Fix Bugs Faster Using Activity Tracing

Session 714
Eric Clements
Core OS Engineering
Overview
Overview

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Considerations
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Asynchronous Development
Asynchronous Development

XPC, GCD and NSOperationQueue simplify complex tasks
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XPC, GCD and NSOperationQueue simplify complex tasks
Difficult to debug and diagnose issues
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Debug tools have not kept pace
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Privilege separation exacerbates the problem
Debug tools have not kept pace
Existing logging mechanisms are insufficient
Diagnostic Challenges
Diagnostic Challenges

Daemon

9395 Thread_140181
9395 _dispatch_mgr_thread (in libdispatch.dylib)
9395 _dispatch_mgr_invoke (in libdispatch.dylib)
9395 kevent64 (in libsystem_kernel.dylib)

9395 Thread_140182
9395 _dispatch_sig_thread (in libdispatch.dylib)
9395 _dispatch_sigsuspend (in libdispatch.dylib)
9395 __sigsuspend_nocancel (in libsystem_kernel.dylib)
Diagnostic Challenges

There’s no way to tell that “Daemon” is blocking process “A” and “B”.

Process A

9395 Thread_140181
  9395 _dispatch_mgr_thread (in libdispatch.dylib)
  9395 _dispatch_mgr_invoke (in libdispatch.dylib)
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Process B

9395 Thread_140181
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    9395 kevent64 (in libsystem_kernel.dylib)

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Debugging Challenges
Debugging Challenges
Complexity of the OS

- Application
- opendirectory
- gssd
- securityd
Complexity of the OS
Complex Crashes
Complex Crashes

Program
- button click
- menu select
- key equiv
- menu select
- menu select

XPCService

Daemon
Complex Crashes

Your query cannot be completed at this time!
Goals
Goals

Include additional data in diagnostic reports
Goals

Include additional data in diagnostic reports
Reduce the time “guessing” what, where, and when
Goals

Include additional data in diagnostic reports
Reduce the time “guessing” what, where, and when
Understand interaction of actions over time
Goals

Include additional data in diagnostic reports
Reduce the time “guessing” what, where, and when
Understand interaction of actions over time
Lightweight and easy to use
Improving Crash Reports

Crashed Thread: 0  Dispatch queue: com.apple.main-thread

Exception Type: EXC_CRASH (SIGABRT)
Exception Codes: 0x0000000000000000, 0x0000000000000000

Breadcrumb Trail (reverse chronological seconds):
6      Query directory using NSRunLoop (Activity ID: 0x0000008f00000002)
15     Query directory using NSRunLoop

Thread 0 Crashed:: Dispatch queue: com.apple.main-thread
0   com.apple.Query-Directory 0x00000001000027ea -[QDAppDelegate query:foundResults:error:] + 554
1   com.apple.OpenDirectory 0x00007fff9066ec88 __delegate_callback + 388
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16  com.apple.AppKit 0x00007fff83c01a9e NSApplicationMain + 1778
17  com.apple.Query-Directory 0x0000000100001a82 main + 34
18  libdyld.dylib 0x0000000100007f8e start + 1

Additional info about key events leading up to crash

Detailed messages associated with the crash point
OS X Performance

<table>
<thead>
<tr>
<th>Device Type</th>
<th>NSLog</th>
<th>syslog</th>
<th>Activity tracing</th>
</tr>
</thead>
<tbody>
<tr>
<td>MacPro 2008</td>
<td>137</td>
<td>87</td>
<td>15</td>
</tr>
<tr>
<td>MacBookPro 15&quot; Late 2013</td>
<td>75</td>
<td>62</td>
<td>10</td>
</tr>
<tr>
<td>iMac 27&quot;</td>
<td>62</td>
<td>41</td>
<td>6</td>
</tr>
</tbody>
</table>
iOS Performance

<table>
<thead>
<tr>
<th>Device</th>
<th>Microseconds</th>
<th>NSLog</th>
<th>syslog</th>
<th>Activity tracing</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPhone 4s</td>
<td>1732</td>
<td></td>
<td>539</td>
<td>6</td>
</tr>
<tr>
<td>iPhone 5c</td>
<td>1109</td>
<td></td>
<td>291</td>
<td>2</td>
</tr>
<tr>
<td>iPad Air</td>
<td>1225</td>
<td></td>
<td>309</td>
<td>2</td>
</tr>
</tbody>
</table>
Terminology

- Program
  - button click
  - menu select
  - key equiv
  - menu select
- XPCService
- Daemon

Activity
Terminology

Program
- Send mail: button click
- menu select
- key equiv
- menu select

XPCService
- menu select

Daemon
- menu select

Activity

Breadcrumb
**Terminology**

Diagram showing the flow of actions:

- Program:
  - Send mail: menu select, button click
  - Compose mail: menu select

- XPCService:
  - key equiv

- Daemon:
  - Trace messages
Activities
What is an Activity?
What is an Activity?

Set of work triggered by an action
What is an Activity?

Set of work triggered by an action
Explicitly defined set of work
System Activity
System Activity

System generated 64-bit identifier (AID)
System Activity

System generated 64-bit identifier (AID)
Autopropagated by the system
System Activity

System generated 64-bit identifier (AID)
Autopropagated by the system
System Activity

System generated 64-bit identifier (AID)
Autopropagated by the system
Activities Over Time
Activities Over Time

Program
- button click (AID: 5)
- menu select (AID: 4)
- key equiv (AID: 3)
- menu select (AID: 2)
- menu select (AID: 1)

XPCService
- (AID: 5)

Daemon
- (AID: 5)

XPCService
- (AID: 3)

Daemon
- (AID: 1)
Activity Creation
Activity Creation

Automatically generated by UIKit and AppKit for UI actions
Activity Creation

Automatically generated by UIKit and AppKit for UI actions
Explicitly created activities
Activity Creation

Automatically generated by UIKit and AppKit for UI actions
Explicitly created activities
Detached activities
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Automatically generated by UIKit and AppKit for UI actions
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Explicitly created activities
Detached activities
Initiating Activities
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os_activity_initiate("Activity Name", flags, ^{ });
Initiating Activities

os_activity_initiate("Activity Name", flags, ^{ });

• Activity name must be a constant string
Initiating Activities

```c
os_activity_initiate("Activity Name", flags, ^{ });
```

- Activity name must be a constant string
- Optional flags to control behavior
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- Non block variants available
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```
#include <os/activity.h>
```
## Automatically Generated Activities

<table>
<thead>
<tr>
<th>Process</th>
<th>AppKit / UIKit</th>
<th>Process Callback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: The table is incomplete and requires additional information.*
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<td><code>os_activity_start();</code></td>
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</tr>
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<tr>
<td><img src="image" alt="Search Bar" /></td>
<td>os_activity_start();</td>
<td>-(IBAction)searchField:(id)sender { results = [self searchString: searchValue]; ... }</td>
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### Automatically Generated Activities

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</tr>
<tr>
<td></td>
<td>os_activity_stop();</td>
<td>results = [self searchString: searchValue];</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>
Explicitly Create Activities

```c
#include <os/activity.h>

- (void)checkCaches {
    if (!verify) {
        /* a lot of work is done during initialization */
        os_activity_initiate("verifying cache", OS_ACTIVITY_FLAG_DEFAULT, ^{
            ..
        });
    }
}
```
Explicitly Create Activities

```
#include <os/activity.h>

- (void)checkCaches {
  if (!verify) {
    /* a lot of work is done during initialization */
    os_activity_initiate("verifying cache", OS_ACTIVITY_FLAG_DEFAULT, ^{
      ...
    });
  }
}
```
Detached Activity

```c
#include <os/activity.h>

-(IBAction) searchField:(id)sender {
    /* will be called with an activity already created */
    if (async_reindex) {
        os_activity_initiate("reindex", OS_ACTIVITY_FLAG_DETACHED, ^{
            /* issue re-index work detached from current activity */
            . . .
        });
    }

    /* issue lookup based on original request */
}
```
Detached Activity

#include <os/activity.h>

-(IBAction) searchField:(id)sender {
    /* will be called with an activity already created */
    if (async_reindex) {
        os_activity_initiate("reindex", OS_ACTIVITY_FLAG_DETACHED, ^{
            /* issue re-index work detached from current activity */
            ...
        });
    }
    /* issue lookup based on original request */
}
Breadcrumbs
Breadcrumbs

Label meaningful activities
Breadcrumbs

Label meaningful activities
Macrolevel interactions over time
Breadcrumbs

Label meaningful activities
Macrolevel interactions over time

- Button click
- Menu select
- Key equivalent
- Menu select
- Menu select
Breadcrumbs

Label meaningful activities
Macrolevel interactions over time

Send mail  Button click
Menu select
Key equivalent
Menu select
Compose mail  Menu select
Adding a Breadcrumb
Adding a Breadcrumb

```c
os_activity_set_breadcrumb("composing mail");
```
Adding a Breadcrumb

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os_activity_set_breadcrumb("composing mail");
```

- Only supported by main process binary
Adding a Breadcrumb

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os_activity_set_breadcrumb("composing mail");
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- Only supported by main process binary
- Cannot be done from libraries, plugins, etc.
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- Constant string must be provided
Adding a Breadcrumb

os_activity_set_breadcrumb("composing mail");

• Only supported by main process binary
• Cannot be done from libraries, plugins, etc.
• Constant string must be provided
  
  #include <os/activity.h>
Breadcrumb Example

#include <os/activity.h>

-(IBAction)searchField:(id)sender {
    if (useCache) {
        os_activity_set_breadcrumb(“searching cache”);
        db = [self _cache];
    } else {
        os_activity_set_breadcrumb(“searching database”);
        db = [self _database];
    }
    [db search:sender];
}
Breadcrumb Example

```c
#include <os/activity.h>

-(IBAction)searchField:(id)sender {
    if (useCache) {
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    }
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#include <os/activity.h>

- (IBAction)searchField:(id)sender {
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    }
    [db search:sender];
}
Trace Messages
Trace Messages
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New API to add trace messages to an activity
Trace Messages

New API to add trace messages to an activity
Uses standard printf-style format strings
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Adjustable behavior
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Adjustable behavior
Stored in an in-memory ring buffer
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<table>
<thead>
<tr>
<th>PC</th>
<th>Timestamp</th>
<th>String Offset</th>
<th>Data1</th>
<th>Data2</th>
<th>⋮</th>
<th>(64-bytes)</th>
</tr>
</thead>
<tbody>
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Trace Message

os_trace("Interface %ld state %d", ifindex, state);
Trace Message

os_trace("Interface %ld state %d", ifindex, state);

• Supports printf-style format strings
os_trace("Interface %ld state %d", ifindex, state);

- Supports printf-style format strings
- Only scalar format types
Trace Message

```c
os_trace("Interface %ld state %d", ifindex, state);
```

- Supports printf-style format strings
- Only scalar format types
- Strings and characters are not supported for privacy, performance, and security
Trace Message

```
#include <os/trace.h>

os_trace("Interface %ld state %d", ifindex, state);
• Supports printf-style format strings
• Only scalar format types
• Strings and characters are not supported for privacy, performance, and security
```
Debug Trace Message
Debug Trace Message

os_trace_debug("Open socket %d total time %2.3f ms", sock, ttime);
Debug Trace Message

os_trace_debug("Open socket %d total time %2.3f ms", sock, ttime);

• Only saved to ring buffer under debug mode
Debug Trace Message

```c
os_trace_debug(“Open socket %d total time %2.3f ms”, sock, ttime);
```

- Only saved to ring buffer under debug mode
- Additional resources used if debug mode is enabled
Debug Trace Message

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os_trace_debug(“Open socket %d total time %2.3f ms”, sock, ttime);
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- Only saved to ring buffer under debug mode
- Additional resources used if debug mode is enabled
- Setting environment variable will enable debug at launch
Debug Trace Message

```
os_trace_debug("Open socket %d total time %2.3f ms", sock, ttime);
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- Only saved to ring buffer under debug mode
- Additional resources used if debug mode is enabled
- Setting environment variable will enable debug at launch
  
  ```
  OS_ACTIVITY_MODE=debug
  ```
Payload Trace Message
Payload Trace Message

os_trace_with_payload("Interface: %ld", ifindex, ^(xpc_object_t xdict) {
    xpc_dictionary_set_string(xdict, "ifname", ifname);
});
Payload Trace Message

```c
os_trace_with_payload("Interface: %ld", ifindex, ^(xpc_object_t xdict) {
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- Block is only called if tools have enabled stream mode
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- Block is only called if tools have enabled stream mode
- Uses XPC to deliver message to diagnosticd
Payload Trace Message

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- Block is only called if tools have enabled stream mode
- Uses XPC to deliver message to diagnosticd
- Setting environment variable will enable stream mode at launch
Payload Trace Message

```c
os_trace_with_payload("Interface: %ld", ifindex, ^(xpc_object_t xdict) {
    xpc_dictionary_set_string(xdict, "ifname", ifname);
});
```

- Block is only called if tools have enabled stream mode
- Uses XPC to deliver message to diagnosticd
- Setting environment variable will enable stream mode at launch
  
  `OS_ACTIVITY_MODE=stream`
Trace Messages

Program
- Send mail (button click)
- menu select
- key equivalent
- menu select
- menu select

XPCService
- key equivalent
- menu select

Daemon

Breadcrumb
- Trace Messages
Trace Messages

- Program: Send mail (button click), menu select, key equivalent, menu select, menu select
- XPCService: button click, key equivalent, menu select
- Daemon: button click, key equivalent, menu select

Activities: Activity, Breadcrumb, Trace messages
Sample Crash

Crashed Thread: 0 Dispatch queue: com.apple.main-thread

Exception Type: EXC_CRASH (SIGABRT)
Exception Codes: 0x0000000000000000, 0x0000000000000000

Additional info about key events leading up to crash

Thread 0 Crashed:: Dispatch queue: com.apple.main-thread
0 com.apple.Query-Directory  0x0000000001000000 + 554
1 com.apple.OpenDirectory  0x0000000007fff9066ec88 + 388
2 com.apple.CFOpenDirectory  0x0000000007fff8d750bed + 568
3 com.apple.CoreFoundation  0x0000000007fff8d74e1f1 + 17
...
16 com.apple.AppKit  0x0000000007ff83c01a9e + 1778
17 com.apple.Query-Directory  0x000000000100001a82 + 34
18 libdyld.dylib  0x0000000007ff874af5c9 + 1

Detailed messages associated with the crash point
Sample Crash

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17  com.apple.Query-Directory 0x0000000100001a82 main + 34
18  libdyld.dylib 0x00007fff874af5c9 start + 1

Activity ID: 0x0000008f00000002
Activity Name: sendAction:
Activity Breadcrumb: Query directory using NSRunLoop
Activity Running Time: 6.028601 sec
Activity Failure Reason: none detected

Trace Messages (reverse chronological seconds):
5.866399 Query Directory 0x0000000100000000 IPC send
5.866463 Query Directory 0x00000001000027e0 aborting test due to no results
5.866529 Query Directory 0x0000000100000000 IPC send
5.866564 Query Directory 0x0000000100002243 skipping record with UID 210 (not member of 'admin')
5.866583 opendirectoryd 0xffffffff00000000 IPC send
5.866596 opendirectoryd 0xffffffff00021c21 request completed, delivered 1 results
• • •
5.866803 opendirectoryd 0xffffffff00021640 UID: 4129, EUID: 4129, GID: 11, EGID: 11
5.866863 opendirectoryd 0xffffffff00000000 IPC receive
5.866883 Query Directory 0x0000000100000000 IPC send
Sample Crash

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Activity Name:           sendAction:
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5.866564     Query Directory            0x0000000100002243 skipping record with UID 210 (not member of 'admin')
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5.866596     opendirectoryd             0xffffffff000021c21 request completed, delivered 1 results
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5.866863     opendirectoryd             0xffffffff00000000 IPC receive
5.866883     Query Directory            0x0000000100000000 IPC send

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5.866529     Query Directory            0x0000000100000000 IPC send
5.866564     Query Directory            0x0000000100002243 skipping record with UID 210 (not member of 'admin')
5.866583     opendirectoryd             0xffffffff00000000 IPC send
5.866596     opendirectoryd             0xffffffff000021c21 request completed, delivered 1 results
• • •
5.866803     opendirectoryd             0xffffffff00021640 UID: 4129, EUID: 4129, GID: 11, EGID: 11
5.866863     opendirectoryd             0xffffffff00000000 IPC receive
5.866883     Query Directory            0x0000000100000000 IPC send
Crashing Process

Diagram showing the sequence of events:
- Send mail
  - button click
  - menu select
  - key equivalent
  - menu select
- Compose mail
  - menu select
- XPCService
- Daemon
- diagnosticd
  - Send mail
    - button click
  - Compose mail

Legend:
- Green: Activity
- Red: Breadcrumb
- Orange: Trace messages
Reporting Unexpected Errors
Reporting Unexpected Errors

os_trace_error("Interface %ld failed error %d", ifindex, errno);
Reporting Unexpected Errors

os_trace_error("Interface %ld failed error %d", ifindex, errno);

• Signals that an error occurred
Reporting Unexpected Errors

os_trace_error("Interface %ld failed error %d", ifindex, errno);

- Signals that an error occurred
- Trace messages are sent to diagnosticd
Reporting Fatal Errors
Reporting Fatal Errors

os_trace_fault("invalid state %d – will likely crash", state);
Reporting Fatal Errors

```
os_trace_fault("invalid state %d - will likely crash", state);
```

- Could be impending catastrophic failure (assert, abort, or crash)
Reporting Fatal Errors

os_trace_fault("invalid state %d - will likely crash", state);

• Could be impending catastrophic failure (assert, abort, or crash)
• Trace messages from all involved processes sent to diagnosticd
Utilizing Faults

- Program
  - Send mail: button click
  - menu select
  - key equivalent
  - menu select
  - menu select

- XPCService

- Daemon

Activity

Breadcrumb

Trace messages
Utilizing Faults

Diagram showing the flow of actions:
- Program: Compose mail, menu select, key equivalent, menu select, Send mail (button click)
- XPCService: menu select, key equivalent, menu select
- Daemon: menu select
- diagnosticd: Send mail (button click), Compose mail
#include <os/trace.h>
#include <os/activity.h>

int main(int argc, char *argv[]) {
    os_activity_initiate("startup initialization", 0, ^{
        os_trace_debug("passed %d args", argc);
        if (!_do_initialization(argc, argv)) {
            os_trace_fault("failed to initialize %d", errno);
            errx(EX_SOFTWARE, "failed to initialize");
        }
    });
}

Example Fault

```c
#include <os/trace.h>
#include <os/activity.h>

int main(int argc, char *argv[]) {
    os_activity_initiate("startup initialization", 0, ^{
        os_trace_debug("passed %d args", argc);
        if (!do_initialization(argc, argv)) {
            os_trace_fault("failed to initialize %d", errno);
            errx(EX_SOFTWARE, "failed to initialize");
        }
    });
}
```
Supported Trace Messages
Supported Trace Messages

```c
os_trace("Running as UID: %d, GID: %d", geteuid(), getegid());
"Running as UID: 501, GID: 20"
```
Supported Trace Messages

os_trace("Running as UID: %d, GID: %d", geteuid(), getegid());
"Running as UID: 501, GID: 20"

os_trace("Initialization phase - state: %d, flags: %ld", state, flags);
"Initialization phase - state: 32, flags: 2328"
Supported Trace Messages

\[
\text{os\_trace("Running as UID: \%d, GID: \%d", geteuid(), getegid());}
\text{Running as UID: 501, GID: 20''}
\]

\[
\text{os\_trace("Initialization phase - state: \%d, flags: \%ld", state, flags);}
\text{Initialization phase - state: 32, flags: 2328''}
\]

\[
\text{os\_trace("New client connection: \%p, idle\text{-}disconnect: \%d", connection, idle);}
\text{New client connection: 0x23211382, idle\text{-}disconnect: 30''}
\]
Supported Trace Messages

os_trace("Running as UID: %d, GID: %d", geteuid(), getegid());
"Running as UID: 501, GID: 20"

os_trace("Initialization phase - state: %d, flags: %ld", state, flags);
"Initialization phase - state: 32, flags: 2328"

os_trace("New client connection: %p, idle-disconnect: %d", connection, idle);
"New client connection: 0x23211382, idle-disconnect: 30"

os_trace("Clients active: %d, average: %2.3f seconds", count, avg);
"Client max: 30, average: 35.253 seconds"
Unsupported Trace Messages
Unsupported Trace Messages

os_trace("Logged in as user %s on host %s", username, hostname);
"Logged in as user UNSUPPORTED_STRING on host UNSUPPORTED_STRING"
Unsupported Trace Messages

os_trace("Logged in as user %s on host %s", username, hostname);
"Logged in as user UNSUPPORTED_STRING on host UNSUPPORTED_STRING"

os_trace("Logged in as UID %d, password: %s", geteuid(), password);
"Logged in as UID 501, password: UNSUPPORTED_STRING"
Unsupported Trace Messages

os_trace("Logged in as user %s on host %s", username, hostname);
"Logged in as user UNSUPPORTED_STRING on host UNSUPPORTED_STRING"

os_trace("Logged in as UID %d, password: %s", geteuid(), password);
"Logged in as UID 501, password: UNSUPPORTED_STRING"

os_trace("Logged in using initial %c", initial[0]);
"Logged in using initial UNSUPPORTED_CHAR"
There are Limits
There are Limits

The format string cannot exceed 100 characters
There are Limits

The format string cannot exceed 100 characters
Trace message content has a limit and will truncate if exceeded
There are Limits

The format string cannot exceed 100 characters
Trace message content has a limit and will truncate if exceeded
• os_trace API will accept a maximum of 7 scalar values
There are Limits

The format string cannot exceed 100 characters
Trace message content has a limit and will truncate if exceeded
• os_trace API will accept a maximum of 7 scalar values
Trace message buffer size may vary by platform and mode
Demo
Crash reports
Debugger Support
Debugger Support

Current activity running on thread
Debugger Support

Current activity running on thread
Trace messages for thread with an activity
Using lldb

(lldb) thread info
thread #1: tid = 0x1c93, 0x00007fff9452a37a
libsystem_kernel.dylib`__pthread_kill + 10, queue = 'com.apple.main-thread',
activity = 'sendAction:', 5 messages, stop reason = signal SIGABRT

Activity 'sendAction:', 0x4d00000002
Current Breadcrumb: Query directory using NSRunLoop
5 trace messages:
  aborting test due to no results
  skipping record with UID 210 (not member of 'admin')
  IPC send
  issued query
  canceling previous query for mode: 0
Using lldb

(lldb) thread info
thread #1: tid = 0x1c93, 0x00007fff9452a37a
libsystem_kernel.dylib`__pthread_kill + 10, queue = 'com.apple.main-thread',
activity = 'sendAction:', 5 messages, stop reason = signal SIGABRT

Activity 'sendAction:', 0x4d00000002

Current Breadcrumb: Query directory using NSRunLoop

5 trace messages:
  aborting test due to no results
  skipping record with UID 210 (not member of 'admin')
  IPC send
  issued query
  canceling previous query for mode: 0
Using lldb

(llldb) thread info
thread #1: tid = 0x1c93, 0x00007fff9452a37a
libsystem_kernel.dylib`__pthread_kill + 10, queue = 'com.apple.main-thread',
activity = 'sendAction:', 5 messages, stop reason = signal SIGABRT

Activity 'sendAction:', 0x4d00000002
Current Breadcrumb: Query directory using NSRunLoop
5 trace messages:
  aborting test due to no results
  skipping record with UID 210 (not member of 'admin')
  IPC send
  issued query
  canceling previous query for mode: 0
Demo
Xcode
Tools
ostraceutil
ostraceutil

Live streaming by process name or pid
ostraceutil

Live streaming by process name or pid
Watch for faults and errors
ostraceutil

Live streaming by process name or pid
Watch for faults and errors
Inspect binaries for various activity tracing strings
Live Streaming

[~] root% ostraceutil -watch -process Query\ Directory

PID: 640
Timestamp: 1141.218854
RELEASE
Activity ID: 0x0000000710000001
Trace ID: 0x00000100000047c7
Thread: 0x32a9
Image UUID: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
Image Path: /Demos/Query Directory.app/Contents/MacOS/Query Directory
Offset: 0x30a7
Message: 'issued query'
Payload: `<dictionary: 0x7fe7331004b0> { count = 1, contents =
    "queryString" => <string: 0x7fe733100580> { length = 1, contents = "z" } }

----------------------
Timestamp: 0.000000
DEBUG
Trace ID: 0x000000200000004a30
Offset: 0x291f
Message: 'query results received 1 more results'
----------------------
Timestamp: 1141.252109
RELEASE
Trace ID: 0x0000001000000046c0
Offset: 0x2243
Message: 'skipping record with UID 210 (not member of 'admin')'
Payload: `<dictionary: 0x7fe730404800> { count = 2, contents =
    "full name" => <string: 0x7fe730403dd0> { length = 18, contents = "AutoTimeZoneDaemon" }
    "name" => <string: 0x7fe730404910> { length = 9, contents = "_timezone" }

'
Live Streaming

[~] root% ostraceutil -watch -process Query\ Directory
PID: 640
Timestamp: 1141.218854

[~] root% ostraceutil -watch -process Query\ Directory
Trace ID: 0x0000001000000047c7
Thread: 0x32a9
Image UUID: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
Image Path: /Demos/Query Directory.app/Contents/MacOS/Query Directory
Offset: 0x30a7
Message: 'issued query'
Payload: '{
    "queryString" => <string: 0x7fe7331004b0> { length = 1, contents = "queryString" },
    "count" => 1
}'
----------------------
Timestamp: 0.000000
DEBUG
Trace ID: 0x000000200000004a30
Offset: 0x291f
Message: 'query results received 1 more results'
----------------------
Timestamp: 1141.252109
RELEASE
Trace ID: 0x0000001000000046c0
Offset: 0x2243
Message: 'skipping record with UID 210 (not member of 'admin')'
Payload: '{
    "fullName" => <string: 0x7fe733100580> { length = 18, contents = "AutoTime Zone Daemon" },
    "name" => <string: 0x7fe733100580> { length = 9, contents = "_timezone" }
}'
Live Streaming

```bash
[~] root% ostraceutil -watch -process Query\ Directory
PID: 640
Timestamp: 1141.218854
RELEASE
Activity ID: 0x0000007100000001
Trace ID: 0x00000100000047c7
Thread: 0x32a9
Image UUID: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
Image Path: /Demos/Query Directory.app/Contents/MacOS/Query Directory
Offset: 0x30a7
Payload: '<dictionary: 0x7fe7331004b0> { count = 1, contents =
  "queryString" => <string: 0x7fe733100580> { length = 1, contents = "z" }
}
```

```
Timestamp: 0.000000
DEBUG
Trace ID: 0x00000020000004a30
Offset: 0x291f
Message: 'query results received 1 more results'
```

```
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Timestamp: 1141.252109
RELEASE
Trace ID: 0x00000100000046c0
Offset: 0x2243
Message: 'skipping record with UID 210 (not member of 'admin')'
Payload: '<dictionary: 0x7fe730404800> { count = 2, contents =
  "full name" => <string: 0x7fe730403dd0> { length = 18, contents = "AutoTimezoneDaemon" }
  "name" => <string: 0x7fe730404910> { length = 9, contents = "_timezone" }
}
```
Watching Faults

[~] root% ostraceutil -watch -faults
Process:
=============
PID: 557
Image_uuid: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
Image_path: /Demos/Debug/Query Directory.app/Contents/MacOS/Query Directory

Application Breadcrumbs:
======================
Timestamp: 996.368669, Breadcrumb ID = 19072, Name = 'Query directory using NSOperationQueue', Activity ID: 0x0000005300000008
Timestamp: 1001.556305, Breadcrumb ID = 19040, Name = 'Query directory using NSRunLoop', Activity ID: 0x000000530000000d

Activity:
==========
Activity ID: 0x000000530000000d
Activity Name: sendAction:
Timestamp: 1001.556262
Reason: none detected

Messages:
==========
Timestamp: 1001.589870
RELEASE
Activity ID: 0x000000530000000d
Trace ID: 0x00000010000005d530
Thread: 0x2821
Image UUID: DECA11C7-EB99-3885-947E-42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
----------------------
Watching Faults

[~] root% ostraceutil -watch -faults
Process:
============
PID: 557
Image_uuid: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
Image_path: /Demos/Debug/Query Directory.app/Contents/MacOS/Query Directory

Application Breadcrumbs:
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Activity ID: 0x000000530000000d
Activity Name: sendAction:
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Activity ID: 0x000000530000000d
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Offset: 0x21c21
Message: 'request completed, delivered 1 results'
Considerations
Privacy
Privacy

Be conscious of privacy when adding trace messages
Privacy

Be conscious of privacy when adding trace messages
Never trace identifying information about a user or device
Propagation Failure

Diagram:
- Program
  - Send mail
    - button click
  - menu select
  - key equivalent
  - menu select
- XPCService
- Daemon
- Daemon
- XPCService

Legend:
- Activity
- Breadcrumb
- Trace messages
Propagation Failure

Program

Send mail: button click
menu select
key equivalent
menu select
Compose mail: menu select

XPCService

Daemon

Daemon

diagnosticd
Send mail: button click
Compose mail
## Support in Diagnostics

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<thead>
<tr>
<th></th>
<th>OS X Yosemite</th>
<th>iOS 8</th>
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<tbody>
<tr>
<td>Crash Reports</td>
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<td>Spin Reports</td>
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<td>llDb</td>
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</table>
Why Use Activity Tracing?
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Automatically included in diagnostic reports
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- Automatically included in diagnostic reports
- Debugger support
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Automatically included in diagnostic reports
Debugger support
Works on both iOS and OS X
Fast and efficient
Integrated with GCD, XPC, NSOperationQueue, and Foundation
Captures data that traditional logging mechanisms do not
Why Use Activity Tracing?

- Automatically included in diagnostic reports
- Debugger support
- Works on both iOS and OS X
- Fast and efficient
- Integrated with GCD, XPC, NSOperationQueue, and Foundation
- Captures data that traditional logging mechanisms do not
- Trace messages scoped to the action
More Information

Paul Danbold
Core OS Technologies Evangelist
danbold@apple.com

Apple Developer Forums
http://devforums.apple.com
## Related Sessions

<table>
<thead>
<tr>
<th>Session</th>
<th>Location</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving Your App with Instruments</td>
<td>Marina</td>
<td>Tuesday 4:30PM</td>
</tr>
<tr>
<td>Writing Energy Efficient Code, Part 1</td>
<td>Russian Hill</td>
<td>Wednesday 10:15AM</td>
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<tr>
<td>Writing Energy Efficient Code, Part 2</td>
<td>Russian Hill</td>
<td>Wednesday 11:30AM</td>
</tr>
<tr>
<td>User Privacy in iOS and OS X</td>
<td>Nob Hill</td>
<td>Thursday 2:00PM</td>
</tr>
<tr>
<td>Power, Performance and Diagnostics: What’s New in GCD and XPC</td>
<td>Russian Hill</td>
<td>Thursday 2:00PM</td>
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<tr>
<td>Labs</td>
<td>Core OS Lab B</td>
<td>Wednesday 2:00PM</td>
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<tr>
<td>Power and Performance Lab</td>
<td>Core OS Lab A</td>
<td>Thursday 3:15PM</td>
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<td>Power and Performance Lab</td>
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