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In my previous article, we had a working setup of ftrace, and explored
options to enable and disable it
(http://www.opensourceforu.com/2010/11/kernel-tracing-with-ftrace-
part-1/). In this article, we will explore a few more capabilities of ftrace.

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Let's begin with tracer options. The output of the tracing can be controlled by a file called `trace_options`. Various fields can be enabled and disabled by updating options in the file `/sys/kernel/debug/tracing/trace_options`. A sample of `trace_options` can be viewed in Figure 1.
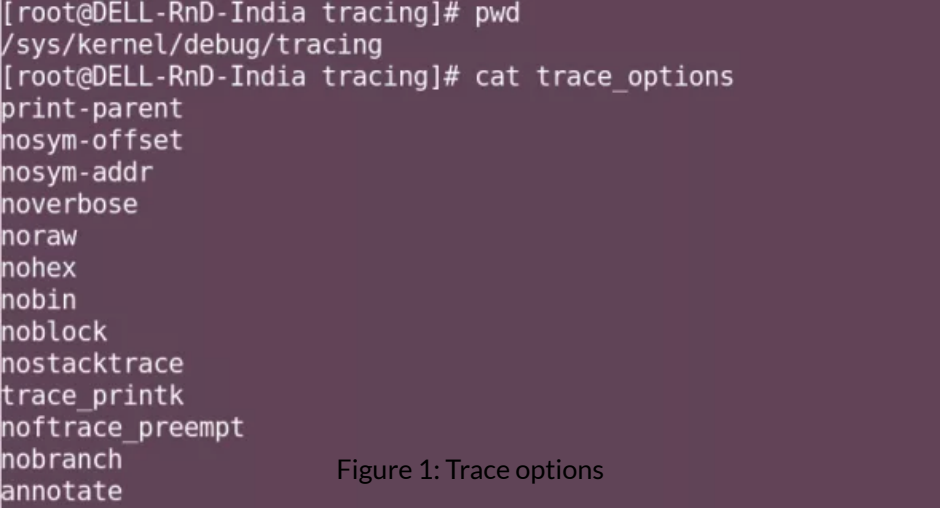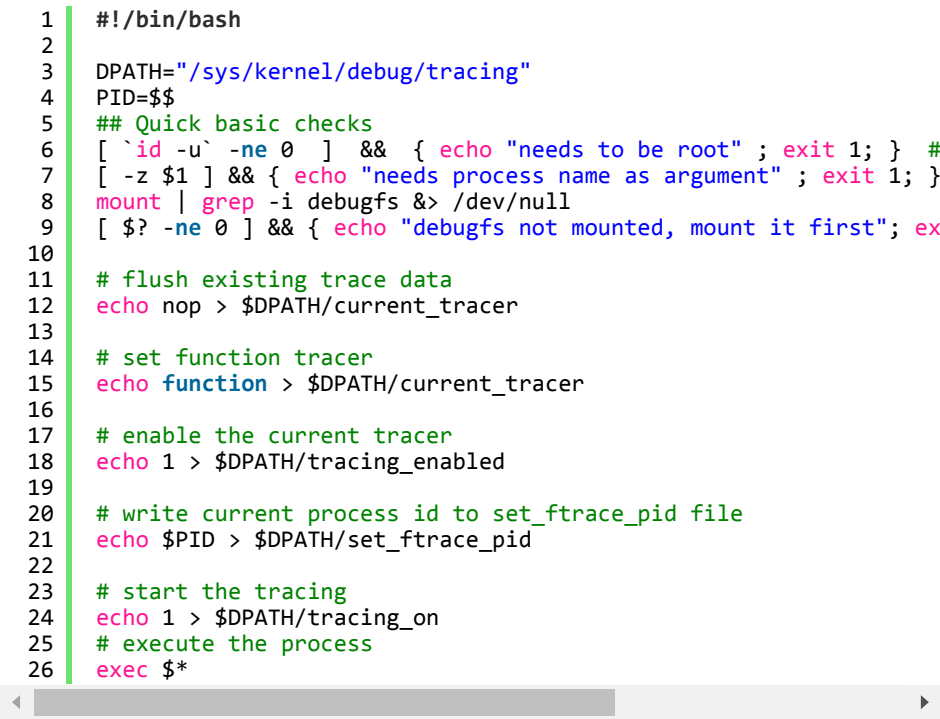
```
[root@DELL-RnD-India tracing]# pwd
/sys/kernel/debug/tracing
[root@DELL-RnD-India tracing]# cat trace_options
print-parent
nosym-offset
nosym-addr
noverbose
noraw
nohex
nobin
noblock
nostacktrace
trace_printk
noftrace_preempt
nobranch
annotate
```

Figure 1: Trace options

To disable a tracing option, a "no" keyword needs to be added to the start of the line. For example, `echo notrace_printk > trace_options`. (Remember not to have a space between no and the option.) To enable a trace again, you could use, for instance, `echo trace_printk > trace_options`.

ftrace for a specific process

ftrace allows you to perform tracing even for a specific process. In the `/sys/kernel/debug/tracing` directory, the file `set_ftrace_pid` needs to be updated with the PID of the process you want to be traced. The `traceprocess.sh` sample script below shows how to capture the PID on-the-go, and enable tracing.

```
1    #!/bin/bash
2
3    DPATH="/sys/kernel/debug/tracing"
4    PID=$$
5    ## Quick basic checks
6    [ `id -u` -ne 0  ]  &&  { echo "needs to be root" ; exit 1; }  #
7    [ -z $1 ] && { echo "needs process name as argument" ; exit 1; }
8    mount | grep -i debugfs &> /dev/null
9    [ $? -ne 0 ] && { echo "debugfs not mounted, mount it first"; ex
10
11   # flush existing trace data
12   echo nop > $DPATH/current_tracer
13
14   # set function tracer
15   echo function > $DPATH/current_tracer
16
17   # enable the current tracer
18   echo 1 > $DPATH/tracing_enabled
19
20   # write current process id to set_ftrace_pid file
21   echo $PID > $DPATH/set_ftrace_pid
22
23   # start the tracing
24   echo 1 > $DPATH/tracing_on
25   # execute the process
26   exec $*
```

You can refine it with your own innovations. Run it with the command whose process you want to trace as the argument, as shown in Figure 2, where we traced the `ls` command.

Figure 2: Executing traceprocess.sh and viewing trace output

Once tracing is complete, you need to clear the `set_ftrace_pid` file, for which you can use the following command:

```
:> set_ftrace_pid
```

Function graph tracer

The function graph tracer tracks the entry and exit of a function, and is quite useful to track its execution time. Functions with a duration of over 10 microseconds are marked with a "+", and those over 100 microseconds with "!". To enable the function graph tracer, use `echo function_graph > current_tracer`. The sample output is as shown in Figure 3.
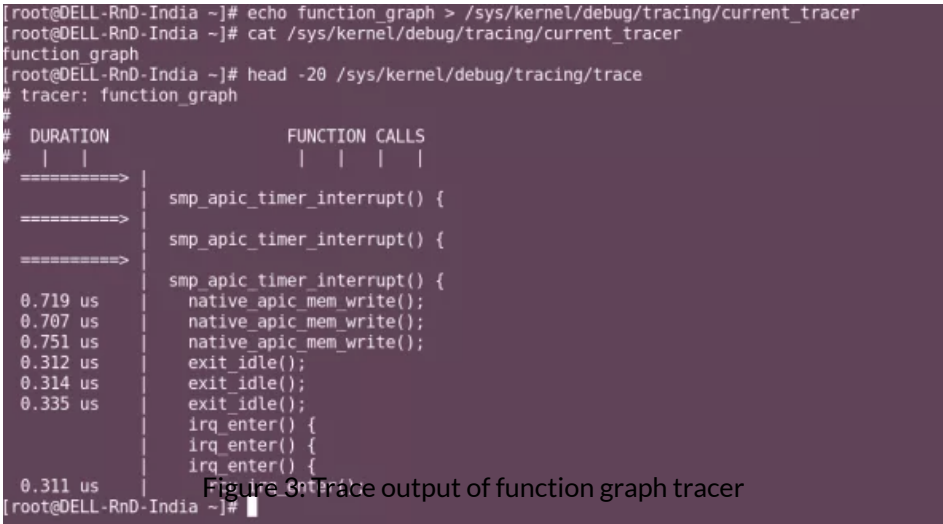
Figure 3: Trace output of function graph tracer

There are a lot of tracers; the entire list is in `linux/Documentation/trace/ftrace.txt`. The tracers are enabled or disabled by echoing the tracer name into the `current_tracer` file.

Dynamic tracing

We can easily get inundated with the amount of data the function tracer throws at us. There is a dynamic way to filter just the functions we need, and eliminate those that we don't need: to specify them in the file `set_ftrace_filter`. (First find the function(s) you want, from the available_filter_functions file.) See Figure 4 for an example of dynamic tracing.

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Figure 4: Listing filter functions, using with wild-cards

As you can see, you can even use wild-cards for the functions' names. I used all the `vmalloc_ functions`, and set them with:

`echo vmalloc_* > set_ftrace_filter` .

Event tracing

Tracing can also be triggered when particular events happen on the system. Available system events are found in the file `available_events`:

```
[root@DELL-RnD-India tracing]# cat available_events | head -10
kvmmmu:kvm_mmu_pagetable_walk
kvmmmu:kvm_mmu_paging_element
kvmmmu:kvm_mmu_set_accessed_bit
kvmmmu:kvm_mmu_set_dirty_bit
kvmmmu:kvm_mmu_walker_error
kvmmmu:kvm_mmu_get_page
kvmmmu:kvm_mmu_sync_page
kvmmmu:kvm_mmu_unsync_page
kvmmmu:kvm_mmu_prepare_zap_page
kvm:kvm_entry
```

For example, to enable an event, you would use:
`echo sys_enter_nice >> set_event` (note that you append the event name to the file, using the `>>` append redirector, and not `>`). To disable an event, precede the event name with a "!":
`echo '!sys_enter_nice' >> set_event` . See Figure 5 for a sample event tracing scenario. The available events are listed in the events directory as well.

Figure 5: Available tracing events, setting and 'unsetting' them.

For further details about event tracing, read the file `Documents/Trace/events.txt` in the kernel directory.

trace-cmd and KernelShark

trace-cmd, introduced by Steven Rostedt in his July 2009 post to the LKML (https://lkml.org/lkml/2009/7/17/126), makes it easy to manipulate the tracer. Follow these steps to get the latest version, including the GUI tool KernelShark, installed on your system:

```
wget http://www.hr.kernel.org/pub/linux/analysis/trace-cmd/trace-cmd-1.
tar -zxvf trace-cmd-1.0.5.tar.gz
cd trace-cmd*
make
make gui # compiles GUI tools (KernelShark)
make install
make install_gui # installs GUI tools
```

With trace-cmd, tracing becomes a breeze (see Figure 6 for sample usage):

```
trace-cmd list                ##to see available events
trace-cmd record -e syscalls ls  ##Initiate tracing on the syscall 'ls'
##(A file called trace.dat gets created in the current directory.)
trace-cmd report              ## displays the report from trace.dat
```

Figure 6: Using trace-cmd for recording and

reporting

Figure 6: Using trace-cmd for recording and reporting

KernelShark, installed by the `make install_gui` step above, can be used to analyse the trace data in the file `trace.dat` , as shown in Figure 7.
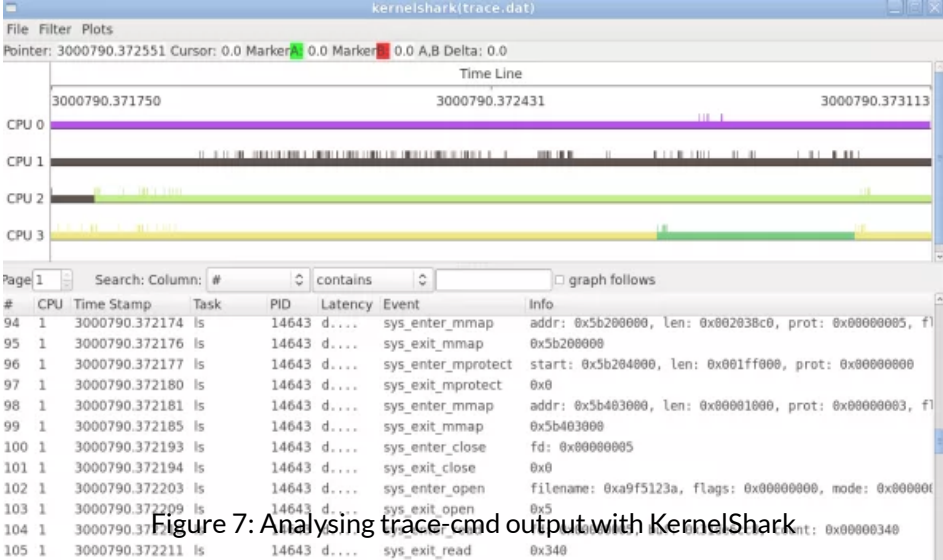

Figure 7: Analysing trace-cmd output with KernelShark

References

You can find abundant information in the following resources, which I used as references for this article:

- The Linux kernel's `Documentation/tracing` directory
- Multiple articles from LWN (http://www.lwn.net/)
- KernelShark developer page (http://rostedt.homelinux.com/kernelshark)

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