pages in swap cache
Swap cache stats: add 0, delete 0, find 0/0
Free swap  = 0kB
Total swap = 0kB
262144 pages of RAM
67147 free pages
5774 reserved pages
881 slab pages
852 pages shared
0 pages swap cached
```

这么一大段都是在 oom_kill_process()->dump_header()->show_mem ()函数里打印的，告诉你现在触发 oom killer 的那个时刻，系统所有的内存系统，包括有多少匿名页面，多少 page cache 等等。

```
[ pid ]   uid  tgid total_vm      rss nr_ptes nr_pmds swapents oom_score_adj name
[  702]     0   702      577        1       3       0        0             0 sh
[  705]     0   705      577        1       3       0        0             0 insmod
```

这里是在 oom_kill_process()->dump_header()->dump_tasks ()函数里打印的，列举出有可能被杀的进程。

```
Out of memory: Kill process 702 (sh) score 0 or sacrifice child
Killed process 705 (insmod) total-vm:2308kB, anon-rss:4kB, file-rss:0kB
```

这里是在 oom_kill_process()函数打印的，告诉你，我现在选择 705 进程来杀了，痛快！

接下来：

```
insmod: page allocation failure: order:0, mode:0xd0
CPU: 0 PID: 705 Comm: insmod Tainted: G           O    4.0.0+ #2
Hardware name: ARM-Versatile Express
[<c002475c>] (unwind_backtrace) from [<c001d640>] (show_stack+0x2c/0x38)
[<c001d640>] (show_stack) from [<c05956e4>] (__dump_stack+0x1c/0x24)
[<c05956e4>] (__dump_stack) from [<c05957bc>] (dump_stack+0xd0/0xf8)
[<c05957bc>] (dump_stack) from [<c01af0f0>] (warn_alloc_failed+0x1a8/0x1e4)
[<c01af0f0>] (warn_alloc_failed) from [<c01b0a34>] (__alloc_pages_nodemask+0x1058/0x1208)
[<c01b0a34>] (__alloc_pages_nodemask) from [<bf00209c>] (my_init+0x9c/0xf0 [alloc_oom])
[<bf00209c>] (my_init [alloc_oom]) from [<c0008dc8>] (do_one_initcall+0x68/0x190)
[<c0008dc8>] (do_one_initcall) from [<c0119af8>] (do_init_module+0xb4/0x278)
[<c0119af8>] (do_init_module) from [<c011a4ac>] (load_module+0x3ec/0x570)
[<c011a4ac>] (load_module) from [<c011a6d8>] (SyS_init_module+0xa8/0xc0)
[<c011a6d8>] (SyS_init_module) from [<c0014d40>] (ret_fast_syscall+0x0/0x34)
```

杀完之后，insmod 进程有发现分配内存失败了，又继续重复刚才的故事。。。

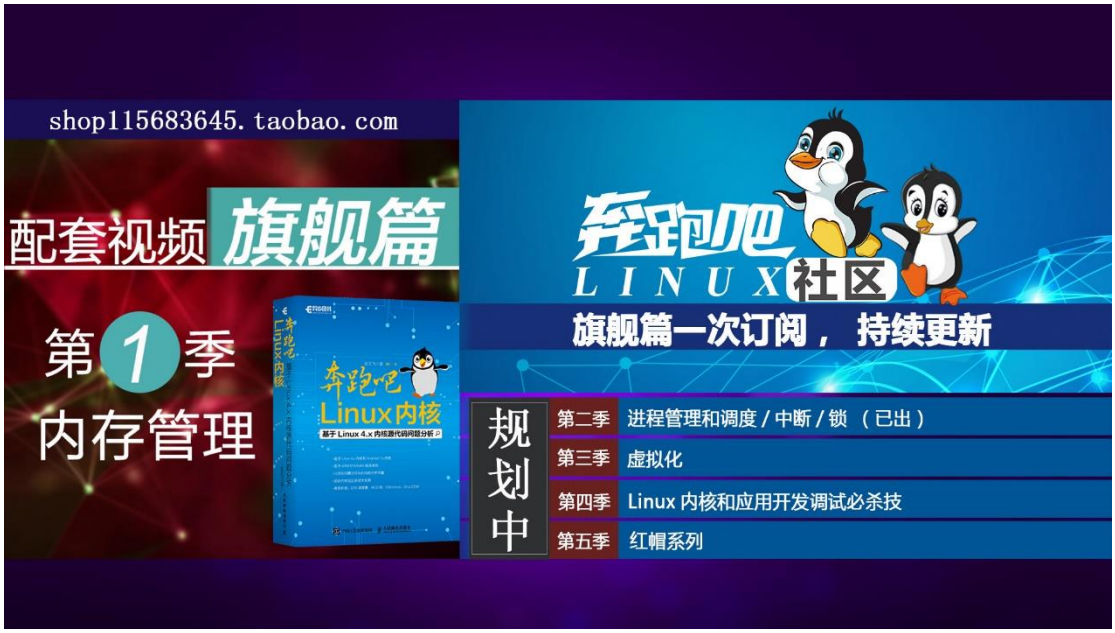
进阶思考：

我们从 log 里看到：

```
Swap cache stats: add 0, delete 0, find 0/0
Free swap  = 0kB
Total swap = 0kB
262144 pages of RAM
67147 free pages
5774 reserved pages
881 slab pages
852 pages shared
0 pages swap cached
```

系统明明空闲页面还有 67147 个，为啥我分配一个页面都会让失败呢？

笨叔在这里没有太详细解析每个参数，如果大家对这个问题感兴趣，可以关注笨叔的第一季旗舰篇视频，笨叔会在视频中和大家详细解答。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