LINUX
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DTrace on Linux

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Kris Van Hees
Languages and Tools
Linux Engineering
<kris.van.hees@oracle.com>

Overview

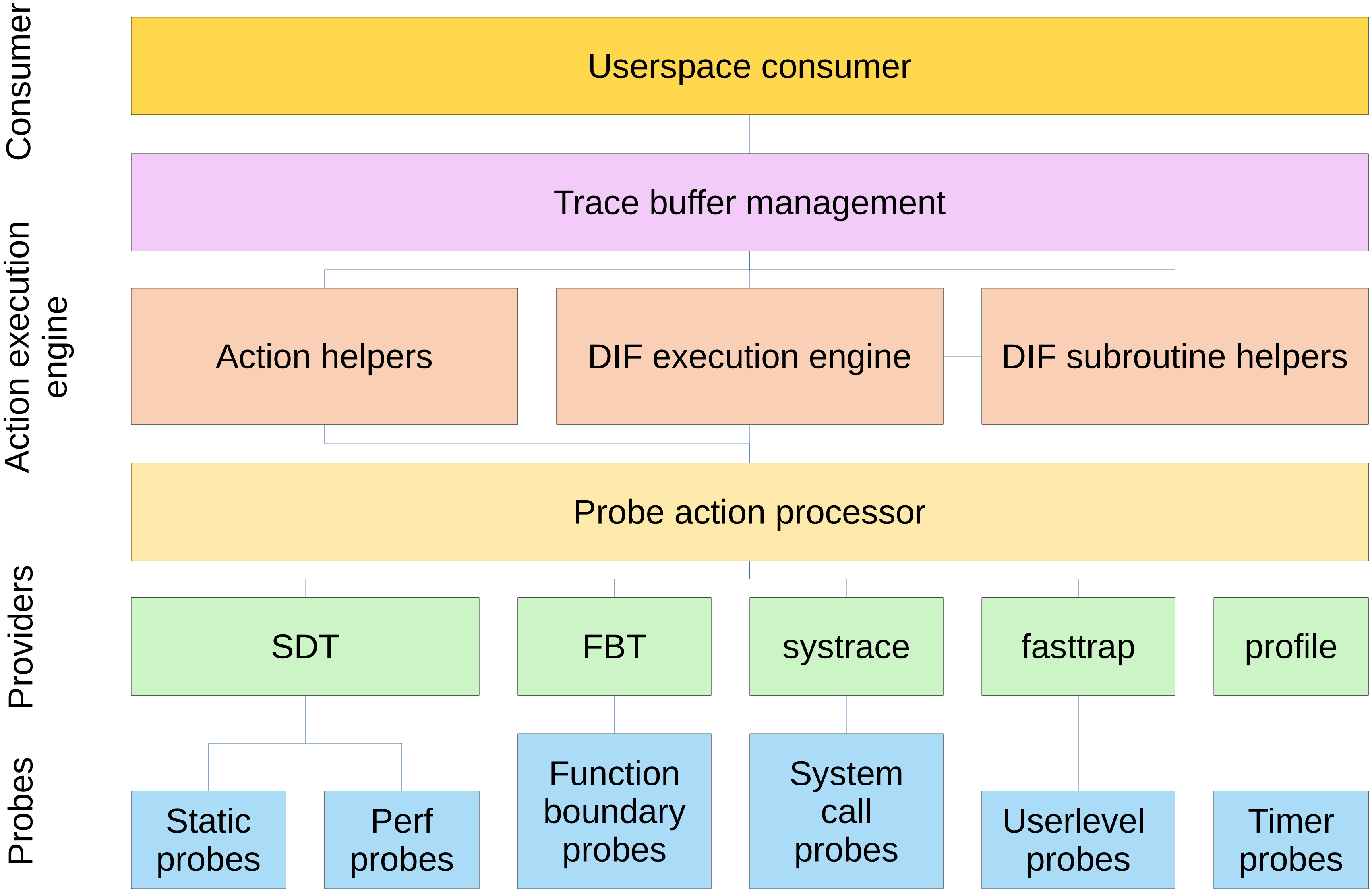
- (Very) short history
- (Very) short DTrace overview
- DTrace using BPF, etc
- Significant implementation details
- Unanswered questions

(Very) short history

- DTrace on Linux started in 2010
- First version in Oct 2011
- Under active development every since
- Redesign without big kernel patches
  - Planning since mid-2018
  - Coding started July 2019

(Very) short DTrace overview

- Two components:
  - Kernel space producer *(~45K lines)*
    - Core kernel support functions
    - Core kernel probes
    - DTrace core and provider modules
  - Userspace consumer *(~55K lines)*
    - Userspace library and front-end



Consumer

Userspace consumer

Action execution engine

Trace buffer management

Action helpers

DIF execution engine

DIF subroutine helpers

Probe action processor

Providers

SDT

FBT

systrace

fasttrap

profile

Probes

Static probes

Perf probes

Function boundary probes

System call probes

Userlevel probes

Timer probes

DTrace using BPF, etc

- Kernel provides probing mechanisms
- BPF gives us an execution engine
- BPF programs attach to probes
- Output written to perf_event ring buffer

Not *that* easy!

BPF

- Probe specific program types
- Probe specific context
- One program per probe

DTrace

- Single program type
- Consistent probe context
- Many clauses per probe

Design philosophy

- Assume we can do everything in userspace

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- Assume this will not impact performance and stability

- Keep dreaming

Design philosophy (revised)

- Assume we can do everything in userspace
- Assume this will not impact performance and stability
- Re-implement DTrace in userspace
- Perform accuracy, performance, and stability tests
- Evaluate findings:
  - Confirm kernel patches are not needed, or
  - Kernel patches are needed (and we can show why)

Implementation details

- Each D clause is compiled into a BPF function *dt_func(dt_dctx_t *dctx)*
- BPF trampoline prògram generated for each probe that is being enabled
- Trampoline calls the BPF functions for the probe clauses
- Completely different from what DTrace used to do
- Much more elegant… but…

Implementation details

- Compile entire clauses instead of actions
- Compiler re-targeted to BPF
- Disassembler re-targeted to BPF
- Added a linker to construct programs
- Implement memory management for local, global, and TLS variables
- BPF support functions (compiled with gcc)

Unanswered questions

- Impact of lack of code sharing
- Pointer value identification
  - Pointer to BPF memory (stack, map value) → direct deref possible
  - Pointer to kernel memory → bpf_probe_read()
- Dynamic variables
- ERROR probes (esp. arguments)
- Standard DTrace SDT probes
- String manipulation functions
- Scalability (what if I need to probe 1000s of probes)

Where to find it?

- Source code: ``

  http://github.com/oracle/dtrace-utils/tree/2.0-branch-dev
- Mailing list:

  dtrace-devel@oss.oracle.com

Why?

- People want it!
  - DTrace has been around for a long time
  - Well documented feature set
  - Available on multiple operating systems
- Powerful programmable tracing system
  - Easy to do very basic tracing
  - Powerful enough for complex tracing across many probes
  - Stable enough for long-term tracing (incl. Always-on tracing)
- Easier to develop new features for it