

Linux Kernel Module for Listing Tasks

- In this project, you will write a kernel module that **lists all current tasks** in a Linux system.

Part I—Iterating over Tasks Linearly

- Design a kernel module that iterates through all tasks in the system using the **for_each_process()** macro(in <linux/sched/signal.h>).
- In particular, output the **process id**, **task name** (known as ***executable name***), and **state** of each task.
- You will probably have to read through the **task_struct** structure in <linux/sched.h> to obtain the names of these fields.
- Write this code in the module entry point so that its contents will appear in the **kernel log buffer**, which can be viewed using the **dmesg** command.

pj@pj-VirtualBox: ~

```
[ 6560.092193] Module removed.
[ 6698.111220] yoooooooo
[ 6698.111224] pid: 1 |pname: systemd |state: 1
[ 6698.111226] pid: 2 |pname: kthreadd |state: 1
[ 6698.111228] pid: 4 |pname: kworker/0:0H |state: 1026
[ 6698.111229] pid: 6 |pname: mm_percpu_wq |state: 1026
[ 6698.111231] pid: 7 |pname: ksoftirqd/0 |state: 1
[ 6698.111232] pid: 8 |pname: rcu_sched |state: 1026
[ 6698.111234] pid: 9 |pname: rcu_bh |state: 1026
[ 6698.111236] pid: 10 |pname: migration/0 |state: 1
[ 6698.111237] pid: 11 |pname: watchdog/0 |state: 1
[ 6698.111239] pid: 12 |pname: cpuhp/0 |state: 1
[ 6698.111241] pid: 13 |pname: kdevtmpfs |state: 1
[ 6698.111242] pid: 14 |pname: netns |state: 1026
[ 6698.111244] pid: 15 |pname: rcu_tasks_kthre |state: 1
[ 6698.111246] pid: 16 |pname: kauditd |state: 1
[ 6698.111247] pid: 17 |pname: khungtaskd |state: 1
[ 6698.111249] pid: 18 |pname: oom_reaper |state: 1
[ 6698.111251] pid: 19 |pname: writeback |state: 1026
[ 6698.111252] pid: 20 |pname: kcompactd0 |state: 1
[ 6698.111254] pid: 21 |pname: ksmd |state: 1
[ 6698.111256] pid: 22 |pname: khugepaged |state: 1
[ 6698.111257] pid: 23 |pname: crypto |state: 1026
[ 6698.111259] pid: 24 |pname: kintegrityd |state: 1026
[ 6698.111261] pid: 25 |pname: kblockd |state: 1026
[ 6698.111263] pid: 26 |pname: ata_sff |state: 1026
[ 6698.111264] pid: 27 |pname: md |state: 1026
[ 6698.111266] pid: 28 |pname: edac-poller |state: 1026
[ 6698.111268] pid: 29 |pname: devfreq_wq |state: 1026
[ 6698.111269] pid: 30 |pname: watchdogd |state: 1026
[ 6698.111271] pid: 34 |pname: kswapd0 |state: 1
[ 6698.111273] pid: 35 |pname: ecryptfs-kthrea |state: 1
[ 6698.111275] pid: 77 |pname: kthrotld |state: 1026
[ 6698.111276] pid: 78 |pname: acpi_thermal_pm |state: 1026
[ 6698.111278] pid: 79 |pname: scsi_eh_0 |state: 1
[ 6698.111280] pid: 80 |pname: scsi_tm_f_0 |state: 1026
[ 6698.111281] pid: 81 |pname: scsi_eh_1 |state: 1
[ 6698.111283] pid: 82 |pname: scsi_tm_f_1 |state: 1026
[ 6698.111285] pid: 88 |pname: ipv6_addrconf |state: 1026
[ 6698.111287] pid: 97 |pname: kstrp |state: 1026
[ 6698.111288] pid: 114 |pname: charger_manager |state: 1026
[ 6698.111290] pid: 154 |pname: kworker/0:1H |state: 1026
[ 6698.111292] pid: 155 |pname: scsi_eh_2 |state: 1
[ 6698.111293] pid: 156 |pname: scsi_tm_f_2 |state: 1026
[ 6698.111295] pid: 180 |pname: jbd2/sda1-8 |state: 1
[ 6698.111297] pid: 181 |pname: ext4-rsv-conver |state: 1026
[ 6698.111299] pid: 216 |pname: systemd-journal |state: 1
[ 6698.111300] pid: 248 |pname: systemd-udev |state: 1
[ 6698.111302] pid: 290 |pname: systemd-timesyn |state: 1
[ 6698.111304] pid: 307 |pname: iprt-VBoxWQueue |state: 1026
[ 6698.111305] pid: 324 |pname: ttm_swap |state: 1026
[ 6698.111307] pid: 584 |pname: rsyslogd |state: 1
[ 6698.111309] pid: 588 |pname: accounts-daemon |state: 1
[ 6698.111310] pid: 600 |pname: snapd |state: 1
[ 6698.111312] pid: 601 |pname: systemd-logind |state: 1
```

- To verify that your code is working correctly, compare the contents of the kernel log buffer with the output of the following command, which lists all tasks in the system: ***ps -el***
- The two values should be very similar. Because tasks are dynamic, however, it is possible that a few tasks may appear in one listing but not the other.

Part II—Iterating over Tasks with a DepthFirst Search Tree

- The second portion of this project involves iterating over all tasks in the system using a **depth-first search** (DFS) tree.

- Examining the task struct in <linux/sched.h>, we see two struct list head objects: **children** and **sibling**.
- These objects are pointers to a list of the task's children, as well as its siblings.
- Beginning from the init_task, design a kernel module that iterates over all tasks in the system using a DFS tree.
- Just as in the first part of this project, output the pid, name, and state of each task.
- Perform this iteration in the kernel entry module so that its output appears in the kernel log buffer.

pj@pj-VirtualBox: ~

```
[ 5699.802548] Loading module...
[ 5699.802551] pid: 1 | pname: systemd | state: 1
[ 5699.802553] pid: 216 | pname: systemd-journal | state: 1
[ 5699.802555] pid: 248 | pname: systemd-udev | state: 1
[ 5699.802556] pid: 290 | pname: systemd-timesyn | state: 1
[ 5699.802558] pid: 584 | pname: rsyslogd | state: 1
[ 5699.802560] pid: 588 | pname: accounts-daemon | state: 1
[ 5699.802562] pid: 600 | pname: snapd | state: 1
[ 5699.802563] pid: 601 | pname: systemd-logind | state: 1
[ 5699.802565] pid: 604 | pname: acpid | state: 1
[ 5699.802567] pid: 608 | pname: avahi-daemon | state: 1
[ 5699.802569] pid: 663 | pname: avahi-daemon | state: 1
[ 5699.802570] pid: 614 | pname: cron | state: 1
[ 5699.802572] pid: 627 | pname: dbus-daemon | state: 1
[ 5699.802574] pid: 684 | pname: NetworkManager | state: 1
[ 5699.802576] pid: 816 | pname: dnsmasq | state: 1
[ 5699.802577] pid: 4899 | pname: dhclient | state: 1
[ 5699.802579] pid: 765 | pname: polkitd | state: 1
[ 5699.802581] pid: 778 | pname: lightdm | state: 1
[ 5699.802582] pid: 792 | pname: Xorg | state: 1
[ 5699.802584] pid: 1015 | pname: lightdm | state: 1
[ 5699.802586] pid: 1225 | pname: upstart | state: 1
[ 5699.802588] pid: 1308 | pname: upstart-udev-br | state: 1
[ 5699.802589] pid: 1312 | pname: dbus-daemon | state: 1
[ 5699.802591] pid: 1324 | pname: window-stack-br | state: 1
[ 5699.802592] pid: 1351 | pname: upstart-dbus-br | state: 1
[ 5699.802594] pid: 1356 | pname: upstart-dbus-br | state: 1
[ 5699.802596] pid: 1360 | pname: upstart-file-br | state: 1
[ 5699.802598] pid: 1372 | pname: bamfd daemon | state: 1
[ 5699.802599] pid: 1374 | pname: ibus-daemon | state: 1
[ 5699.802601] pid: 1390 | pname: ibus-dconf | state: 1
[ 5699.802603] pid: 1393 | pname: ibus-ui-gtk3 | state: 1
[ 5699.802604] pid: 1426 | pname: ibus-engine-sim | state: 1
[ 5699.802606] pid: 1383 | pname: gvfsd | state: 1
[ 5699.802608] pid: 1388 | pname: gvfsd-fuse | state: 1
[ 5699.802609] pid: 1401 | pname: ibus-x11 | state: 1
[ 5699.802611] pid: 1406 | pname: at-spi-bus-laun | state: 1
[ 5699.802613] pid: 1412 | pname: dbus-daemon | state: 1
[ 5699.802614] pid: 1416 | pname: at-spi2-registr | state: 1
[ 5699.802616] pid: 1433 | pname: gpg-agent | state: 1
[ 5699.802618] pid: 1443 | pname: hud-service | state: 1
[ 5699.802619] pid: 1445 | pname: unity-settings- | state: 1
[ 5699.802621] pid: 1461 | pname: gnome-session-b | state: 1
[ 5699.802623] pid: 1633 | pname: polkit-gnome-au | state: 1
[ 5699.802625] pid: 1641 | pname: nm-applet | state: 1
[ 5699.802627] pid: 1643 | pname: gnome-software | state: 1
[ 5699.802628] pid: 1644 | pname: nautilus | state: 1
[ 5699.802630] pid: 1649 | pname: unity-fallback- | state: 1
[ 5699.802632] pid: 1800 | pname: zeitgeist-datah | state: 1
[ 5699.802633] pid: 1848 | pname: update-notifier | state: 1
[ 5699.802635] pid: 2001 | pname: deja-dup-monito | state: 1
[ 5699.802637] pid: 1469 | pname: unity-panel-ser | state: 1
[ 5699.802638] pid: 1501 | pname: indicator-messa | state: 1
[ 5699.802640] pid: 1504 | pname: indicator-bluet | state: 1
[ 5699.802642] pid: 1508 | pname: indicator-power | state: 1
```

- To check the output of the DFS tree, use the command ***ps -el***


```
[ 6526.765396] DFS Starting...
[ 6526.765398] pid: 0 name: swapper/0          state: 0
[ 6526.765399] pid: 1 name: systemd                state: 1
[ 6526.765401] pid: 216 name: systemd-journal        state: 1
[ 6526.765403] pid: 247 name: systemd-udev          state: 1
[ 6526.765405] pid: 644 name: rsyslogd              state: 1
[ 6526.765406] pid: 645 name: dbus-daemon           state: 1
[ 6526.765408] pid: 649 name: NetworkManager        state: 1
[ 6526.765409] pid: 805 name: dnsmasq               state: 1
[ 6526.765411] pid: 4874 name: dhclient             state: 1
[ 6526.765413] pid: 650 name: avahi-daemon          state: 1
[ 6526.765414] pid: 666 name: avahi-daemon          state: 1
[ 6526.765416] pid: 654 name: cron                  state: 1
[ 6526.765418] pid: 671 name: systemd-logind         state: 1
[ 6526.765419] pid: 683 name: accounts-daemon        state: 1
[ 6526.765421] pid: 696 name: acpid                state: 1
[ 6526.765422] pid: 759 name: polkitd           state: 1
[ 6526.765424] pid: 875 name: whoopsie           state: 1
[ 6526.765426] pid: 1044 name: VBoxClient        state: 1
[ 6526.765427] pid: 1046 name: VBoxClient        state: 1
[ 6526.765429] pid: 1061 name: lightdm             state: 1
[ 6526.765431] pid: 1088 name: Xorg              state: 0
[ 6526.765432] pid: 1164 name: lightdm             state: 1
[ 6526.765434] pid: 1291 name: upstart            state: 1
[ 6526.765435] pid: 1437 name: upstart-udev-br        state: 1
[ 6526.765437] pid: 1448 name: dbus-daemon          state: 1
[ 6526.765438] pid: 1460 name: window-stack-br        state: 1
[ 6526.765440] pid: 1502 name: bamfdaemon           state: 1
[ 6526.765442] pid: 1508 name: upstart-dbus-br        state: 1
[ 6526.765443] pid: 1510 name: upstart-dbus-br        state: 1
[ 6526.765445] pid: 1512 name: upstart-file-br        state: 1
[ 6526.765446] pid: 1519 name: ibus-daemon          state: 1
[ 6526.765448] pid: 1551 name: ibus-dconf           state: 1
[ 6526.765450] pid: 1552 name: ibus-ui-gtk3           state: 1
[ 6526.765451] pid: 1571 name: ibus-engine-sim        state: 1
[ 6526.765453] pid: 1518 name: at-spi-bus-laun        state: 1
[ 6526.765454] pid: 1527 name: dbus-daemon          state: 1
[ 6526.765456] pid: 1536 name: at-spi2-registr        state: 1
[ 6526.765458] pid: 1533 name: gvfsd                state: 1
[ 6526.765459] pid: 1543 name: gvfsd-fuse             state: 1
[ 6526.765461] pid: 1554 name: ibus-x11              state: 1
[ 6526.765463] pid: 1591 name: hud-service           state: 1
[ 6526.765464] pid: 1593 name: unity-settings-        state: 1
[ 6526.765466] pid: 1601 name: gnome-session-b         state: 1
[ 6526.765467] pid: 1795 name: nm-applet              state: 1
[ 6526.765469] pid: 1804 name: unity-fallback-        state: 1
[ 6526.765471] pid: 1807 name: nautilus              state: 1
[ 6526.765472] pid: 1811 name: polkit-gnome-au        state: 1
[ 6526.765474] pid: 1832 name: gnome-software        state: 1
```

```

hank@hank-VirtualBox:~/Desktop/HW2$ ps -e1

```

F	S	UID	PID	PPID	C	PRI	NI	ADDR	SZ	WCHAN	TTY	TIME	CMD
4	S	0	1	0	0	80	0	-	6281	-	?	00:00:18	systemd
1	S	0	2	0	0	80	0	-	0	-	?	00:00:00	kthreadd
1	I	0	4	2	0	60	-20	-	0	-	?	00:00:00	kworker/0:0H
1	I	0	6	2	0	60	-20	-	0	-	?	00:00:00	mm_percpu_wq
1	S	0	7	2	0	80	0	-	0	-	?	00:00:01	ksoftirqd/0
1	I	0	8	2	0	80	0	-	0	-	?	00:00:04	rcu_sched
1	I	0	9	2	0	80	0	-	0	-	?	00:00:00	rcu_bh
1	S	0	10	2	0	-40	-	-	0	-	?	00:00:00	migration/0
5	S	0	11	2	0	-40	-	-	0	-	?	00:00:00	watchdog/0
1	S	0	12	2	0	80	0	-	0	-	?	00:00:00	cpuhp/0
5	S	0	13	2	0	80	0	-	0	-	?	00:00:00	kdevtmpfs
1	I	0	14	2	0	60	-20	-	0	-	?	00:00:00	netns
1	S	0	15	2	0	80	0	-	0	-	?	00:00:00	rcu_tasks_kthre
1	S	0	16	2	0	80	0	-	0	-	?	00:00:00	kauditd
1	S	0	17	2	0	80	0	-	0	-	?	00:00:00	khungtaskd
1	S	0	18	2	0	80	0	-	0	-	?	00:00:00	oom_reaper
1	I	0	19	2	0	60	-20	-	0	-	?	00:00:00	writeback
1	S	0	20	2	0	80	0	-	0	-	?	00:00:00	kcompactd0
1	S	0	21	2	0	85	5	-	0	-	?	00:00:00	ksmd
1	S	0	22	2	0	99	19	-	0	-	?	00:00:00	khugepaged
1	I	0	23	2	0	60	-20	-	0	-	?	00:00:00	crypto
1	I	0	24	2	0	60	-20	-	0	-	?	00:00:00	kintegrityd
1	I	0	25	2	0	60	-20	-	0	-	?	00:00:00	kblockd
1	I	0	26	2	0	60	-20	-	0	-	?	00:00:00	ata_sff
1	I	0	27	2	0	60	-20	-	0	-	?	00:00:00	md
1	I	0	28	2	0	60	-20	-	0	-	?	00:00:00	edac-poller
1	I	0	29	2	0	60	-20	-	0	-	?	00:00:00	devfreq_wq
1	I	0	30	2	0	60	-20	-	0	-	?	00:00:00	watchdogd
1	S	0	34	2	0	80	0	-	0	-	?	00:00:00	kswapd0
1	I	0	35	2	0	60	-20	-	0	-	?	00:00:00	kworker/u3:0
1	S	0	36	2	0	80	0	-	0	-	?	00:00:00	ecryptfs-kthrea

4	S	0	649	1	0	80	0	-	22648	-	?	00:00:01	NetworkManager
4	S	111	650	1	0	80	0	-	1481	-	?	00:00:00	avahi-daemon
4	S	0	654	1	0	80	0	-	1467	-	?	00:00:00	cron
1	S	111	666	650	0	80	0	-	1481	-	?	00:00:00	avahi-daemon
4	S	0	671	1	0	80	0	-	1041	-	?	00:00:00	systemd-logind
4	S	0	683	1	0	80	0	-	9491	-	?	00:00:00	accounts-daemon
0	S	0	696	1	0	80	0	-	562	-	?	00:00:00	acpid
4	S	0	759	1	0	80	0	-	9861	-	?	00:00:01	polkitd
4	S	65534	805	649	0	80	0	-	2352	-	?	00:00:00	dnsmasq
4	S	109	875	1	0	80	0	-	14578	-	?	00:00:00	whoopsie
1	S	0	1044	1	0	80	0	-	5901	-	?	00:00:00	VBoxClient
5	S	0	1046	1044	0	80	0	-	5940	-	?	00:00:00	VBoxClient
4	S	0	1061	1	0	80	0	-	10856	-	?	00:00:00	lightdm
1	S	0	1076	1	0	80	0	-	7731	-	?	00:00:03	VBoxService
4	S	0	1088	1061	3	80	0	-	67740	-	tty7	00:04:04	Xorg
4	S	0	1092	1	0	80	0	-	1188	-	tty1	00:00:00	agetty
4	S	0	1164	1061	0	80	0	-	6986	-	?	00:00:00	lightdm
4	S	118	1216	1	0	81	1	-	5948	-	?	00:00:00	rtkit-daemon
4	S	0	1248	1	0	80	0	-	20022	-	?	00:00:00	upowerd
4	S	113	1261	1	0	80	0	-	10512	-	?	00:00:00	colord
4	S	1000	1282	1	0	80	0	-	1602	ep_pol	?	00:00:00	systemd
5	S	1000	1284	1282	0	80	0	-	6535	-	?	00:00:00	(sd-pam)
1	S	1000	1289	1	0	80	0	-	9734	-	?	00:00:00	gnome-keyring-d
4	S	1000	1291	1164	0	80	0	-	2206	poll_s	?	00:00:02	upstart
1	S	1000	1312	1	0	80	0	-	4040	wait	?	00:00:00	VBoxClient
1	S	1000	1313	1312	0	80	0	-	4076	poll_s	?	00:00:00	VBoxClient
1	S	1000	1317	1	0	80	0	-	4040	wait	?	00:00:00	VBoxClient
1	S	1000	1318	1317	0	80	0	-	4846	rtR0Se	?	00:00:00	VBoxClient
1	S	1000	1322	1	0	80	0	-	4040	wait	?	00:00:00	VBoxClient
1	S	1000	1323	1322	0	80	0	-	4975	futex_	?	00:00:21	VBoxClient
1	S	1000	1437	1291	0	80	0	-	1926	poll_s	?	00:00:00	upstart-udev-br
1	S	1000	1448	1291	0	80	0	-	1636	ep_pol	?	00:00:06	dbus-daemon
0	S	1000	1460	1291	0	80	0	-	11525	poll_s	?	00:00:00	window-stack-br
0	S	1000	1502	1291	0	80	0	-	18503	poll_s	?	00:00:04	bamfdaemon
1	S	1000	1508	1291	0	80	0	-	1907	poll_s	?	00:00:01	upstart-dbus-br
1	S	1000	1510	1291	0	80	0	-	1907	poll_s	?	00:00:00	upstart-dbus-br
1	S	1000	1512	1291	0	80	0	-	1987	poll_s	?	00:00:00	upstart-file-br
0	S	1000	1518	1291	0	80	0	-	10872	poll_s	?	00:00:00	at-spi-bus-laun

- Hw2_{studentID}.zip
 - I. hw2_linear.c (40%)
 - II. hw2_dfs.c (40%)
 - III. hw2_report.pdf(20%)
- Tell us how you implement your homework **in detail** and show us your results.
- **0 will be given to cheaters**, so don't copy & paste your friend's code directly.
- We will choose 1/4 students to demo.
- **Deadline:4/9(Thu.) 23:59**