Unified Tracing Platform

Bringing tracing together

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The many faces of tracing

- Ftrace
- Perf
- LTTng
- Dtrace
- systemtap
- BPF tracing
- ktap
- strace
- gdb

A brief history (ftrace)

- logdev - 1998
  - One of the “parents” of ftrace
  - Created during my masters thesis (to see what was happening)
  - Mostly trace_printk() like functionality (with a flexible ring buffer)
  - Very portable (even ported it to Xen hypervisor!)
- latency tracer (preempt-realtime patch) - 2004
  - From Nadia Yvette Chambers and Ingo Molnar
  - Included tracing of functions via mcount
  - Function tracing had to be compiled in
    - either traced functions on boot, or did not
  - Included the preemption and interrupt disabled latency tracing
  - Very basic ring buffer (all events were the same size)
- Merged into ftrace in 2008

A brief history (perf)

- Perf - 2009
  - Started as just a profiler
  - Added to the Linux kernel git tree (under tools/perf)
  - Created its own ring buffer
    - ftrace ring buffer was not lockless yet
    - Needed large event sizes (greater than a page)
  - Hooked into the ftrace trace event infrastructure
    - Was able to duplicate several ftrace features (event tracing)
  - Optimized for profiling (but has gotten better)

A brief history (LTT - before ng)

- Linux Trace Toolkit (LTT) - 2000?
  - Written by Karim Yaghmour
  - First real attempt to do Linux tracing in mainline
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https://lore.kernel.org/lkml/3D8E1AF8.91C1915D@opersys.com/T/#m2cea7cab3f7e7b6720a00645981582e000130e77

```
my problem with this stuff is conceptual: it introduces a constant drag on
the kernel sourcecode, while 99% of development will not want to trace,
ever. When i do need tracing occasionally, then i take those 30 minutes to
write up a tracer from pre-existing tracing patches, tailored to specific
problems. Eg. for the scheduler i wrote a simple tracer, but the rate of
trace points that started to make sense for me from a development and
debugging POV also made kernel/sched.c butt-ugly and unmaintainable, so i
always kept the tracer separate and did the hacking in the untained code.
```

- Ingo Molnar (9/22/2002)

A brief history (LTTng)

- Linux Trace Toolkit next generation (LTTng) - 2006
  - Complete rewrite and implementation by Mathieu Desnoyers
  - Implemented the original tracepoints
    - What ftrace trace events are built on top of
  - Mostly maintained as an out of tree kernel module (and user tools)
  - Hooks into the tracepoint infrastructure that is upstream

A brief history (Dtrace)

- Dtrace - Solaris 10 (Available 2003 / officially released 2005)
  - First to allow scripting in the kernel (custom traces)
  - Now owned by Oracle
  - Oracle ported Dtrace to Linux
    - Released under the GPL in 2017
    - Never made it into mainline
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- Note - Some say that Dtrace came from IBM's dprobe work that was shipped by SLES (SUSE's Linux) But latter dropped.

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2008 Kernel Summit

https://lwn.net/Articles/298685/

Linus came in to proclaim that he hates every tracing tool he has seen. SystemTap is far too complicated; these tools need to be simpler. [...]

We should be making better use of the simple tools which are currently in the kernel before trying to put more complicated stuff in.

A brief history (eBPF)

- BPF (Berkeley Packet Filter)
  - Just in Time (JIT) compiler added to x86 in 2011
  - Customize network packet filtering extremely fast
- eBPF (Extended BPF)
  - Introduced by Alexei Starovoitov in 2014
  - Extends the BPF JIT to other areas of the kernel besides just network filtering
  - Can be used for tracing with custom scripts (Dtrace / SystemTap like)
  - bpftrace (user tool incorporating eBPF)

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  - bpftrace (user tool incorporating eBPF)
- Both SystemTap and Dtrace are working to build on top of eBPF

Where are we today?

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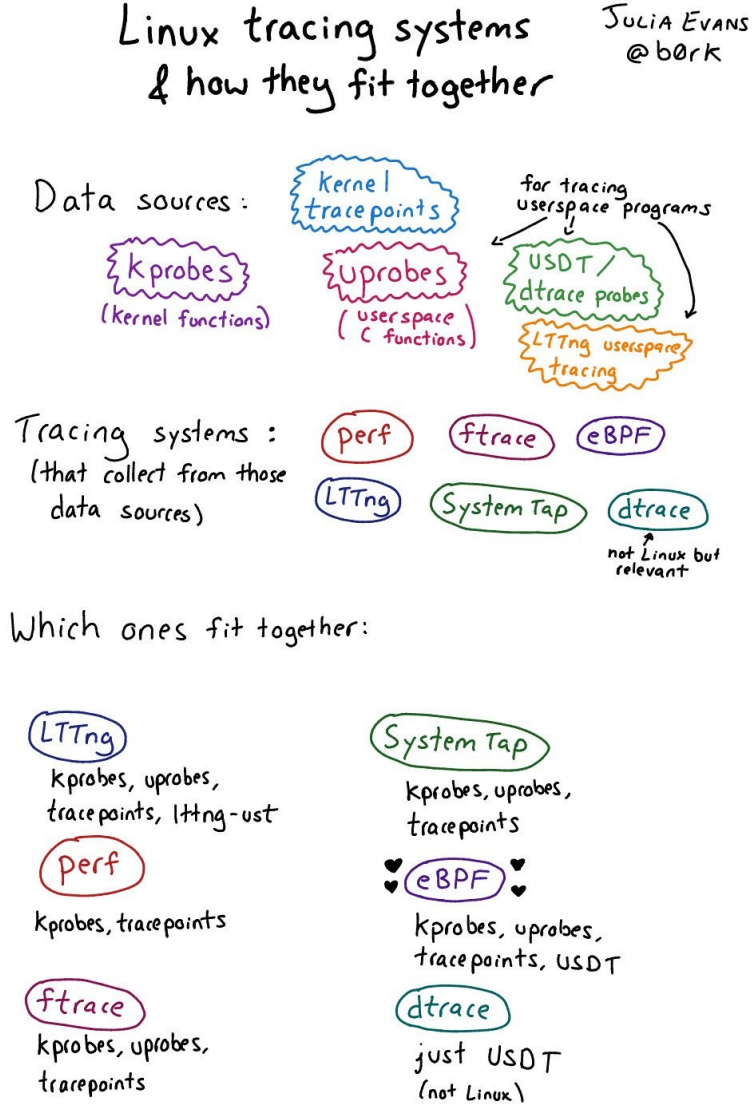
Julia Evans
@b0rk
30 Jun 2017



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- Isn't too much choice a problem?
- Wasting effort on multiple approaches
  - Splitting the skill set?

Can't we just have one tracer?

- Isn't too much choice a problem?
- Wasting effort on multiple approaches
  - Splitting the skill set?
  - But diversity brings innovation!

Can't we just have one tracer?

Creative Commons 2006 - Holger.Ellgaard

Can't we just have one tracer?

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Tabs vs Spaces

Can't we just have one tracer?

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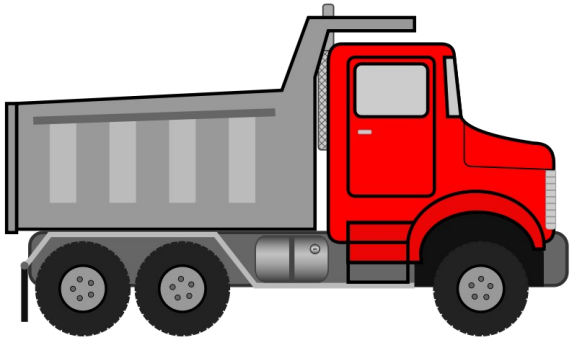
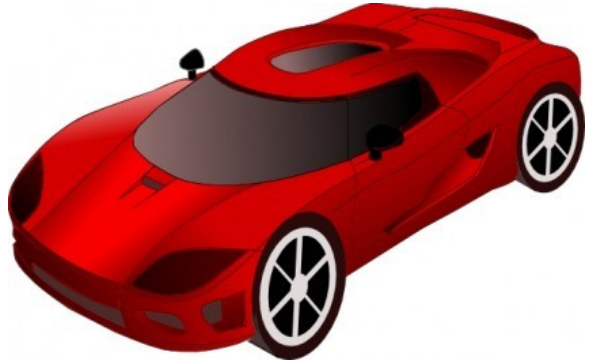
Tabs vs Spaces

Vim vs Emacs

Can't we just have one tracer?





http://clipart-library.com

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  - Too many flavors

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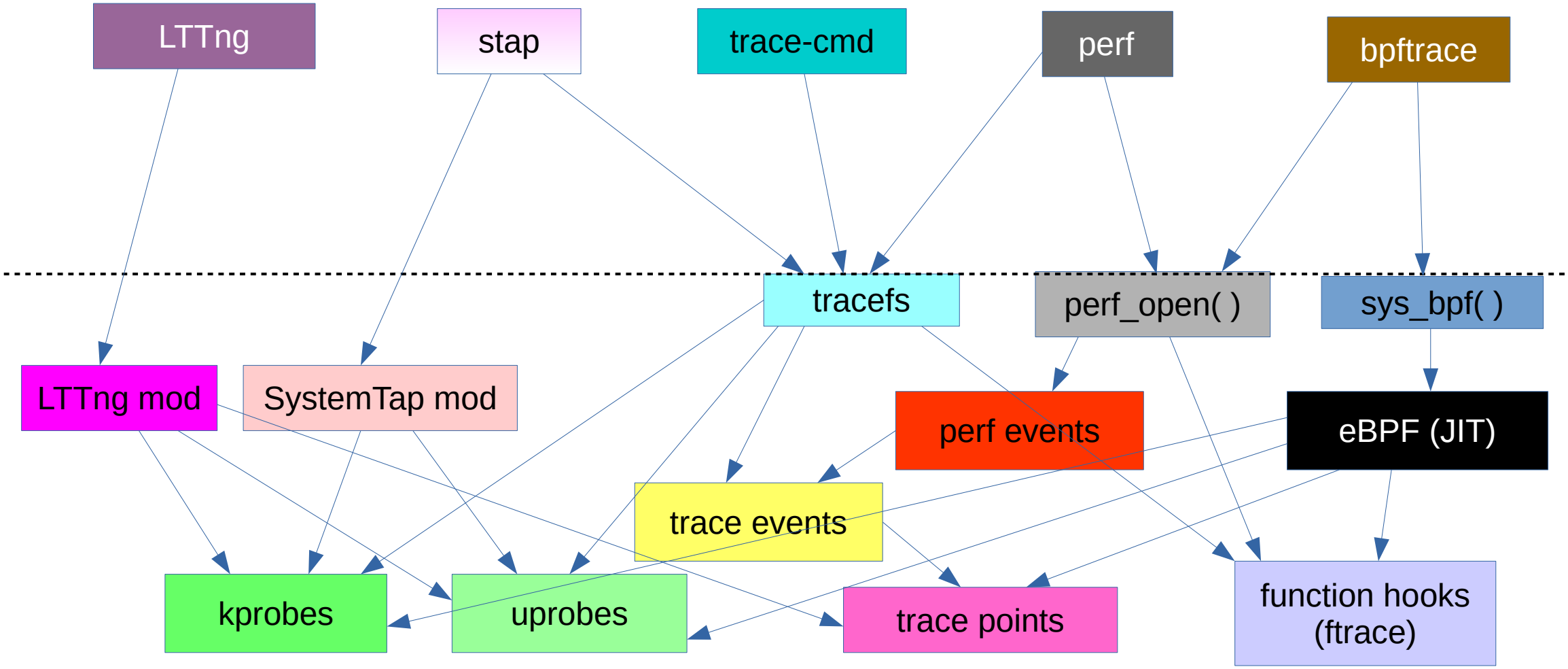
Can't we just have one tracer?

- But diversity killed Unix!
  - Too many flavors
- They were proprietary!
  - Could not share features
- Diversity is the strength of Open Source!
  - We can share!

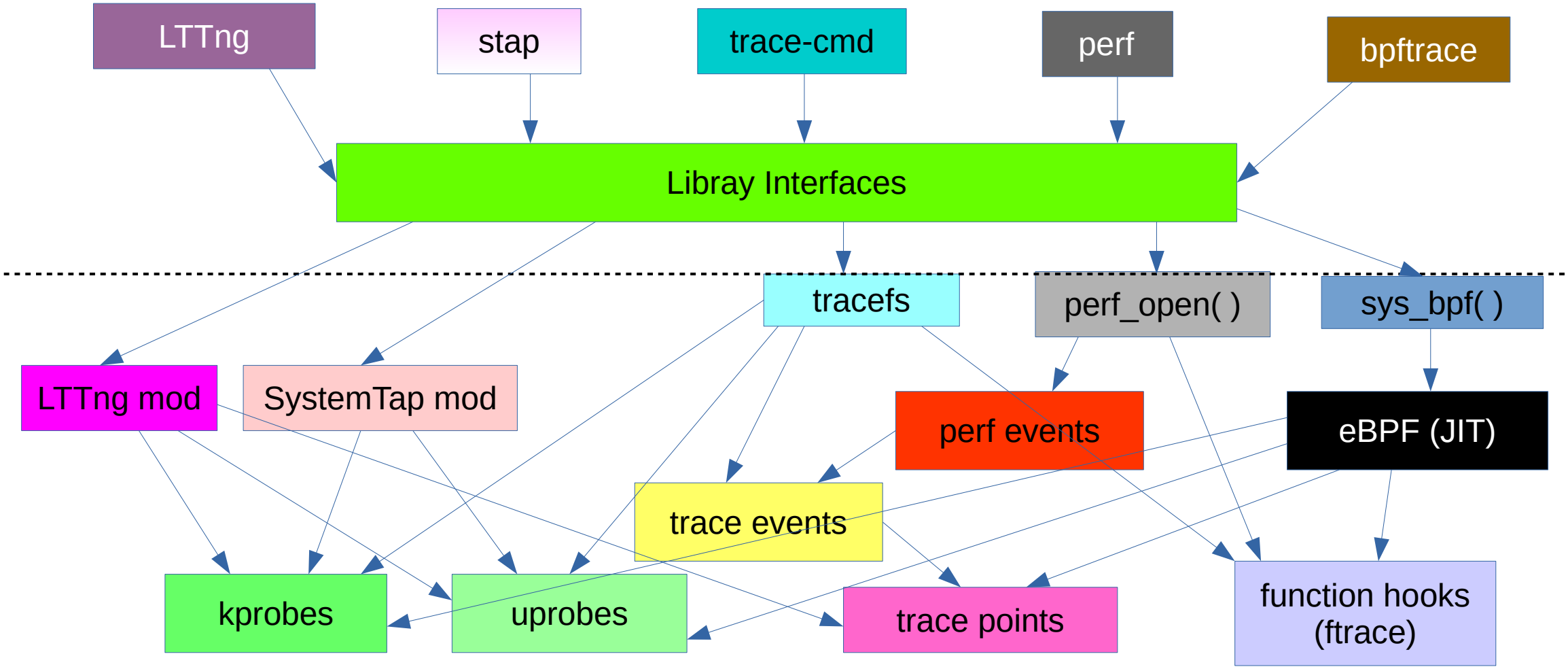
Commonality

- Trace point
  - static location in the kernel, that passes specific data via a “hook”
- Kprobes
  - Dynamic “hook” (like placing a static trace point almost anywhere)
- Uprobes
  - Dynamic “hook” into an application (takes a breakpoint TBD)
- ftrace - Function hooks
  - Allows callbacks from most kernel functions

Commonality



Commonality



Progress!

- Babel trace
- libtraceevent
- libperf

Babel Trace

- Developed from LTTng
- Parses the Common Trace Format (CFT)
- Goal is to allow any utility to read any tracing data format

libtraceevent

- Developed from ftrace utilities
- Parses the trace event format files
- Tells user applications how the trace events are written by the kernel in binary format
- Works with both perf and ftrace event data
- Works with kprobe and uprobe events

libperf

- Wraps the perf_event_open( ) system call
  - Which acts like a large ioctl to the perf interface

```
 1 #include <perf/cpumap.h>
 2
 3 int main(int argc, char **Argv)
 4 {
 5         struct perf_cpu_map *cpus;
 6         int cpu, tmp;
 7
 8         cpus = perf_cpu_map__new(NULL);
 9
10         perf_cpu_map__for_each_cpu(cpu, tmp, cpus)
11                 fprintf(stdout, "%d ", cpu);
12
13         fprintf(stdout, "\n");
14
15         perf_cpu_map__put(cpus);
16         return 0;
17 }
```

Coming Soon!

- libftrace
- libtracecmd
- libkshark

libftrace

- Interface to the tracefs directory
  - Start and stop tracers (function, latency, etc)
  - Enable or disable events
  - Create kprobes and uprobes
  - Read the tracing data
    - Only handles the raw data
    - Does not create the file

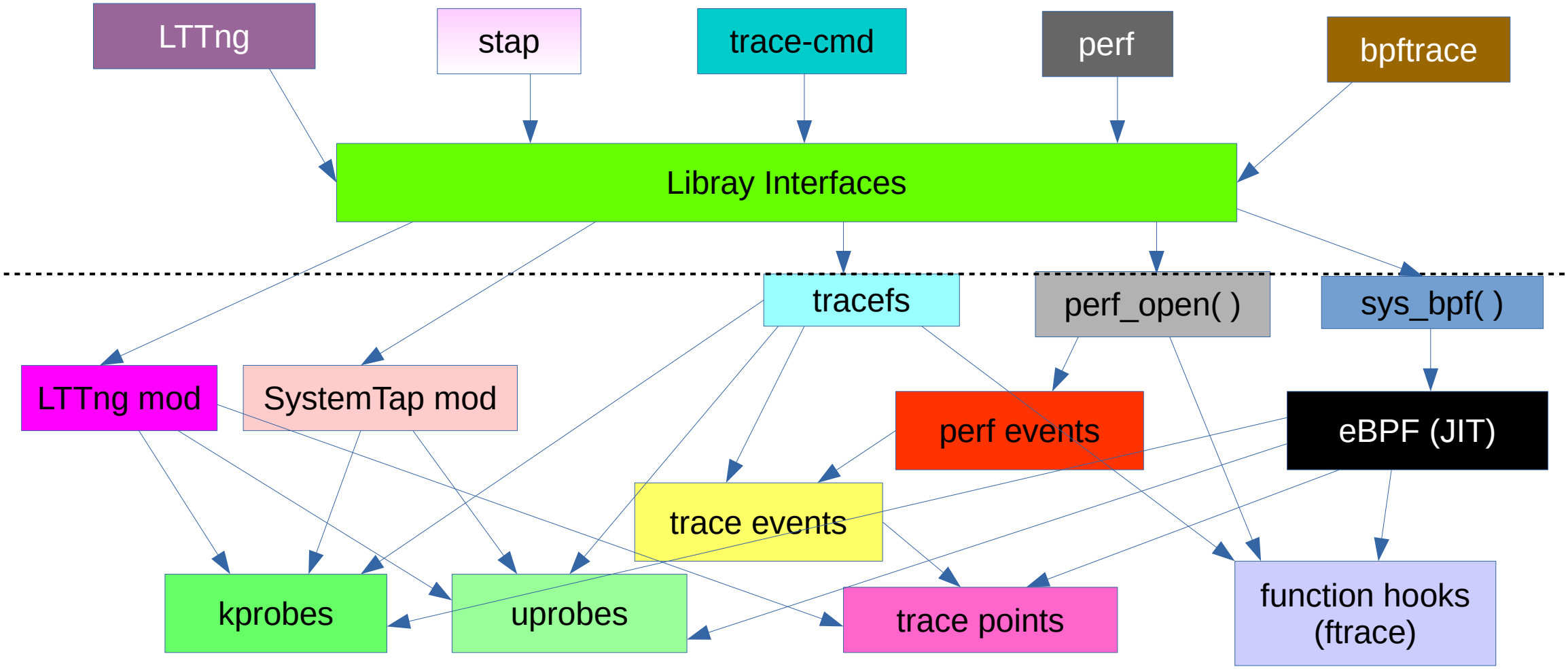
libtrace-cmd

- Allow you to do everything trace-cmd does!
  - Enable traces (will use libftrace)
  - Write to a file (saves a trace.dat)
  - Connect to guests (virt-server tracing)

libkshark

- A GUI library
- Will allow you to do whatever KernelShark does
- Plot CPU data
- Plot Task data
- Make flame graphs
- Does not have to be trace-cmd format
  - Will work with CTF (in the near future)

Commonality



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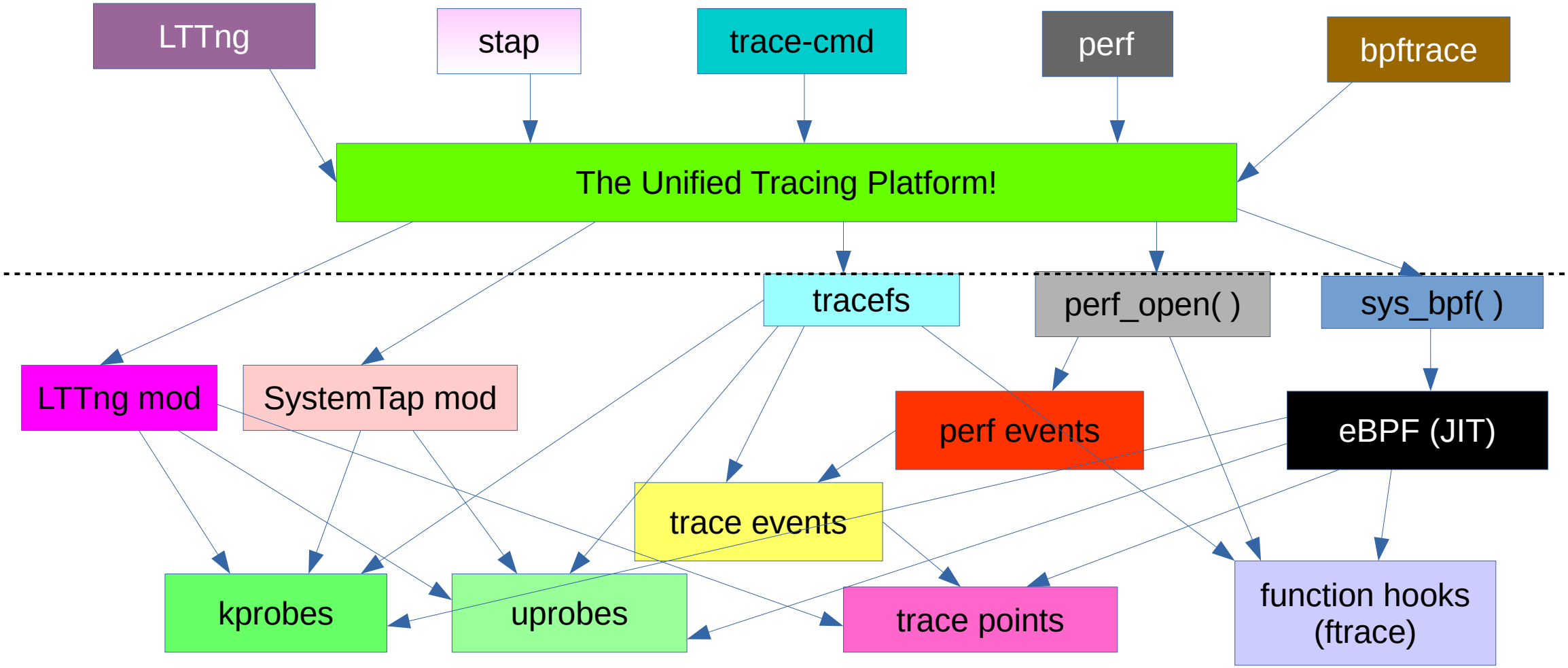

The Unix way DOTADIW

Do One Thing And Do It Well

The Linux way DOLADIW

Do One Library And Do It Well

Conclusion

- The tools are not competing with each other
  - Does vim really compete with emacs?
- Each has its strengths and weaknesses
- All are open source
- All can utilize each others work
- This is what makes Linux the best OS in the world!

Thank You

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