Tracing in the QEMU emulator
USER CASE STUDY

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About me

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Happy to use any tool available...

• ftrace, perf, LTTng, SystemTap, DTrace

...to answer questions about:

• What is making everything slow?
• What does this EINVAL errno really mean?
What is QEMU?

QEMU is a hardware emulator, used by:

- KVM, Xen, Linaro

Emulates 17 CPU architectures

- x86, arm, ppc, etc

Emulates hardware devices

- net, disk, graphics, etc

Runs on 6+ OS families

- Linux, BSD, Windows, Mac, etc
QEMU architecture

QEMU is a userspace process on the host

Guest runs as part of QEMU

KVM kernel module switches between host and guest mode

QEMU performs I/O on behalf of guest

Each guest vCPU is a thread on the host when using KVM
How to observe the stack

Use tools inside guest
Guest kernel using perf-kvm(1)

Static probes in QEMU
Dynamic probes using uprobes
gdb, perf, strace, etc

perf, LTTng, SystemTap, ftrace

...and top, netstat, mpstat, iostat, etc
Static probes in QEMU

**Problem:** Support static probes across all host operating systems that QEMU compiles on.

Maybe your application faces the same challenge?

**Solution:** A code generator that emits tracing code for multiple tracers.

```
tracetool
```

```
trace-events
```

```
LTTng UST
```

```
SystemTap
```
Tracers supported by tracetoool

DTrace – generate static probes in .d file
SystemTap – generate tapset containing all probes
LTTng UST – generate TRACEPOINT_EVENT()
simple – QEMU's built-in tracer
stderr – trace_foo(val) -> fprintf(stderr,“foo %#x\n”,val)
nop – compile out all probes (performance paranoid)
Writing analysis scripts using “simple” tracer

#!/usr/bin/env python
# Print virtqueue elements not returned to the guest.

import simpletrace

class VirtqueueRequestTracker(simpletrace.Analyzer):
    def __init__(self):
        self.elems = set()

    def virtqueue_pop(self, vq, elem, in_num, out_num):
        self.elems.add(elem)

    def virtqueue_fill(self, vq, elem, length, idx):
        self.elems.remove(elem)

    def end(self):
        for elem in self.elems:
            print hex(elem)

simpletrace.run(VirtqueueRequestTracker())
Interested in tracetool?

- Python script with tracer backend plugins
- GPLv2 or Later license
- Part of the QEMU source tree today, but could be spun out if there is demand
TCG tracing

**Problem:** How to plant probes for Just-in-Time compiled code?

QEMU's TCG translator compiles machine code from the guest architecture to the host architecture

**Solution:** Generate static probes at compile-time. Let Just-in-Time compiler plant calls to these static probes.
Static probes in run-time generated code

1. Generate static probe at compile-time

2. Plant call to static probe in JIT target code
Questions?

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