DTrace & MySQL

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DTrace

- Dynamic Tracing Framework
- The ultimate observability tool.
- Created by Sun for Solaris 10
- Open Source! (CDDL License)
- Ported to OS X (10.5), FreeBSD, and QNX

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Advantages

- You don’t have to login to the database
- Not limited to data provided by SHOW ...;
- Ability to observe and profile discrete actions down to the function level
- Observe interaction between dependancies (Apache/PHP/MySQL, etc.) or system (I/O, etc)
- Queries don’t slip through the cracks due to a polling interval (processlist, sleep, processlist,..)
- ... and much more.

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Basics

- Tens of thousands of “probes” embedded into the kernel
- Organized as: provider:module:function:name
- Example: syscall::write:entry
- When probe “fires” an action can conditionally (predicates) be run
- D language (“D Script”) borrows from C & AWK
- Zero impact when probe not enabled; Production safe!

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Probes

- List all probes via ‘dtrace -l’
- Most probes include at least an “entry” and “return” (or “start”/”done”, etc.)

```
root@ultra ~$ dtrace -l | wc -l
  127574

root@ultra ~$ dtrace -l
   ID   PROVIDER            MODULE                          FUNCTION NAME
    1     dtrace                                                 BEGIN
    2     dtrace                                                 END
    3     dtrace                                                 ERROR
    4        fbt              smbios                       smb_info entry
    5        fbt              smbios                       smb_info return
...
```

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Example: Syscall Provider

```
#!/usr/sbin/dtrace -s

syscall:::entry
{

}
```

```
$ sudo ./syscall-simple.d
dtrace: script './syscall-simple.d' matched 427 probes
CPU     ID                    FUNCTION:NAME
  1  17702                      ioctl:entry
  1  17702                      ioctl:entry
  1  17998                     __sysctl:entry
  1  17998                     __sysctl:entry
  1  17686                    sigaction:entry
  1  17686                    sigaction:entry
  1  17686                    sigaction:entry
  1  17686                    sigaction:entry

  1  17690                  sigprocmask:entry
```

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Syscall Part 2: Variables

```
#!/usr/sbin/dtrace -s

syscall:::entry
/ execname != "dtrace" /
{
        trace(execname);
}
```

```
$ sudo ./syscall-simple2.d
dtrace: script './syscall-simple2.d' matched 427 probes
CPU     ID                    FUNCTION:NAME
  0  17988                      mmap:entry    iTerm
  0  17740                    munmap:entry    iTerm
  0  18320                    kevent:entry    Stickies
  0  17974                     lstat:entry    fseventsd
  0  17974                     lstat:entry    fseventsd
  0  17974                     lstat:entry    fseventsd
  0  17974                     lstat:entry    fseventsd
  0  18034                getattrlist:entry    Stickies
```

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Syscall Part 3: Aggregations

```
#!/usr/sbin/dtrace -s

syscall:::entry
/ execname != "dtrace" /
{
        @foo[probefunc] = count();
}
```

```
$ sudo ./syscall-simple3.d
dtrace: script './syscall-simple3.d' matched 427 probes
^C

  __disable_threadsignal                                    1
  accept                                                    1
  access                                                    1
...
  sigaltstack                                              73
  sigprocmask                                              82
  close                                                  2574
```

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Syscall Part 4: Drilling Down

```
#!/usr/sbin/dtrace -s

syscall::close:entry
/ execname != "dtrace" /
{
        @foo[execname] = count();
}
```

```
$ sudo ./syscall-simple4.d
dtrace: script './syscall-simple4.d' matched 1 probe
^C

  syslogd                                                   4
  airport                                                   7
  iStumbler                                              2565
```

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Syscall Part 4: ustack

```
$ sudo ./syscall-simple5.d
dtrace: script './syscall-simple5.d' matched 1 probe
^C
```

```
#!/usr/sbin/dtrace -s

syscall::close:entry
/ execname == "iStumbler" /
{
        @close[ustack()] = count();
}
```

```
              libSystem.B.dylib`close$UNIX2003+0xa
              Foundation`-[NSConcretePipe dealloc]+0x3f
              CoreFoundation`CFRelease+0x5a
              CoreFoundation`__CFDictionaryDeallocate+0x119
              CoreFoundation`_CFRelease+0xd8
              Foundation`-[NSConcreteTask dealloc]+0x26
              CoreFoundation`CFRelease+0x5a
              Foundation`_taskDied+0xd9
              CoreFoundation`__CFFileDescriptorPerform+0x55
              CoreFoundation`CFRunLoopRunSpecific+0xf51
              CoreFoundation`CFRunLoopRunInMode+0x58
              Foundation`-[NSRunLoop(NSRunLoop) runMode:beforeD
              Foundation`-[NSRunLoop(NSRunLoop) run]+0x54
              RadioStore`-[RSScanner run:]+0x143
              Foundation`-[NSThread main]+0x2d
              Foundation`__NSThread__main__+0x134
              libSystem.B.dylib`_pthread_start+0x141
              libSystem.B.dylib`thread_start+0x22
                1
```

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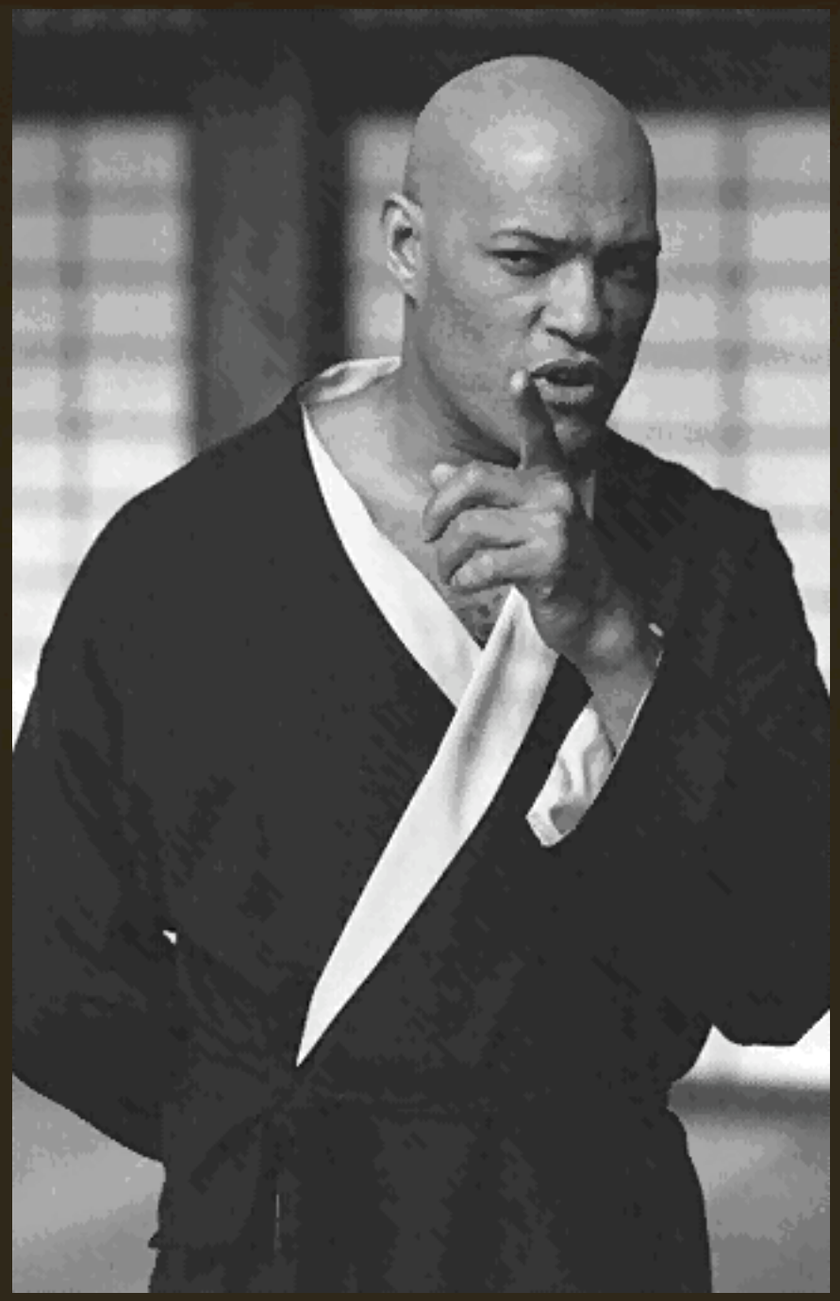

Free Your Mind.

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Statically Defined User Probes

- Probes can be explicitly embedded in your code
- Static probes improves user experience by providing them with a pre-defined listing of relevant probe points
- Simple to do:
  - Create .d source file defining your probes
  - Inserted DTRACE_PROBEn(arg0, arg1,...); macro at desired points
  - Generate a header file (dtrace -h..)
  - Recompile, running ‘dtrace -G’ prior to final link.

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The PID Provider

- PID Provider allows tracing of entry and return of functions within user applications (“Function Boundary Tracing”)
- NO MODIFICATIONS REQUIRED, PERIOD!
- Probe format example:
  - pid123:a.out:some_function:entry
  - pid123:mysqld:some_function:entry
  - pid123:::entry
  - pid123::*write*:return

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MySQL Internals... Buy it.

- PID provider allows us to peer into the entry or return of any function inside MySQL (or anything else), any version, no mods.
- .. you do know what all those functions do right?
- Copies of “MySQL Internals” (O’Reilly) or “Expert MySQL” (Apress) recommended.

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Watching Queries

```
#!/usr/sbin/dtrace -s

#pragma D option quiet

pid$target::*dispatch_command*:entry
{
        printf("Query: %s\n", copyinstr(arg2));
}
```

```
$ ./query_watch.d -p `pgrep -x mysqld`
Query: show tables
Query: select * from Country LIMIT 10
Query: explain user
Query: select Host,User,Password,Select_priv from user where User = 'benr'
Query: blah blah blah....
```

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Counting Queries

```
#!/usr/sbin/dtrace -s

#pragma D option quiet

dtrace:::BEGIN
{
        printf("Tracing... Hit Ctrl-C to end.\n");
}

pid$target::*mysql_parse*:entry
{
        @query[copyinstr(arg1)] = count();
}
```

```
$ ./querycounts.d  -p `pgrep  -x mysqld`
Tracing... Hit Ctrl-C to end.
^C

  select * from CountryLanguage LIMIT 5                     1
  show tables                                               1
  select * from City                                        2
```

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Queries, Qcache, & Time

```
pid$target:mysqld:*dispatch_command*:entry
{
        self->query = copyinstr(arg2);
        self->start = timestamp;
}

pid$target:mysqld:*send_result_to_client*:entry
{
        self->cache = "Yes";
}

pid$target:mysqld:*do_select*:entry
{
        self->cache = "No";
}

pid$target:mysqld:*dispatch_command*:return
{
        this->end = timestamp;
        this->elapsed = (this->end - self->start)/1000000;
        printf("From Query Cache?: %s in %d ms \t| Query: %s\n", self->cache, this->elapsed, self->query);
        self->start = 0;
        self->query = 0;
}
```

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Queries, Qcache & Time: Output

```
$ ./my_qcache.d -p `pgrep -x mysqld`
Waiting for queries... hit ^c to quit.

From Query Cache?: No in 1 ms    | Query: SELECT * FROM Country
From Query Cache?:Yes in 0 ms    | Query: SELECT * FROM Country
From Query Cache?: No in 48 ms   | Query: select * from City where CountryCode = 'USA'
From Query Cache?:Yes in 0 ms    | Query: select * from City where CountryCode = 'USA'
From Query Cache?: No in 16 ms   | Query: select * from City where CountryCode LIKE 'USA%'
^C
```

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Watching MySQL Flow

```
#!/usr/sbin/dtrace -s

#pragma D option flowindent

pid$target:mysqld::entry
{
}
pid$target:mysqld::return
{
}
```

```
  -> _Z34create_thread_to_handle_connectionP3THD
    -> my_micro_time
    <- my_micro_time
  <- _Z34create_thread_to_handle_connectionP3THD
  -> handle_one_connection
    -> my_micro_time
    <- my_micro_time
    -> _Z34init_new_connection_handler_threadv
      -> my_thread_init
      <- my_thread_init
    <- _Z34init_new_connection_handler_threadv
  -> _Z31setup_connection_thread_globalsP3THD
    -> _ZN3THD13store_globalsEv
      -> _my_thread_var
      <- _my_thread_var
      -> thr_lock_info_init
        -> _my_thread_var
        <- _my_thread_var
      <- thr_lock_info_init
    <- _ZN3THD13store_globalsEv
  <- _Z31setup_connection_thread_globalsP3THD
  -> _Z9lex_startP3THD
    -> _ZN18st_select_lex_unit10init_queryEv
```

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Broadening the Scope

- DTrace and see the whole system at the same time allowing for correlations, such as...
- Trace physical IO, paging, etc, as a result of some action in the database
- Trace Firefox, Apache, PHP, and MySQL together to profile end-to-end. (On one system obviously.)

Static Probes in MySQL & THD

- PID provider is awesome, but can't look inside THD which can be limiting (May be possible, but no ones done it yet...)
- Tracing requires a knowledge of what your tracing... choosing which function to trace can be daunting.
- Static probes in MySQL would give us visibility into interesting aspects of THD where appropriate and make tracing much more straight forward.

Status of Probe Integration

- Sun frequently demo's probes in MySQL 5.0 but has not released a patch. They are not present in any release from anyone (Coolstack, etc.)
- Probes currently in the 6.0 tree, but... only a handful of probes and no arguments passed, making them effectively useless for anything but aggregate counting.
- Probes currently in Falcon, will be coming to more engines soon.

Resources

- DTrace Toolkit (System) by Brendan Gregg
- MySQL DTrace Toolkit (MySQL, PID) by Derek Crudgington
- “Solaris Dynamic Tracing Guide” (docs.sun.com)
- DTrace “Google Talk” (youtube)
- OpenSolaris DTrace Community (opensolaris.org)
- Search for “DTrace MySQL”

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Thank You.

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