Fix Bugs Faster Using Activity Tracing

Session 714
Eric Clements
Core OS Engineering

Overview

Overview

Background

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Background

Activities

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Activities

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Activities

Breadcrumbs

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Activities

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Trace messages

Tools

Overview

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Trace messages

Tools

Considerations

Background

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

Asynchronous Development

XPC, GCD and NSOperationQueue simplify complex tasks

Difficult to debug and diagnose issues

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)
   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)
```

Process B

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

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Daemon

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```
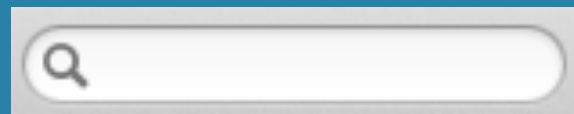
Debugging Challenges

Debugging Challenges
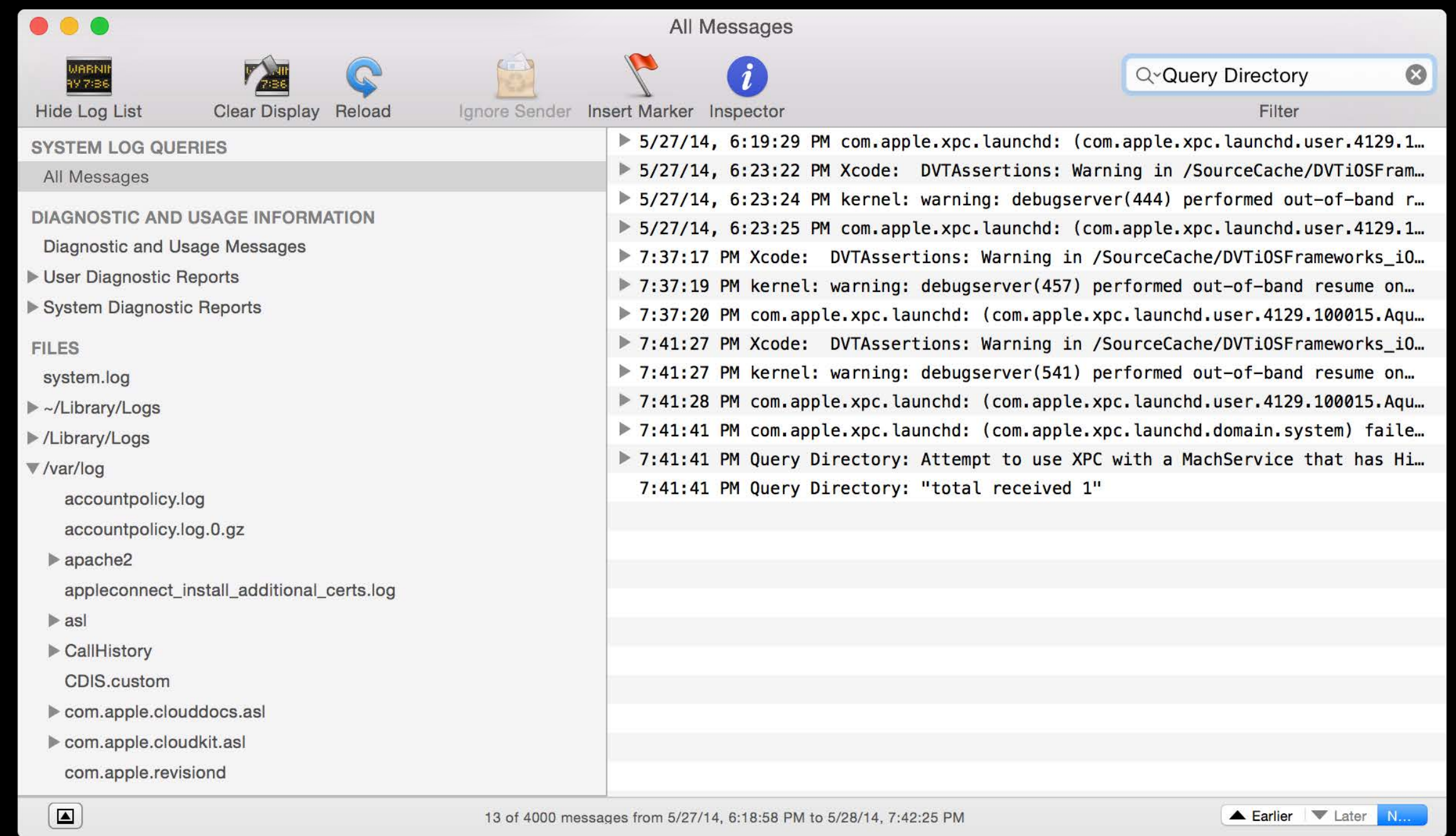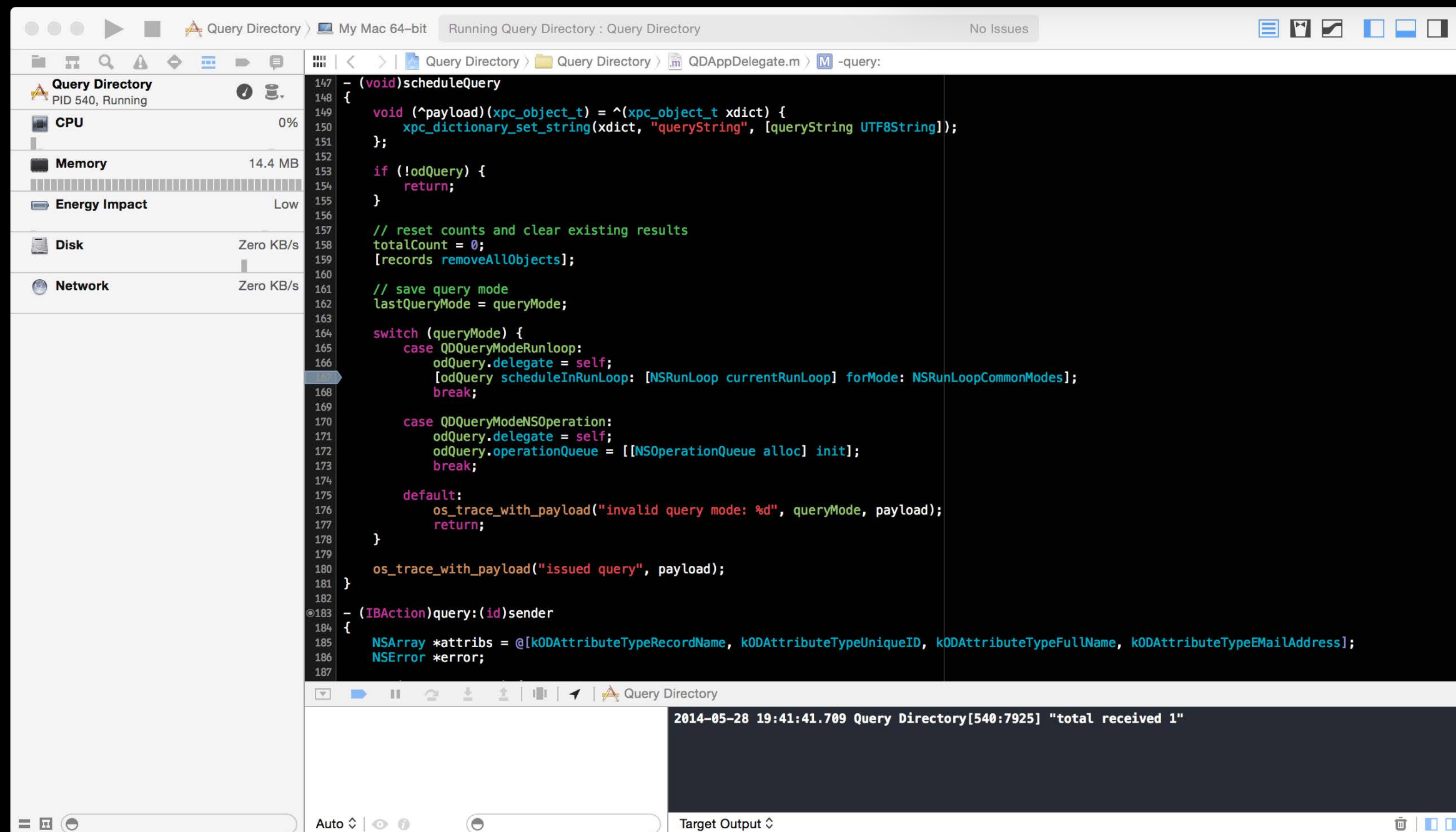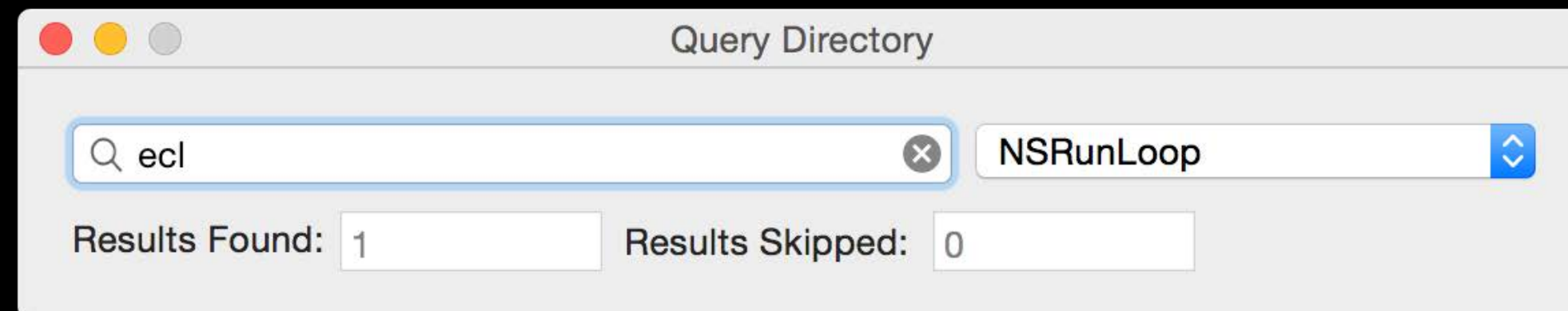
Complexity of the OS

Application

opendirectory

gssd

securityd

Complexity of the OS

Complex Crashes

Time

Program
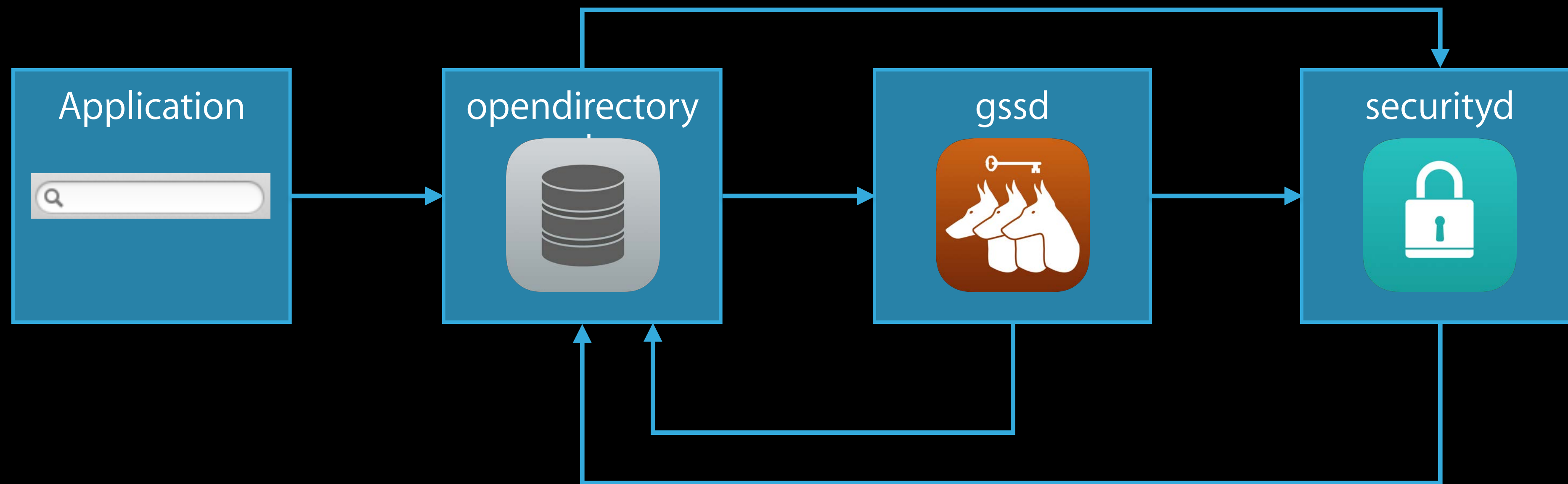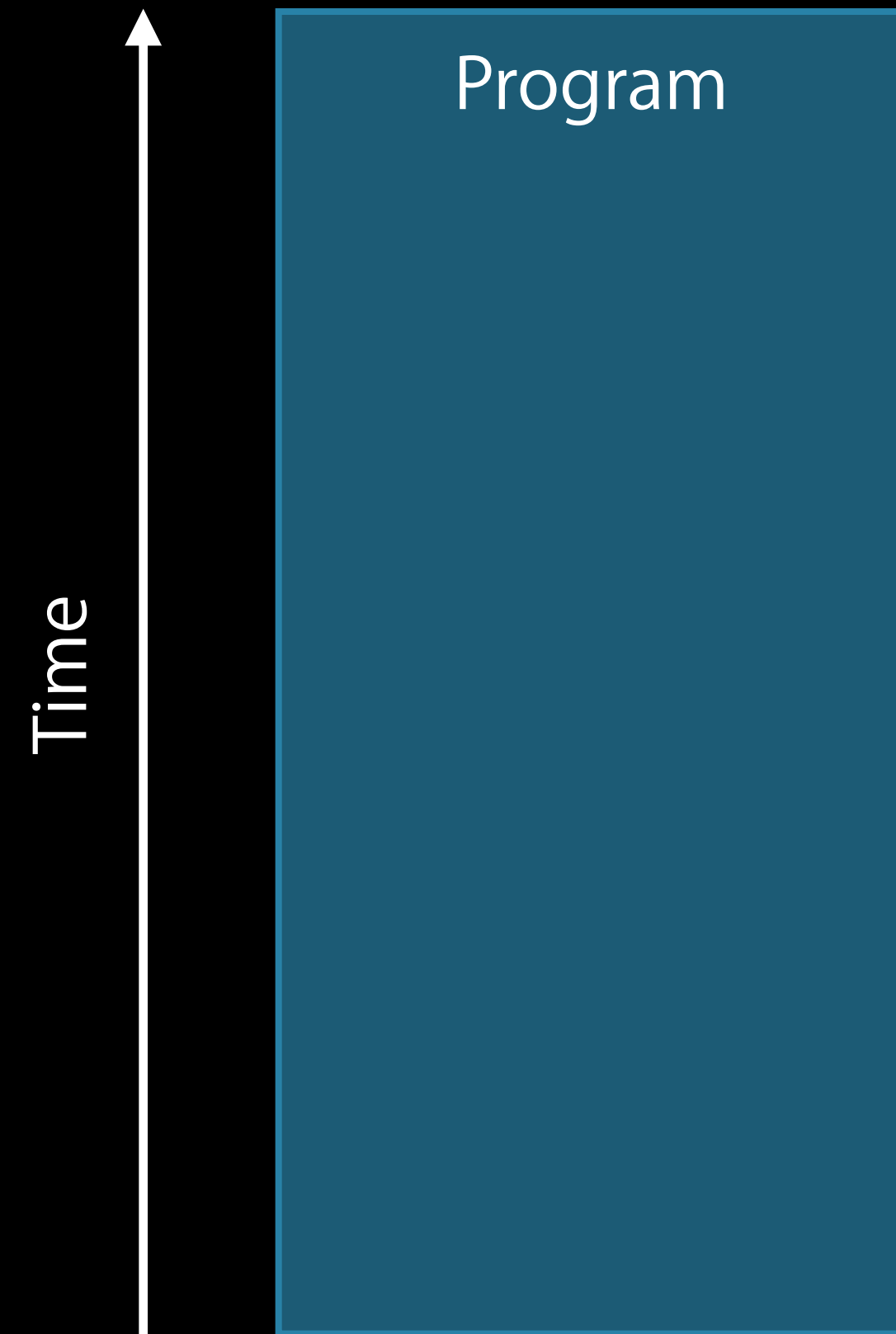
Complex Crashes

Complex Crashes

Time

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

Your query cannot be completed at this time!

XPCService

Daemon

Daemon
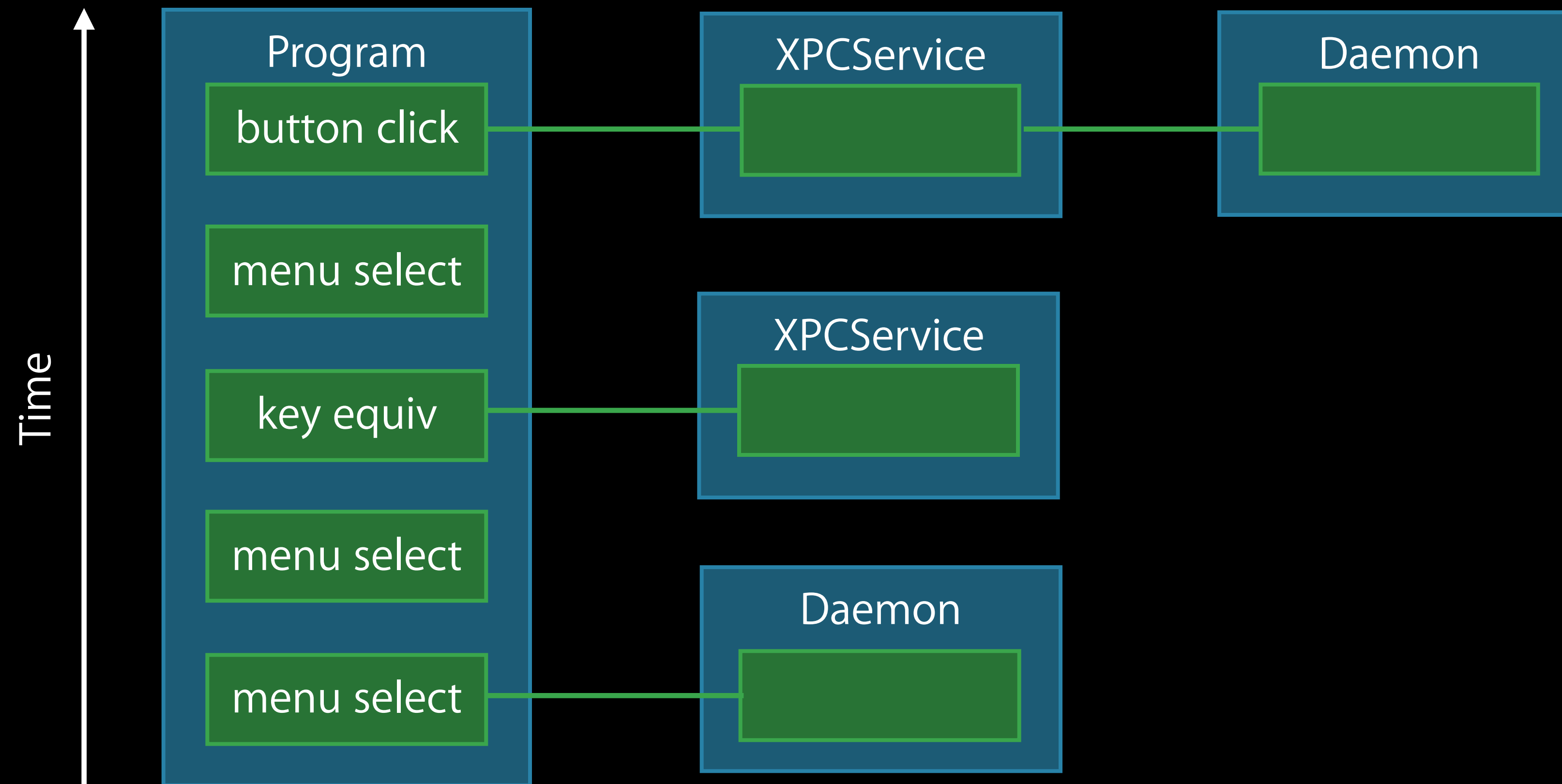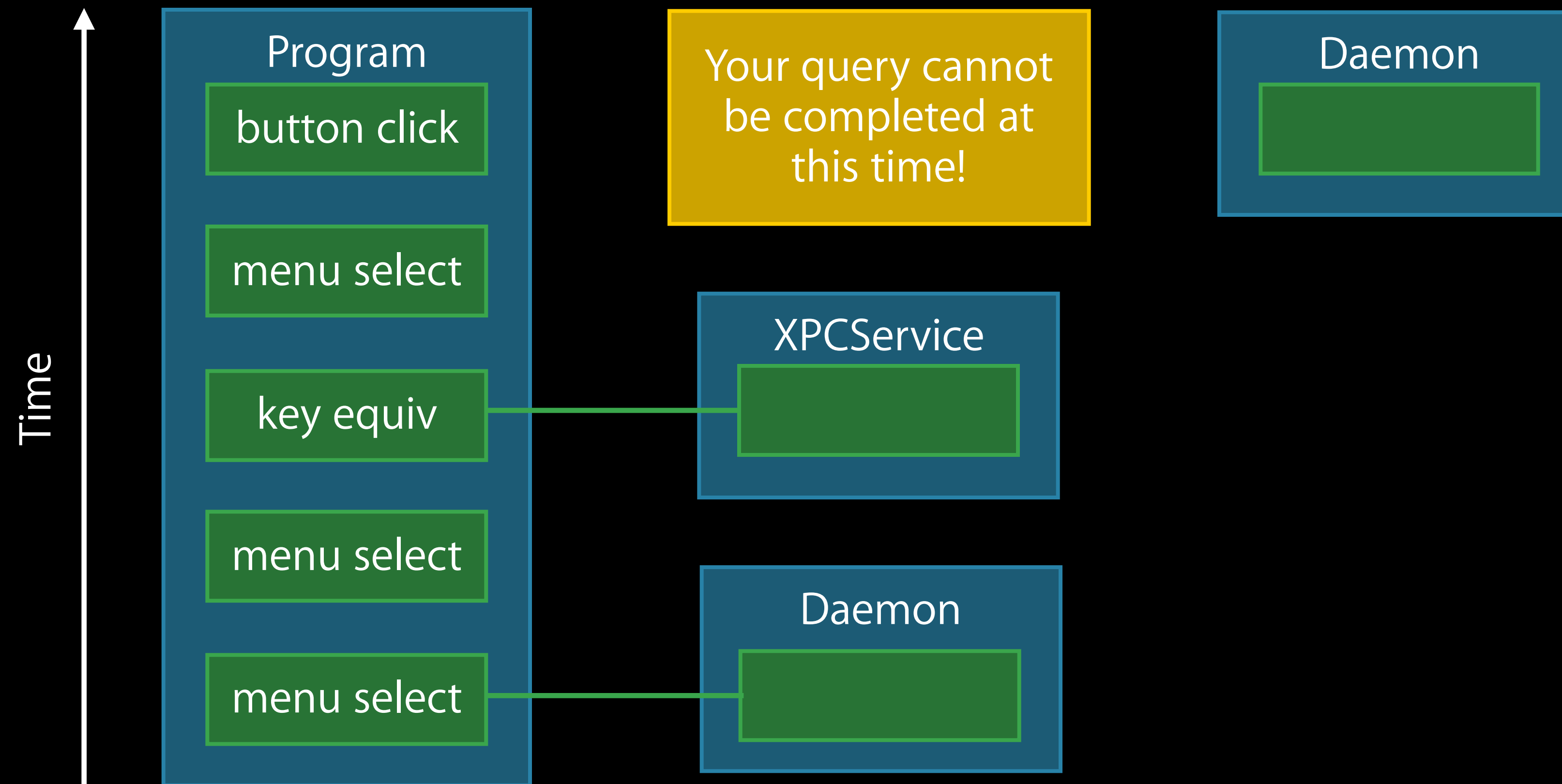
Goals

Goals

Include additional data in diagnostic reports

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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
```
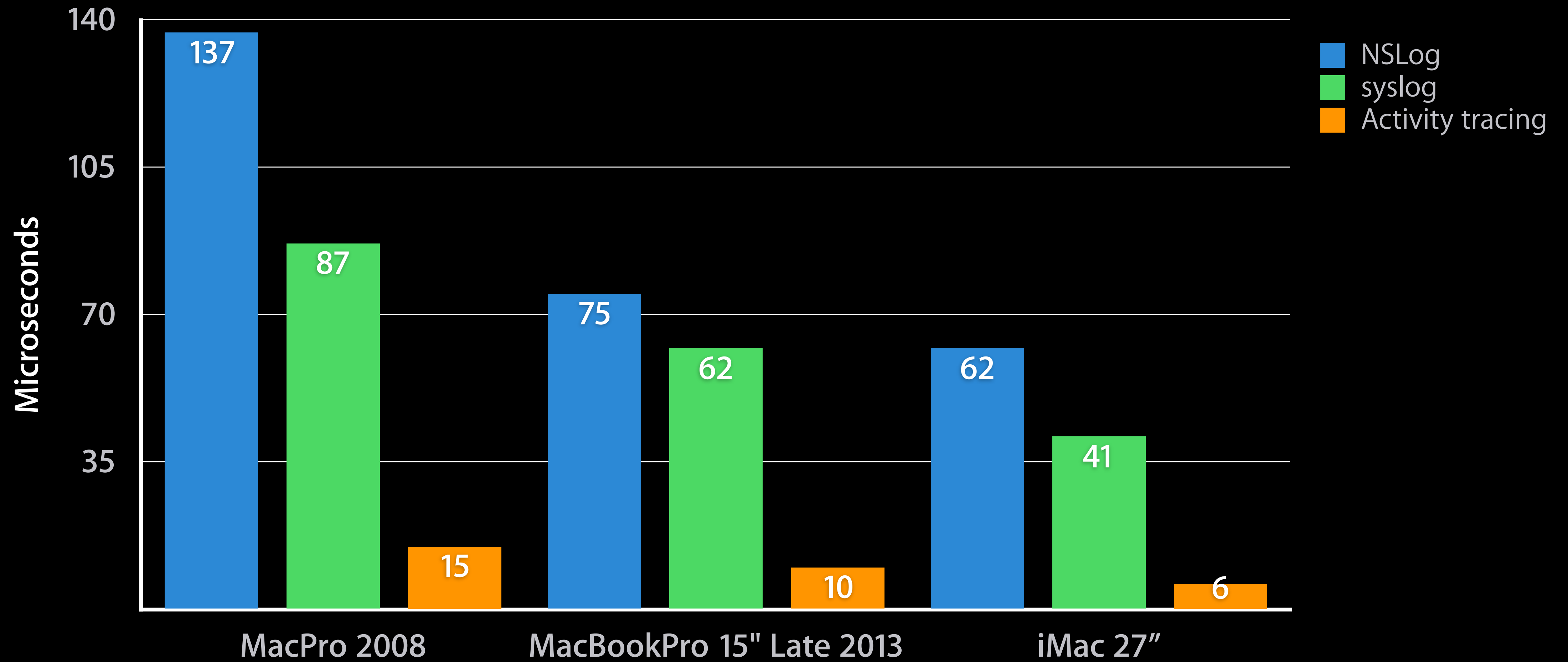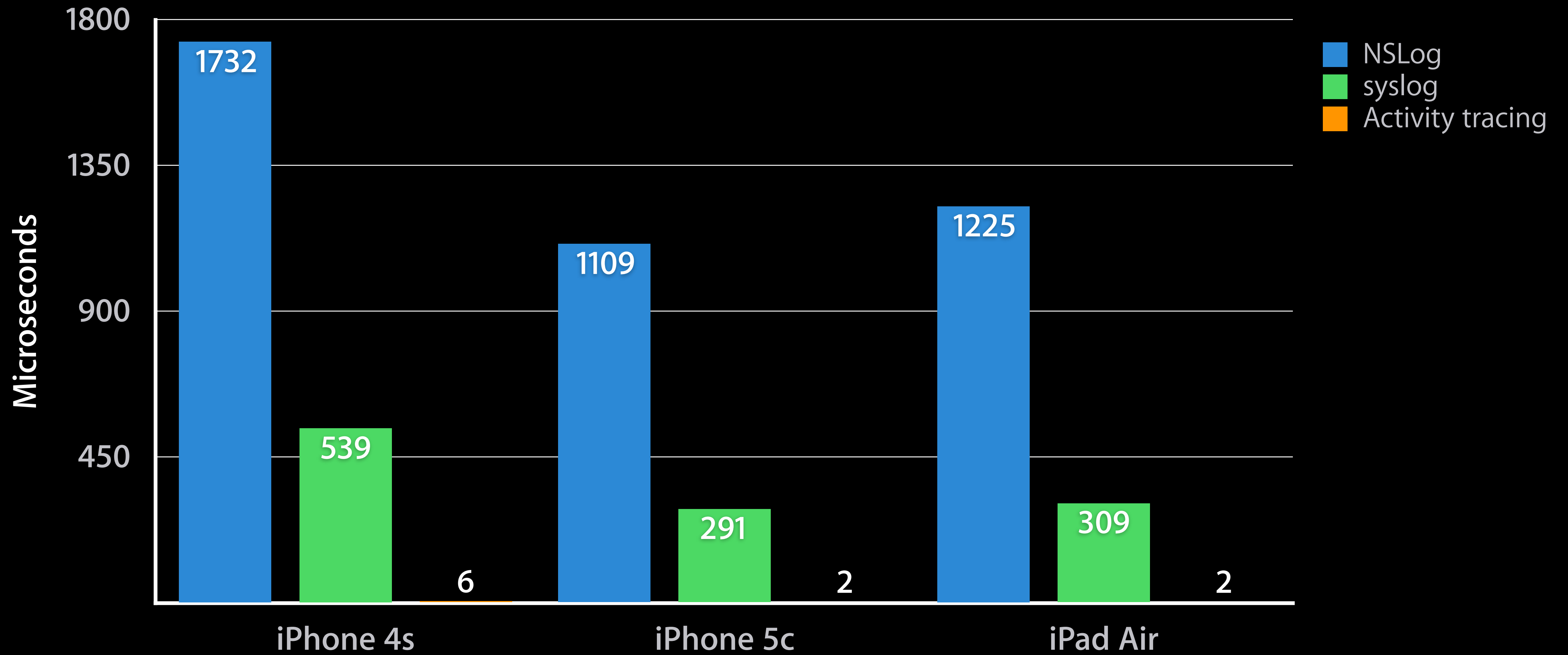
Additional info about key events leading up to crash

```
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
2   com.apple.CFOpenDirectory       0x00007fff84750bed _query_perform + 568
3   com.apple.CoreFoundation        0x00007fff8964e1f1 __CFRUNLOOP_IS_CALLING_OUT_TO_A_SOURCE0_PERFORM_FUNCTION__ + 17
• • •
16  com.apple.AppKit                0x00007fff83c01a9e NSApplicationMain + 1778
17  com.apple.Query-Directory       0x0000000100001a82 main + 34
18  libdyld.dylib                   0x00007fff874af5c9 start + 1
```

Detailed messages associated with the crash point

OS X Performance

iOS Performance

	iPhone 4s	iPhone 5c	iPad Air
NSLog	1732	1109	1225
syslog	539	291	309
Activity tracing	6	2	2

Microseconds

- NSLog
- syslog
- Activity tracing

Terminology

Time

Program

XPCService

XPCService

Daemon

Daemon

Terminology

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

Time
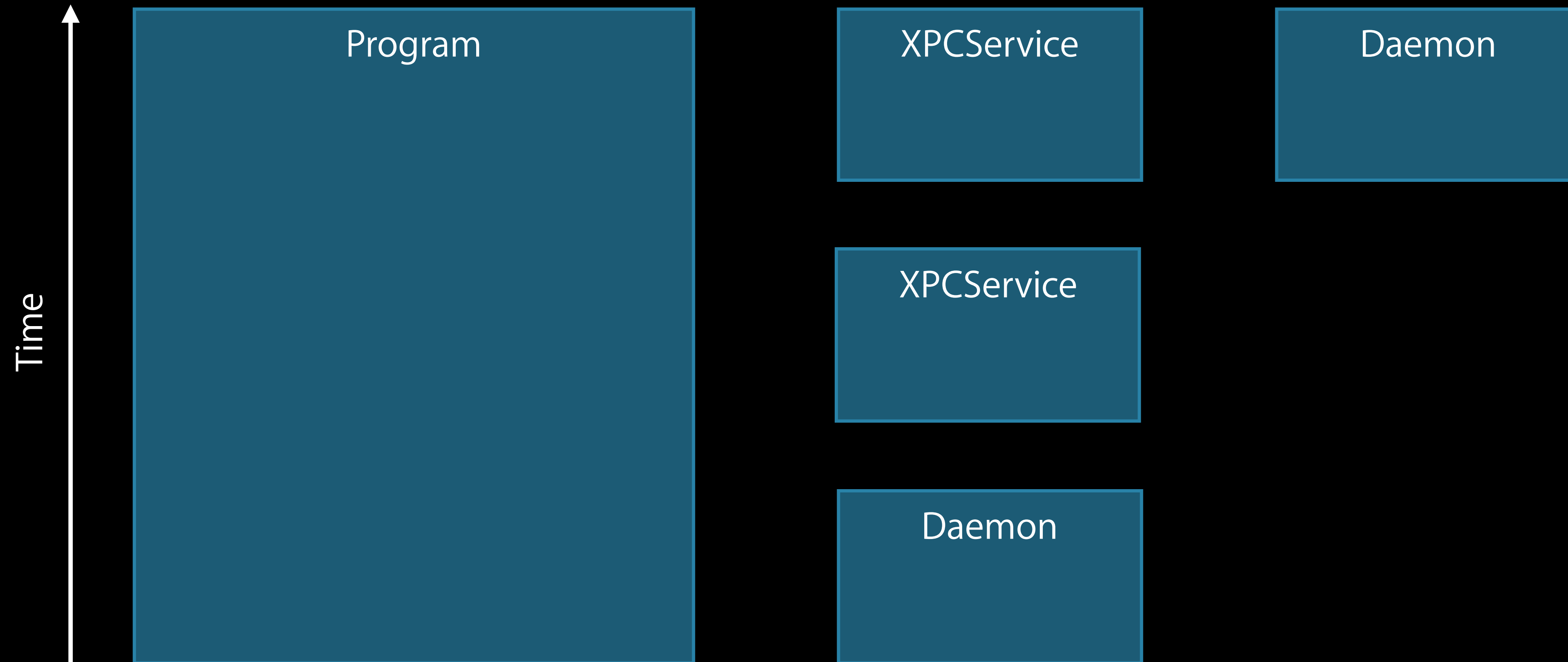
Activity

Terminology

Terminology

Program	
Send mail *(Breadcrumb)*	button click *(Activity)* — Trace messages
	menu select *(Activity)* — Trace messages
	key equiv *(Activity)* — Trace messages
	menu select *(Activity)* — Trace messages
Compose mail *(Breadcrumb)*	menu select *(Activity)* — Trace messages

XPCService — Activity / Trace messages
Daemon — Activity / Trace messages
XPCService — Activity / Trace messages
Daemon — Activity / Trace messages

Time

Legend:
- Activity (green)
- Breadcrumb (red)
- Trace messages (orange)
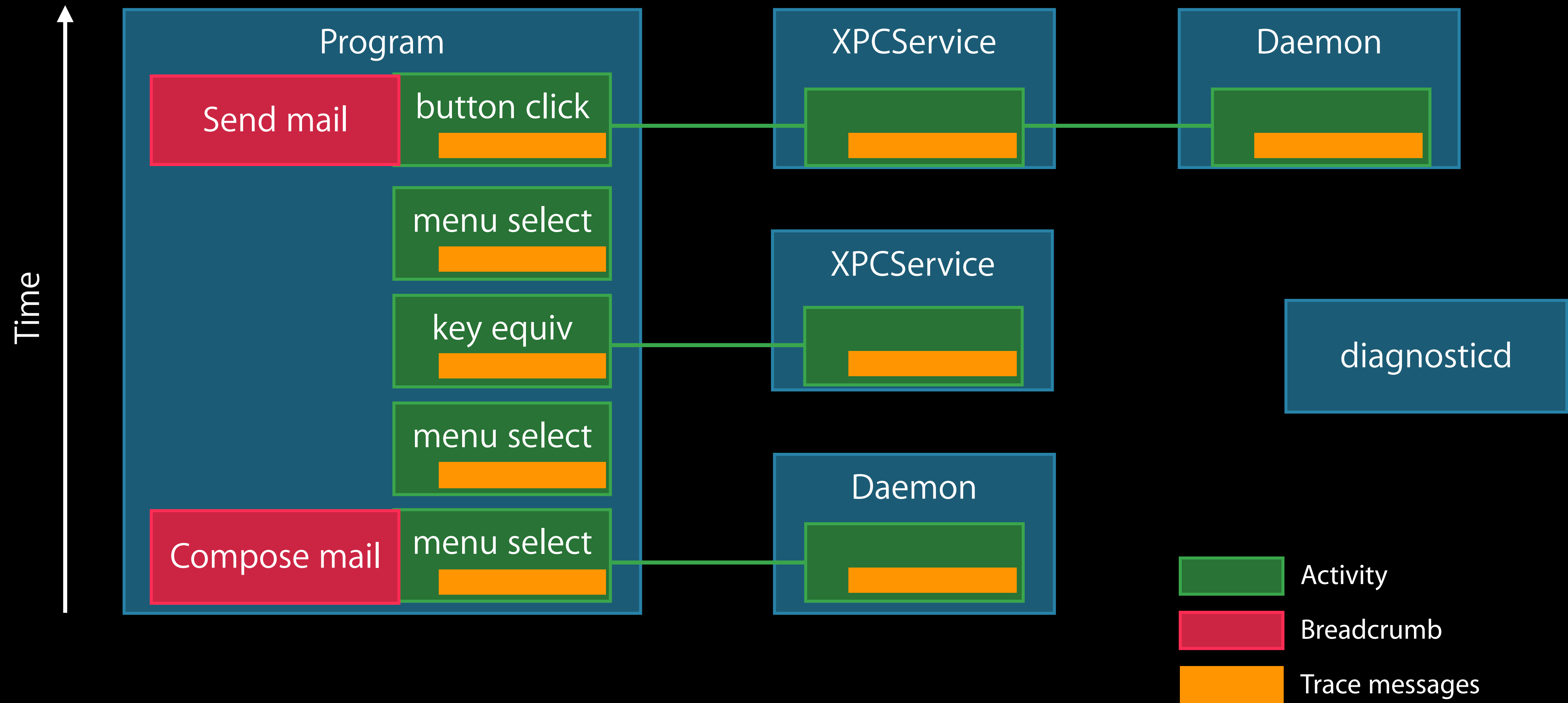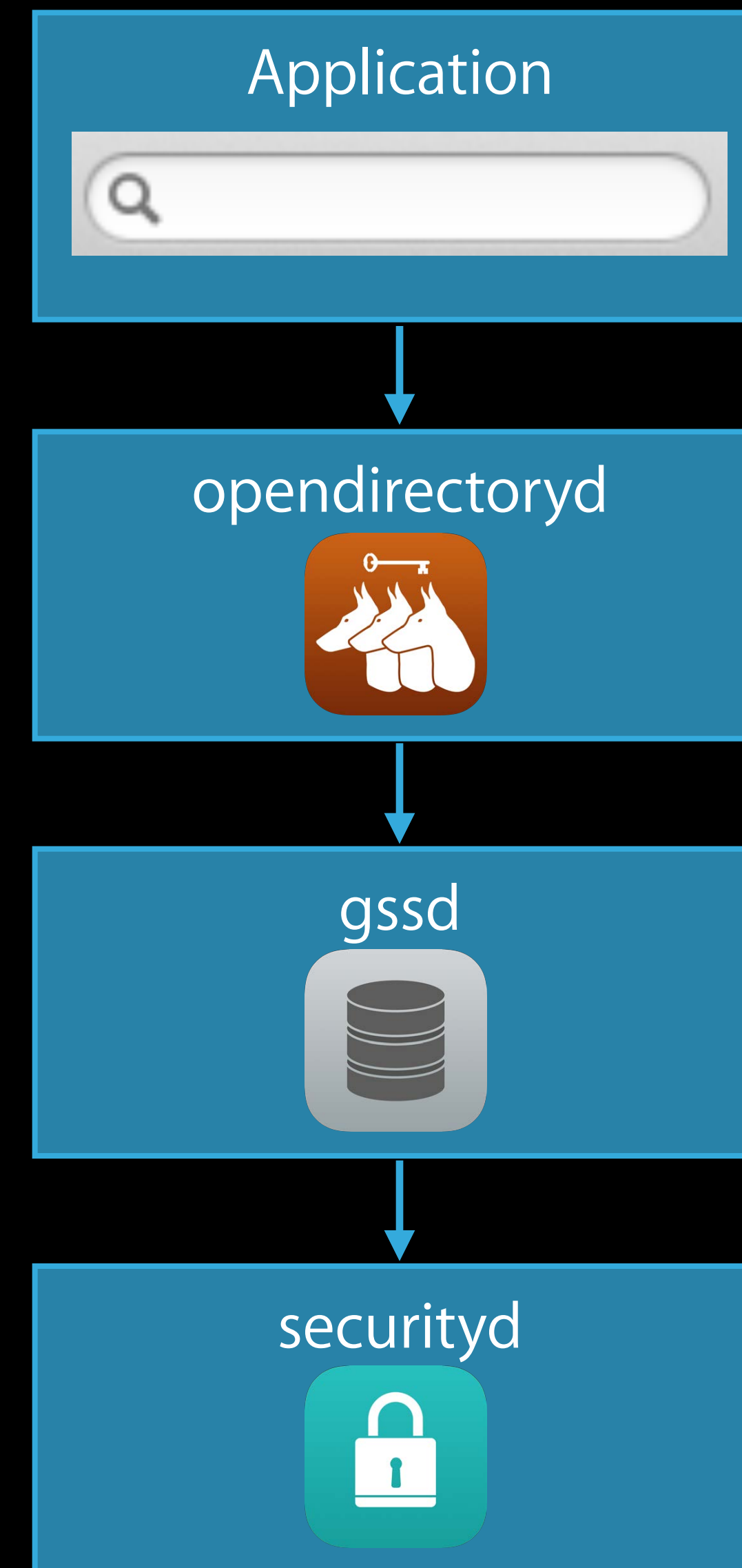
Terminology

Activities

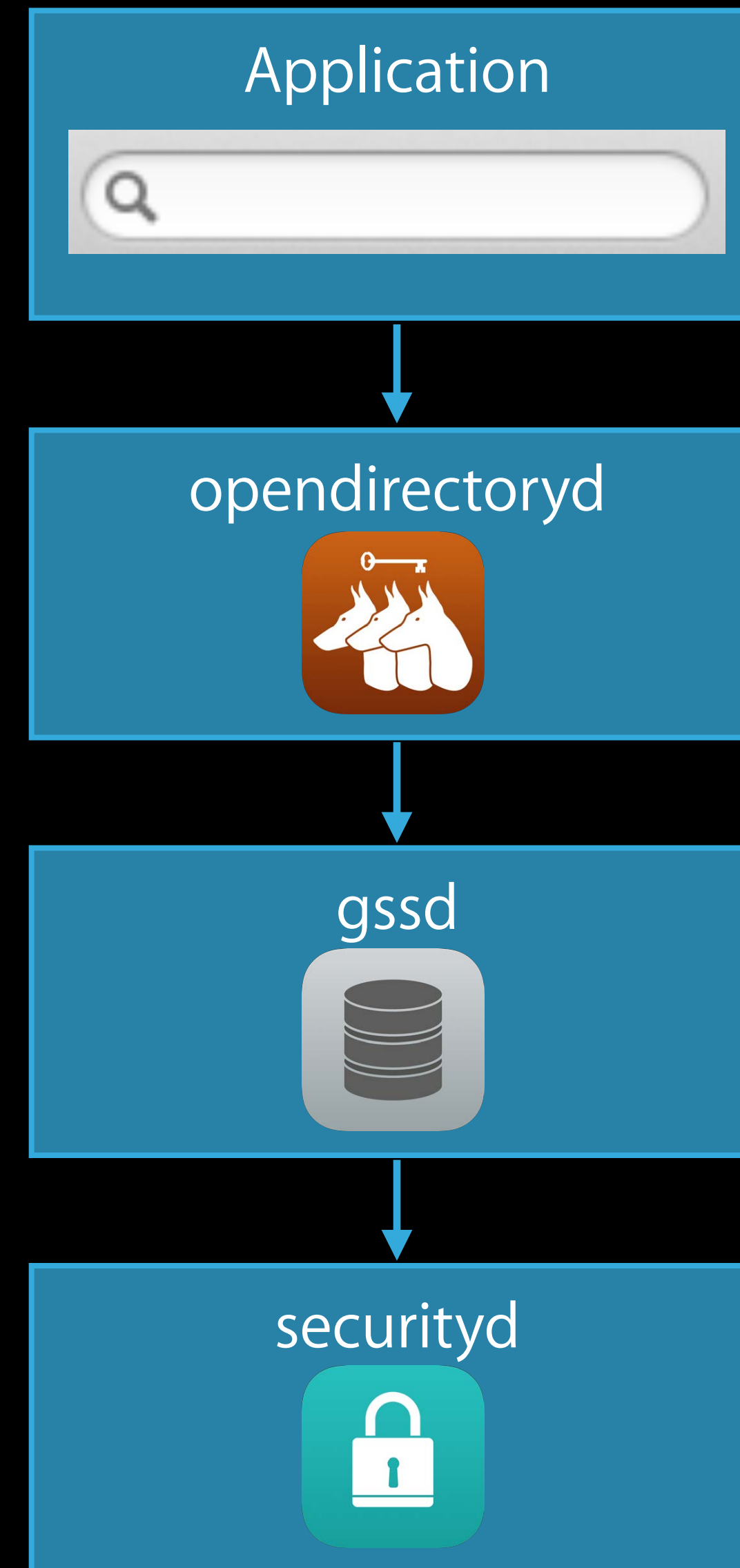# What is an Activity?

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

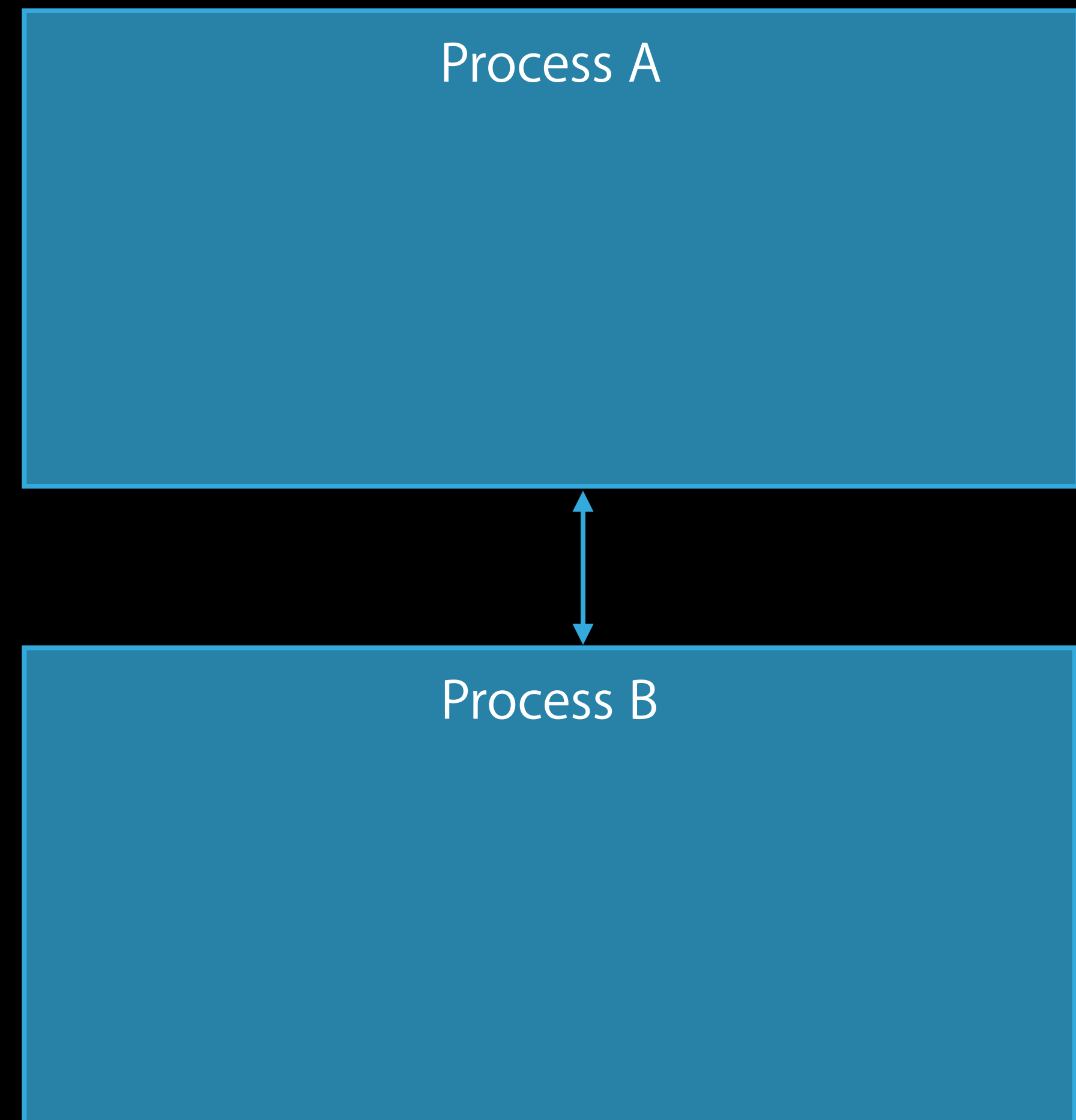System generated 64-bit identifier (AID)
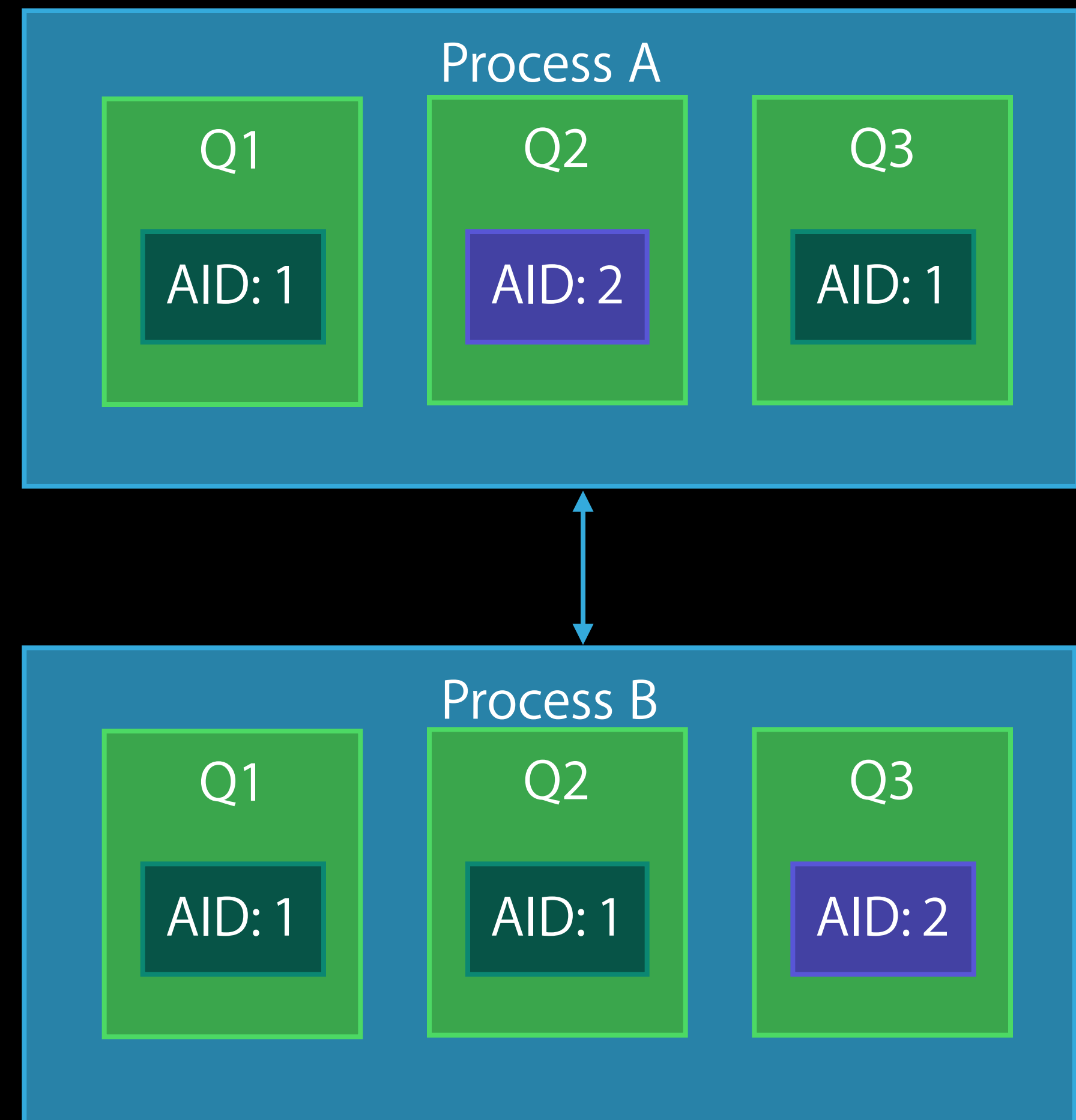
System Activity

System generated 64-bit identifier (AID)

Autopropagated by the system

System Activity

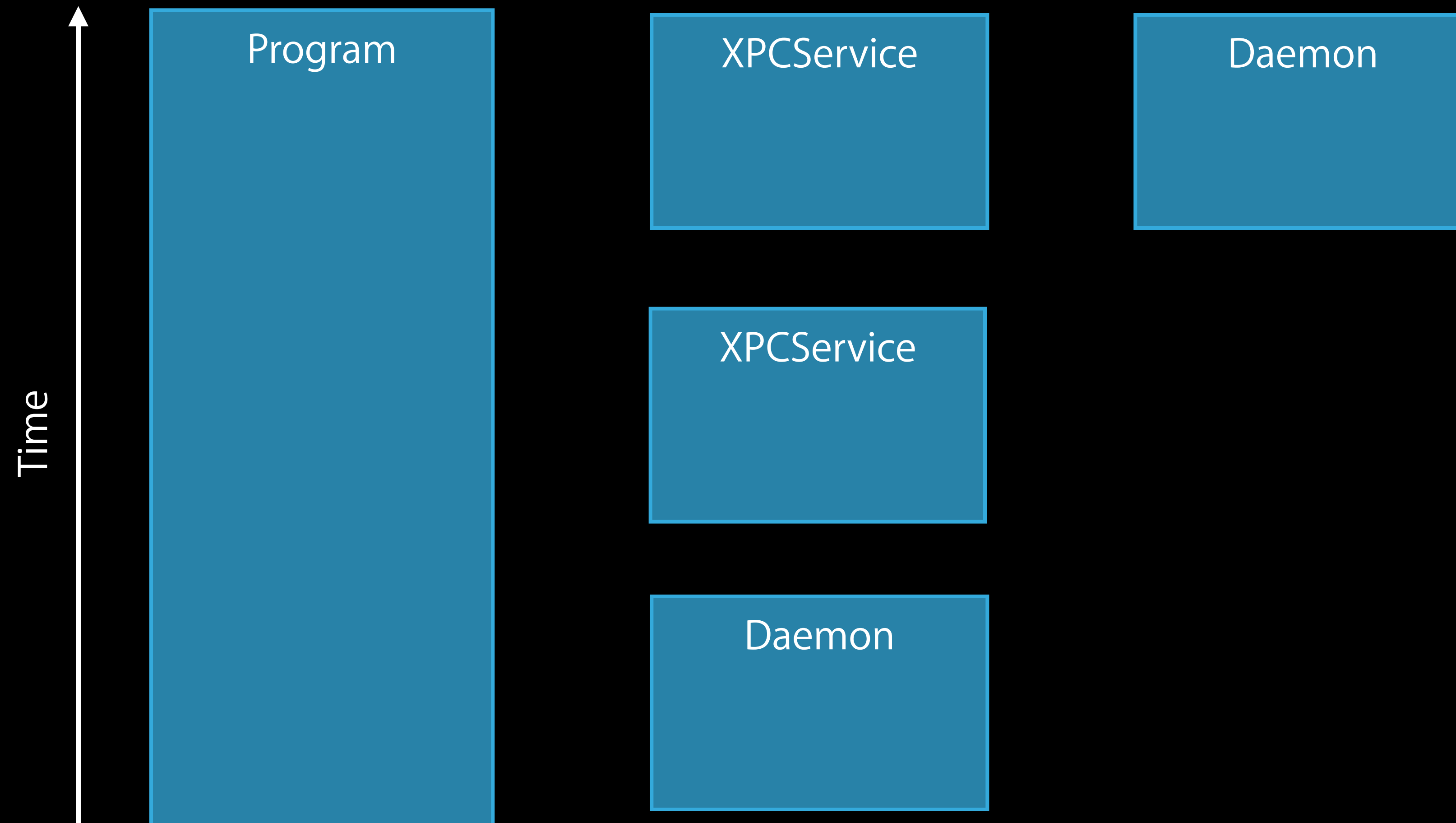System generated 64-bit identifier (AID)

Autopropagated by the system

Process A

Process B

System Activity

System generated 64-bit identifier (AID)

Autopropagated by the system

Activities Over Time

Activities Over Time

Time →

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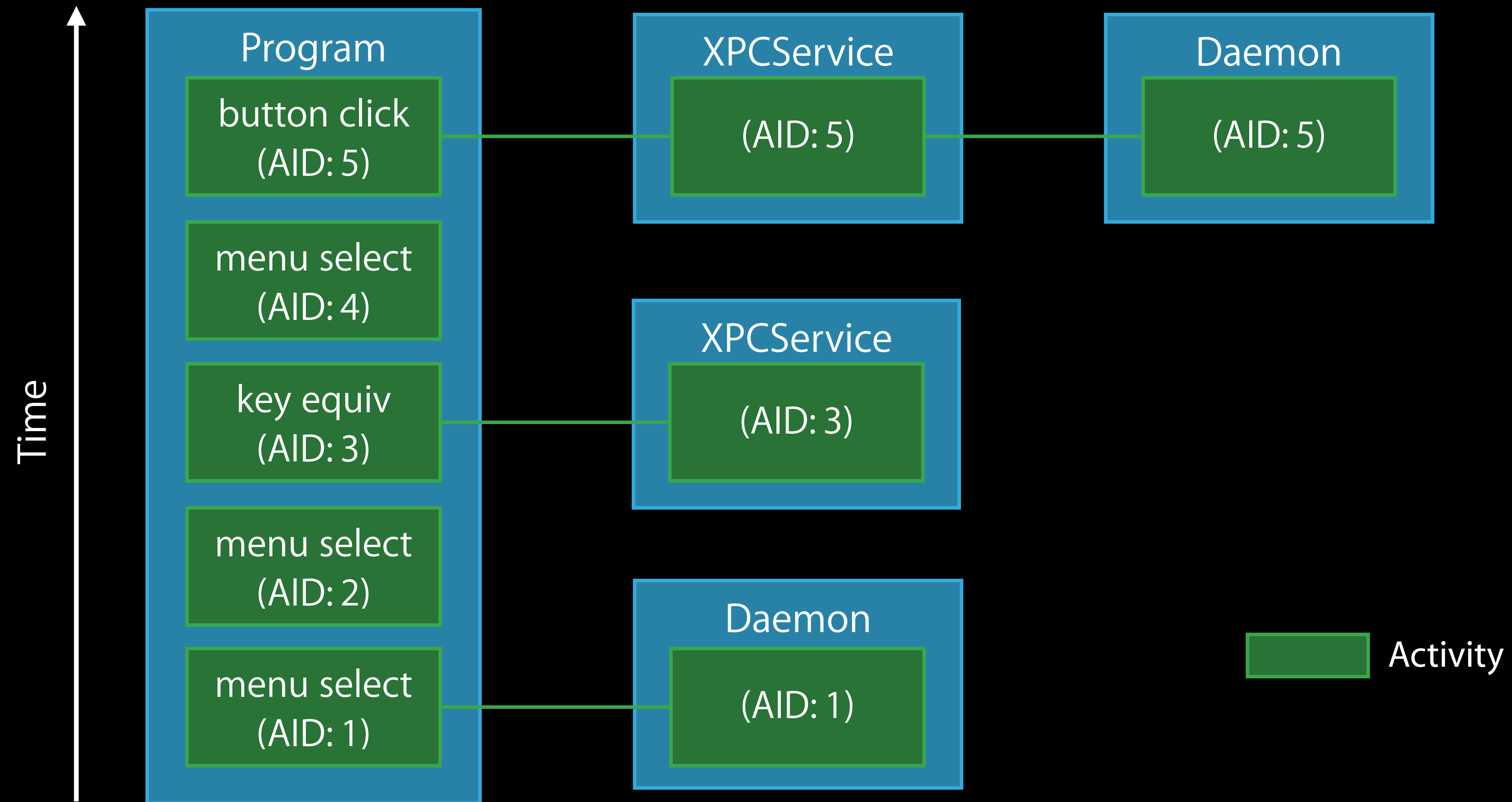
Activity

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

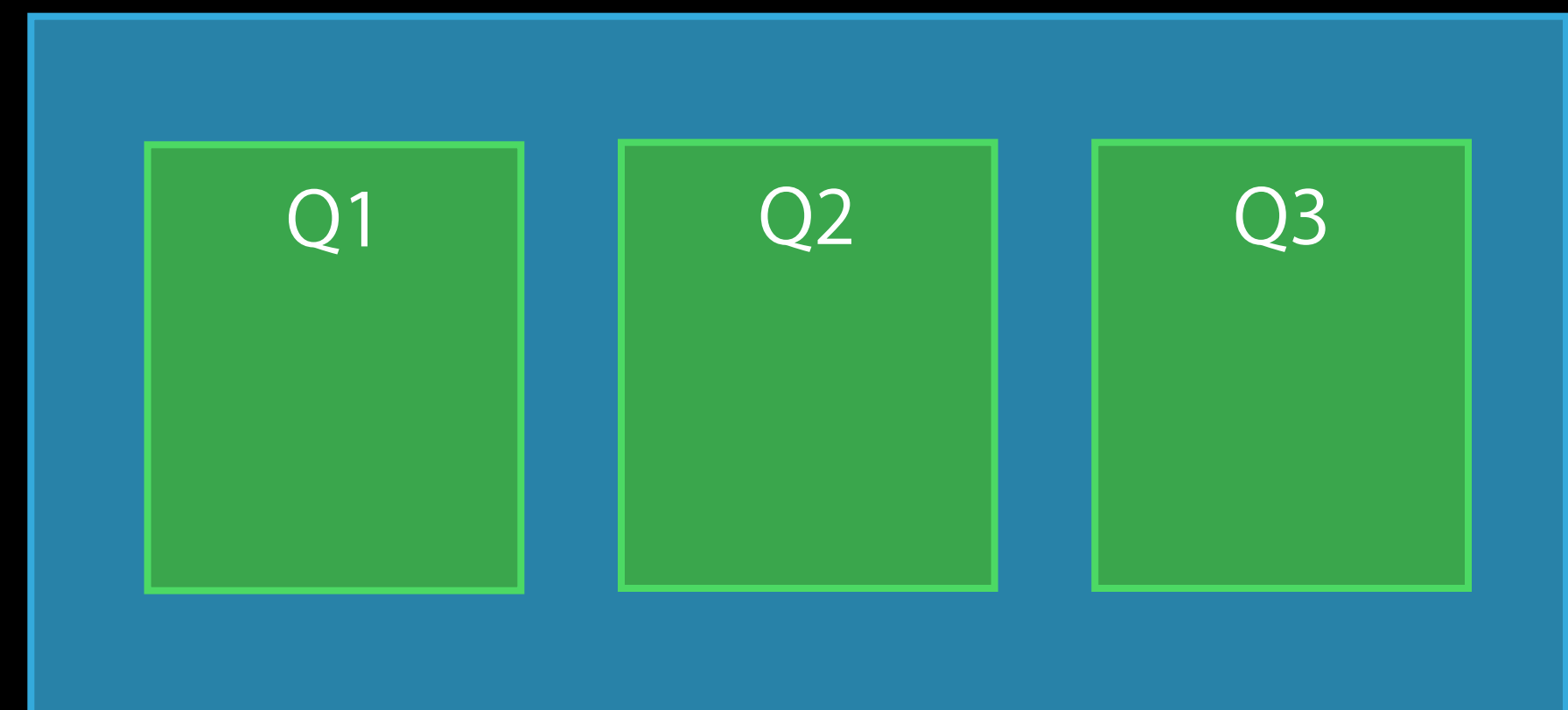Explicitly created activities

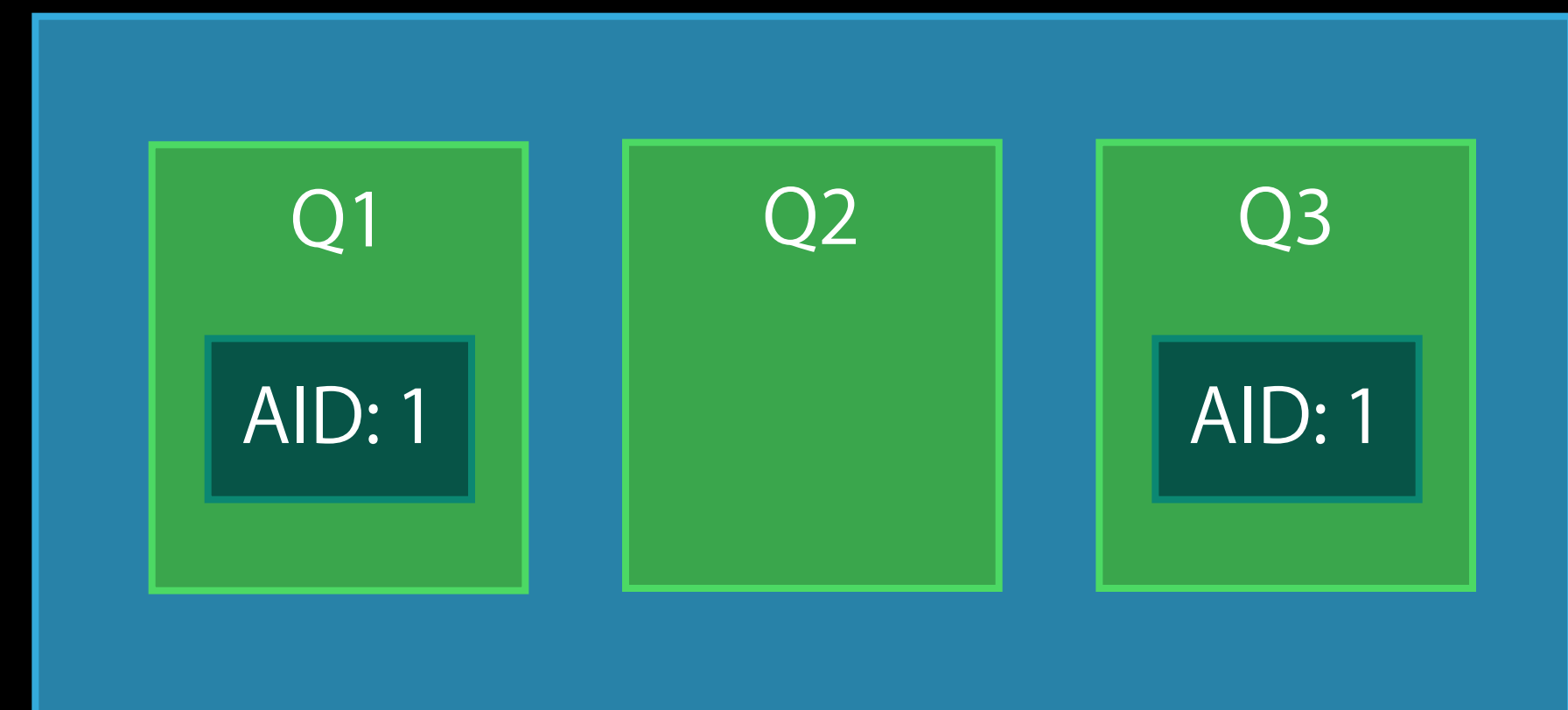Detached activities

Activity Creation

Automatically generated by UIKit and AppKit for UI actions

Explicitly created activities

Detached activities

Activity Creation

Automatically generated by UIKit and AppKit for UI actions

Explicitly created activities
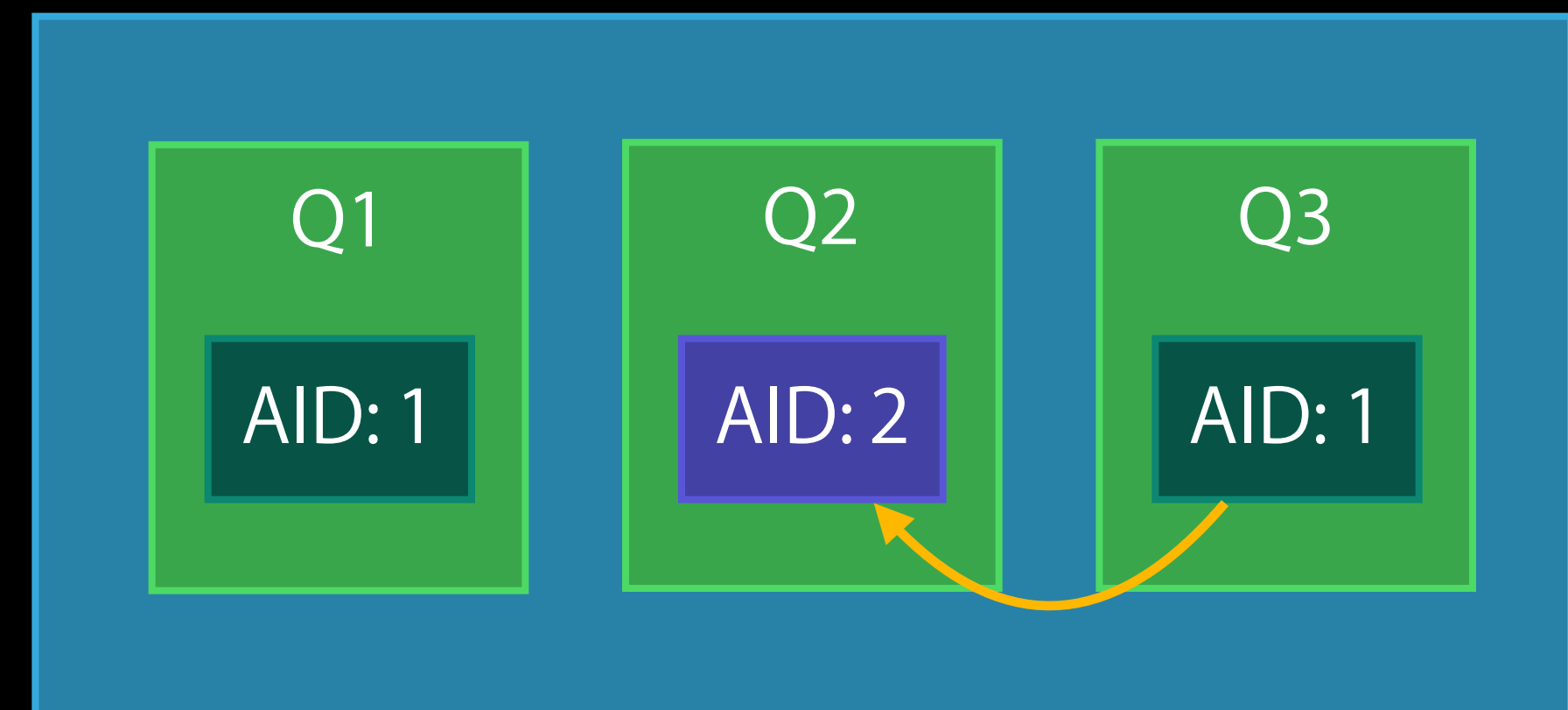
Detached activities

Initiating Activities

NEW

Initiating Activities

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

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```
#include <os/activity.h>
```
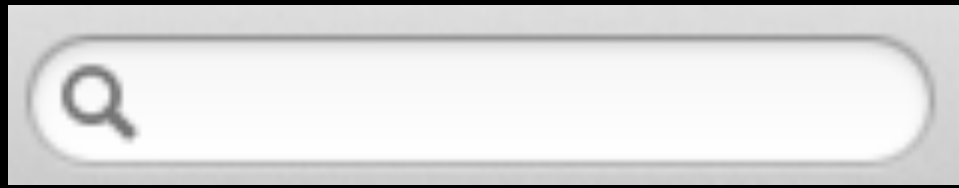
Automatically Generated Activities
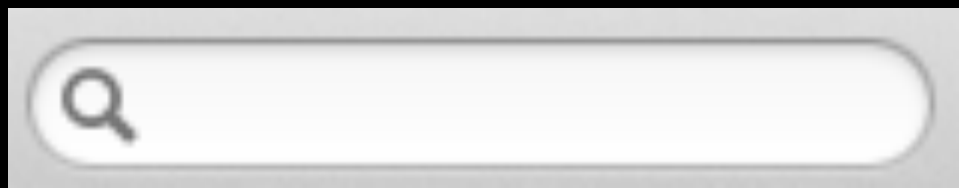
Process	AppKit / UIKit	Process Callback
🔍		

Automatically Generated Activities

Process	AppKit / UIKit	Process Callback
	`os_activity_start();`	

Automatically Generated Activities

Process	AppKit / UIKit	Process Callback

	`os_activity_start();`	`- (IBAction)searchField:(id)sender {`
		`    results = [self searchString: searchValue];`
		`    •••`
		`}`

Automatically Generated Activities

Process	AppKit / UIKit	Process Callback
	`os_activity_start();`	

		`- (IBAction)searchField:(id)sender {`
		`    results = [self searchString: searchValue];`
		`    •••`
		`}`

	`os_activity_stop();`	

Explicitly Create Activities

```objc
#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

```objc
#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

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

- (IBAction) searchField:(id)sender {
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```

Breadcrumbs

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
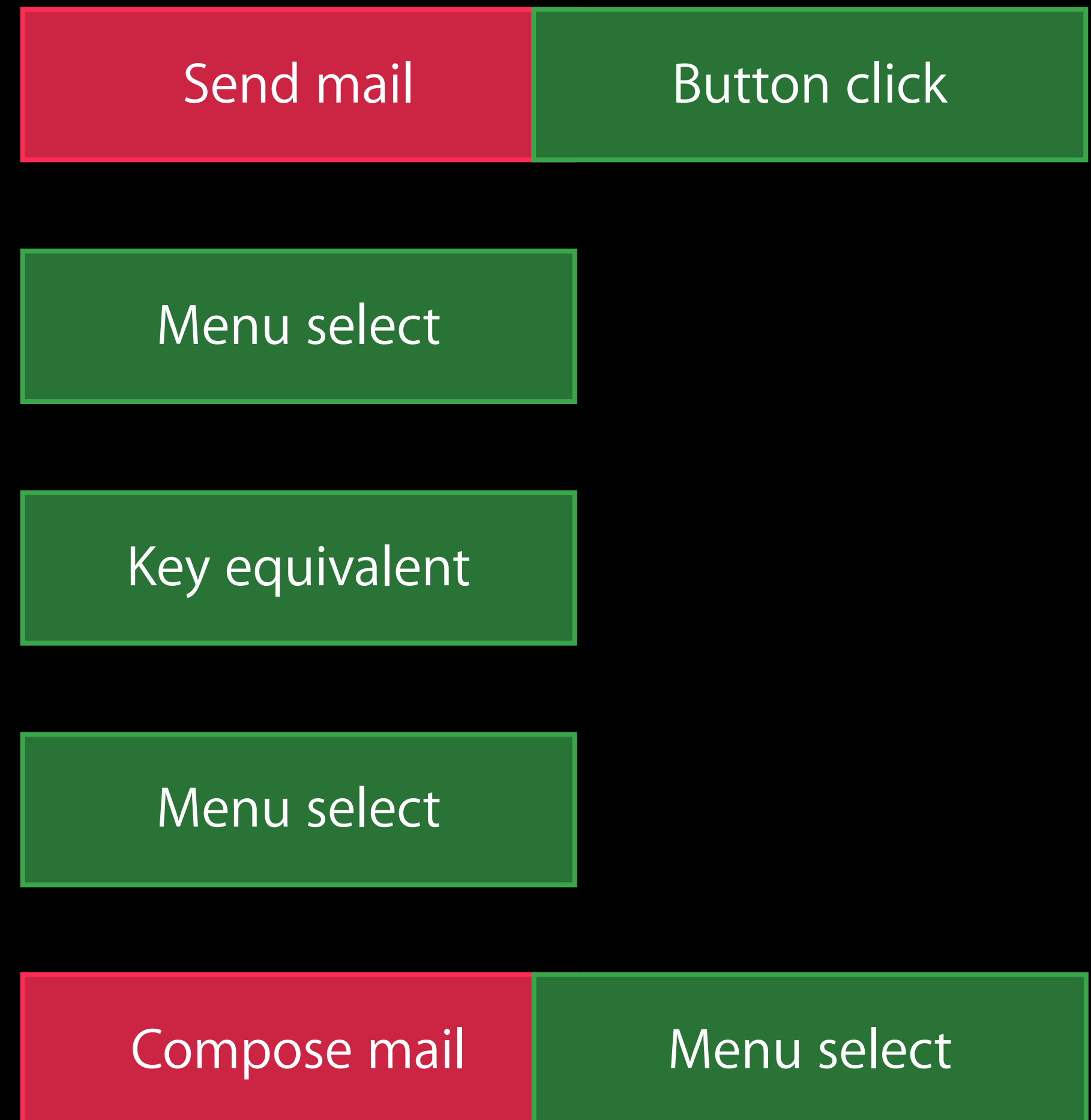
Breadcrumb Diagram

Breadcrumb Diagram

Program

Send mail — button click (AID: 5)

menu select (AID: 4)

key equivalent (AID: 3)

menu select (AID: 2)

Compose mail — menu select (AID: 1)

XPCService (AID: 5)

Daemon (AID: 5)

XPCService (AID: 3)

Daemon (AID: 1)

Time
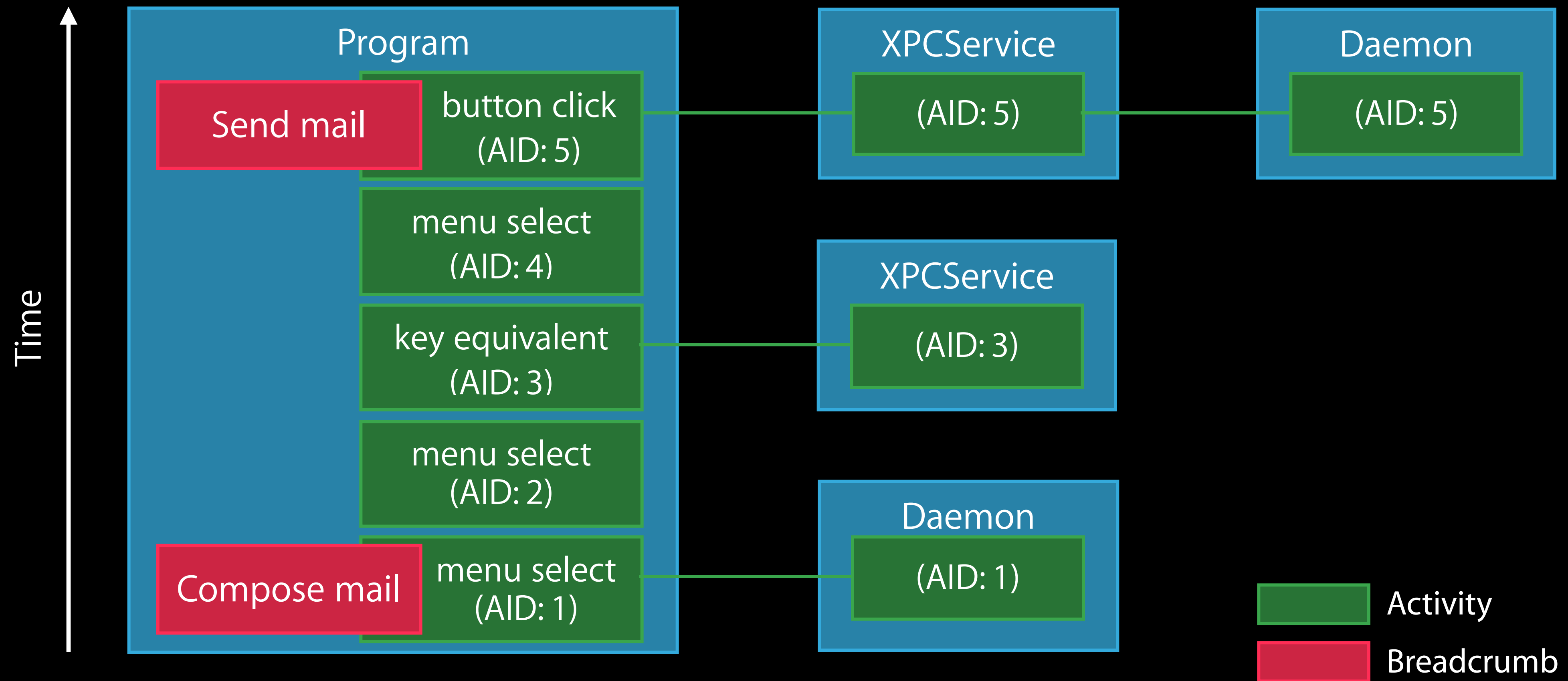
Activity

Breadcrumb

Adding a Breadcrumb

NEW

Adding a Breadcrumb

NEW

```
os_activity_set_breadcrumb("composing mail");
```

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Adding a Breadcrumb

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```
#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

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

- (IBAction)searchField:(id)sender {
    if (useCache) {
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Breadcrumb Example

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```

Trace Messages

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New API to add trace messages to an activity

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Uses standard printf-style format strings

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Stored in an in-memory ring buffer

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Adjustable behavior

Stored in an in-memory ring buffer

	PC	Timestamp	String Offset	Data1	Data2	• • •	(64-bytes)
	PC	Timestamp	String Offset	Data1	Data2	• • •	
	PC	Timestamp	String Offset	Data1	Data2	• • •	
	PC	Timestamp	String Offset	Data1	Data2	• • •	

Trace Message

NEW

Trace Message

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

Trace Message

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

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os_trace("Interface %ld state %d", ifindex, state);
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- Strings and characters are not supported for privacy, performance, and security

Trace Message

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os_trace("Interface %ld state %d", ifindex, state);
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- Only scalar format types

- Strings and characters are not supported for privacy, performance, and security

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

Debug Trace Message

NEW

Debug Trace Message

NEW

```
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

NEW

```
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

NEW

```
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
- Setting environment variable will enable debug at launch

```
OS_ACTIVITY_MODE=debug
```

Payload Trace Message

NEW

Payload Trace Message

NEW

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

Payload Trace Message

NEW

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

- Block is only called if tools have enabled stream mode

Payload Trace Message

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- Uses XPC to deliver message to diagnosticd

Payload Trace Message

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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
- Uses XPC to deliver message to diagnosticd
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Payload Trace Message

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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
```
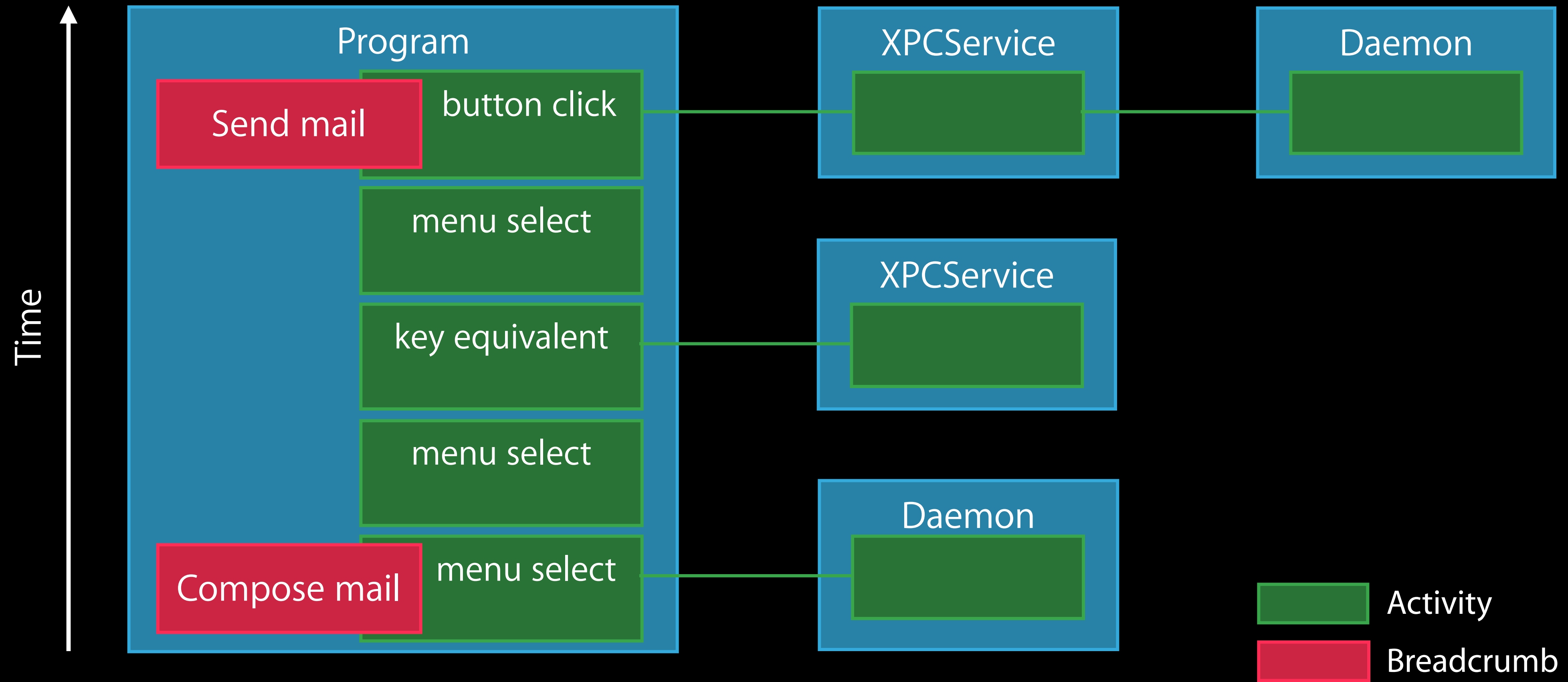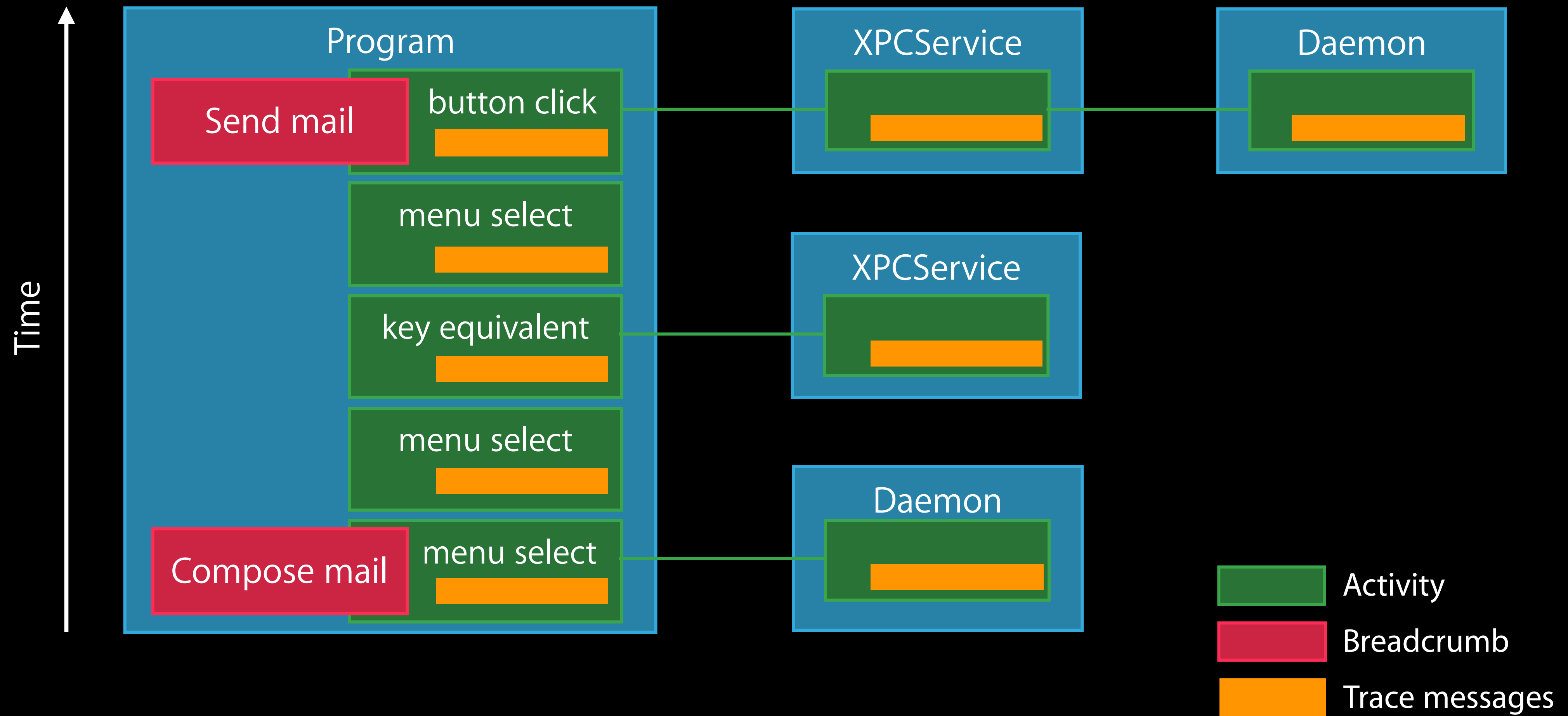
Trace Messages

Trace Messages

Program

Send mail

button click

menu select

key equivalent

menu select

Compose mail

menu select

XPCService

XPCService

Daemon

Daemon

Time

Activity

Breadcrumb

Trace messages

Sample Crash

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

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

```
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
2   com.apple.CFOpenDirectory          0x00007fff84750bed _query_perform + 568
3   com.apple.CoreFoundation           0x00007fff8964e1f1 __CFRUNLOOP_IS_CALLING_OUT_TO_A_SOURCE0_PERFORM_FUNCTION__ + 17
...
16  com.apple.AppKit                   0x00007fff83c01a9e NSApplicationMain + 1778
17  com.apple.Query-Directory          0x0000000100001a82 main + 34
18  libdyld.dylib                      0x00007fff874af5c9 start + 1
```

Detailed messages associated with the crash point

Sample Crash

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
0   com.apple.Query-Directory   0x0000000100027ea -[QDAppDelegate query:foundResults:error:] + 554
1   com.apple.OpenDirectory   0x00007fff9066ec88 __delegate_callback + 388
2   com.apple.CFOpenDirectory   0x00007fff84750bed _query_perform + 568
3   com.apple.CoreFoundation   0x00007fff8964e1f1 __CFRUNLOOP_IS_CALLING_OUT_TO_A_SOURCE0_PERFORM_FUNCTION__ + 17
• • •
16   com.apple.AppKit   0x00007fff83c01a9e NSApplicationMain + 1778
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

```
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
```

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

```
Activity Name:          sendAction:
Activity Breadcrumb:    Query directory using NSRunLoop
Activity Running Time:  6.028601 sec
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Trace Messages (reverse chronological seconds):
5.866399    Query Directory          0x0000000100000000 IPC send
5.866463    Query Directory          0x00000001000027e0 aborting test due to no results
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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
```
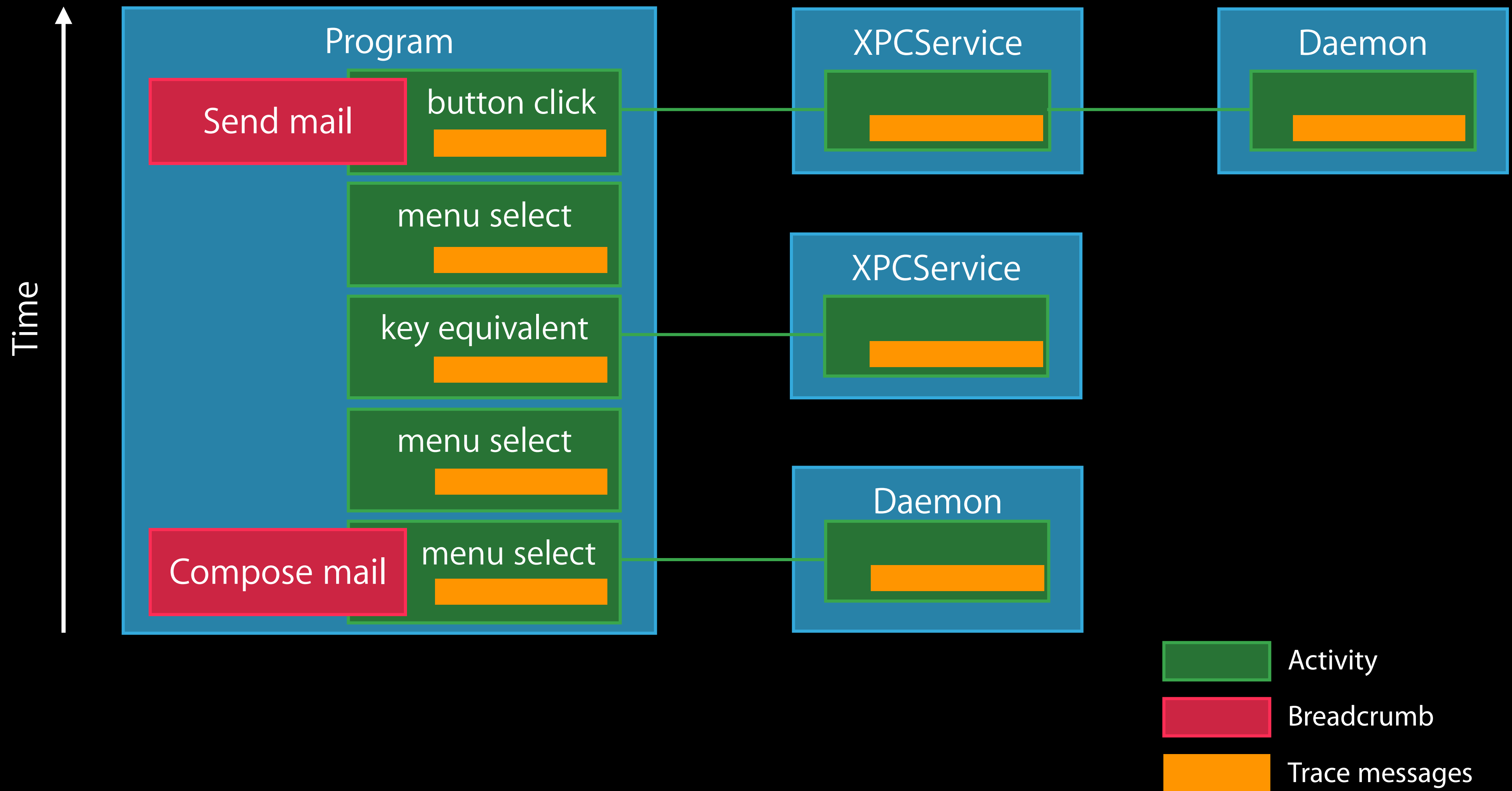
Sample Crash

```
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
```
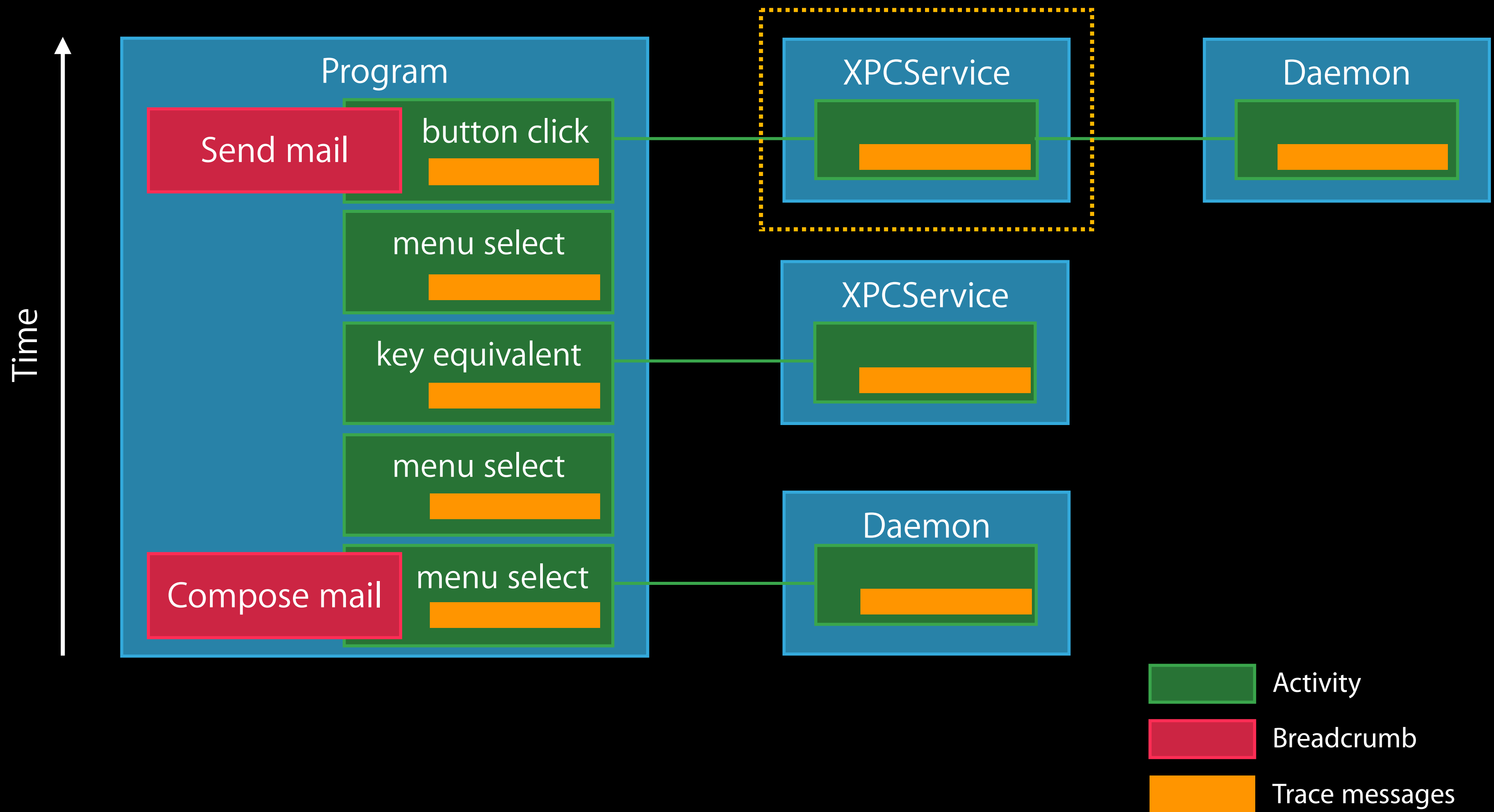
Trace Messages (reverse chronological seconds):
```
5.866399     Query Directory              0x0000000100000000 IPC send
5.866463     Query Directory              0x00000001000027e0 aborting test due to no results
5.866529     Query Directory              0x0000000100000000 IPC send
5.866564     Query 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
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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
```

```
Activity Running Time:   6.028601 sec
Activity Failure Reason: none detected
```

Crashing Process

Program

Send mail

button click

menu select

key equivalent

menu select

Compose mail

menu select

XPCService
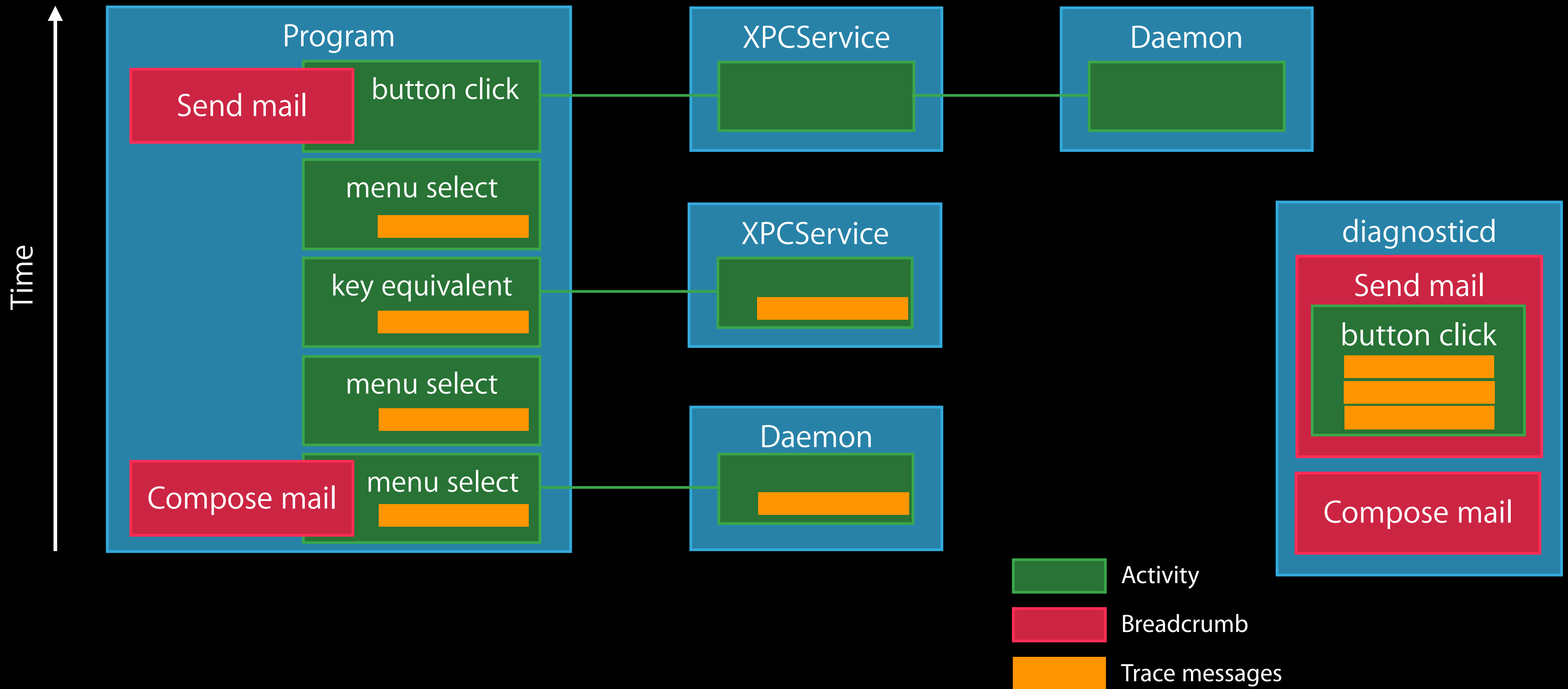
XPCService

Daemon

Daemon

Time

Activity

Breadcrumb

Trace messages

Crashing Process

Reporting Unexpected Errors

NEW

Reporting Unexpected Errors

NEW

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

Reporting Unexpected Errors

NEW

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

- Signals that an error occurred

Reporting Unexpected Errors

NEW

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

- Signals that an error occurred

- Trace messages are sent to diagnosticd

Reporting Fatal Errors

NEW

Reporting Fatal Errors

NEW

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

Reporting Fatal Errors

NEW

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

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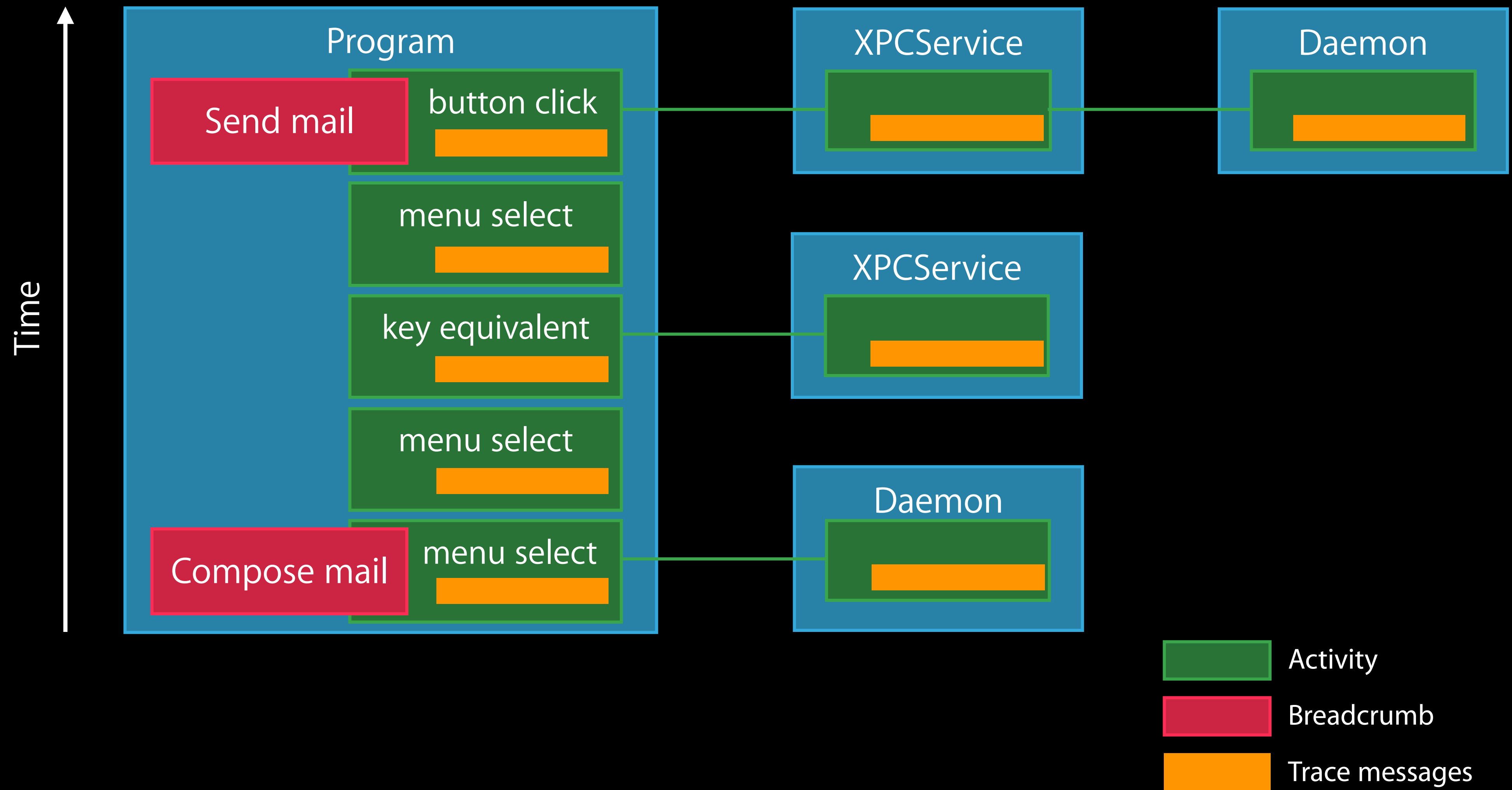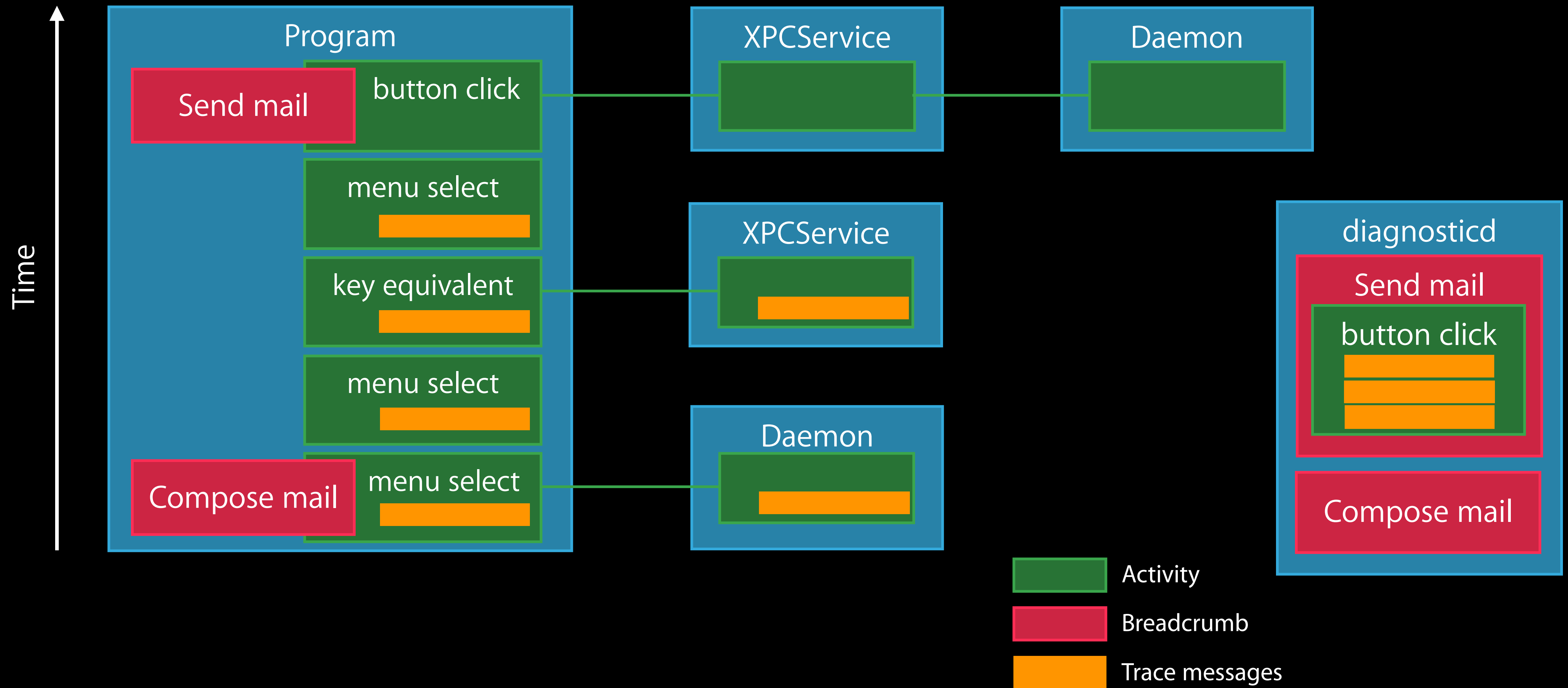
Reporting Fatal Errors

NEW

```
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

Time

Program		XPCService	Daemon

Program

Send mail — button click

menu select

key equivalent

XPCService

menu select

Daemon

Compose mail — menu select

Legend:
- Activity (green)
- Breadcrumb (red)
- Trace messages (orange)

Utilizing Faults

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");
        }
    });
}
```

Example Fault

```
#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

```
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

```
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"

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

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The format string cannot exceed 100 characters

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Trace message content has a limit and will truncate if exceeded

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- os_trace API will accept a maximum of 7 scalar values

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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

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    Activity 'sendAction:', 0x4d00000002

    Current Breadcrumb: Query directory using NSRunLoop

    5 trace messages:

        aborting test due to no results
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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: 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
Message: 'issued query'
Payload: '<dictionary: 0x7fe7331004b0> { count = 1, contents =
    "queryString" => <string: 0x7fe733100580> { length = 1, contents = "z" }
}'
----------------------
Timestamp: 0.000000
DEBUG
Trace ID: 0x0000020000004a30
Offset: 0x291f
Message: 'query results received 1 more results'
----------------------
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" }
}'
```

NEW

Live Streaming

NEW

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

```
Trace ID: 0x00000100000047c7
Thread: 0x32a9
Image UUID: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
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    "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: 0x000001000005d530
Thread: 0x2821
Image UUID: DECA11C7—EB99—3885—947E—42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
-----------------------
```

Watching Faults

NEW

```
[~] root% ostraceutil –watch –faults
Process:
==================
PID: 557
Image_uuid: 28
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: 0x000001000005d530
Thread: 0x2821
Image UUID: DECA11C7–EB99–3885–947E–42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
--------------------------
```

[~] root% ostraceutil –watch –faults

Watching Faults

NEW

```
[~] root% ostraceutil -watch -faults
Process:
```

<span style="color:orange">

```
Process:
===================

PID: 557
Image_uuid: 28B91236-BAEA-3979-9DFD-791EBC32E1D6
Image_path: /Demos/Debug/Query Directory.app/Contents/MacOS/Query Directory
```



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

Messages:
===================
Timestamp: 1001.589870
RELEASE
Activity ID: 0x000000530000000d
Trace ID: 0x000001000005d530
Thread: 0x2821
Image UUID: DECA11C7-EB99-3885-947E-42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
--------------------------
```

Watching Faults

NEW

```
[~] 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:
```

Application Breadcrumbs:

==================

Timestamp: 996.368669, Breadcrumb ID = 19072, Name = 'Query
Timestamp: 1001.556305, Breadcrumb ID = 19040, Name = 'Query

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

Messages:
==================
Timestamp: 1001.589870
RELEASE
Activity ID: 0x000000530000000d
Trace ID: 0x000001000005d530
Thread: 0x2821
Image UUID: DECA11C7-EB99-3885-947E-42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
--------------------------
```

Watching Faults

NEW

```
[~] 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: 0x
Activity Name:
Timestamp: 1001
Reason: none de

Messages:
==================
Timestamp: 1001
RELEASE
Activity ID: 0x000000530000000d
Trace ID: 0x000001000005d530
Thread: 0x2821
Image UUID: DECA11C7—EB99—3885—947E—42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
---------------------------
```

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

Watching Faults

NEW

```
[~] 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,          ): 0x0000005300000008
Timestamp: 1001.55630!          )0000530000000d

Activity:
==================
Activity ID: 0x000000!
Activity Name: sendAc
Timestamp: 1001.55626:
Reason: none detected

Messages:
==================
Timestamp: 1001.58987(
RELEASE
Activity ID: 0x000000!
Trace ID: 0x0000010000
Thread: 0x2821
Image UUID: DECA11C7–
Image Path: /usr/libe
Offset: 0x21c21
Message: 'request com
```

```
Messages:
====================
Timestamp: 1001.589870
RELEASE
Activity ID: 0x000000530000000d
Trace ID: 0x000001000005d530
Thread: 0x2821
Image UUID: DECA11C7–EB99–3885–947E–42DBD0F9374C
Image Path: /usr/libexec/opendirectoryd
Offset: 0x21c21
Message: 'request completed, delivered 1 results'
_____
```
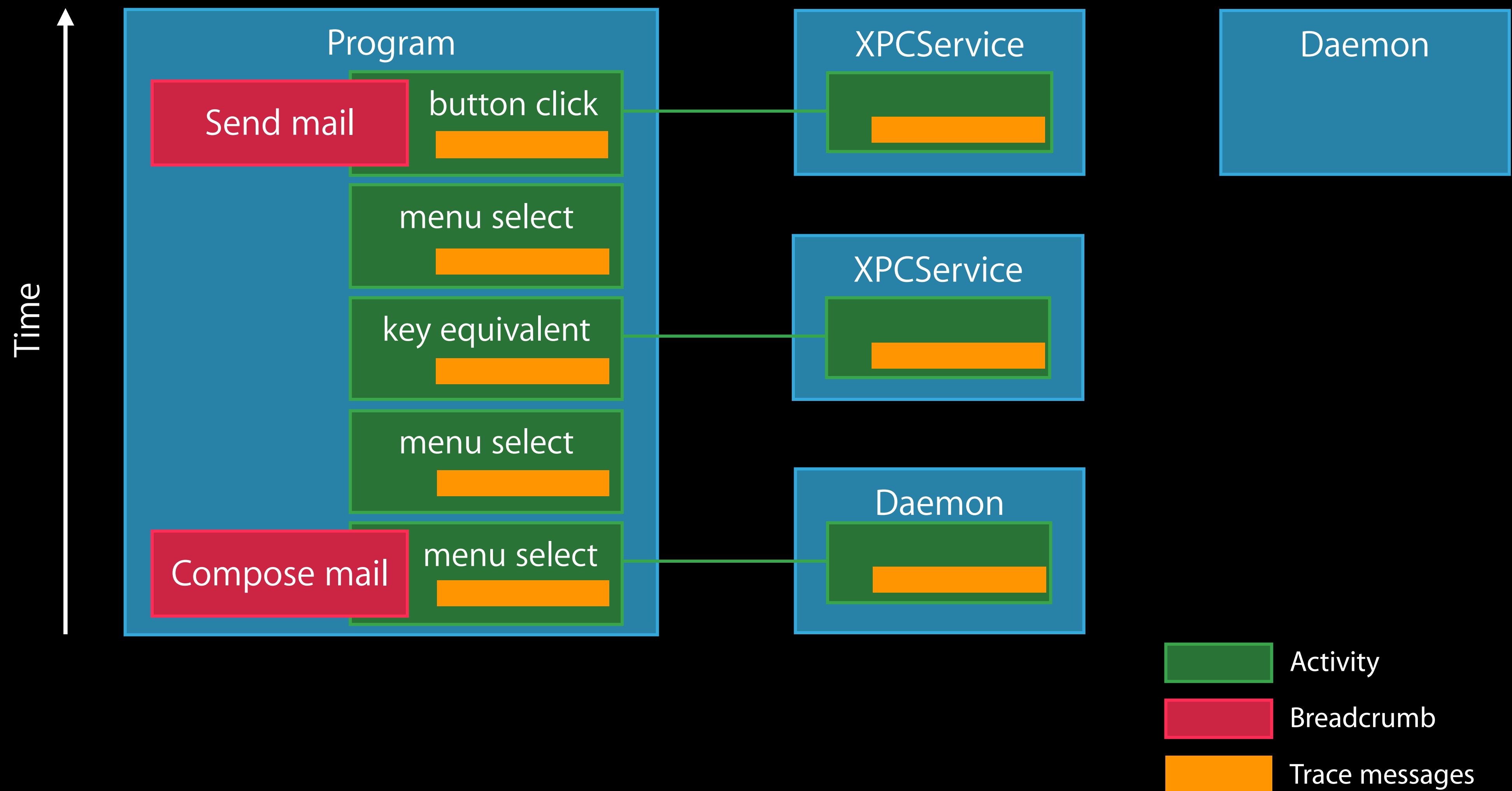
Considerations

Privacy

Privacy
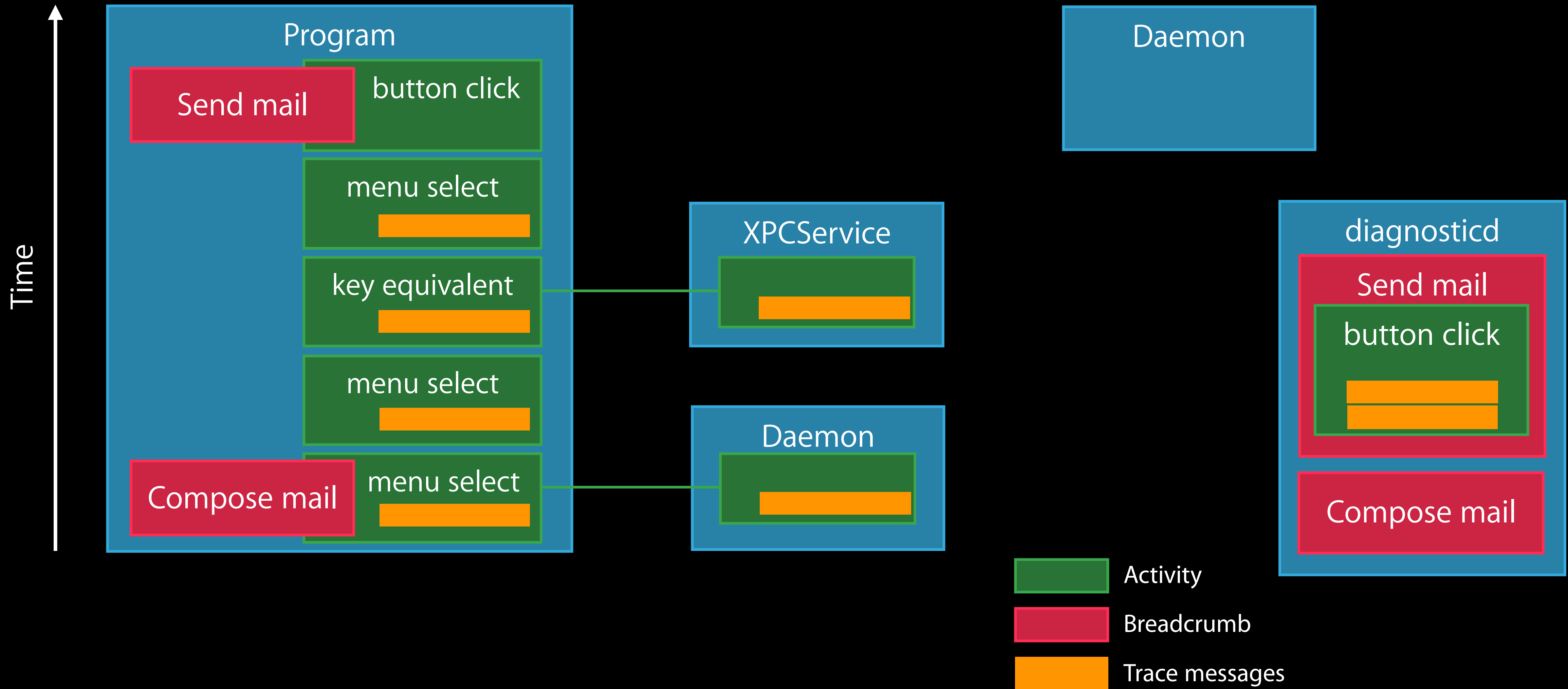
Be conscious of privacy when adding trace messages

Privacy

Be conscious of privacy when adding trace messages

Never trace identifying information about a user or device

Propagation Failure

Time

Program

Send mail

button click

menu select

key equivalent

menu select

Compose mail

menu select

XPCService

XPCService

Daemon

Daemon

Activity

Breadcrumb

Trace messages

Propagation Failure

Support in Diagnostics

	OS X Yosemite	iOS 8
Crash Reports	✓	✓
Spin Reports	✓	
Stackshot	✓	
lldb	✓	✓

Why Use Activity Tracing?

Why Use Activity Tracing?

Automatically included in diagnostic reports

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Debugger support

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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

● Improving Your App with Instruments	Marina	Tuesday 4:30PM
● Writing Energy Efficient Code, Part 1	Russian Hill	Wednesday 10:15AM
● Writing Energy Efficient Code, Part 2	Russian Hill	Wednesday 11:30AM
● User Privacy in iOS and OS X	Nob Hill	Thursday 2:00PM
● Power, Performance and Diagnostics: What's New in GCD and XPC	Russian Hill	Thursday 2:00PM

Labs

- Power and Performance Lab   Core OS Lab B   Wednesday 2:00PM

- Power and Performance Lab   Core OS Lab A   Thursday 3:15PM