

The Linux Kernel Tracepoint API

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by Jason Baron and William Cohen

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Chapter 1. Introduction

Tracepoints are static probe points that are located in strategic points throughout the kernel. 'Probes' register/unregister with tracepoints via a callback mechanism. The 'probes' are strictly typed functions that are passed a unique set of parameters defined by each tracepoint.

From this simple callback mechanism, 'probes' can be used to profile, debug, and understand kernel behavior. There are a number of tools that provide a framework for using 'probes'. These tools include Systemtap, ftrace, and LTTng.

Tracepoints are defined in a number of header files via various macros. Thus, the purpose of this document is to provide a clear accounting of the available tracepoints. The intention is to understand not only what tracepoints are available but also to understand where future tracepoints might be added.

The API presented has functions of the form: `trace_tracepointname(function parameters)`. These are the tracepoints callbacks that are found throughout the code. Registering and unregistering probes with these callback sites is covered in the `Documentation/trace/*` directory.

Chapter 2. IRQ

Name

`trace_irq_handler_entry` — called immediately before the irq action handler

Synopsis

```
void trace_irq_handler_entry (int irq, struct irqaction * action);
```

Arguments

irq irq number

action pointer to struct irqaction

Description

The struct irqaction pointed to by *action* contains various information about the handler, including the device name, *action->name*, and the device id, *action->dev_id*. When used in conjunction with the `irq_handler_exit` tracepoint, we can figure out irq handler latencies.

Name

`trace_irq_handler_exit` — called immediately after the irq action handler returns

Synopsis

```
void trace_irq_handler_exit (int irq, struct irqaction * action, int ret);
```

Arguments

irq irq number

action pointer to struct irqaction

ret return value

Description

If the *ret* value is set to `IRQ_HANDLED`, then we know that the corresponding *action->handler* successfully handled this irq. Otherwise, the irq might be a shared irq line, or the irq was not handled successfully. Can be used in conjunction with the `irq_handler_entry` to understand irq handler latencies.

Name

`trace_softirq_entry` — called immediately before the softirq handler

Synopsis

```
void trace_softirq_entry (unsigned int vec_nr);
```

Arguments

vec_nr softirq vector number

Description

When used in combination with the `softirq_exit` tracepoint we can determine the softirq handler routine.

Name

`trace_softirq_exit` — called immediately after the softirq handler returns

Synopsis

```
void trace_softirq_exit (unsigned int vec_nr);
```

Arguments

vec_nr softirq vector number

Description

When used in combination with the `softirq_entry` tracepoint we can determine the softirq handler routine.

Name

`trace_softirq_raise` — called immediately when a softirq is raised

Synopsis

```
void trace_softirq_raise (unsigned int vec_nr);
```

Arguments

vec_nr softirq vector number

Description

When used in combination with the `softirq_entry` tracepoint we can determine the softirq raise to run latency.

Chapter 3. SIGNAL

Name

`trace_signal_generate` — called when a signal is generated

Synopsis

```
void trace_signal_generate (int sig, struct siginfo * info, struct
task_struct * task, int group, int result);
```

Arguments

<i>sig</i>	signal number
<i>info</i>	pointer to struct siginfo
<i>task</i>	pointer to struct task_struct
<i>group</i>	shared or private
<i>result</i>	TRACE_SIGNAL_*

Description

Current process sends a 'sig' signal to 'task' process with 'info' siginfo. If 'info' is SEND_SIG_NOINFO or SEND_SIG_PRIV, 'info' is not a pointer and you can't access its field. Instead, SEND_SIG_NOINFO means that si_code is SI_USER, and SEND_SIG_PRIV means that si_code is SI_KERNEL.

Name

`trace_signal_deliver` — called when a signal is delivered

Synopsis

```
void trace_signal_deliver (int sig, struct siginfo * info, struct  
k_sigaction * ka);
```

Arguments

sig signal number

info pointer to struct siginfo

ka pointer to struct k_sigaction

Description

A 'sig' signal is delivered to current process with 'info' siginfo, and it will be handled by 'ka'. `ka->sa.sa_handler` can be `SIG_IGN` or `SIG_DFL`. Note that some signals reported by `signal_generate` tracepoint can be lost, ignored or modified (by debugger) before hitting this tracepoint. This means, this can show which signals are actually delivered, but matching generated signals and delivered signals may not be correct.

Chapter 4. Block IO

Name

`trace_block_touch_buffer` — mark a buffer accessed

Synopsis

```
void trace_block_touch_buffer (struct buffer_head * bh);
```

Arguments

bh `buffer_head` being touched

Description

Called from `touch_buffer`.

Name

`trace_block_dirty_buffer` — mark a buffer dirty

Synopsis

```
void trace_block_dirty_buffer (struct buffer_head * bh);
```

Arguments

bh `buffer_head` being dirtied

Description

Called from `mark_buffer_dirty`.

Name

`trace_block_rq_abort` — abort block operation request

Synopsis

```
void trace_block_rq_abort (struct request_queue * q, struct request *  
rq);
```

Arguments

q queue containing the block operation request

rq block IO operation request

Description

Called immediately after pending block IO operation request *rq* in queue *q* is aborted. The fields in the operation request *rq* can be examined to determine which device and sectors the pending operation would access.

Name

`trace_block_rq_requeue` — place block IO request back on a queue

Synopsis

```
void trace_block_rq_requeue (struct request_queue * q, struct request  
* rq);
```

Arguments

q queue holding operation

rq block IO operation request

Description

The block operation request *rq* is being placed back into queue *q*. For some reason the request was not completed and needs to be put back in the queue.

Name

`trace_block_rq_complete` — block IO operation completed by device driver

Synopsis

```
void trace_block_rq_complete (struct request_queue * q, struct request  
* rq, unsigned int nr_bytes);
```

Arguments

q queue containing the block operation request

rq block operations request

nr_bytes number of completed bytes

Description

The `block_rq_complete` tracepoint event indicates that some portion of operation request has been completed by the device driver. If the `rq->bio` is `NULL`, then there is absolutely no additional work to do for the request. If `rq->bio` is non-`NULL` then there is additional work required to complete the request.

Name

`trace_block_rq_insert` — insert block operation request into queue

Synopsis

```
void trace_block_rq_insert (struct request_queue * q, struct request  
* rq);
```

Arguments

q target queue

rq block IO operation request

Description

Called immediately before block operation request *rq* is inserted into queue *q*. The fields in the operation request *rq* struct can be examined to determine which device and sectors the pending operation would access.

Name

`trace_block_rq_issue` — issue pending block IO request operation to device driver

Synopsis

```
void trace_block_rq_issue (struct request_queue * q, struct request *  
rq);
```

Arguments

q queue holding operation

rq block IO operation operation request

Description

Called when block operation request *rq* from queue *q* is sent to a device driver for processing.

Name

`trace_block_bio_bounce` — used bounce buffer when processing block operation

Synopsis

```
void trace_block_bio_bounce (struct request_queue * q, struct bio *  
bio);
```

Arguments

q queue holding the block operation

bio block operation

Description

A bounce buffer was used to handle the block operation *bio* in *q*. This occurs when hardware limitations prevent a direct transfer of data between the *bio* data memory area and the IO device. Use of a bounce buffer requires extra copying of data and decreases performance.

Name

`trace_block_bio_complete` — completed all work on the block operation

Synopsis

```
void trace_block_bio_complete (struct request_queue * q, struct bio *  
bio, int error);
```

Arguments

q queue holding the block operation

bio block operation completed

error io error value

Description

This tracepoint indicates there is no further work to do on this block IO operation *bio*.

Name

`trace_block_bio_backmerge` — merging block operation to the end of an existing operation

Synopsis

```
void trace_block_bio_backmerge (struct request_queue * q, struct request  
* rq, struct bio * bio);
```

Arguments

q queue holding operation

rq request bio is being merged into

bio new block operation to merge

Description

Merging block request *bio* to the end of an existing block request in queue *q*.

Name

`trace_block_bio_frontmerge` — merging block operation to the beginning of an existing operation

Synopsis

```
void trace_block_bio_frontmerge (struct request_queue * q, struct  
request * rq, struct bio * bio);
```

Arguments

q queue holding operation

rq request bio is being merged into

bio new block operation to merge

Description

Merging block IO operation *bio* to the beginning of an existing block operation in queue *q*.

Name

`trace_block_bio_queue` — putting new block IO operation in queue

Synopsis

```
void trace_block_bio_queue (struct request_queue * q, struct bio * bio);
```

Arguments

q queue holding operation

bio new block operation

Description

About to place the block IO operation *bio* into queue *q*.

Name

`trace_block_getrq` — get a free request entry in queue for block IO operations

Synopsis

```
void trace_block_getrq (struct request_queue * q, struct bio * bio,  
int rw);
```

Arguments

q queue for operations

bio pending block IO operation

rw low bit indicates a read (0) or a write (1)

Description

A request struct for queue *q* has been allocated to handle the block IO operation *bio*.

Name

`trace_block_sleeprq` — waiting to get a free request entry in queue for block IO operation

Synopsis

```
void trace_block_sleeprq (struct request_queue * q, struct bio * bio,  
int rw);
```

Arguments

q queue for operation

bio pending block IO operation

rw low bit indicates a read (0) or a write (1)

Description

In the case where a request struct cannot be provided for queue *q* the process needs to wait for an request struct to become available. This tracepoint event is generated each time the process goes to sleep waiting for request struct become available.

Name

`trace_block_plug` — keep operations requests in request queue

Synopsis

```
void trace_block_plug (struct request_queue * q);
```

Arguments

q request queue to plug

Description

Plug the request queue *q*. Do not allow block operation requests to be sent to the device driver. Instead, accumulate requests in the queue to improve throughput performance of the block device.

Name

`trace_block_unplug` — release of operations requests in request queue

Synopsis

```
void trace_block_unplug (struct request_queue * q, unsigned int depth,  
bool explicit);
```

Arguments

<i>q</i>	request queue to unplug
<i>depth</i>	number of requests just added to the queue
<i>explicit</i>	whether this was an explicit unplug, or one from schedule

Description

Unplug request queue *q* because device driver is scheduled to work on elements in the request queue.

Name

`trace_block_split` — split a single bio struct into two bio structs

Synopsis

```
void trace_block_split (struct request_queue * q, struct bio * bio,  
unsigned int new_sector);
```

Arguments

<i>q</i>	queue containing the bio
<i>bio</i>	block operation being split
<i>new_sector</i>	The starting sector for the new bio

Description

The bio request *bio* in request queue *q* needs to be split into two bio requests. The newly created *bio* request starts at *new_sector*. This split may be required due to hardware limitation such as operation crossing device boundaries in a RAID system.

Name

`trace_block_bio_remap` — map request for a logical device to the raw device

Synopsis

```
void trace_block_bio_remap (struct request_queue * q, struct bio * bio,  
dev_t dev, sector_t from);
```

Arguments

q queue holding the operation

bio revised operation

dev device for the operation

from original sector for the operation

Description

An operation for a logical device has been mapped to the raw block device.

Name

`trace_block_rq_remap` — map request for a block operation request

Synopsis

```
void trace_block_rq_remap (struct request_queue * q, struct request *  
rq, dev_t dev, sector_t from);
```

Arguments

q queue holding the operation

rq block IO operation request

dev device for the operation

from original sector for the operation

Description

The block operation request *rq* in *q* has been remapped. The block operation request *rq* holds the current information and *from* hold the original sector.

Chapter 5. Workqueue

Name

`trace_workqueue_queue_work` — called when a work gets queued

Synopsis

```
void trace_workqueue_queue_work (unsigned int req_cpu, struct  
pool_workqueue * pwq, struct work_struct * work);
```

Arguments

req_cpu the requested cpu

pwq pointer to struct `pool_workqueue`

work pointer to struct `work_struct`

Description

This event occurs when a work is queued immediately or once a delayed work is actually queued on a workqueue (ie: once the delay has been reached).

Name

`trace_workqueue_activate_work` — called when a work gets activated

Synopsis

```
void trace_workqueue_activate_work (struct work_struct * work);
```

Arguments

work pointer to struct `work_struct`

Description

This event occurs when a queued work is put on the active queue, which happens immediately after queueing unless *max_active* limit is reached.

Name

`trace_workqueue_execute_start` — called immediately before the workqueue callback

Synopsis

```
void trace_workqueue_execute_start (struct work_struct * work);
```

Arguments

work pointer to struct `work_struct`

Description

Allows to track workqueue execution.

Name

`trace_workqueue_execute_end` — called immediately after the workqueue callback

Synopsis

```
void trace_workqueue_execute_end (struct work_struct * work);
```

Arguments

work pointer to struct `work_struct`

Description

Allows to track workqueue execution.