

#WWDC18

Creating Custom Instruments

Instruments 10

Session 410

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Why create custom instruments

Architecture

Getting started

Intermediate

Advanced

Best practices

Why create custom instruments

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Advanced

Best practices

Instruments

blue-satellite > Signpost Sender.app

Run 1 of 1 | 00:00:10

ANY INSTRUMENT * CORE * TRACK ATTRIBUTE target All Instruments Threads CPUs

00:00.000 00:01.000 00:02.000 00:03.000 00:04.000 00:05.000 00:06.000 00:07.000 00:08.000 00:09.000

Points

Half Second

User Interactive Load (10ms)

Context Switches

Virtual Memory Activity

System Calls Made

Main Thread 0xf1fe
Signpost Sender (1503)

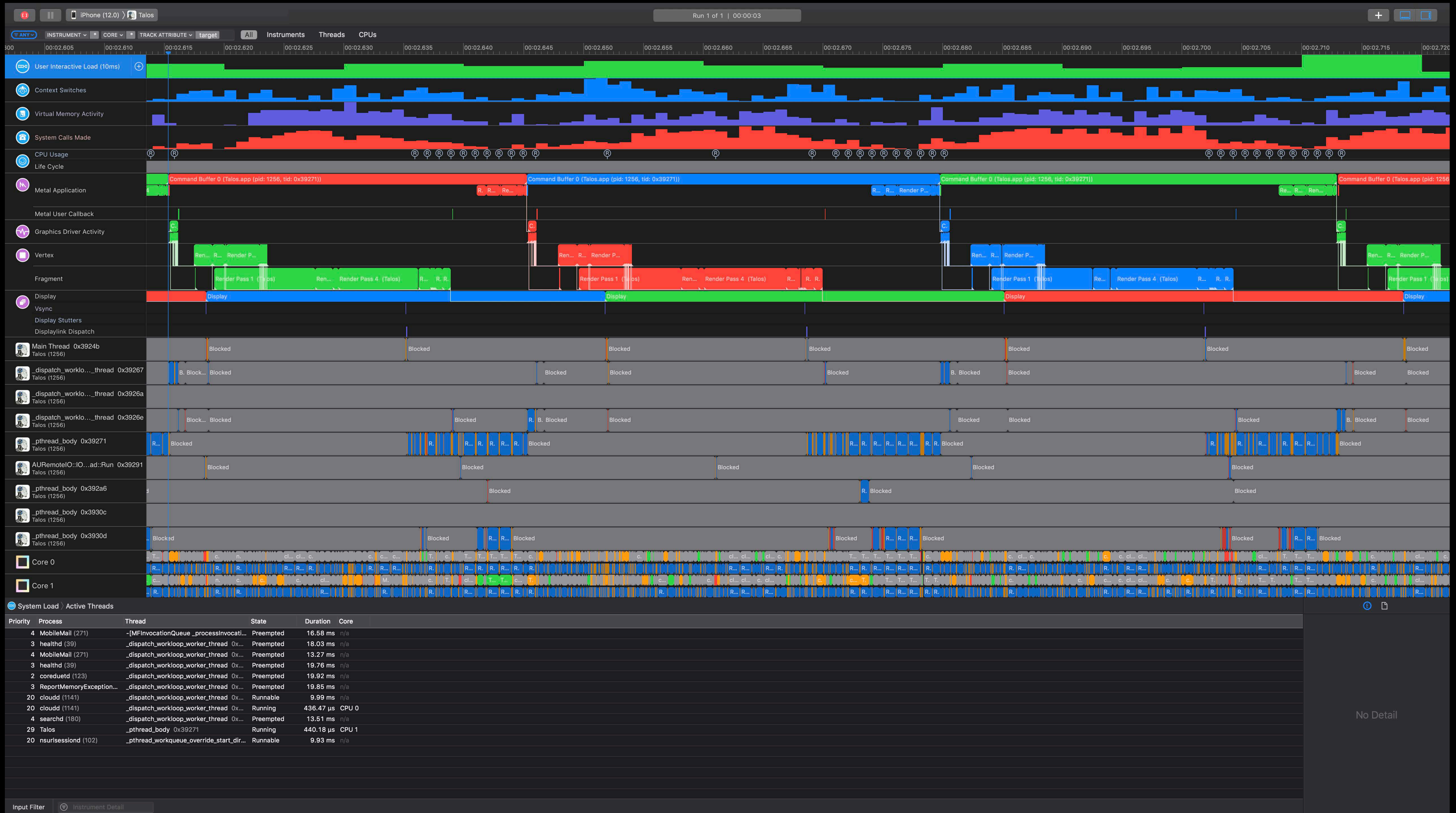
Main Thread 0xf1fe > Narrative

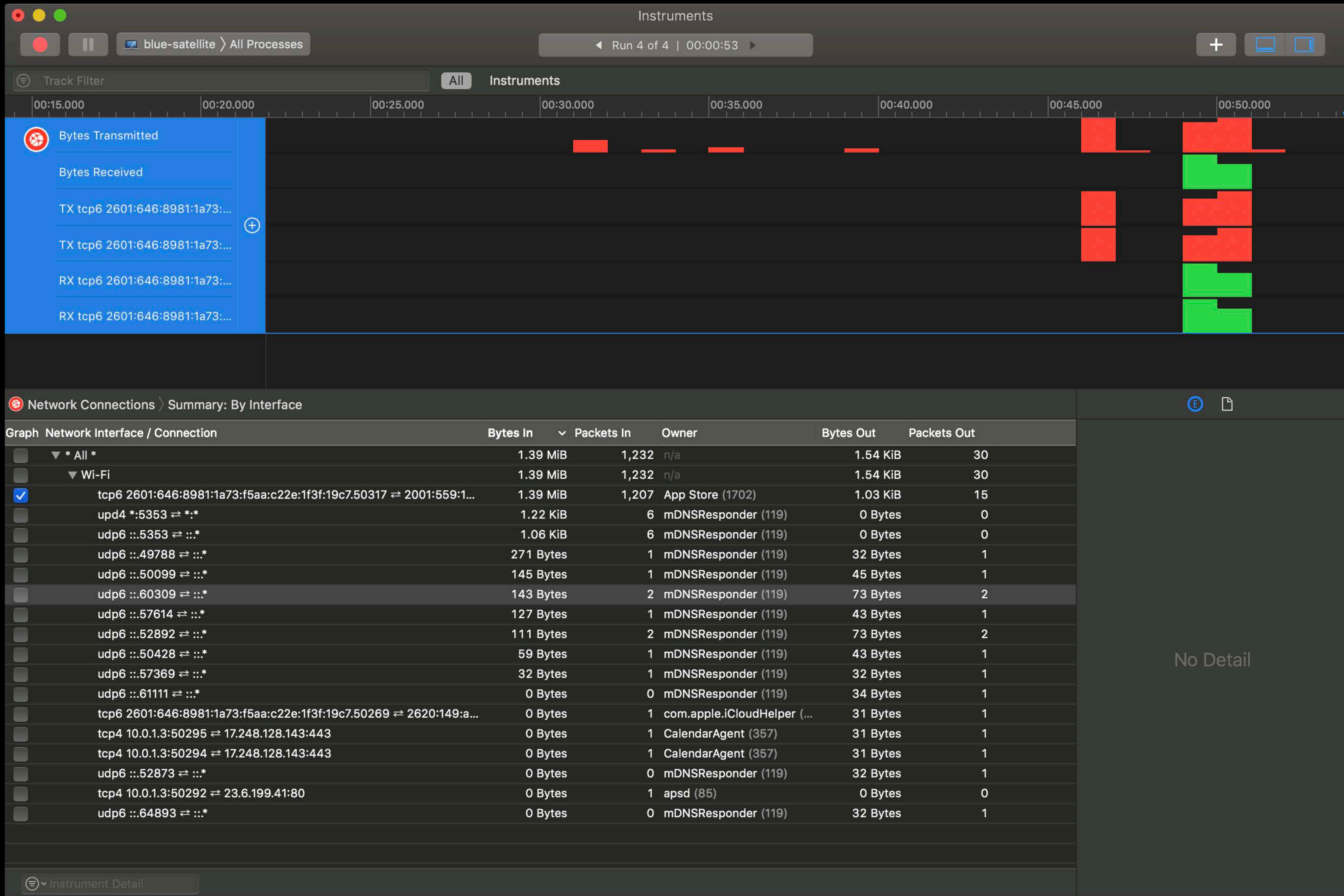
Timestamp	Narrative
00:06.552.026	Called "mach_msg_trap()" for 3.48 μs
00:06.552.036	Called "mach_port_extract_member_trap()" for 1.11 μs
00:06.552.098	Called "mach_msg_trap()" for 8.48 μs
00:06.552.117	Called "mach_port_insert_member_trap()" for 6.64 μs
00:06.552.144	Called "mach_port_extract_member_trap()" for 2.25 μs
00:06.552.167	Called "mach_port_insert_member_trap()" for 2.82 μs
00:06.552.177	Called "mach_msg_trap()" for 1.40 μs
00:06.552.185	Called "mach_port_extract_member_trap()" for 1.02 μs
00:06.552.197	Called "mach_msg_trap()" for 7.57 μs
00:06.552.213	Called "mach_port_deallocate_trap()" for 18.68 μs
00:06.552.222	Interrupted for 7.61 μs (40.7% of mach_port_deallocate_trap's duration) while CPU 0 serviced an interrupt handler.
00:06.552.230	Ran for 40.12 μs on CPU 0 at priority 47
00:06.552.262	Called "mach_port_insert_member_trap()" for 2.03 μs
00:06.552.269	Called "mach_msg_trap()" for 7.62 ms
00:06.552.270	Blocked for 7.59 ms (99.7% of mach_msg_trap's duration) starting at priority 47
00:06.559.862	The thread was made runnable by Signpost Sender.app (pid: 1503, tid: 0xf240) running on CPU 2. It waited for an available CPU for 18.84 μs (0.2% of mach_msg_trap's duration)
00:06.559.881	Ran for 214.18 μs on CPU 2 at priority 47
00:06.559.893	Called "mach_port_extract_member_trap()" for 1.12 μs
00:06.559.915	Called "mach_msg_trap()" for 8.12 μs
00:06.559.933	Called "mach_port_insert_member_trap()" for 2.95 μs
00:06.559.941	Called "mach_msg_trap()" for 2.37 μs
00:06.559.948	Called "mach_port_extract_member_trap()" for 746 ns

Backtrace

- mach_msg_trap
- mach_msg
- _CFLRunLoopServiceMachPort
- _CFLRunLoopRun
- CFLRunLoopRunSpecific
- RunCurrentEventLoopInMode
- ReceiveNextEventCommon
- _BlockUntilNextEventMatchingListInMode
- _DPSNextEvent
- [NSApplication(NSEvent) _nextEventMi
- [NSWindow(NSEventRouting) trackEve
- [NSDragEventTracker trackEvent:using
- [NSCell trackMouse:inRect:ofView:unti
- [NSButtonCell trackMouse:inRect:ofVi
- [NSControl mouseDown:]
- [NSWindow(NSEventRouting) _handleM
- [NSWindow(NSEventRouting) _reallySe
- [NSWindow(NSEventRouting) sendEve
- [NSApplication(NSEvent) sendEvent:]
- [NSApplication run]
- NSApplicationMain
- start

Input Filter Instrument Detail





Instruments

blue-satellite > Signpost Sender.app

Run 1 of 1 | 00:00:37

Track Filter: All Instruments Threads CPUs

00:00.000 00:05.000 00:10.000 00:15.000 00:20.000 00:25.000 00:30.000

CPU Usage

Life Cycle: L. Foreground

Points

Frame Work

Half Second

Main Thread 0x18f05 Signpost Sender (1903)

_dispatch_worker_thread2 0x1907f Signpost Sender (1903)

Time Profiler > Profile > Root

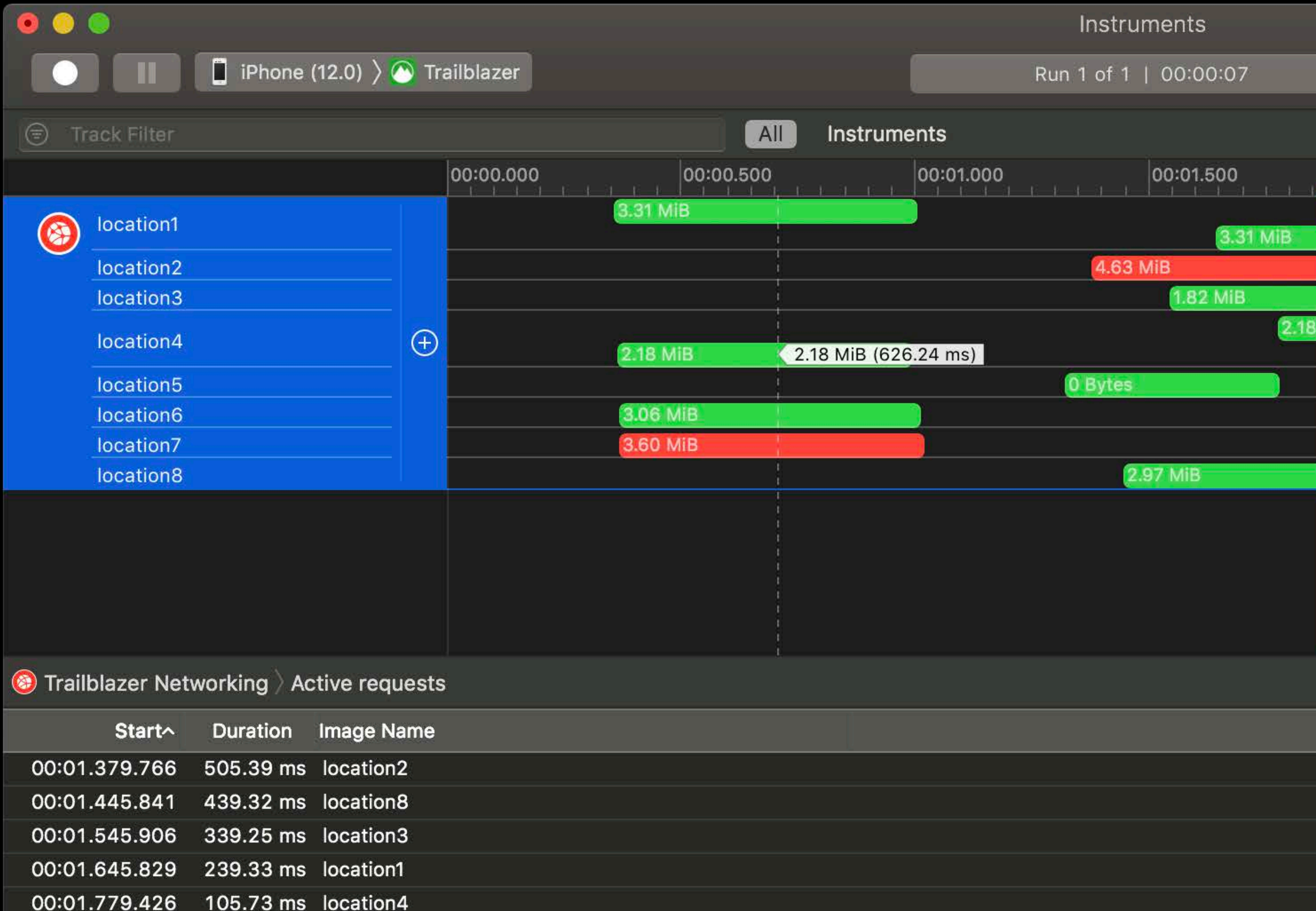
Weight	Self Weight	Symbol Name
1.53 s 100.0%	0 s	Signpost Sender (1903)
1.08 s 70.7%	0 s	Main Thread 0x18f05
1.03 s 67.3%	0 s	start libdyld.dylib
1.03 s 67.3%	0 s	NSApplicationMain AppKit
921.00 ms 60.1%	0 s	-[NSApplication run] AppKit
754.00 ms 49.2%	1.00 ms	-[NSApplication(NSEvent) _nextEventMatchingEventMask:untilDate:inMode:dequeue:] AppKit
705.00 ms 46.0%	1.00 ms	_DPSNextEvent AppKit
687.00 ms 44.8%	0 s	_BlockUntilNextEventMatchingListInModeWithFilter HIToolbox
686.00 ms 44.8%	1.00 ms	ReceiveNextEventCommon HIToolbox
624.00 ms 40.7%	0 s	RunCurrentEventLoopInMode HIToolbox
558.00 ms 36.4%	1.00 ms	CFRunLoopRunSpecific CoreFoundation
519.00 ms 33.8%	0 s	_CFRunLoopRun CoreFoundation
275.00 ms 17.9%	0 s	_CFRunLoopDoTimers CoreFoundation
173.00 ms 11.2%	1.00 ms	_CFRunLoopDoObservers CoreFoundation
20.00 ms 1.3%	1.00 ms	mach_port_insert_member libsystem_kernel.dylib
16.00 ms 1.0%	0 s	_CFRunLoopServiceMachPort CoreFoundation
14.00 ms 0.9%	0 s	_CFRunLoopDoBlocks CoreFoundation
8.00 ms 0.5%	0 s	mach_port_extract_member libsystem_kernel.dylib
3.00 ms 0.1%	0 s	CFAbsoluteTimeGetCurrent CoreFoundation
3.00 ms 0.1%	0 s	_CFRunLoopDoSources0 CoreFoundation
3.00 ms 0.1%	0 s	_CFRUNLOOP_IS_SERVICING_THE_MAIN_DISPATCH_QUEUE_ CoreFoundation
1.00 ms 0.0%	0 s	pthread_mutex_firstfit_lock_slow libsystem_pthread.dylib
1.00 ms 0.0%	0 s	_CFRunLoopModelsEmpty CoreFoundation
1.00 ms 0.0%	1.00 ms	pthread_mutex_unlock libsystem_pthread.dylib
1.00 ms 0.0%	1.00 ms	pthread_mutex_firstfit_unlock_slow libsystem_pthread.dylib

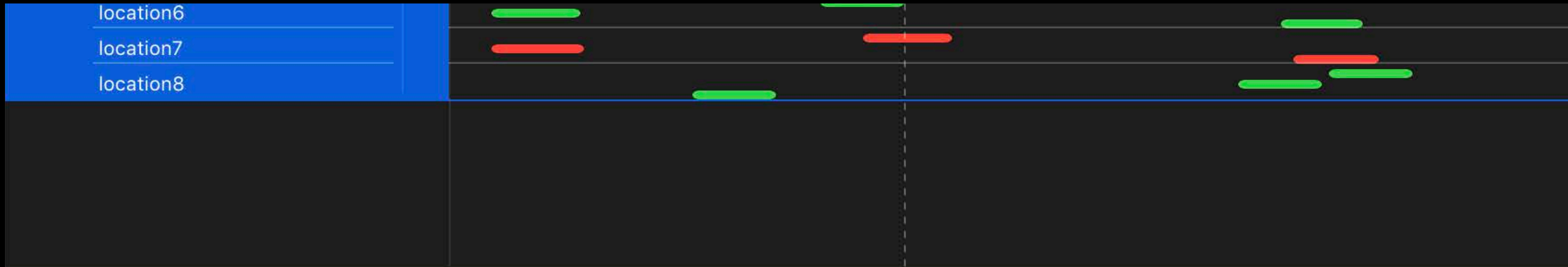
Heaviest Stack Trace

- 1531.0 Signpost Sender (1903)
- 1083.0 Main Thread 0x18f05
- 1031.0 start
- 1031.0 NSApplicationMain
- 921.0 -[NSApplication run]
- 754.0 -[NSApplication(NSEvent) _nextEventMatchingEventMask:untilDate:inMode:dequeue:]
- 705.0 _DPSNextEvent
- 687.0 _BlockUntilNextEventMatchingListInModeWithFilter
- 686.0 ReceiveNextEventCommon
- 624.0 RunCurrentEventLoopInMode
- 558.0 CFRunLoopRunSpecific
- 519.0 _CFRunLoopRun
- 275.0 _CFRunLoopDoTimers
- 275.0 _CFRunLoopDoTimer
- 273.0 _CFRUNLOOP_IS_CALLING_OUT_TO_A_TIMER_CALLBACK_FUNCTION_
- 264.0 _NSFireTimer
- 263.0 __34-[ViewController send10Events]
- 224.0 _os_signpost_emit_with_name_impl
- 223.0 _os_signpost_emit_impl
- 211.0 _os_log_impl_flatten_and_send
- 206.0 _os_log_impl_stream
- 203.0 _os_activity_stream_reflect
- 115.0 dispatch_block_perform
- 115.0 _dispatch_block_invoke_direct

Input Filter: Involves Symbol

Call Tree Call Tree Constraints Data Mining





 Trailblazer Networking > Narrative

Timestamp^	Description
00:06.037.270	Duplicated requested detected made by object: 0x10908d800. It requested location6, while having another request for location2 already running.
00:06.120.501	Duplicated requested detected made by object: 0x104801800. It requested location7, while having another request for location8 already running.
00:06.225.804	Duplicated requested detected made by object: 0x109011400. It requested location5, while having another request for location3 already running.
00:06.303.212	Duplicated requested detected made by object: 0x109065c00. It requested location2, while having another request for location1 already running.
00:06.386.450	Duplicated requested detected made by object: 0x10905d600. It requested location8, while having another request for location4 already running.
00:06.503.195	Duplicated requested detected made by object: 0x10908d800. It requested location3, while having another request for location6 already running.

Why create custom instruments

Architecture

Getting started

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Advanced

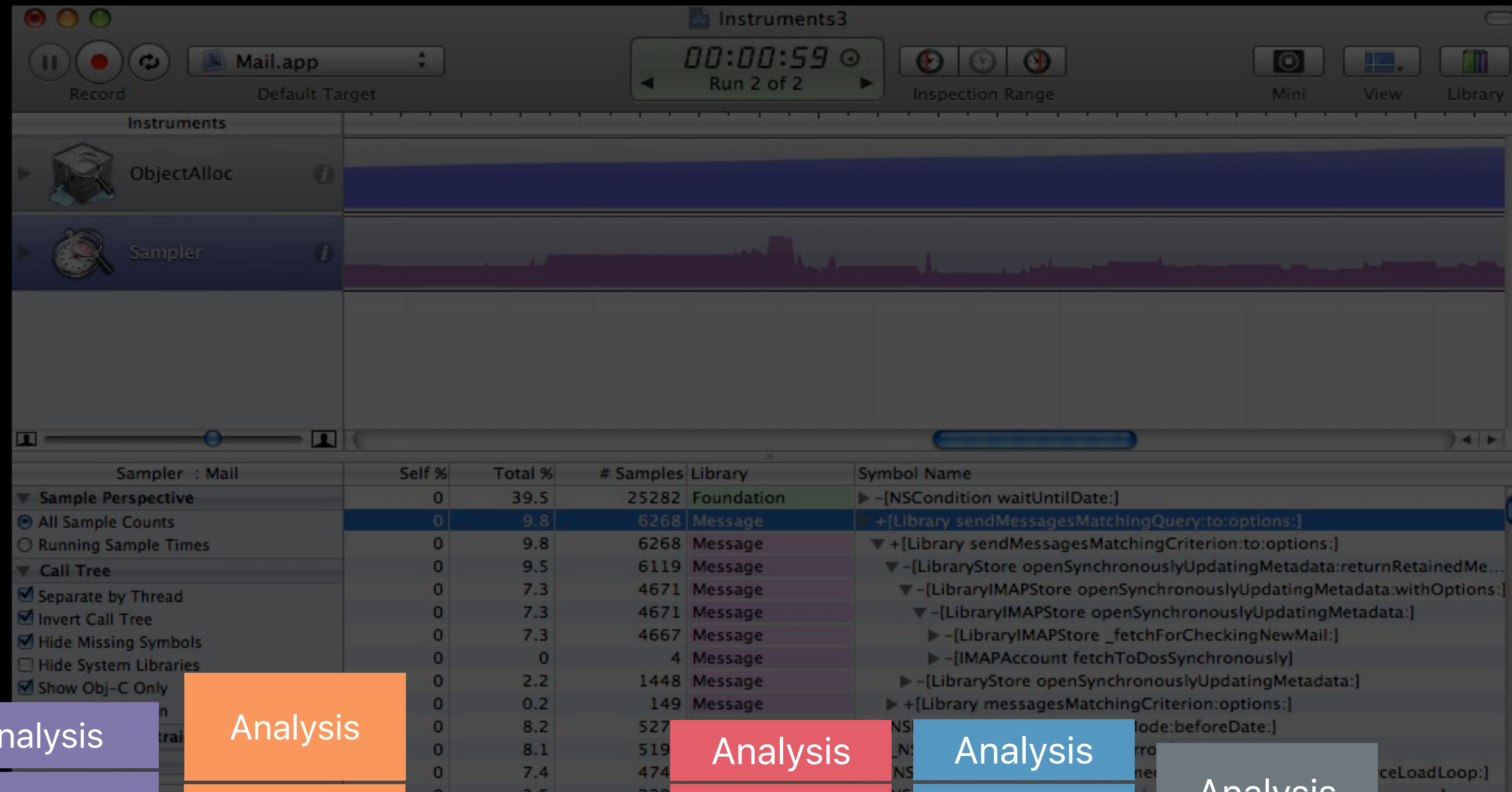
Best practices

In the Beginning...

The screenshot shows the Instruments3 application window. At the top, it displays 'Mail.app' as the target and 'Run 2 of 2' with a timer at 00:00:59. The 'Instruments' panel on the left shows 'ObjectAlloc' and 'Sampler' active. The main area contains a performance graph. Below the graph is a table of call tree data for the 'Sampler : Mail' instrument.

Sample Perspective	Self %	Total %	# Samples	Library	Symbol Name
▼ Sample Perspective	0	39.5	25282	Foundation	▶-[NSCondition waitUntilDate:]
● All Sample Counts	0	9.8	6268	Message	▶+[Library sendMessagesMatchingQuery:to:options:]
○ Running Sample Times	0	9.8	6268	Message	▼+[Library sendMessagesMatchingCriterion:to:options:]
▼ Call Tree	0	9.5	6119	Message	▼-[LibraryStore openSynchronouslyUpdatingMetadata:returnRetainedMe...
<input checked="" type="checkbox"/> Separate by Thread	0	7.3	4671	Message	▼-[LibraryIMAPStore openSynchronouslyUpdatingMetadata:withOptions:]
<input checked="" type="checkbox"/> Invert Call Tree	0	7.3	4671	Message	▼-[LibraryIMAPStore openSynchronouslyUpdatingMetadata:]
<input checked="" type="checkbox"/> Hide Missing Symbols	0	7.3	4667	Message	▶-[LibraryIMAPStore _fetchForCheckingNewMail:]
<input type="checkbox"/> Hide System Libraries	0	0	4	Message	▶-[IMAPAccount fetchToDosSynchronously]
<input checked="" type="checkbox"/> Show Obj-C Only	0	2.2	1448	Message	▶-[LibraryStore openSynchronouslyUpdatingMetadata:]
<input type="checkbox"/> Flatten Recursion	0	0.2	149	Message	▶+[Library messagesMatchingCriterion:options:]
▶ Call Tree Constraints	0	8.2	5270	Foundation	▶-[NSRunLoop(NSRunLoop) runMode:beforeDate:]
▼ Active Thread	0	8.1	5198	Message	▶-[_NSSocket readBytes:length:error:]
All Threads	0	7.4	4748	Foundation	▶+[NSURLConnection(NSURLConnectionReallyInternal) _resourceLoadLoop:]
	0	3.5	2294	AppKit	▶-[NSApplication nextEventMatchingMask:untilDate:inMode:dequeue:]
	0	2.9	1895	AppKit	▶-[NSUIHeartBeat _heartBeatThread:]
	0	2.7	1762	Message	▶-[LibraryStore _newMessagesAvailable:]
	0	2.2	1455	Foundation	▶-[NSCondition wait]

In the Beginning...



Analysis
Recording

Analysis
Recording

Analysis
Recording

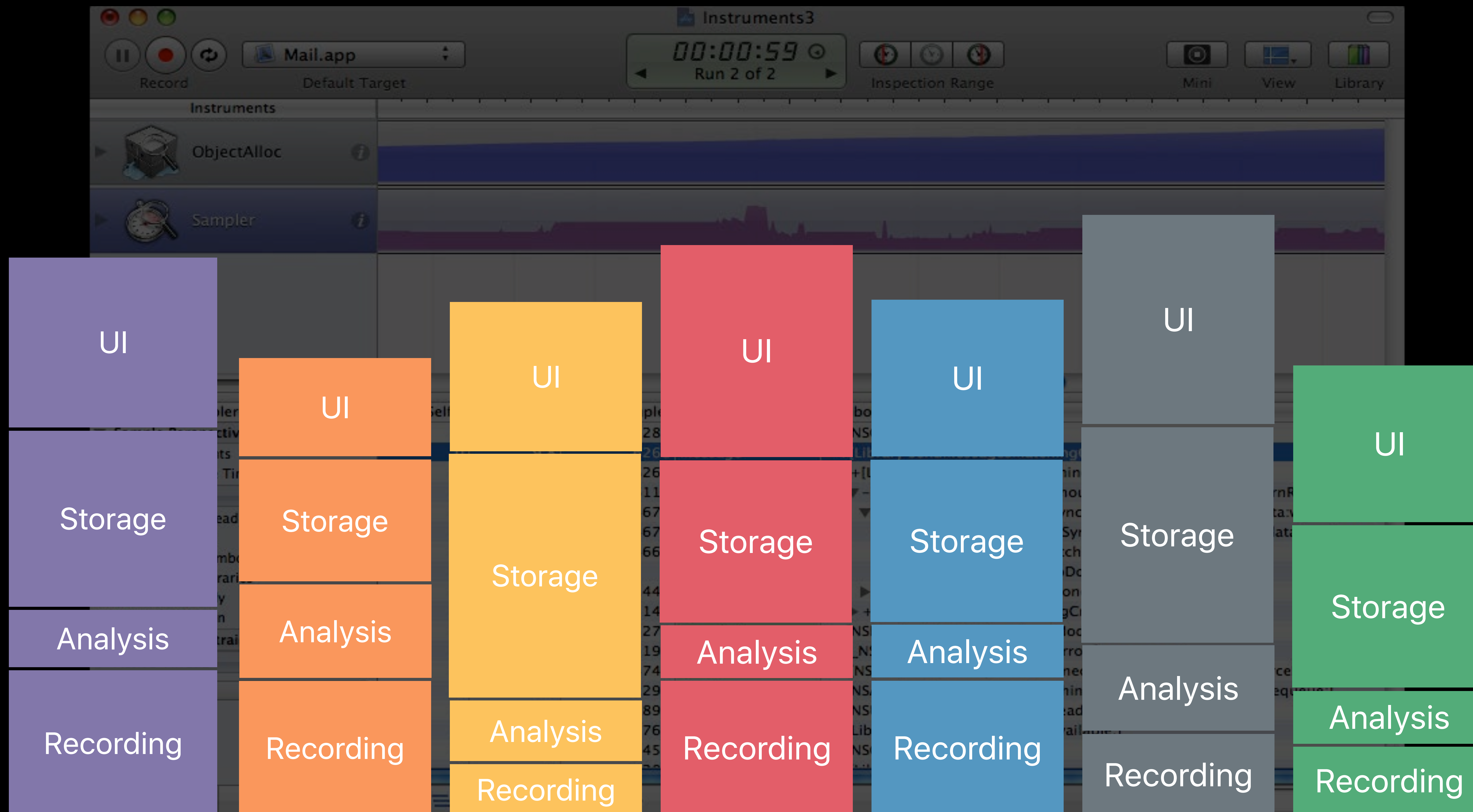
Analysis
Recording

Analysis
Recording

Analysis
Recording

Analysis
Recording

In the Beginning...



Today

The screenshot displays the Instruments application interface for a process named 'Signpost Sender.app' (pid: 1503, tid: 0xf240) running on CPU 2. The main window shows a timeline from 00:00.000 to 00:09.000. The 'Main Thread 0xf1fe' is selected, showing a narrative of system calls and thread execution. The 'Backtrace' panel on the right shows the call stack for the selected event.

Timeline Instruments:

- Points: Half Second
- User Interactive Load (10ms)
- Context Switches
- Virtual Memory Activity
- System Calls Made
- Main Thread 0xf1fe (Signpost Sender (1503))

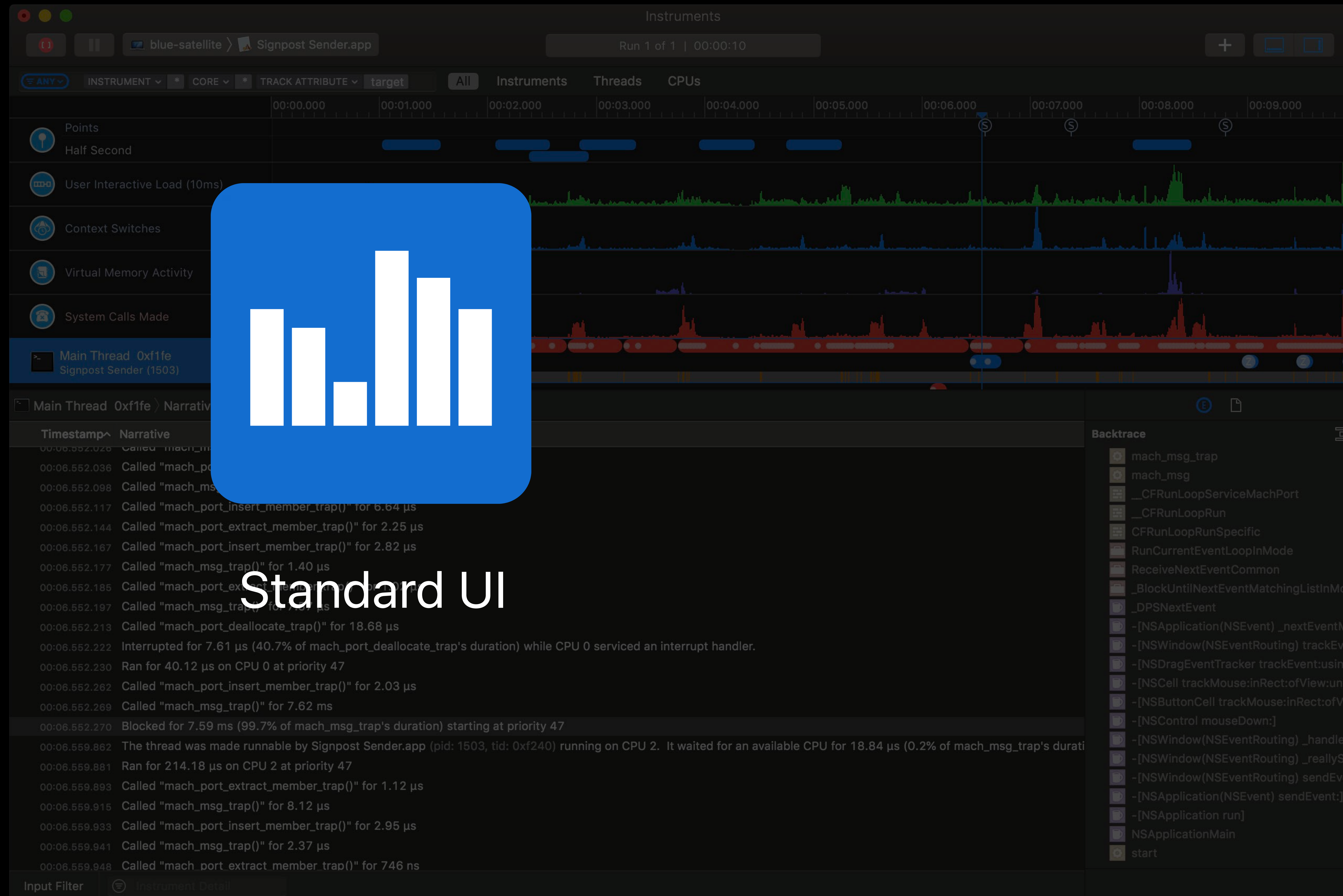
Main Thread 0xf1fe Narrative:

Timestamp	Narrative
00:06.552.026	Called "mach_msg_trap()" for 3.40 μs
00:06.552.036	Called "mach_port_extract_member_trap()" for 1.11 μs
00:06.552.098	Called "mach_msg_trap()" for 8.48 μs
00:06.552.117	Called "mach_port_insert_member_trap()" for 6.64 μs
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00:06.552.213	Called "mach_port_deallocate_trap()" for 18.68 μs
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00:06.552.230	Ran for 40.12 μs on CPU 0 at priority 47
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00:06.552.269	Called "mach_msg_trap()" for 7.62 ms
00:06.552.270	Blocked for 7.59 ms (99.7% of mach_msg_trap's duration) starting at priority 47
00:06.559.862	The thread was made runnable by Signpost Sender.app (pid: 1503, tid: 0xf240) running on CPU 2. It waited for an available CPU for 18.84 μs (0.2% of mach_msg_trap's duration)
00:06.559.881	Ran for 214.18 μs on CPU 2 at priority 47
00:06.559.893	Called "mach_port_extract_member_trap()" for 1.12 μs
00:06.559.915	Called "mach_msg_trap()" for 8.12 μs
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00:06.559.941	Called "mach_msg_trap()" for 2.37 μs
00:06.559.948	Called "mach_port_extract_member_trap()" for 746 ns

Backtrace:

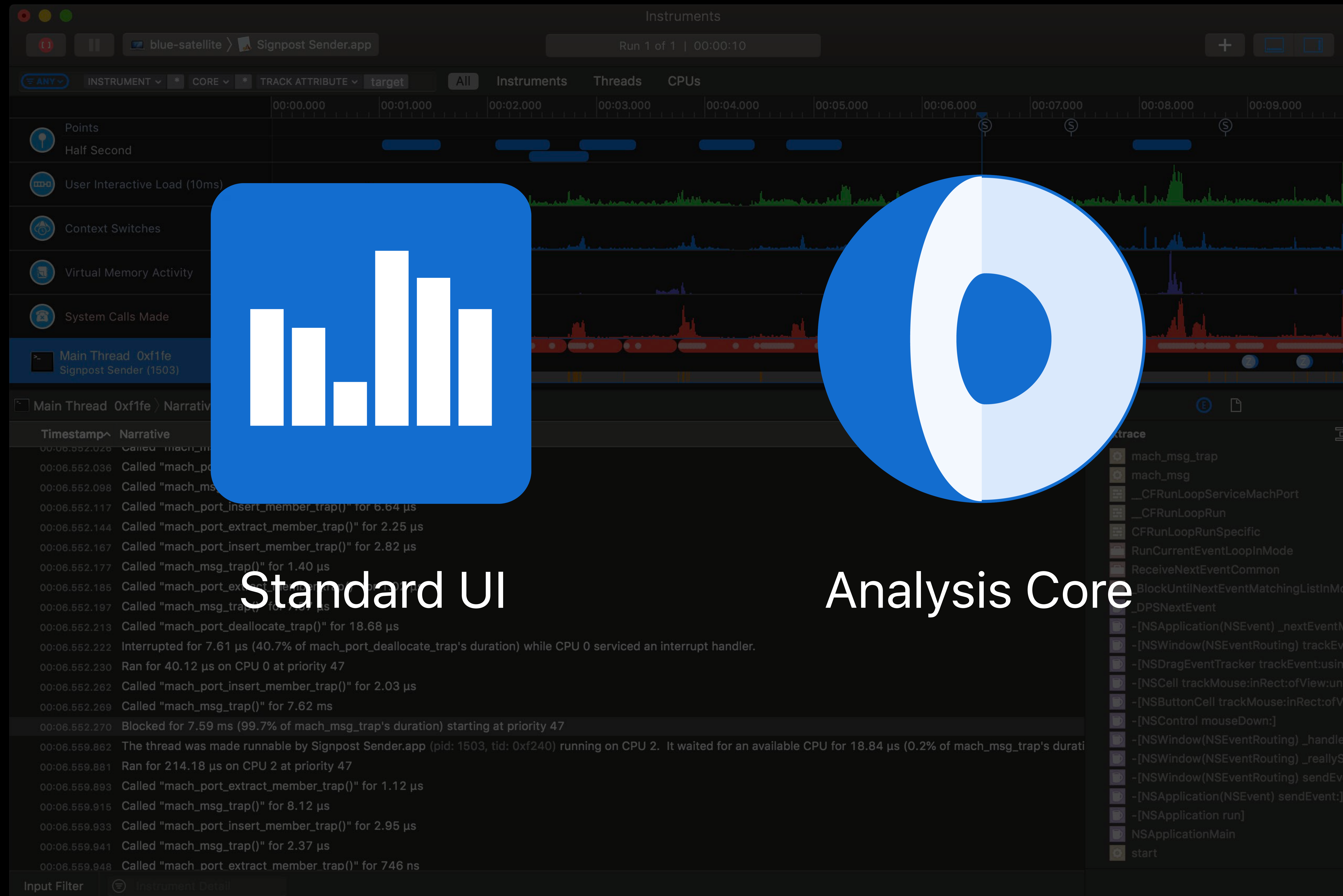
- mach_msg_trap
- mach_msg
- __CFRunLoopServiceMachPort
- __CFRunLoopRun
- CFRunLoopRunSpecific
- RunCurrentEventLoopInMode
- ReceiveNextEventCommon
- _BlockUntilNextEventMatchingListInMode
- _DPSNextEvent
- [NSApplication(NSEvent) _nextEventMi
- [NSWindow(NSEventRouting) trackEve
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- [NSButtonCell trackMouse:inRect:ofVi
- [NSControl mouseDown:]
- [NSWindow(NSEventRouting) _handleM
- [NSWindow(NSEventRouting) _reallySe
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- NSApplicationMain
- start

Today



Standard UI

Today



Instruments

blue-satellite > Signpost Sender.app

Run 1 of 1 | 00:00:10

ANY INSTRUMENT * CORE * TRACK ATTRIBUTE target All Instruments Threads CPUs

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Context Switches
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System Calls Made
Main Thread 0xf1fe
Signpost Sender (1503)

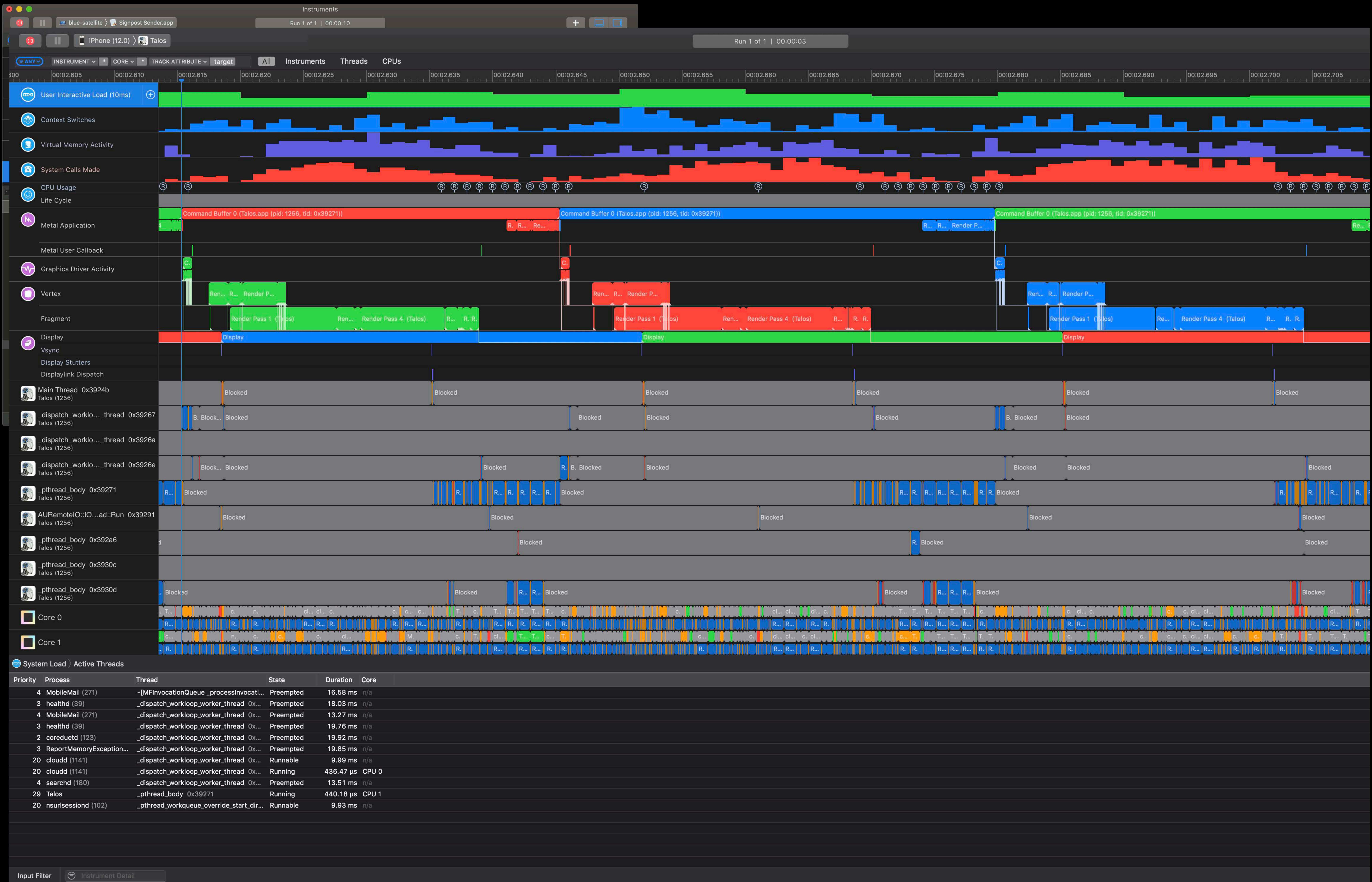
Main Thread 0xf1fe > Narrative

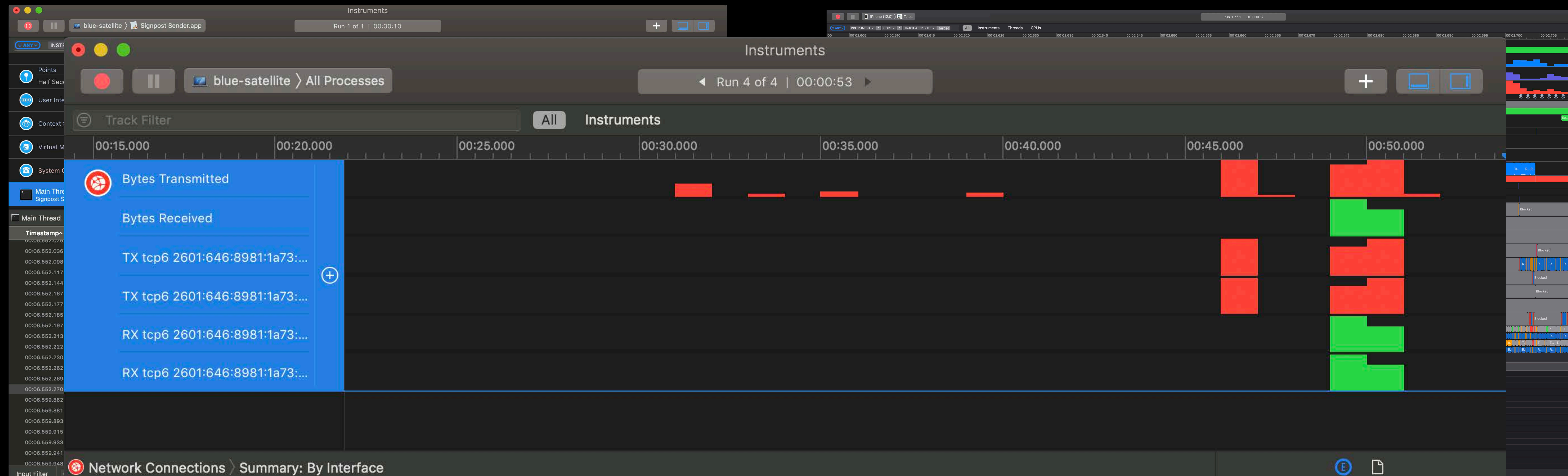
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Input Filter Instrument Detail

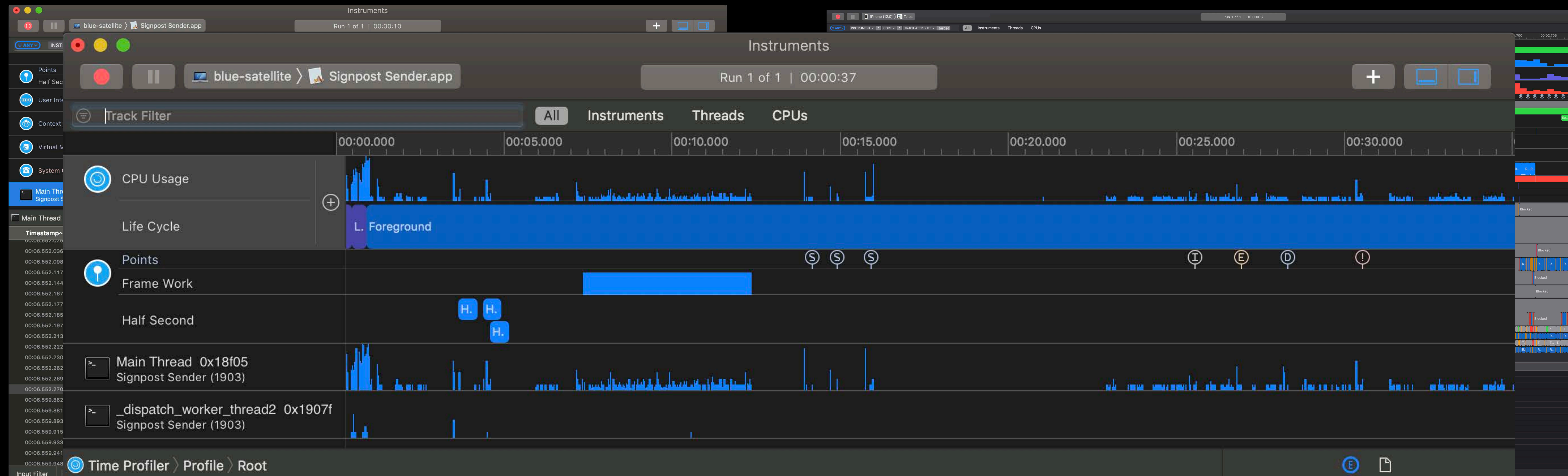




Network Connections Summary: By Interface

Graph	Network Interface / Connection	Bytes In	Packets In	Owner	Bytes Out	Packets Out
<input type="checkbox"/>	* All *	1.39 MiB	1,232	n/a	1.54 KiB	30
<input type="checkbox"/>	Wi-Fi	1.39 MiB	1,232	n/a	1.54 KiB	30
<input checked="" type="checkbox"/>	tcp6 2601:646:8981:1a73:f5aa:c22e:1f3f:19c7.50317 ⇌ 2001:559:1...	1.39 MiB	1,207	App Store (1702)	1.03 KiB	15
<input type="checkbox"/>	udp4 *:5353 ⇌ *.*	1.22 KiB	6	mDNSResponder (119)	0 Bytes	0
<input type="checkbox"/>	udp6 ::5353 ⇌ ::*	1.06 KiB	6	mDNSResponder (119)	0 Bytes	0
<input type="checkbox"/>	udp6 ::49788 ⇌ ::*	271 Bytes	1	mDNSResponder (119)	32 Bytes	1
<input type="checkbox"/>	udp6 ::50099 ⇌ ::*	145 Bytes	1	mDNSResponder (119)	45 Bytes	1
<input type="checkbox"/>	udp6 ::60309 ⇌ ::*	143 Bytes	2	mDNSResponder (119)	73 Bytes	2
<input type="checkbox"/>	udp6 ::57614 ⇌ ::*	127 Bytes	1	mDNSResponder (119)	43 Bytes	1
<input type="checkbox"/>	udp6 ::52892 ⇌ ::*	111 Bytes	2	mDNSResponder (119)	73 Bytes	2
<input type="checkbox"/>	udp6 ::50428 ⇌ ::*	59 Bytes	1	mDNSResponder (119)	43 Bytes	1
<input type="checkbox"/>	udp6 ::57369 ⇌ ::*	32 Bytes	1	mDNSResponder (119)	32 Bytes	1
<input type="checkbox"/>	udp6 ::61111 ⇌ ::*	0 Bytes	0	mDNSResponder (119)	34 Bytes	1
<input type="checkbox"/>	tcp6 2601:646:8981:1a73:f5aa:c22e:1f3f:19c7.50269 ⇌ 2620:149:a...	0 Bytes	1	com.apple.iCloudHelper (...)	31 Bytes	1
<input type="checkbox"/>	tcp4 10.0.1.3:50295 ⇌ 17.248.128.143:443	0 Bytes	1	CalendarAgent (357)	31 Bytes	1
<input type="checkbox"/>	tcp4 10.0.1.3:50294 ⇌ 17.248.128.143:443	0 Bytes	1	CalendarAgent (357)	31 Bytes	1
<input type="checkbox"/>	udp6 ::52873 ⇌ ::*	0 Bytes	0	mDNSResponder (119)	32 Bytes	1
<input type="checkbox"/>	tcp4 10.0.1.3:50292 ⇌ 23.6.199.41:80	0 Bytes	1	apsd (85)	0 Bytes	0
<input type="checkbox"/>	udp6 ::64893 ⇌ ::*	0 Bytes	0	mDNSResponder (119)	32 Bytes	1

No Detail



Time Profiler > Profile > Root

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3.00 ms 0.1%	0 s	_CFRUNLOOP_IS_SERVICING_THE_MAIN_DISPATCH_QUEUE_ CoreFoundation
1.00 ms 0.0%	0 s	_pthread_mutex_firstfit_lock_slow libsystem_pthread.dylib
1.00 ms 0.0%	0 s	_CFRunLoopModelsEmpty CoreFoundation
1.00 ms 0.0%	1.00 ms	pthread_mutex_unlock libsystem_pthread.dylib
1.00 ms 0.0%	1.00 ms	_pthread_mutex_firstfit_unlock_slow libsystem_pthread.dylib

Heaviest Stack Trace

1531.0	Signpost Sender (1903)
1083.0	Main Thread 0x18f05
1031.0	start
1031.0	NSApplicationMain
921.0	-[NSApplication run]
754.0	-[NSApplication(NSEvent) _nextEventMatchingEventMask:untilDate:inMode:dequeue:]
705.0	_DPSNextEvent
687.0	_BlockUntilNextEventMatchingListInModeWithFilter
686.0	ReceiveNextEventCommon
624.0	RunCurrentEventLoopInMode
558.0	CFRunLoopRunSpecific
519.0	_CFRunLoopRun
275.0	_CFRunLoopDoTimers
275.0	_CFRunLoopDoTimer
273.0	_CFRUNLOOP_IS_CALLING_OUT_TO_A_TIMER_CALLBACK_FUNCTION_
264.0	_NSFireTimer
263.0	_34-[ViewController send10Event]
224.0	_os_signpost_emit_with_name_impl
223.0	_os_signpost_emit_impl
211.0	_os_log_impl_flatten_and_send
206.0	_os_log_impl_stream
203.0	_os_activity_stream_reflect
115.0	dispatch_block_perform
115.0	_dispatch_block_invoke_direct

Instruments
Run 1 of 1 | 00:00:10

INSTRUMENT: CORE TRACK ATTRIBUTE: target

Main Thread 0x11fe Signpost Sender (1803)

Timestamp Narrative

- 00:06.552.929 Value mach_msg_trap() for 0.40 μs
- 00:06.552.936 Called "mach_port_extract_member_trap()" for 1.11 μs
- 00:06.552.998 Called "mach_msg_trap()" for 8.48 μs
- 00:06.552.117 Called "mach_port_insert_member_trap()" for 6.64 μs
- 00:06.552.144 Called "mach_port_extract_member_trap()" for 2.25 μs
- 00:06.552.167 Called "mach_port_insert_member_trap()" for 2.82 μs
- 00:06.552.177 Called "mach_msg_trap()" for 1.40 μs
- 00:06.552.185 Called "mach_port_extract_member_trap()" for 1.02 μs
- 00:06.552.197 Called "mach_msg_trap()" for 7.57 μs
- 00:06.552.213 Called "mach_port_deallocate_trap()" for 18.68 μs
- 00:06.552.222 Interrupted for 7.61 μs (40.7% of mach_port_deallocate_trap's duration) while CPU 0 serviced an interrupt handler.
- 00:06.552.230 Ran for 40.12 μs on CPU 0 at priority 47
- 00:06.552.262 Called "mach_port_insert_member_trap()" for 2.03 μs
- 00:06.552.269 Called "mach_msg_trap()" for 7.62 ms
- 00:06.552.270 Blocked for 7.59 ms (99.7% of mach_msg_trap's duration) starting at priority 47
- 00:06.559.882 The thread was made runnable by Signpost Sender.app (pid: 1503, tid: 0x1240) running on CPU 2. It waited for an available CPU for 18.84 μs (0.2% of mach_msg_trap's duration).
- 00:06.559.881 Ran for 214.18 μs on CPU 2 at priority 47
- 00:06.559.893 Called "mach_port_extract_member_trap()" for 1.12 μs
- 00:06.559.915 Called "mach_msg_trap()" for 8.12 μs
- 00:06.559.933 Called "mach_port_insert_member_trap()" for 2.95 μs
- 00:06.559.941 Called "mach_msg_trap()" for 2.37 μs
- 00:06.559.948 Called "mach_port_extract_member_trap()" for 746 ns

Backtrace

- mach_msg_trap
- mach_msg
- __CFRunLoopServiceMachPort
- __CFRunLoopRun
- CFRunLoopRunSpecific
- RunCurrentEventLoopInMode
- ReceiveNextEventCommon
- _BlockUntilNextEventMatchingListInMode
- _DPSNextEvent
- [NSApplication(NSEvent) _nextEventMatchingRootEvent]
- [NSWindow(NSEventRouting) trackMouseEvent]
- [NSDragEventTracker trackEventUsingEvent]
- [NSCell trackMouseEvent:inRect:ofView:untilMouseIsReleased:]
- [NSButtonCell trackMouseEvent:inRect:ofView:untilMouseIsReleased:]
- [NSControl mouseDown:]
- [NSWindow(NSEventRouting) _handleMouseEvent]
- [NSWindow(NSEventRouting) _reallySendEvent:from:atPoint:inContext:]
- [NSWindow(NSEventRouting) sendEvent:]
- [NSApplication(NSEvent) sendEvent:]
- [NSApplication run]
- NSApplicationMain
- start

Instruments
Run 1 of 1 | 00:00:03

INSTRUMENT: CORE TRACK ATTRIBUTE: target

System Load - Active Threads

Priority	Process	Thread	State	Duration	Core
4	ModemMux (271)	0x11fe000000000000 - process/mux...	Preempted	15.58 ms	-
3	healthd (39)	_dispatch_workloop_worker_thread 0x...	Preempted	18.03 ms	-
4	ModemMux (271)	_dispatch_workloop_worker_thread 0x...	Preempted	13.22 ms	-
3	healthd (39)	_dispatch_workloop_worker_thread 0x...	Preempted	12.78 ms	-
2	coreaudi (123)	_dispatch_workloop_worker_thread 0x...	Preempted	19.92 ms	-
3	ReportMemoryException...	_dispatch_workloop_worker_thread 0x...	Preempted	19.85 ms	-
20	cloudsd (111)	_dispatch_workloop_worker_thread 0x...	Running	9.99 ms	-
20	cloudsd (111)	_dispatch_workloop_worker_thread 0x...	Running	436.47 μs	CPU 0
4	searchd (180)	_dispatch_workloop_worker_thread 0x...	Preempted	13.51 ms	-
20	Time	_pthread_body (0x12071)	Running	840.18 μs	CPU 1
20	hourssind (102)	_pthread_workqueue_override_start_thr...	Runnable	9.93 ms	-

Instruments
Run 4 of 4 | 00:00:53

Track Filter: All Instruments

Bytes Transmitted

Bytes Received

Network Connections Summary: By Interface

Graph	Network Interface / Connection	Bytes In	Packets In	Owner	Bytes Out	Packets Out
[-]	* All *	1.39 MiB	1,232	n/a	1.54 KiB	30
[-]	[-] Wi-Fi	1.39 MiB	1,232	n/a	1.54 KiB	30
[x]	tcp6 2601:646:8981:1a73:f5aa:c22e:1f3f:19c7:50317 ⇐ 2001:559:1...	1.39 MiB	1,207	App Store (1702)	1.03 KiB	15
	udp4 *:5353 ⇐ *	1.22 KiB	6	mDNSResponder (119)	0 Bytes	0
	udp6 ::5353 ⇐ ::*	1.06 KiB	6	mDNSResponder (119)	0 Bytes	0
	udp6 ::49788 ⇐ ::*	271 Bytes	1	mDNSResponder (119)	32 Bytes	1
	udp6 ::50099 ⇐ ::*	145 Bytes	1	mDNSResponder (119)	45 Bytes	1
	udp6 ::60309 ⇐ ::*	143 Bytes	2	mDNSResponder (119)	73 Bytes	2
	udp6 ::57614 ⇐ ::*	127 Bytes	1	mDNSResponder (119)	43 Bytes	1
	udp6 ::52892 ⇐ ::*	111 Bytes	2	mDNSResponder (119)	73 Bytes	2
	udp6 ::50426 ⇐ ::*	59 Bytes	1	mDNSResponder (119)	43 Bytes	1
	udp6 ::57369 ⇐ ::*	32 Bytes	1	mDNSResponder (119)	32 Bytes	1
	udp6 ::61111 ⇐ ::*	0 Bytes	0	mDNSResponder (119)	34 Bytes	1
	tcp6 2601:646:8981:1a73:f5aa:c22e:1f3f:19c7:50269 ⇐ 2620:149:a...	0 Bytes	1	com.apple.iCloudHelper (...)	31 Bytes	1
	tcp4 10.0.1.3:50295 ⇐ 17.248.128.143:443	0 Bytes	1	CalendarAgent (357)	31 Bytes	1
	tcp4 10.0.1.3:50294 ⇐ 17.248.128.143:443	0 Bytes	1	CalendarAgent (357)	31 Bytes	1
	udp6 ::52873 ⇐ ::*	0 Bytes	0	mDNSResponder (119)	32 Bytes	1
	tcp4 10.0.1.3:50292 ⇐ 23.8.199.41:80	0 Bytes	1	apsd (85)	0 Bytes	0
	udp6 ::64893 ⇐ ::*	0 Bytes	1	mDNSResponder (119)	32 Bytes	1

Instruments
Run 1 of 1 | 00:00:37

Track Filter: All Instruments

CPU Usage

Life Cycle

Points

Frame Work

Half Second

Main Thread 0x18f05 Signpost Sender (1903)

_dispatch_workloop_thread2 0x19071 Signpost Sender (1903)

Time Profiler Profile > Root

Weight	Self Weight	Symbol Name
1.53 s	100.0%	0 s
1.08 s	70.7%	0 s
1.03 s	67.3%	0 s
1.03 s	67.3%	0 s
921.00 ms	60.1%	0 s
754.00 ms	49.2%	1.00 ms
705.00 ms	46.0%	1.00 ms
687.00 ms	44.8%	0 s
886.00 ms	44.8%	1.00 ms
824.00 ms	40.7%	0 s
558.00 ms	36.4%	1.00 ms
519.00 ms	33.8%	0 s
275.00 ms	17.9%	0 s
173.00 ms	11.2%	1.00 ms
20.00 ms	1.3%	1.00 ms
16.00 ms	1.0%	0 s
14.00 ms	0.9%	0 s
8.00 ms	0.5%	0 s
3.00 ms	0.1%	0 s
3.00 ms	0.1%	0 s
3.00 ms	0.1%	0 s
1.00 ms	0.0%	0 s
1.00 ms	0.0%	0 s
1.00 ms	0.0%	1.00 ms
1.00 ms	0.0%	0 s

Heaviest Stack Trace

- 1531.0 Signpost Sender (1903)
- 1083.0 Main Thread 0x18f05
- 1031.0 start
- 1031.0 NSApplicationMain
- 921.0 -[NSApplication run]
- 754.0 -[NSApplication(NSEvent) _nextEventMatchingRootEvent]
- 705.0 _DPSNextEvent
- 687.0 _BlockUntilNextEventMatchingListInModeWithFilter
- 886.0 _BlockUntilNextEventMatchingListInMode
- 886.0 ReceiveNextEventCommon
- 824.0 RunCurrentEventLoopInMode
- 558.0 CFRunLoopRunSpecific
- 519.0 _CFRunLoopRun
- 275.0 _CFRunLoopDoTimers
- 275.0 _CFRunLoopDoTimers
- 273.0 _CFRunLoop_IS_CALLING_OUT_TO_OBSERVER
- 264.0 _NSFireTimer
- 263.0 _34-[ViewController send10Eve]
- 224.0 _os_signpost_emit_with_name_inr
- 223.0 _os_signpost_emit_impl
- 211.0 _os_log_impl_flatten_and_send
- 206.0 _os_log_impl_stream
- 203.0 _os_activity_stream_reflect
- 115.0 dispatch_block_perform
- 115.0 _dispatch_block_invoke_direct



Precise control over font, text style, & paragraph settings

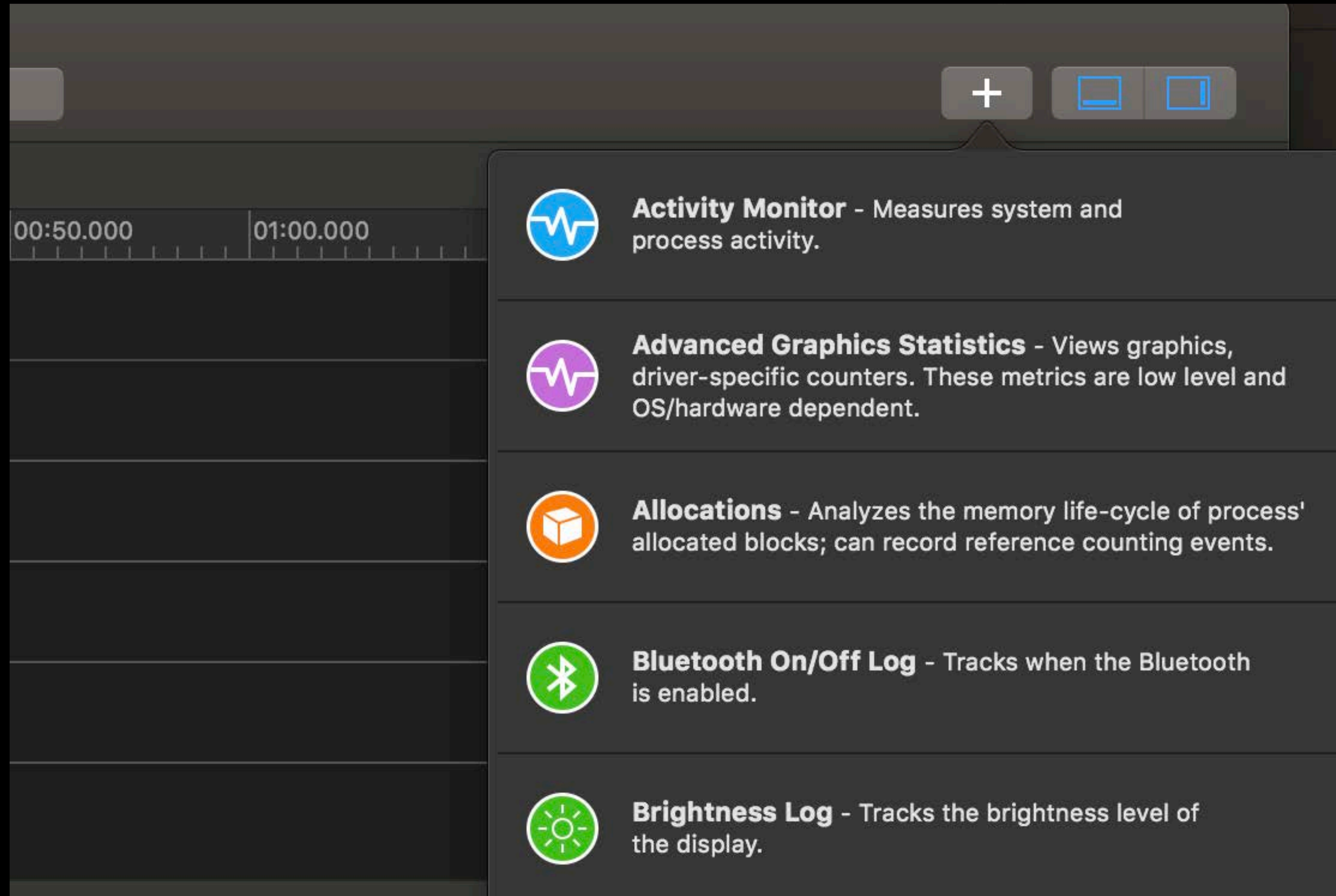
- Measuring tools
- Text spacing
 - Alignment
 - Grid tool

Transpa Effects






XCODE



Instruments



The screenshot shows the Instruments application interface. On the left, there is a timeline with markers at 00:50.000 and 01:00.000. On the right, a panel displays a list of instruments, each with a unique icon and a brief description of its function.

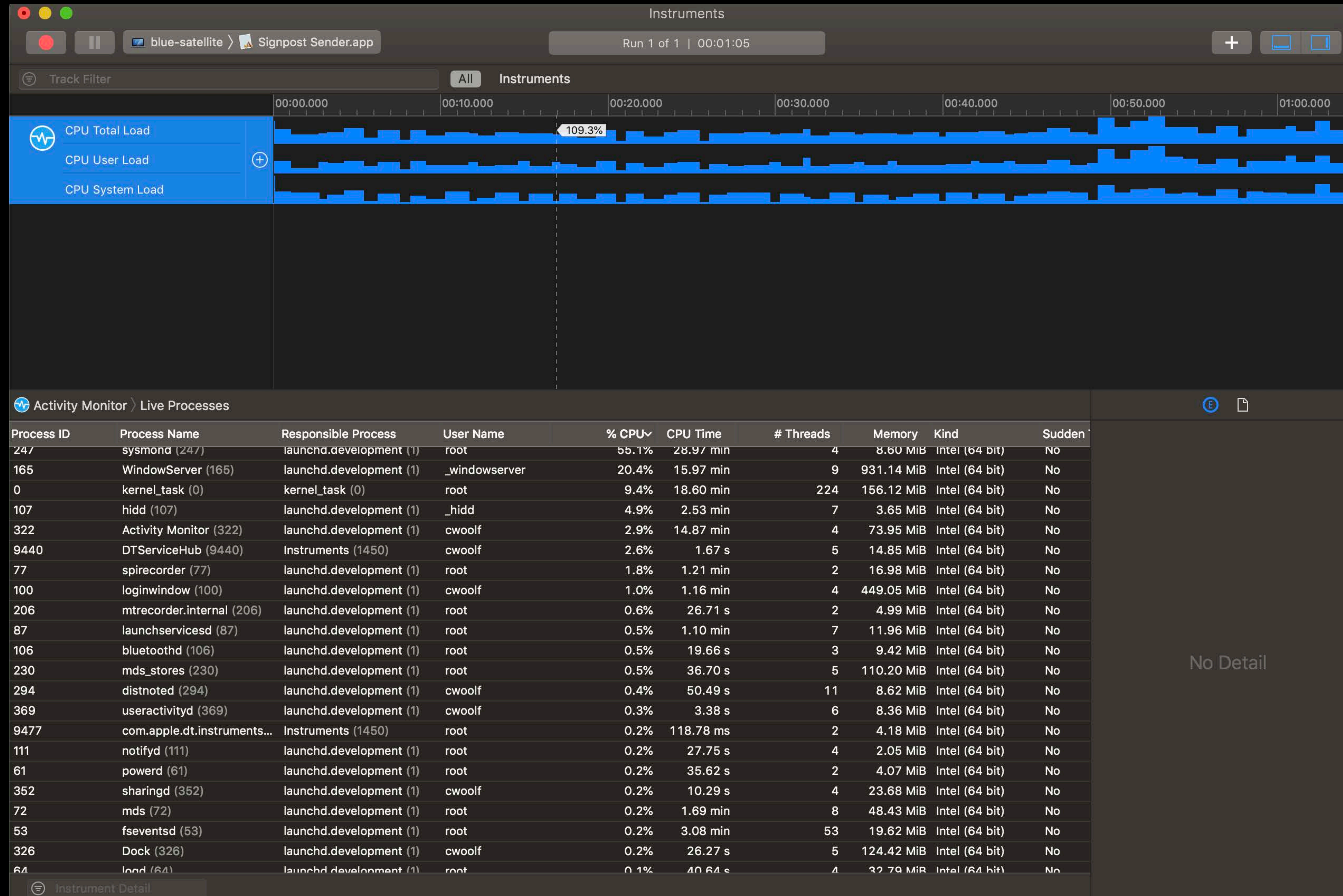
-  **Activity Monitor** - Measures system and process activity.
-  **Advanced Graphics Statistics** - Views graphics, driver-specific counters. These metrics are low level and OS/hardware dependent.
-  **Allocations** - Analyzes the memory life-cycle of process' allocated blocks; can record reference counting events.
-  **Bluetooth On/Off Log** - Tracks when the Bluetooth is enabled.
-  **Brightness Log** - Tracks the brightness level of the display.

Instruments

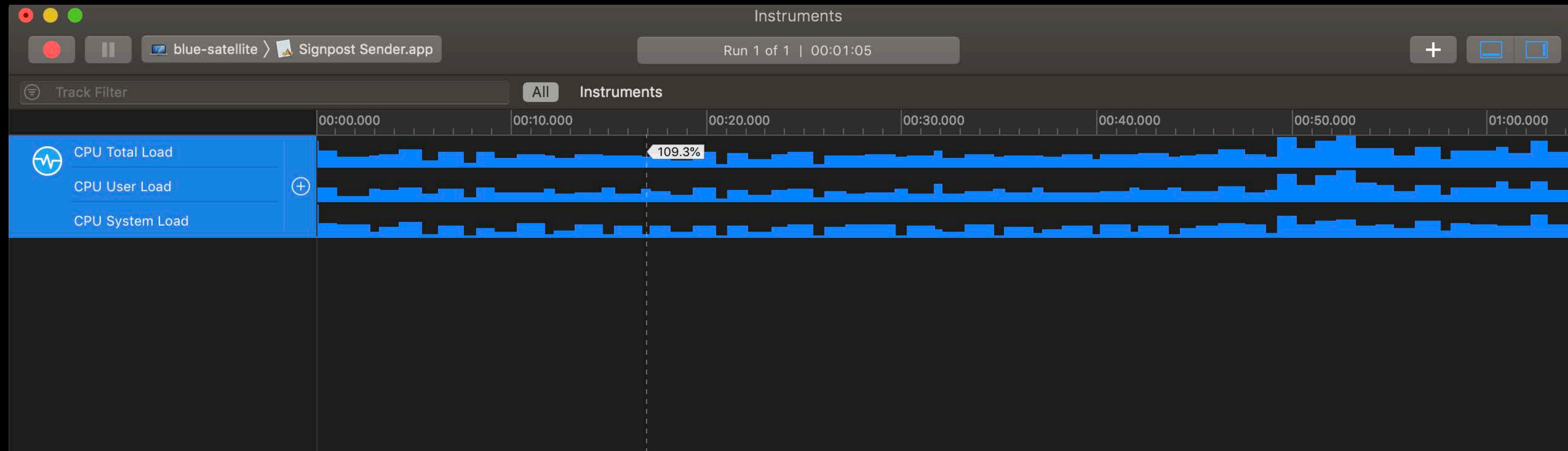
The screenshot shows the Instruments application window. At the top, the title bar reads "Instruments". Below it, the target application is identified as "blue-satellite" running "Signpost Sender.app". The status bar indicates "No Runs". A "Track Filter" section is set to "All Instruments". A timeline at the top shows time intervals from 00:00.000 to 01:40.000. The "Activity Monitor" instrument is selected and highlighted in blue. Below the timeline, the "Activity Monitor > Live Processes" view is active, displaying a table with the following columns: Process ID, Process Name, Responsible Process, User Name, % CPU, CPU Time, # Threads, Memory, Kind, and Sudden. The table is currently empty. To the right of the table, there is a "No Detail" message. At the bottom left, there is an "Instrument Detail" button.

Process ID	Process Name	Responsible Process	User Name	% CPU	CPU Time	# Threads	Memory	Kind	Sudden
No Detail									

Instruments



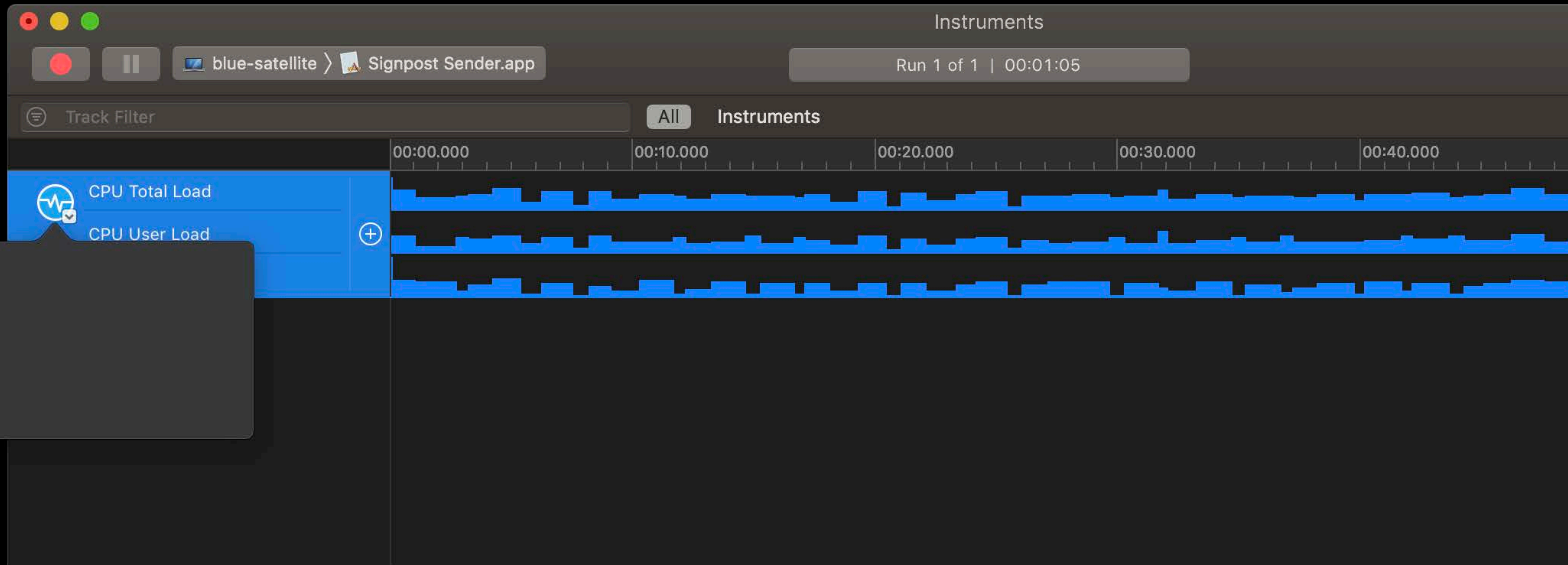
Instruments



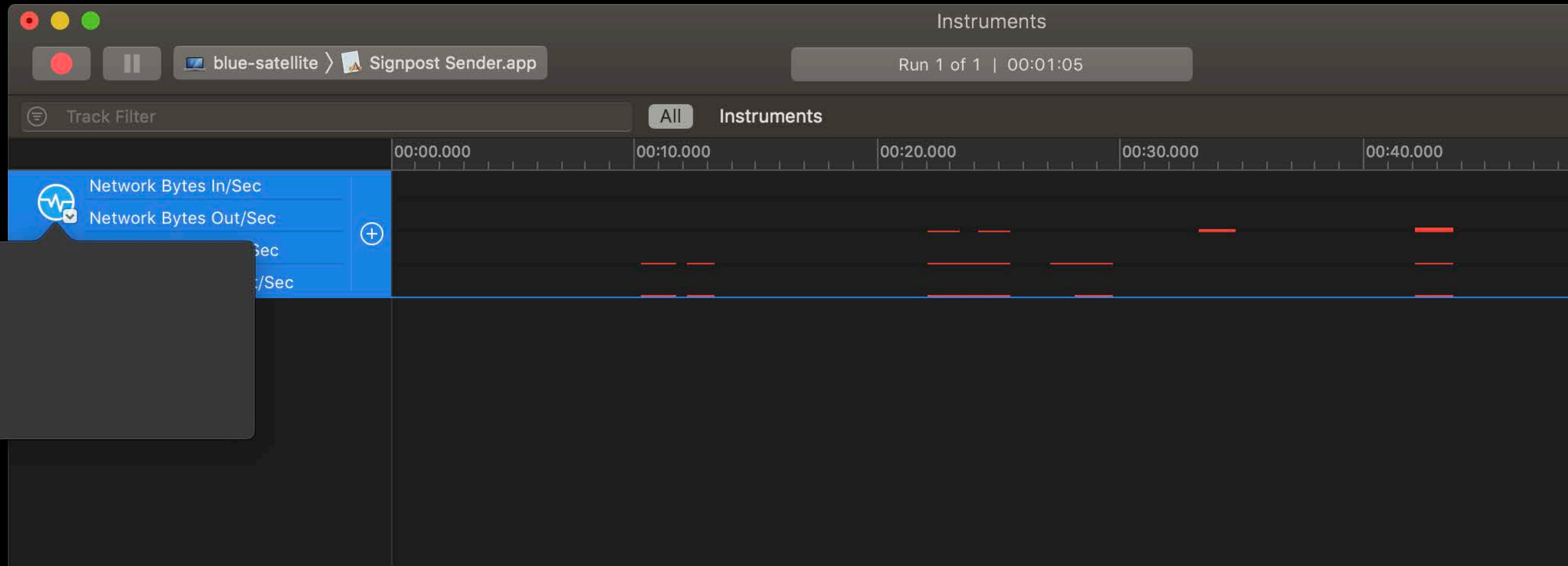
Process ID	Process Name	Responsible Process	User Name	% CPU	CPU Time	# Threads	Memory	Kind	Sudden
247	sysmond (247)	launchd.development (1)	root	55.1%	28.97 min	4	8.60 MiB	Intel (64 bit)	No
165	WindowServer (165)	launchd.development (1)	_windowserver	20.4%	15.97 min	9	931.14 MiB	Intel (64 bit)	No
0	kernel_task (0)	kernel_task (0)	root	9.4%	18.60 min	224	156.12 MiB	Intel (64 bit)	No
107	hidd (107)	launchd.development (1)	_hidd	4.9%	2.53 min	7	3.65 MiB	Intel (64 bit)	No
322	Activity Monitor (322)	launchd.development (1)	cwoolf	2.9%	14.87 min	4	73.95 MiB	Intel (64 bit)	No
9440	DTSserviceHub (9440)	Instruments (1450)	cwoolf	2.6%	1.67 s	5	14.85 MiB	Intel (64 bit)	No
77	spirecorder (77)	launchd.development (1)	root	1.8%	1.21 min	2	16.98 MiB	Intel (64 bit)	No
100	loginwindow (100)	launchd.development (1)	cwoolf	1.0%	1.16 min	4	449.05 MiB	Intel (64 bit)	No
206	mtrecorder.internal (206)	launchd.development (1)	root	0.6%	26.71 s	2	4.99 MiB	Intel (64 bit)	No
87	launchservicesd (87)	launchd.development (1)	root	0.5%	1.10 min	7	11.96 MiB	Intel (64 bit)	No
106	bluetoothd (106)	launchd.development (1)	root	0.5%	19.66 s	3	9.42 MiB	Intel (64 bit)	No
230	mds_stores (230)	launchd.development (1)	root	0.5%	36.70 s	5	110.20 MiB	Intel (64 bit)	No
294	distnoted (294)	launchd.development (1)	cwoolf	0.4%	50.49 s	11	8.62 MiB	Intel (64 bit)	No
369	useractivityd (369)	launchd.development (1)	cwoolf	0.3%	3.38 s	6	8.36 MiB	Intel (64 bit)	No
9477	com.apple.dt.instruments...	Instruments (1450)	root	0.2%	118.78 ms	2	4.18 MiB	Intel (64 bit)	No
111	notifyd (111)	launchd.development (1)	root	0.2%	27.75 s	4	2.05 MiB	Intel (64 bit)	No
61	powerd (61)	launchd.development (1)	root	0.2%	35.62 s	2	4.07 MiB	Intel (64 bit)	No
352	sharingd (352)	launchd.development (1)	cwoolf	0.2%	10.29 s	4	23.68 MiB	Intel (64 bit)	No
72	mds (72)	launchd.development (1)	root	0.2%	1.69 min	8	48.43 MiB	Intel (64 bit)	No
53	fsevents (53)	launchd.development (1)	root	0.2%	3.08 min	53	19.62 MiB	Intel (64 bit)	No
326	Dock (326)	launchd.development (1)	cwoolf	0.2%	26.27 s	5	124.42 MiB	Intel (64 bit)	No
64	load (64)	launchd.development (1)	root	0.1%	40.64 s	4	32.79 MiB	Intel (64 bit)	No

No Detail

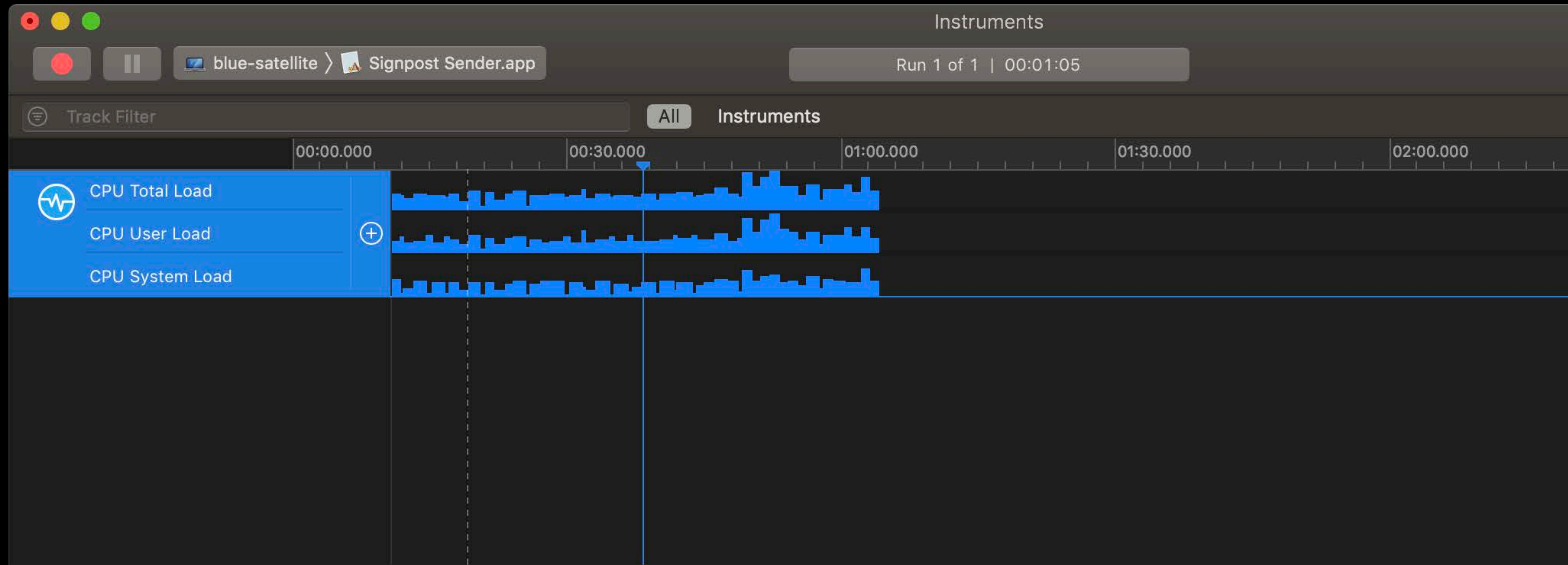
Graphs



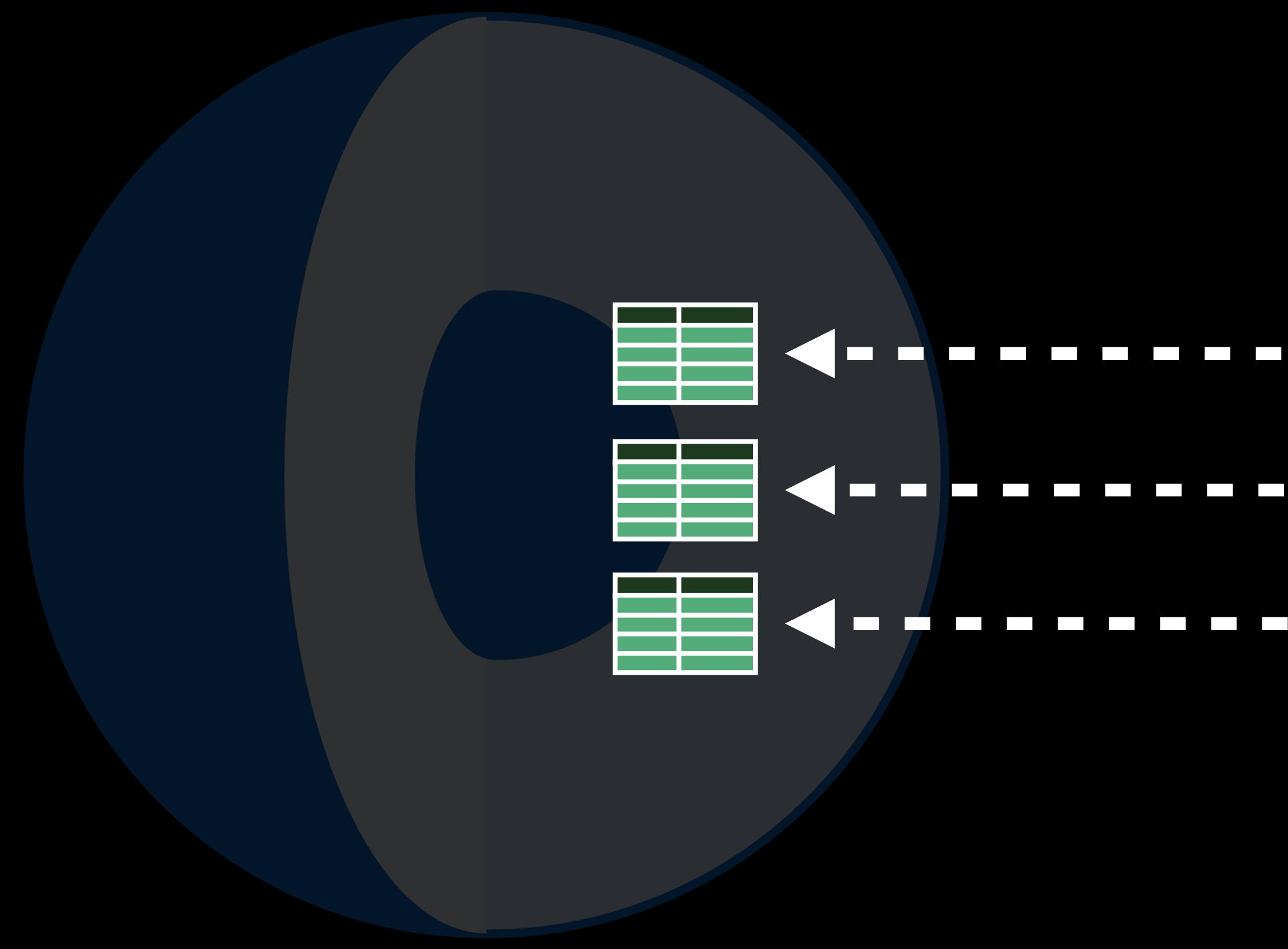
Graphs



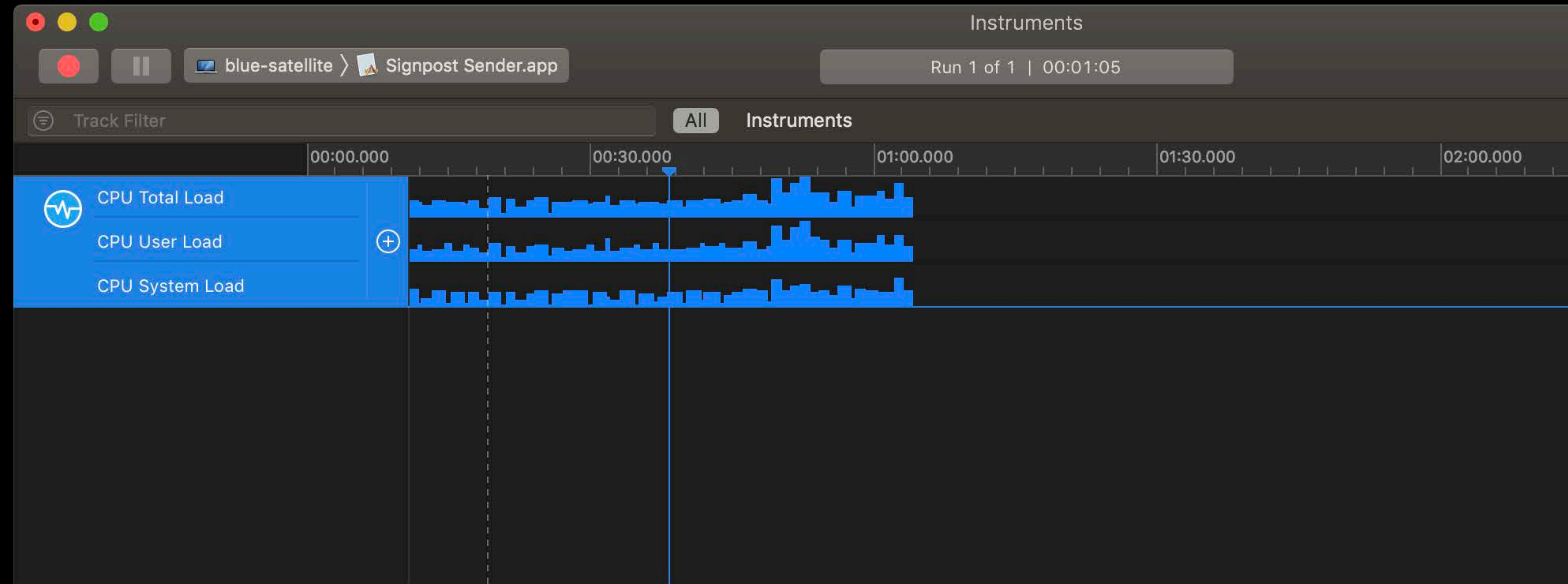
Graphs



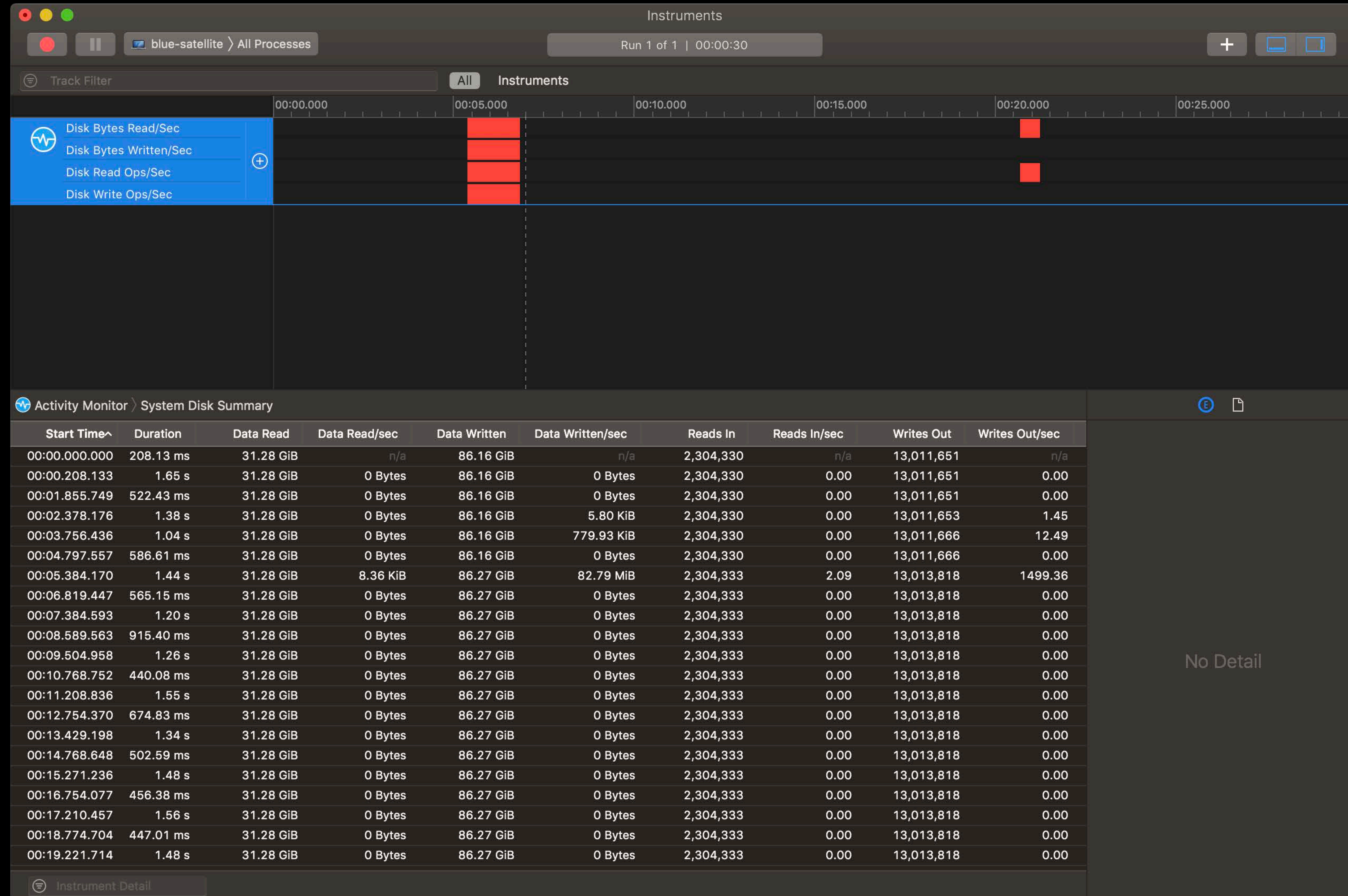
Graphs



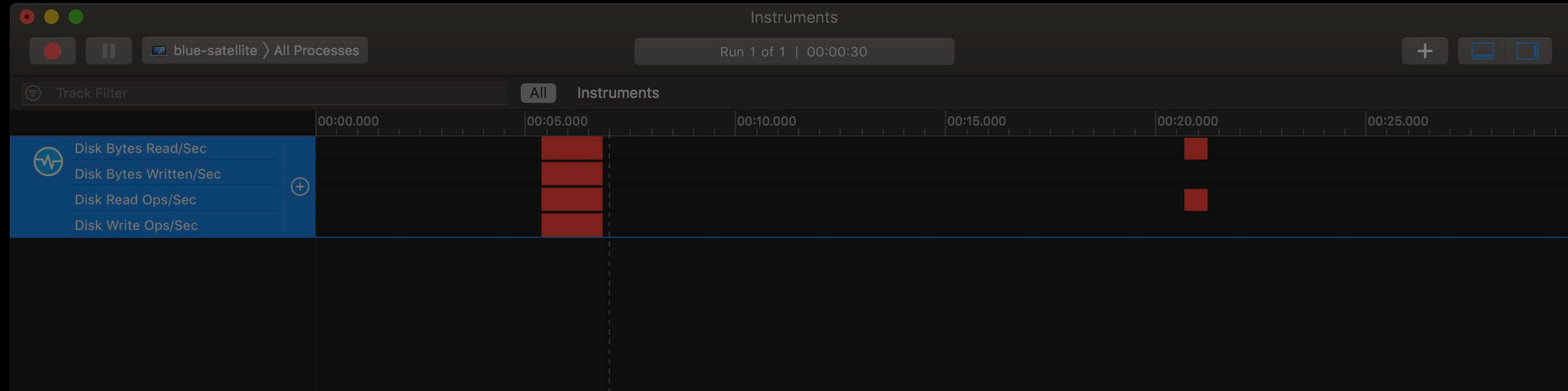
Analysis Core



Detail Views



Detail Views




Activity Monitor > System Disk Summary

Start Time	Duration	Data Read	Data Read/sec	Data Written	Data Written/sec	Reads In	Reads In/sec	Writes Out	Writes Out/sec
00:00.000.000	208.13 ms	31.28 GiB	n/a	86.16 GiB	n/a	2,304,330	n/a	13,011,651	n/a
00:00.208.133	1.65 s	31.28 GiB	0 Bytes	86.16 GiB	0 Bytes	2,304,330	0.00	13,011,651	0.00
00:01.855.749	522.43 ms	31.28 GiB	0 Bytes	86.16 GiB	0 Bytes	2,304,330	0.00	13,011,651	0.00
00:02.378.176	1.38 s	31.28 GiB	0 Bytes	86.16 GiB	5.80 KiB	2,304,330	0.00	13,011,653	1.45
00:03.756.436	1.04 s	31.28 GiB	0 Bytes	86.16 GiB	779.93 KiB	2,304,330	0.00	13,011,666	12.49
00:04.797.557	586.61 ms	31.28 GiB	0 Bytes	86.16 GiB	0 Bytes	2,304,330	0.00	13,011,666	0.00
00:05.384.170	1.44 s	31.28 GiB	8.36 KiB	86.27 GiB	82.79 MiB	2,304,333	2.09	13,013,818	1499.36
00:06.819.447	565.15 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:07.384.593	1.20 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:08.589.563	915.40 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:09.504.958	1.26 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:10.768.752	440.08 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:11.208.836	1.55 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:12.754.370	674.83 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:13.429.198	1.34 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:14.768.648	502.59 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:15.271.236	1.48 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:16.754.077	456.38 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:17.210.457	1.56 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:18.774.704	447.01 ms	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00
00:19.221.714	1.48 s	31.28 GiB	0 Bytes	86.27 GiB	0 Bytes	2,304,333	0.00	13,013,818	0.00

Instrument Detail

Detail Views

 Activity Monitor > System Disk Summary

Start Time^	Duration	Data Read	Data Read/sec	Data Written	Data W
00:00.000.000	208.13 ms	31.28 GiB	n/a	86.16 GiB	
00:00.208.133	1.65 s	31.28 GiB	0 Bytes	86.16 GiB	
00:01.855.749	522.43 ms	31.28 GiB	0 Bytes	86.16 GiB	
00:02.378.176	1.38 s	31.28 GiB	0 Bytes	86.16 GiB	
00:03.756.436	1.04 s	31.28 GiB	0 Bytes	86.16 GiB	
00:04.797.557	586.61 ms	31.28 GiB	0 Bytes	86.16 GiB	
00:05.384.170	1.44 s	31.28 GiB	8.36 KiB	86.27 GiB	
00:06.819.447	565.15 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:07.384.593	1.20 s	31.28 GiB	0 Bytes	86.27 GiB	
00:08.589.563	915.40 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:09.504.958	1.26 s	31.28 GiB	0 Bytes	86.27 GiB	
00:10.768.752	440.08 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:11.208.836	1.55 s	31.28 GiB	0 Bytes	86.27 GiB	
00:12.754.370	674.83 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:13.429.198	1.34 s	31.28 GiB	0 Bytes	86.27 GiB	
00:14.768.648	502.59 ms	31.28 GiB	0 Bytes	86.27 GiB	

Detail Views


Activity Monitor		System Disk Summary			
Start Time	Duration	Data Read	Data Read/sec	Data Written	Data W
00:00.000.000	208.13 ms	31.28 GiB	n/a	86.16 GiB	
00:00.208.133	1.65 s	31.28 GiB	0 Bytes	86.16 GiB	
00:01.855.749	522.43 ms	31.28 GiB	0 Bytes	86.16 GiB	
00:02.378.176	1.38 s	31.28 GiB	0 Bytes	86.16 GiB	
00:03.756.436	1.04 s	31.28 GiB	0 Bytes	86.16 GiB	
00:04.797.557	586.61 ms	31.28 GiB	0 Bytes	86.16 GiB	
00:05.384.170	1.44 s	31.28 GiB	8.36 KiB	86.27 GiB	
00:06.819.447	565.15 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:07.384.593	1.20 s	31.28 GiB	0 Bytes	86.27 GiB	
00:08.589.563	915.40 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:09.504.958	1.26 s	31.28 GiB	0 Bytes	86.27 GiB	
00:10.768.752	440.08 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:11.208.836	1.55 s	31.28 GiB	0 Bytes	86.27 GiB	
00:12.754.370	674.83 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:13.429.198	1.34 s	31.28 GiB	0 Bytes	86.27 GiB	
00:14.768.648	502.59 ms	31.28 GiB	0 Bytes	86.27 GiB	

Detail Views

Activity Monitor			/sec	Data Written	Data W
Start Time^					
00:00.000.000			n/a	86.16 GiB	
00:00.208.133			Bytes	86.16 GiB	
00:01.855.749			Bytes	86.16 GiB	
00:02.378.176			Bytes	86.16 GiB	
00:03.756.436			Bytes	86.16 GiB	
00:04.797.557	586.61 ms	31.28 GiB	0 Bytes	86.16 GiB	
00:05.384.170	1.44 s	31.28 GiB	8.36 KiB	86.27 GiB	
00:06.819.447	565.15 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:07.384.593	1.20 s	31.28 GiB	0 Bytes	86.27 GiB	
00:08.589.563	915.40 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:09.504.958	1.26 s	31.28 GiB	0 Bytes	86.27 GiB	
00:10.768.752	440.08 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:11.208.836	1.55 s	31.28 GiB	0 Bytes	86.27 GiB	
00:12.754.370	674.83 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:13.429.198	1.34 s	31.28 GiB	0 Bytes	86.27 GiB	
00:14.768.648	502.59 ms	31.28 GiB	0 Bytes	86.27 GiB	

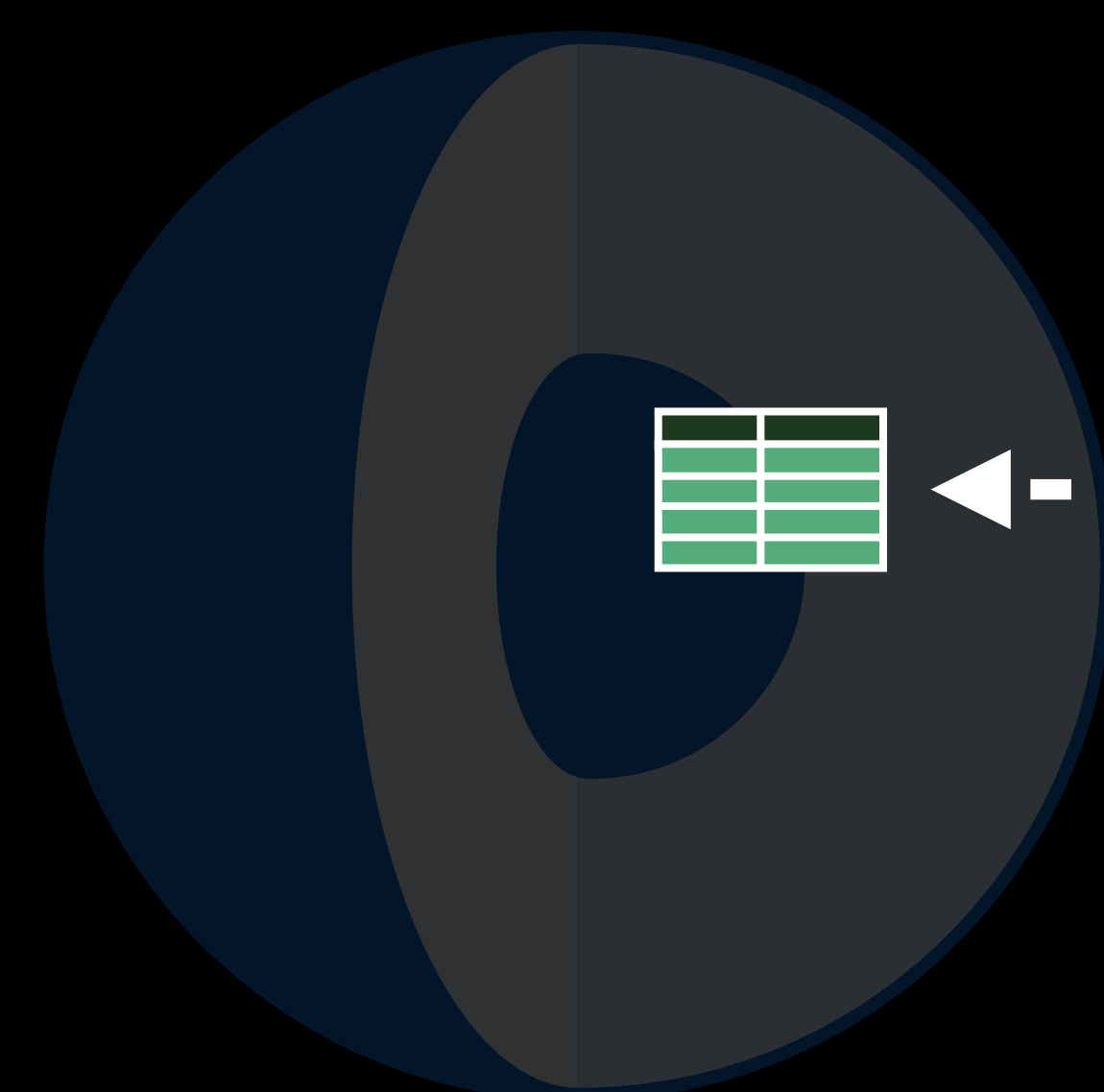
- Live Processes
- Process History
- System CPU Summary
- System Memory Summary
- ✓ System Disk Summary
- System Network Summary

Detail Views

 Activity Monitor > System Disk Summary

Start Time^	Duration	Data Read	Data Read/sec	Data Written	Data W
00:00.000.000	208.13 ms	31.28 GiB	n/a	86.16 GiB	
00:00.208.133	1.65 s	31.28 GiB	0 Bytes	86.16 GiB	
00:01.855.749	522.43 ms	31.28 GiB	0 Bytes	86.16 GiB	
00:02.378.176	1.38 s	31.28 GiB	0 Bytes	86.16 GiB	
00:03.756.436	1.04 s	31.28 GiB	0 Bytes	86.16 GiB	
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00:11.208.836	1.55 s	31.28 GiB	0 Bytes	86.27 GiB	
00:12.754.370	674.83 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:13.429.198	1.34 s	31.28 GiB	0 Bytes	86.27 GiB	
00:14.768.648	502.59 ms	31.28 GiB	0 Bytes	86.27 GiB	

Detail Views

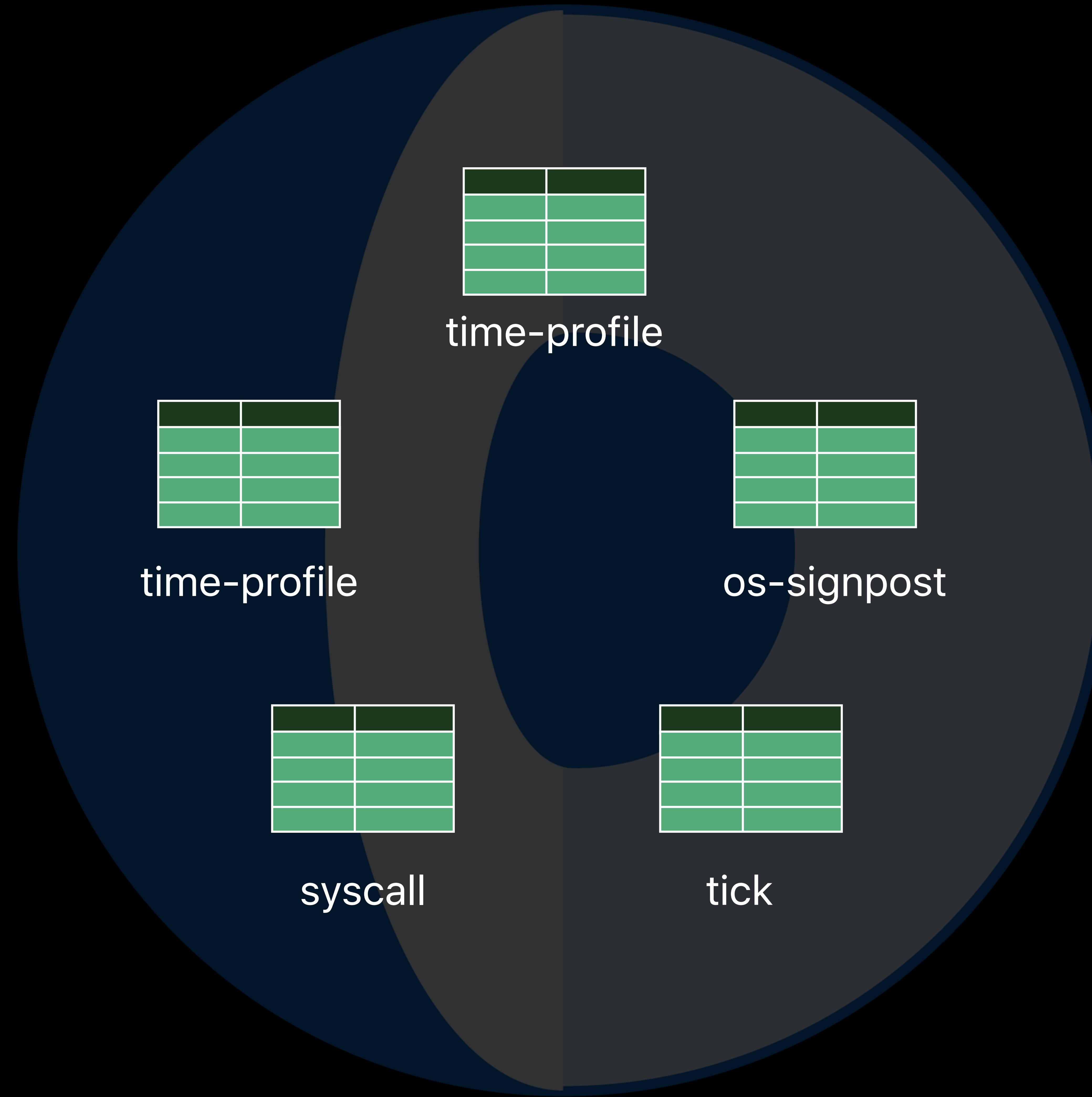


Analysis Core

Activity Monitor > System Disk Summary

Start Time^	Duration	Data Read	Data Read/sec	Data Written	Data W
00:00.000.000	208.13 ms	31.28 GiB	n/a	86.16 GiB	
00:00.208.133	1.65 s	31.28 GiB	0 Bytes	86.16 GiB	
00:01.855.749	522.43 ms	31.28 GiB	0 Bytes	86.16 GiB	
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00:12.754.370	674.83 ms	31.28 GiB	0 Bytes	86.27 GiB	
00:13.429.198	1.34 s	31.28 GiB	0 Bytes	86.27 GiB	
00:14.768.648	502.59 ms	31.28 GiB	0 Bytes	86.27 GiB	

Analysis Core



Tables

Tables

Schema

- Columns
- Types

column-1	column-2

schema

Tables

Schema

- Columns
- Types

Attributes

- Key/value
- Content

column-1	column-2

schema

{attribute=value,...}

Tick Schema

tick

Synthetic Clock Tick

Note: Used to provide modelers with a fixed reference in time for modeling per-tick statistics

Optional Attributes

frequency

[1-9]+[0-9]*

Frequency at which this tick data should be generated in this table

Columns

time

Title	Timestamp
Engineering Type	sample-time

Tick Schema

tick

Synthetic Clock Tick

Note: Used to provide modelers with a fixed reference in time for modeling per-tick statistics

Optional Attributes

frequency

[1-9]+[0-9]*

Frequency at which this tick data should be generated in this table

Columns

time

Title	Timestamp
Engineering Type	sample-time

Tick Schema

tick

Synthetic Clock Tick

Note: Used to provide modelers with a fixed reference in time for modeling per-tick statistics

Optional Attributes

frequency	[1-9]+[0-9]*	Frequency at which this tick data should be generated in this table
------------------	--------------	---

Columns

time

Title	Timestamp
Engineering Type	sample-time

Why create custom instruments

Architecture

Getting started

Intermediate

Advanced

Best practices

Tick Instrument

The screenshot shows the Instruments application window titled "Instruments". The top bar includes a play button, a pause button, the target "Kacper's MacBook Pro" with a submenu arrow, and "All Processes". A progress bar shows "Run 1 of 1 | 00:00:07". On the right, there are buttons for adding (+), zooming in (⌘+), and zooming out (⌘-).

Below the top bar is a "Track Filter" section with a menu icon and a filter button labeled "All". The main area is titled "Instruments" and shows a timeline with a "Ticks" instrument track highlighted in blue. The timeline has vertical grid lines and a dashed vertical line at 00:04.350. Time markers at the top of the timeline are 00:04.300, 00:04.350, 00:04.400, and 00:04.4.

At the bottom, there is a "Ticks" panel with a "Ticks" header and a list of timestamps. To the right of the panel is a "Recording Info" section with details about the target and recording duration.

Timestamp^
00:00.020.000
00:00.030.000
00:00.040.000
00:00.050.000
00:00.060.000

Recording Info

- Target Name: Kacper's MacBook Pro
- Target Model: MacBook Pro
- Target macOS: 10.14 (18A293I)
- Start Time: May 31, 2018 at 12:22:52 PM
- End Time: May 31, 2018 at 12:22:59 PM
- Duration: 7 seconds

Demo

Getting started with custom instruments

Kacper Harasim, Performance Tools Engineer

Tick Instrument

The screenshot shows the Instruments application interface. At the top, the title bar reads "Instruments". Below it, the target is identified as "Kacper's MacBook Pro" under "All Processes". The recording status is "Run 1 of 1" with a duration of "00:00:07". A "Track Filter" is set to "All Instruments". The main display area shows a timeline with a "Ticks" instrument track highlighted in blue. The timeline has vertical grid lines at 00:04.300, 00:04.350, 00:04.400, and 00:04.450. A vertical dashed line is positioned at approximately 00:04.375. The bottom of the window features a "Ticks" panel with a table of timestamps and a "Recording Info" section.

Timestamp^
00:00.020.000
00:00.030.000
00:00.040.000
00:00.050.000
00:00.060.000

Recording Info

- Target Name: Kacper's MacBook Pro
- Target Model: MacBook Pro
- Target macOS: 10.14 (18A293I)
- Start Time: May 31, 2018 at 12:22:52 PM
- End Time: May 31, 2018 at 12:22:59 PM
- Duration: 7 seconds

Why create custom instruments

Architecture

Getting started

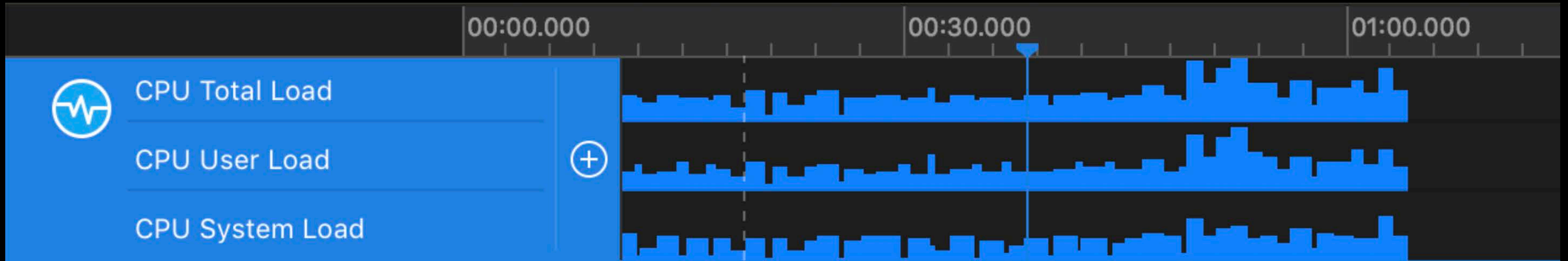
Intermediate

Advanced

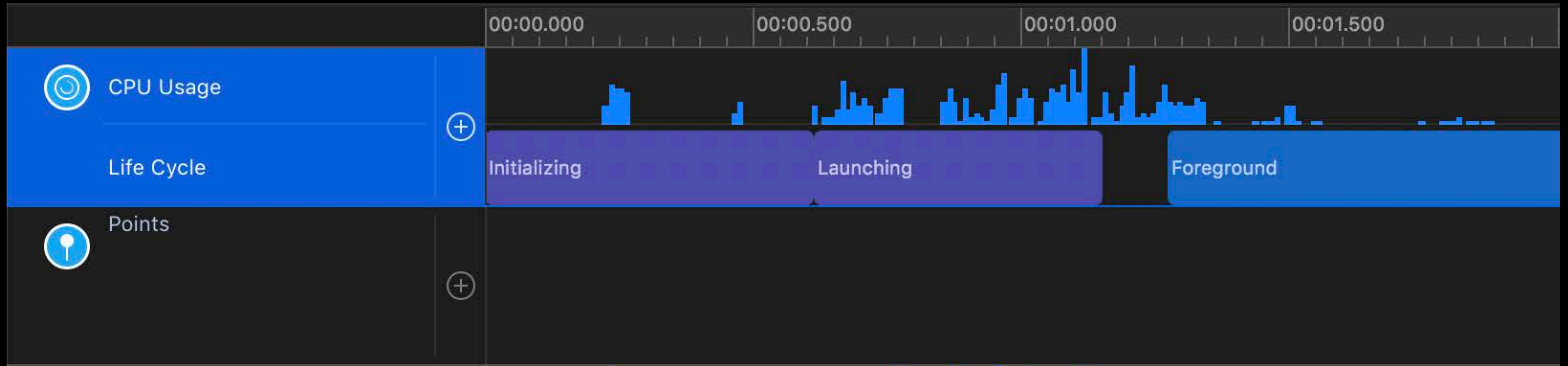
Best practices

Graph Lanes

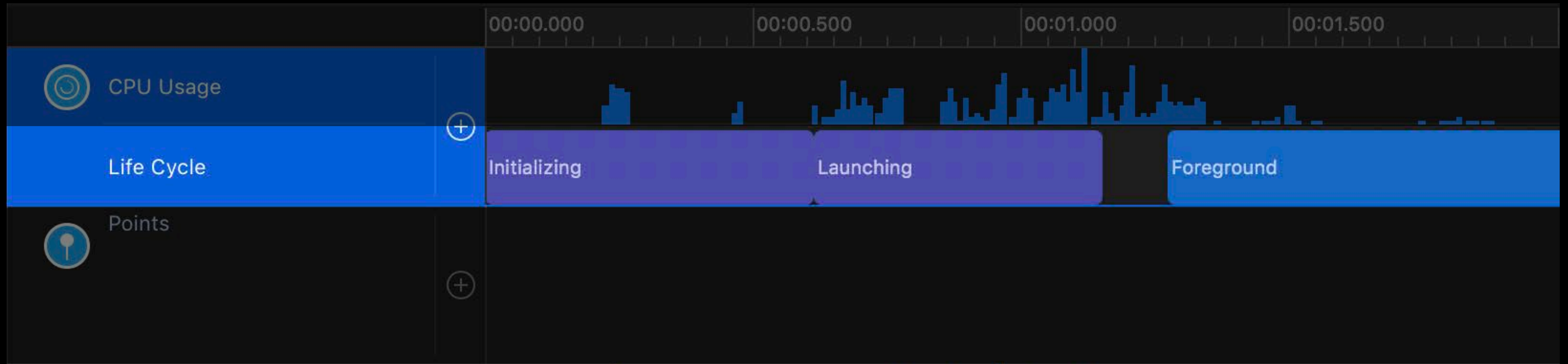
Plot



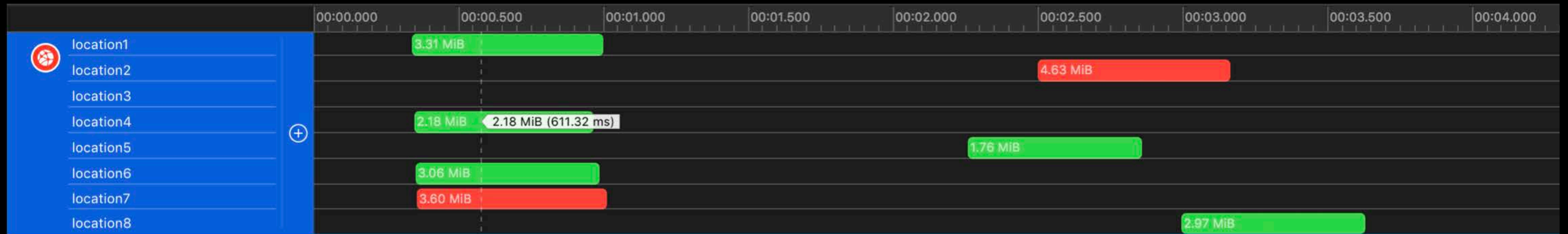
Automatic Treatment



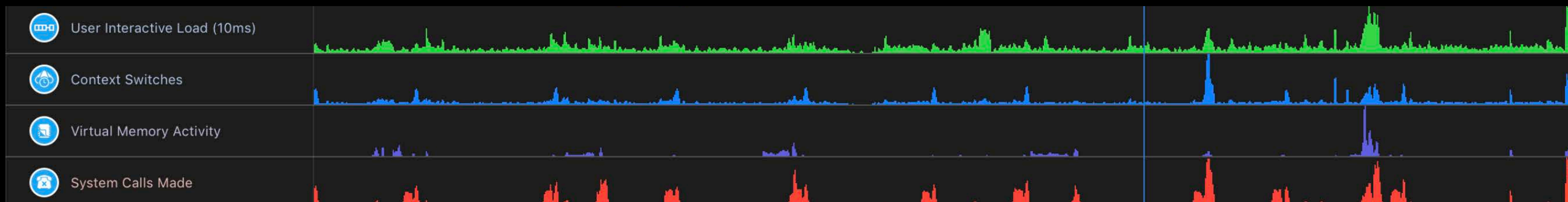
Automatic Treatment



Plot Template



Histogram



Details

Details



Details



List

Aggregation

Virtual Memory Trace > By Threads						
Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev	
▼ * All *	7,963	40.57 ms	224 ns	5.09 µs	34.0	
▶ DTServiceHub (2771)	204	24.96 ms	607 ns	122.34 µs	176.0	
▶ WindowServer (196)	2,257	4.60 ms	276 ns	2.04 µs	2.0	
▶ com.apple.dt.instruments.dtsecurity (2793)	2,343	2.80 ms	224 ns	1.20 µs	1.0	
▼ Instruments (2769)	543	1.95 ms	403 ns	3.58 µs	3.0	
▶ _NSEventThread 0x1f0bf	152	1.00 ms	1.58 µs	6.59 µs	4.0	
▼ Main Thread 0x1f075	274	633.67 µs	403 ns	2.31 µs	2.0	
Zero Fill	225	489.64 µs	638 ns	2.18 µs	1.0	
Page Cache Hit	48	114.97 µs	403 ns	2.40 µs	2.0	
File Backed Page In	1	29.06 µs	29.06 µs	29.06 µs		
▶ _dispatch_workloop_worker_thread 0x2030e	15	57.95 µs	641 ns	3.86 µs	6.0	
▶ _dispatch_worker_thread2 0x20458	31	56.13 µs	502 ns	1.81 µs	8.0	
▶ _dispatch_workloop_worker_thread 0x20505	15	53.05 µs	838 ns	3.54 µs	2.0	
▶ _dispatch_worker_thread2 0x2045d	15	45.16 µs	1.22 µs	3.01 µs	2.0	
▶ _dispatch_workloop_worker_thread 0x2042a	17	43.85 µs	823 ns	2.58 µs	2.0	
▶ _dispatch_worker_thread2 0x20507	8	25.75 µs	1.21 µs	3.22 µs	2.0	
▶ _dispatch_worker_thread2 0x2045e	14	24.23 µs	1.24 µs	1.73 µs	5.0	
▶ -[XRFrameCommutator_thread:] 0x1f146	2	4.38 µs	1.41 µs	2.19 µs	1.0	
▶ iOSScreenCaptureAssistant (2238)	480	1.43 ms	605 ns	2.97 µs	3.0	
▶ ControlStrip (407)	719	1.24 ms	545 ns	1.72 µs	2.0	

Aggregation



Virtual Memory Trace > By Threads						
Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev	
▼ * All *	7,963	40.57 ms	224 ns	5.09 µs	34.0	
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Aggregation



Columns are functions

Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev
▼ * All *	7,963	40.57 ms	224 ns	5.09 µs	34.0
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Aggregation



Columns are functions

- sum

Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev
▼ * All *	7,963	40.57 ms	224 ns	5.09 µs	34.0
▶ DTServiceHub (2771)	204	24.96 ms	607 ns	122.34 µs	176.0
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Aggregation



Columns are functions

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- average

Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev
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Aggregation



Columns are functions

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- average
- count

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Aggregation



Columns are functions

- sum
- average
- count
- More...

Virtual Memory Trace > By Threads

Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev
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▶ com.apple.dt.instruments.dtsecurity (2793)	2,343	2.80 ms	224 ns	1.20 µs	1.0
▼ Instruments (2769)	543	1.95 ms	403 ns	3.58 µs	3.0
▶ _NSEventThread 0x1f0bf	152	1.00 ms	1.58 µs	6.59 µs	4.0
▼ Main Thread 0x1f075	274	633.67 µs	403 ns	2.31 µs	2.0
Zero Fill	225	489.64 µs	638 ns	2.18 µs	1.0
Page Cache Hit	48	114.97 µs	403 ns	2.40 µs	2.0
File Backed Page In	1	29.06 µs	29.06 µs	29.06 µs	
▶ _dispatch_workloop_worker_thread 0x2030e	15	57.95 µs	641 ns	3.86 µs	6.0
▶ _dispatch_worker_thread2 0x20458	31	56.13 µs	502 ns	1.81 µs	8.0
▶ _dispatch_workloop_worker_thread 0x20505	15	53.05 µs	838 ns	3.54 µs	2.0
▶ _dispatch_worker_thread2 0x2045d	15	45.16 µs	1.22 µs	3.01 µs	2.0
▶ _dispatch_workloop_worker_thread 0x2042a	17	43.85 µs	823 ns	2.58 µs	2.0
▶ _dispatch_worker_thread2 0x20507	8	25.75 µs	1.21 µs	3.22 µs	2.0
▶ _dispatch_worker_thread2 0x2045e	14	24.23 µs	1.24 µs	1.73 µs	5.0
▶ -[XRFrameCommutator_thread:] 0x1f146	2	4.38 µs	1.41 µs	2.19 µs	1.0
▶ iOSScreenCaptureAssistant (2238)	480	1.43 ms	605 ns	2.97 µs	3.0
▶ ControlStrip (407)	719	1.24 ms	545 ns	1.72 µs	2.0

Aggregation



Columns are functions

- sum
- average
- count
- More...

Hierarchy

Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev
▼ * All *	7,963	40.57 ms	224 ns	5.09 µs	34.0
▶ DTServiceHub (2771)	204	24.96 ms	607 ns	122.34 µs	176.0
▶ WindowServer (196)	2,257	4.60 ms	276 ns	2.04 µs	2.0
▶ com.apple.dt.instruments.dtsecurity (2793)	2,343	2.80 ms	224 ns	1.20 µs	1.0
▼ Instruments (2769)	543	1.95 ms	403 ns	3.58 µs	3.0
▶ _NSEventThread 0x1f0bf	152	1.00 ms	1.58 µs	6.59 µs	4.0
▼ Main Thread 0x1f075	274	633.67 µs	403 ns	2.31 µs	2.0
Zero Fill	225	489.64 µs	638 ns	2.18 µs	1.0
Page Cache Hit	48	114.97 µs	403 ns	2.40 µs	2.0
File Backed Page In	1	29.06 µs	29.06 µs	29.06 µs	
▶ _dispatch_workloop_worker_thread 0x2030e	15	57.95 µs	641 ns	3.86 µs	6.0
▶ _dispatch_worker_thread2 0x20458	31	56.13 µs	502 ns	1.81 µs	8.0
▶ _dispatch_workloop_worker_thread 0x20505	15	53.05 µs	838 ns	3.54 µs	2.0
▶ _dispatch_worker_thread2 0x2045d	15	45.16 µs	1.22 µs	3.01 µs	2.0
▶ _dispatch_workloop_worker_thread 0x2042a	17	43.85 µs	823 ns	2.58 µs	2.0
▶ _dispatch_worker_thread2 0x20507	8	25.75 µs	1.21 µs	3.22 µs	2.0
▶ _dispatch_worker_thread2 0x2045e	14	24.23 µs	1.24 µs	1.73 µs	5.0
▶ -[XRFrameCommutator_thread:] 0x1f146	2	4.38 µs	1.41 µs	2.19 µs	1.0
▶ iOSScreenCaptureAssistant (2238)	480	1.43 ms	605 ns	2.97 µs	3.0
▶ ControlStrip (407)	719	1.24 ms	545 ns	1.72 µs	2.0

Details



List

Aggregation

Virtual Memory Trace > By Threads						
Process / Thread / Operation	Count	Duration	Min Duration	Avg Duration	Std Dev	
▼ * All *	7,963	40.57 ms	224 ns	5.09 µs	34.0	
▶ DTServiceHub (2771)	204	24.96 ms	607 ns	122.34 µs	176.0	
▶ WindowServer (196)	2,257	4.60 ms	276 ns	2.04 µs	2.0	
▶ com.apple.dt.instruments.dtsecurity (2793)	2,343	2.80 ms	224 ns	1.20 µs	1.0	
▼ Instruments (2769)	543	1.95 ms	403 ns	3.58 µs	3.0	
▶ _NSEventThread 0x1f0bf	152	1.00 ms	1.58 µs	6.59 µs	4.0	
▼ Main Thread 0x1f075	274	633.67 µs	403 ns	2.31 µs	2.0	
Zero Fill	225	489.64 µs	638 ns	2.18 µs	1.0	
Page Cache Hit	48	114.97 µs	403 ns	2.40 µs	2.0	
File Backed Page In	1	29.06 µs	29.06 µs	29.06 µs		
▶ _dispatch_workloop_worker_thread 0x2030e	15	57.95 µs	641 ns	3.86 µs	6.0	
▶ _dispatch_worker_thread2 0x20458	31	56.13 µs	502 ns	1.81 µs	8.0	
▶ _dispatch_workloop_worker_thread 0x20505	15	53.05 µs	838 ns	3.54 µs	2.0	
▶ _dispatch_worker_thread2 0x2045d	15	45.16 µs	1.22 µs	3.01 µs	2.0	
▶ _dispatch_workloop_worker_thread 0x2042a	17	43.85 µs	823 ns	2.58 µs	2.0	
▶ _dispatch_worker_thread2 0x20507	8	25.75 µs	1.21 µs	3.22 µs	2.0	
▶ _dispatch_worker_thread2 0x2045e	14	24.23 µs	1.24 µs	1.73 µs	5.0	
▶ -[XRFrameCommutator_thread:] 0x1f146	2	4.38 µs	1.41 µs	2.19 µs	1.0	
▶ iOSScreenCaptureAssistant (2238)	480	1.43 ms	605 ns	2.97 µs	3.0	
▶ ControlStrip (407)	719	1.24 ms	545 ns	1.72 µs	2.0	

Details



List

Aggregation

Call Tree

Time Profiler > Profile > Root

	Weight	Self Weight		Symbol Name
	1.53 s	100.0%	0 s	▼ Signpost Sender (1903)
	1.08 s	70.7%	0 s	▼ Main Thread 0x18f05
	1.03 s	67.3%	0 s	▼ start libdyld.dylib
	1.03 s	67.3%	0 s	▼ NSApplicationMain AppKit
	921.00 ms	60.1%	0 s	▼ -[NSApplication run] AppKit
	754.00 ms	49.2%	1.00 ms	▼ -[NSApplication(NSEvent) _nextEventMatch
	705.00 ms	46.0%	1.00 ms	▼ _DPSNextEvent AppKit
	687.00 ms	44.8%	0 s	▼ _BlockUntilNextEventMatchingListInMo
	686.00 ms	44.8%	1.00 ms	▼ ReceiveNextEventCommon HIToolbc
	624.00 ms	40.7%	0 s	▼ RunCurrentEventLoopInMode HITo
	558.00 ms	36.4%	1.00 ms	▼ CFRRunLoopRunSpecific CoreFou
	519.00 ms	33.8%	0 s	▼ __CFRunLoopRun CoreFoundati
	275.00 ms	17.9%	0 s	▶ __CFRunLoopDoTimers CoreF
	173.00 ms	11.2%	1.00 ms	▶ __CFRunLoopDoObservers Co
	20.00 ms	1.3%	1.00 ms	▶ mach_port_insert_member lib
	16.00 ms	1.0%	0 s	▶ __CFRunLoopServiceMachPort

Details



List

Aggregation

Call Tree

Narrative

Main Thread 0x1f075 > Narrative

Timestamp^ Narrative

00:00.007.645	Called "mach_port_extract_member_trap()" for 1.27 μ s
00:00.007.656	Called "mk_timer_arm()" for 826 ns
00:00.007.693	Called "mach_msg_trap()" for 845 ns
00:00.007.700	Called "mach_port_insert_member_trap()" for 2.00 μ s
00:00.007.704	Called "mach_msg_trap()" for 8.64 ms
00:00.007.705	Blocked for 8.63 ms (99.9% of mach_msg_trap's duration) starting at priority 0
00:00.016.339	The thread was made runnable by Instruments (pid: 2769, tid: 0x1f0bf) running on CPU 4. It waited for an
00:00.016.341	Ran for 30.41 μ s on CPU 6 at priority 47
00:00.016.353	Called "mach_port_extract_member_trap()" for 1.15 μ s
00:00.016.359	Called "bsdthread_ctl()" for 888 ns
00:00.016.368	Called "bsdthread_ctl()" for 895 ns
00:00.016.372	Interrupted for 220 ns while CPU 6 serviced an interrupt handler.
00:00.016.372	Ran for 24.35 μ s on CPU 6 at priority 47
00:00.016.374	Called "bsdthread_ctl()" for 459 ns
00:00.016.391	Called "psynch_mutexwait()" for 17.05 μ s
00:00.016.396	Blocked for 1.88 μ s (11.0% of psynch_mutexwait's duration) starting at priority 47
00:00.016.398	The thread was made runnable by Instruments (pid: 2769, tid: 0x1f0bf) running on CPU 4. It waited for an
00:00.016.403	Ran for 369.32 μ s on CPU 6 at priority 47

Details



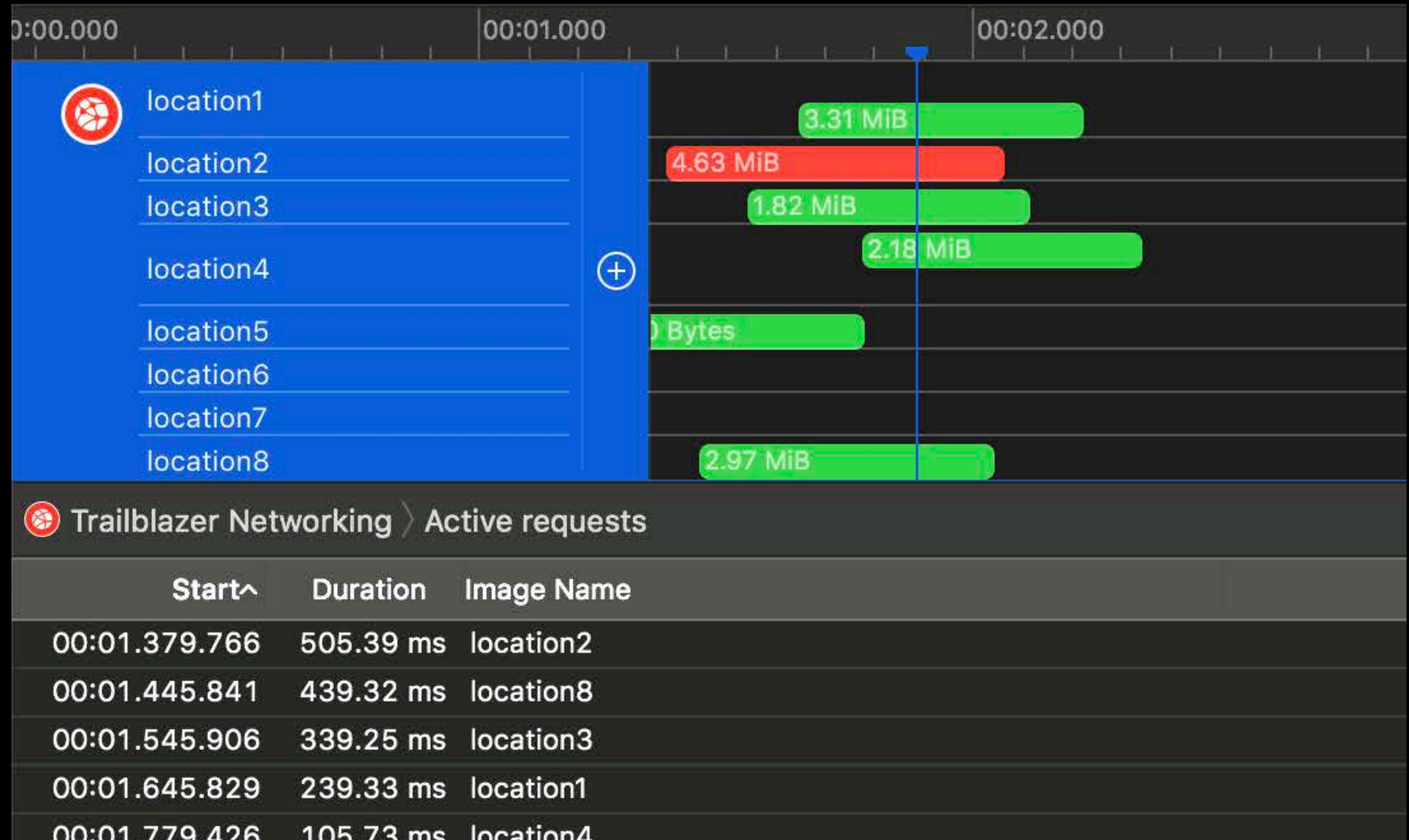
List

Aggregation

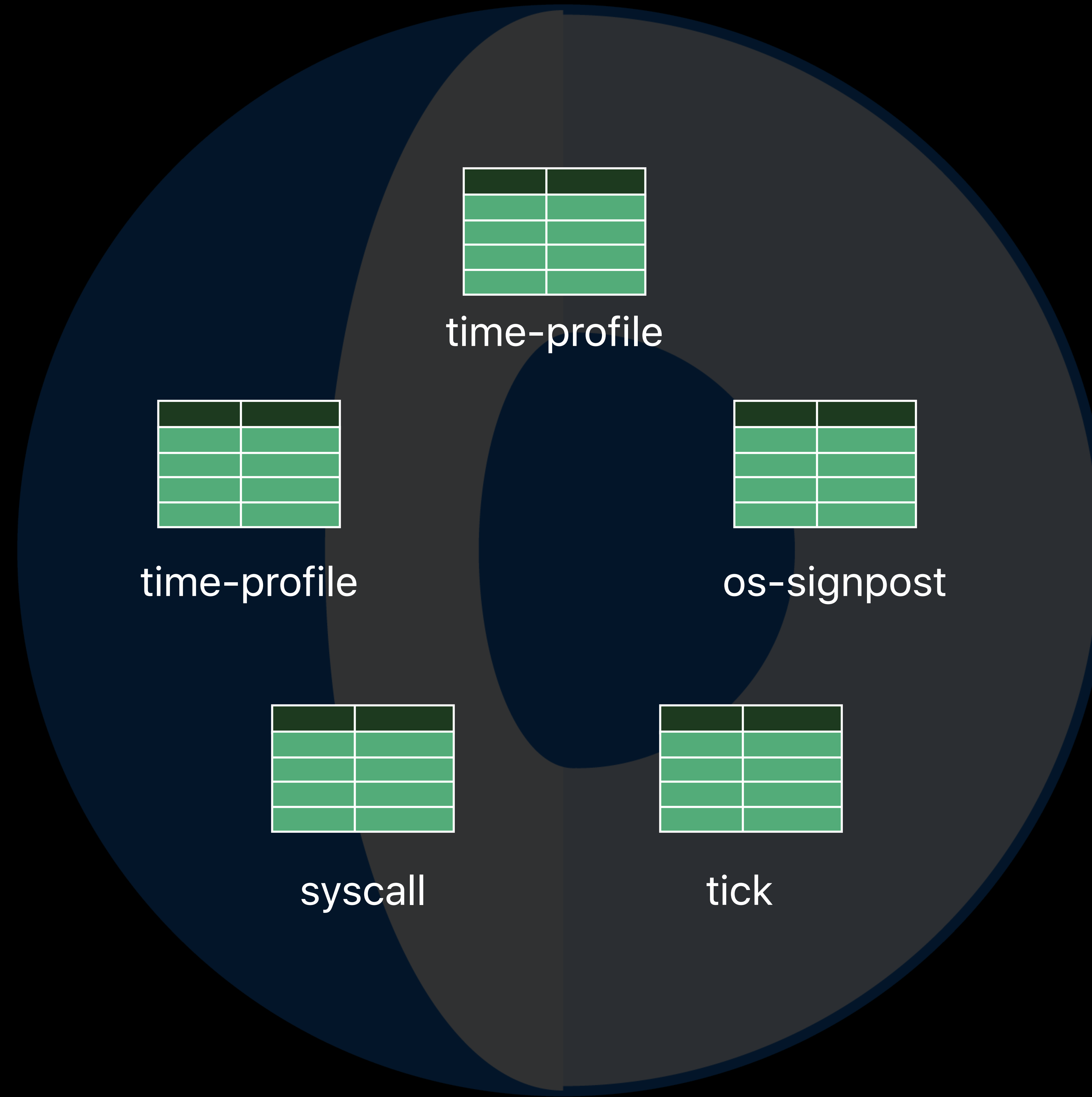
Call Tree

Narrative

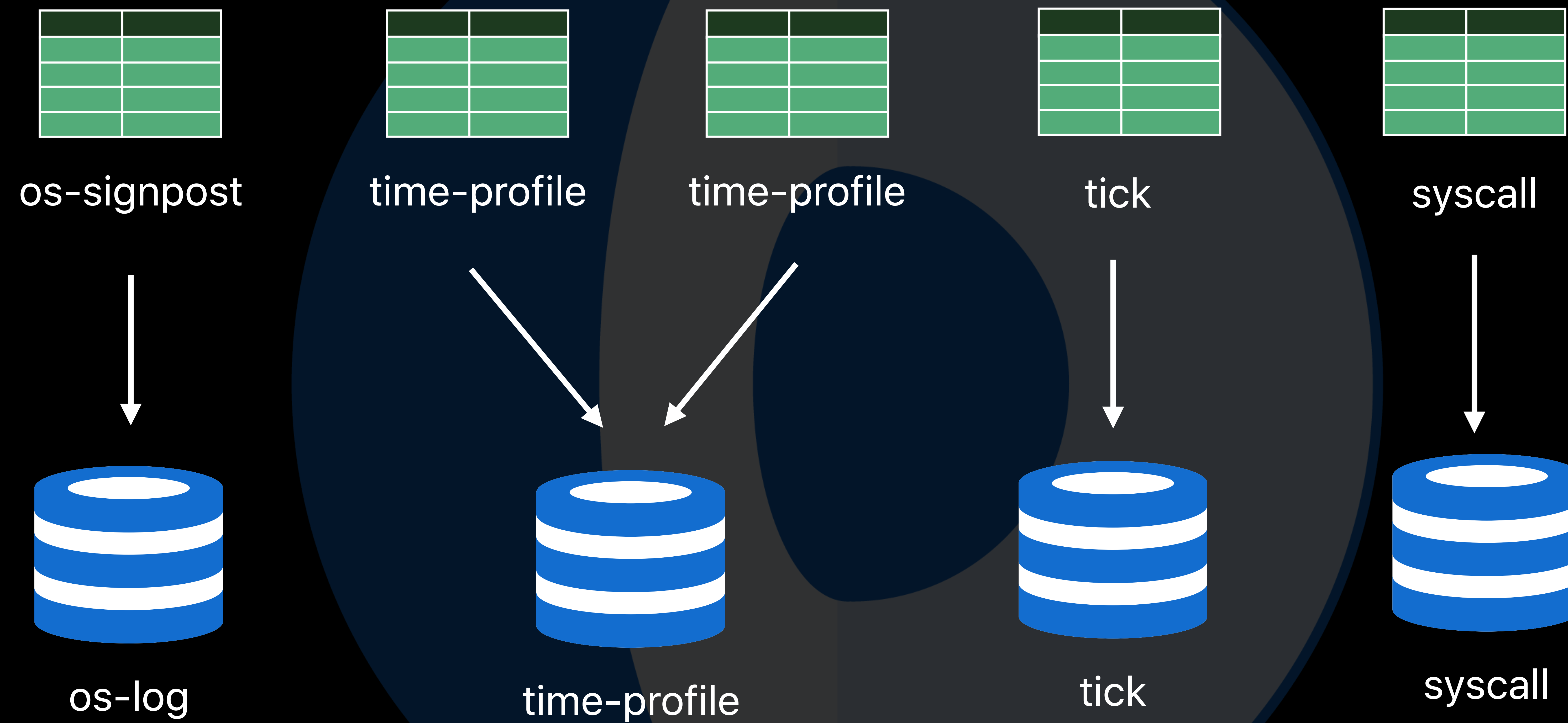
Time Slice



Analysis Core



Step 1: Reduce



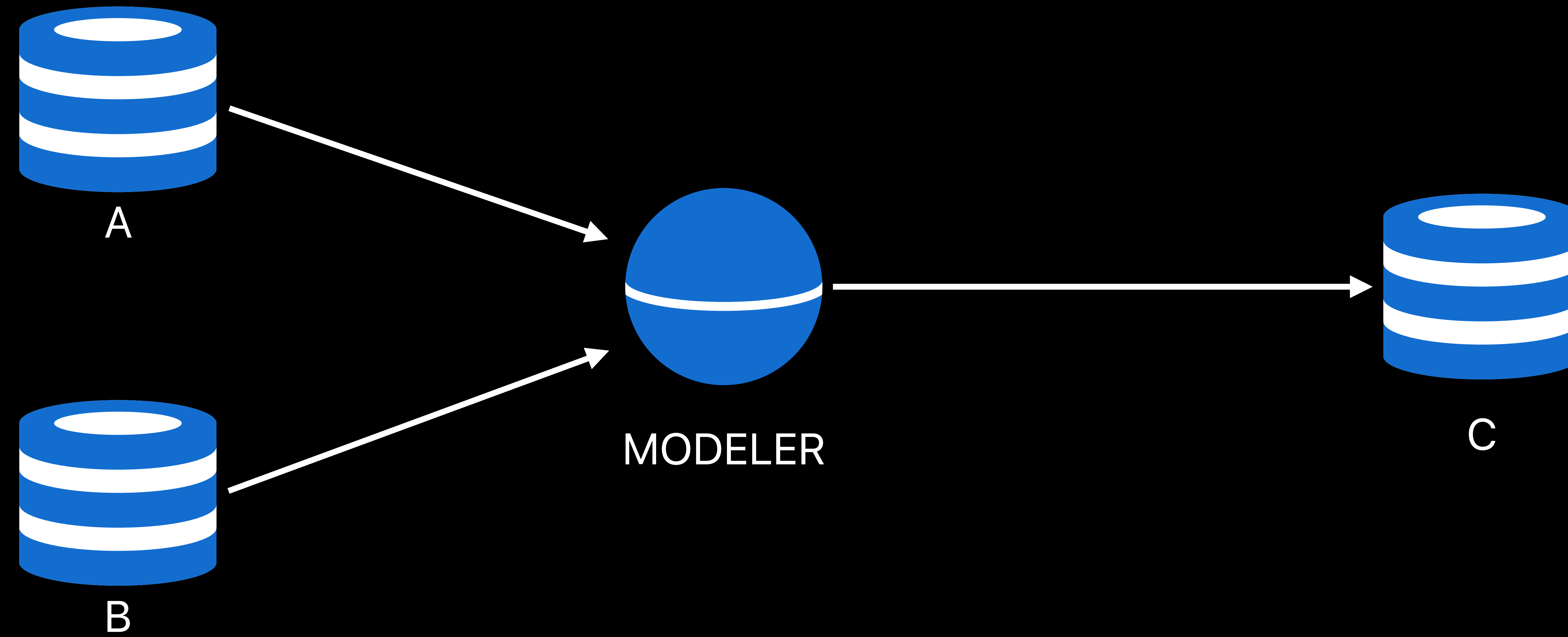
Step 2: Search



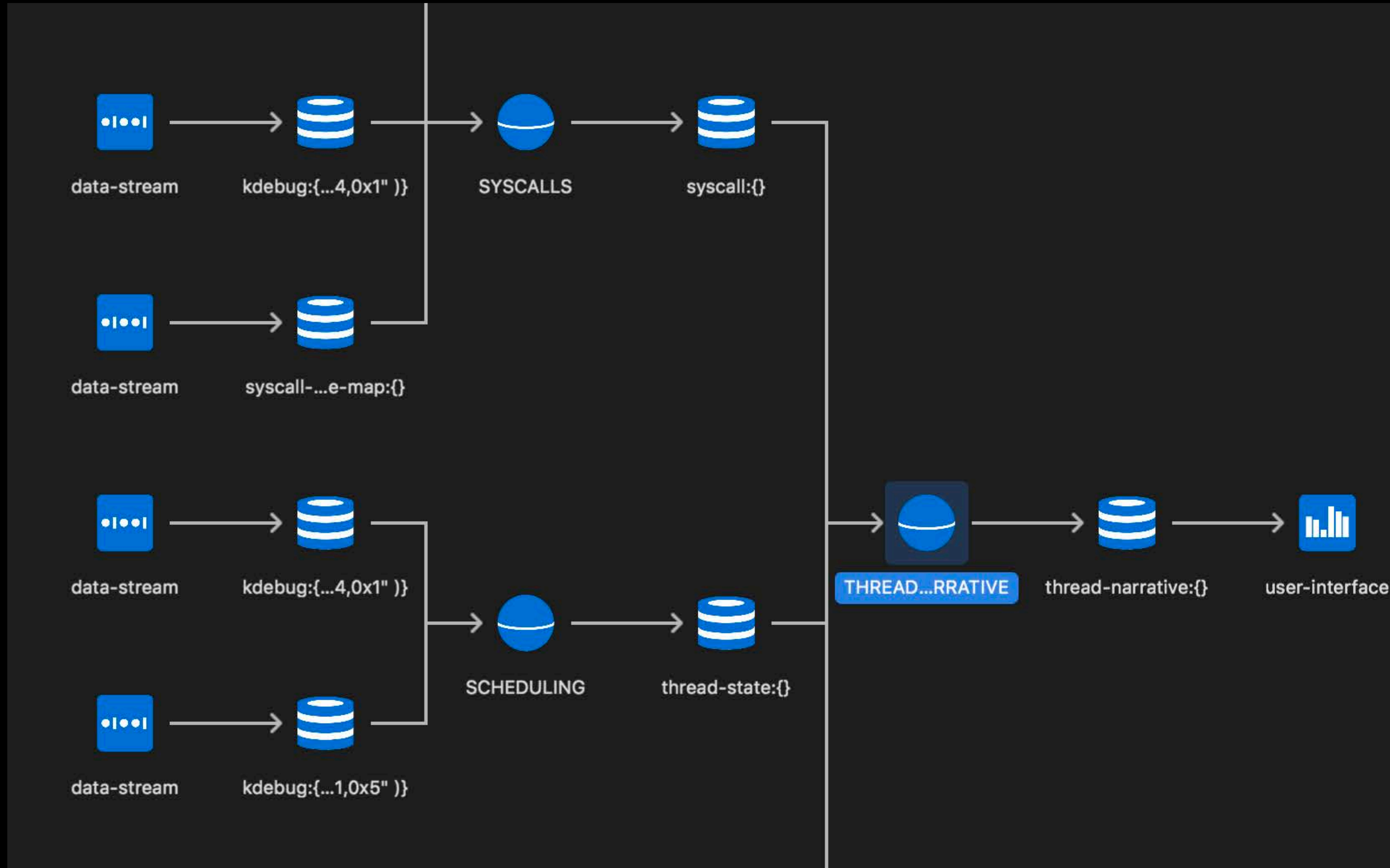
Step 2: Search



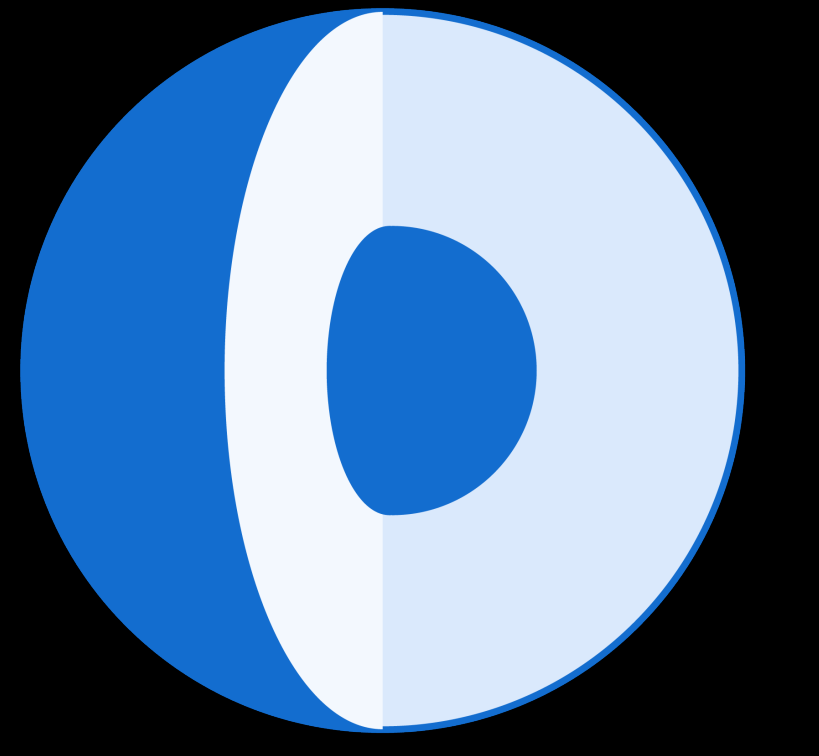
Step 2: Search



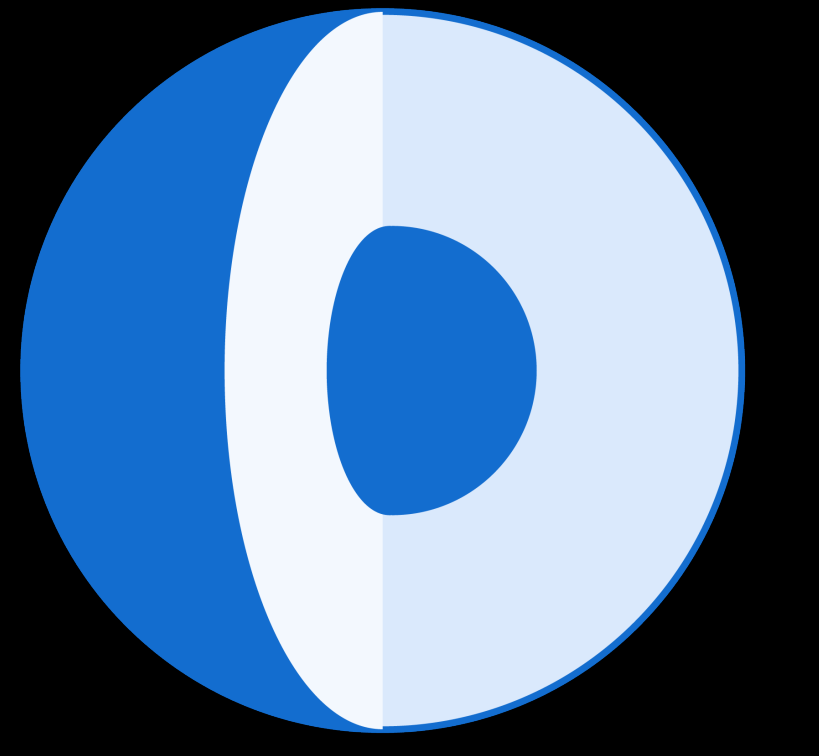
Step 3: Optimize



Binding Solution

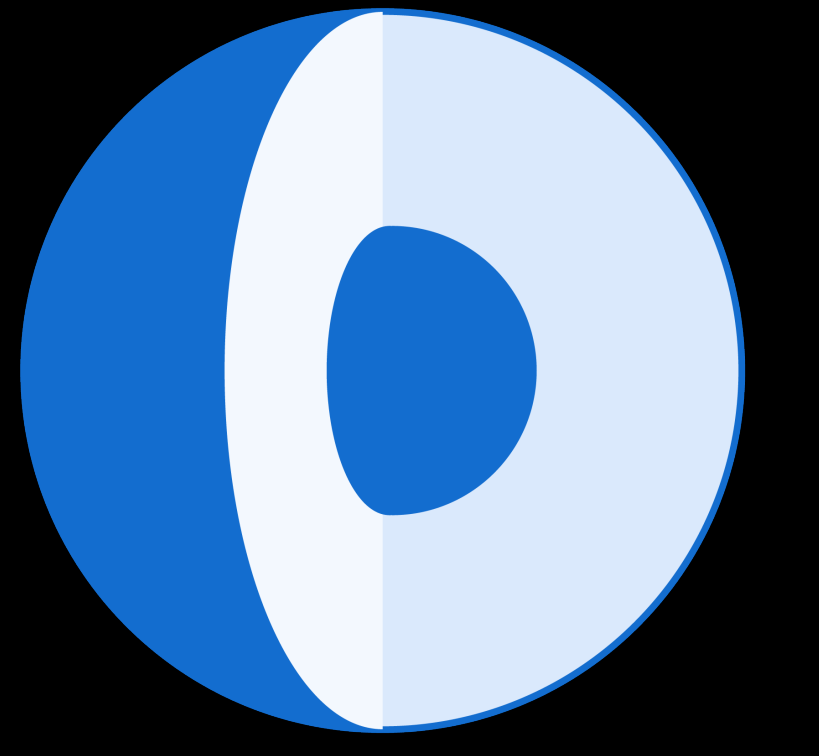


Binding Solution



Trace-wide

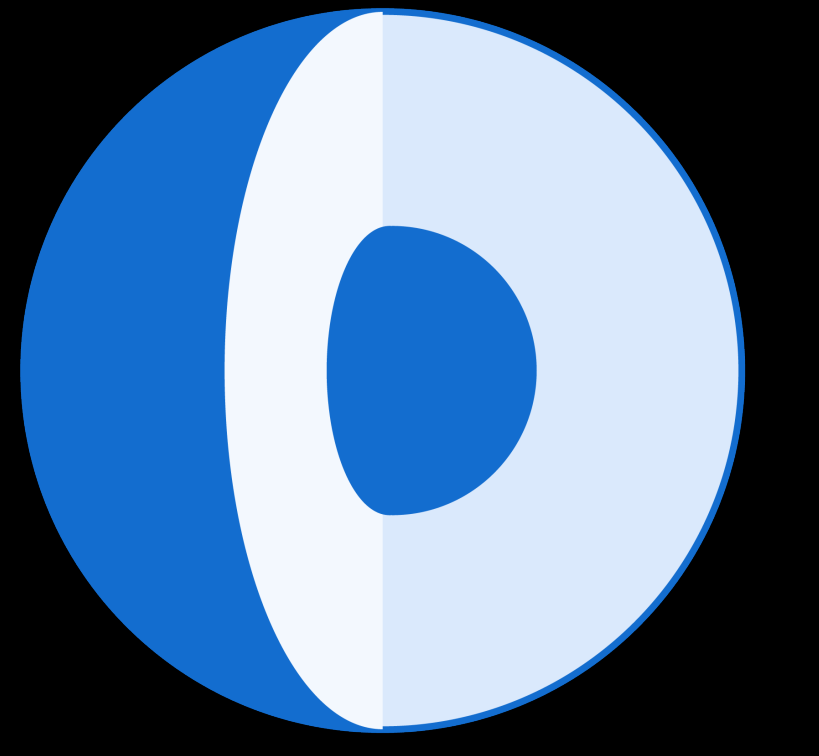
Binding Solution



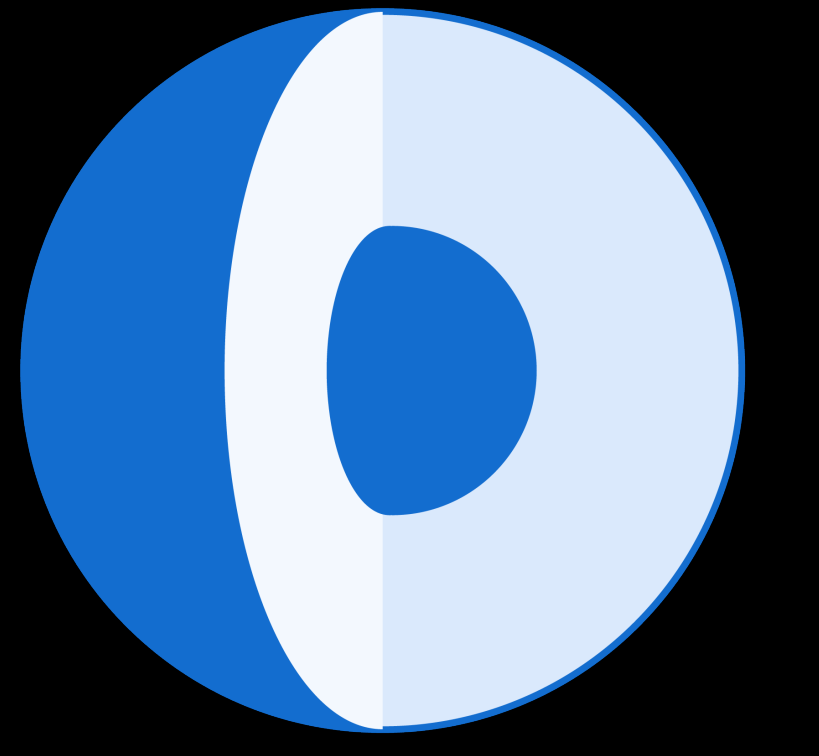
Trace-wide

Minimizes recording impact

Schemas

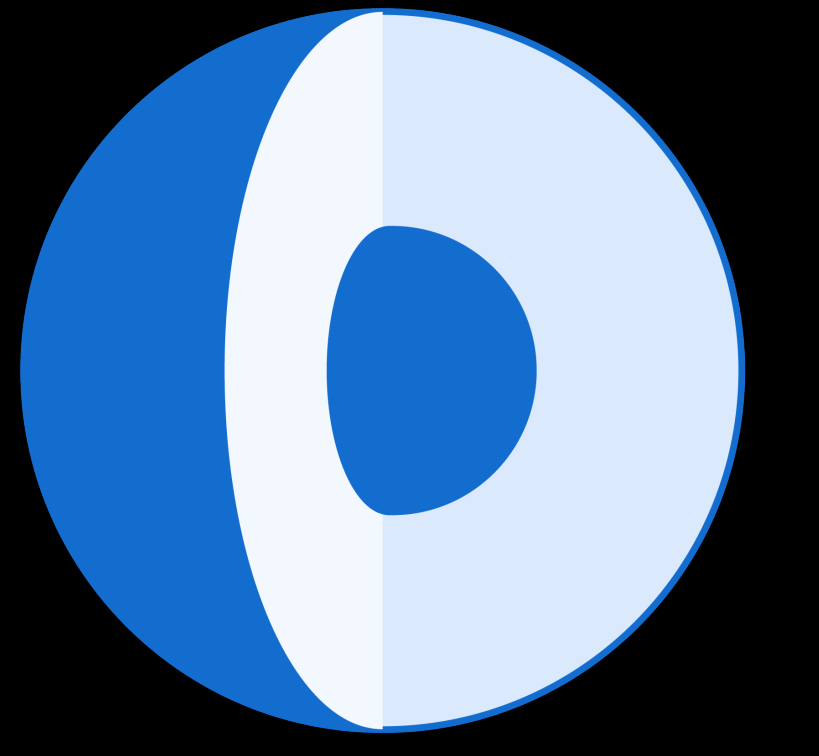


Schemas



100+ schemas already

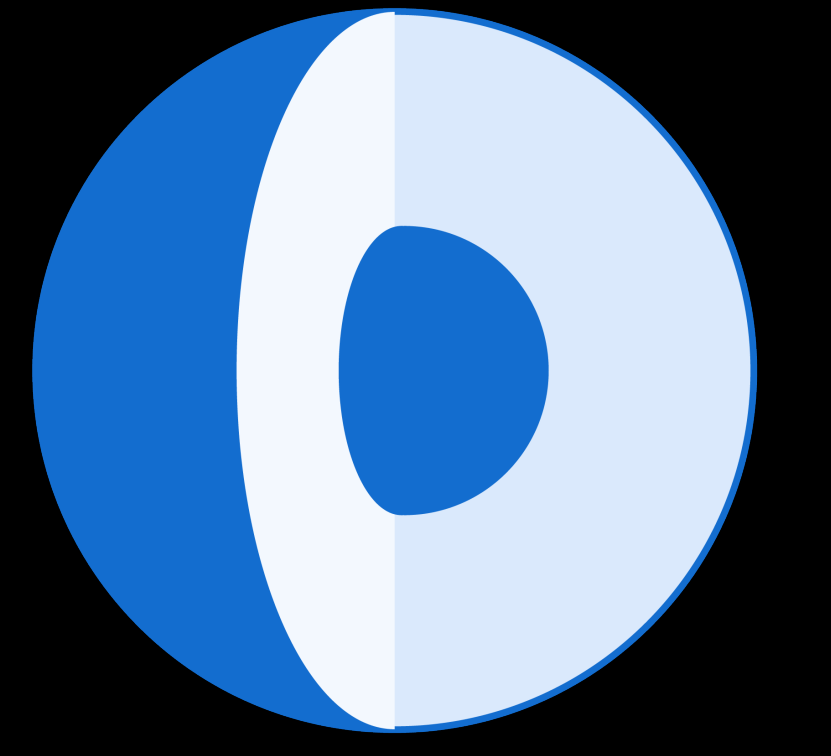
Schemas



100+ schemas already

Contained in packages

Schemas



100+ schemas already

Contained in packages

Link build setting

▼ Instruments Package Builder - Linking

Setting

📦 Resolved

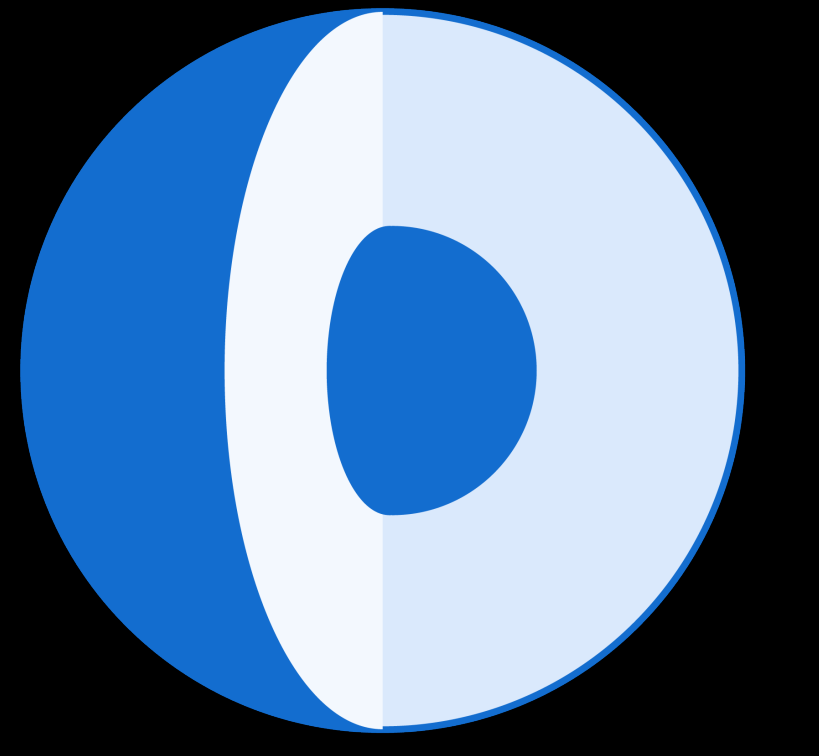
📦 Sampling

▶ **Linked Instruments Packages**

Base ktrace Apps

Base ktrace Apps

Schemas



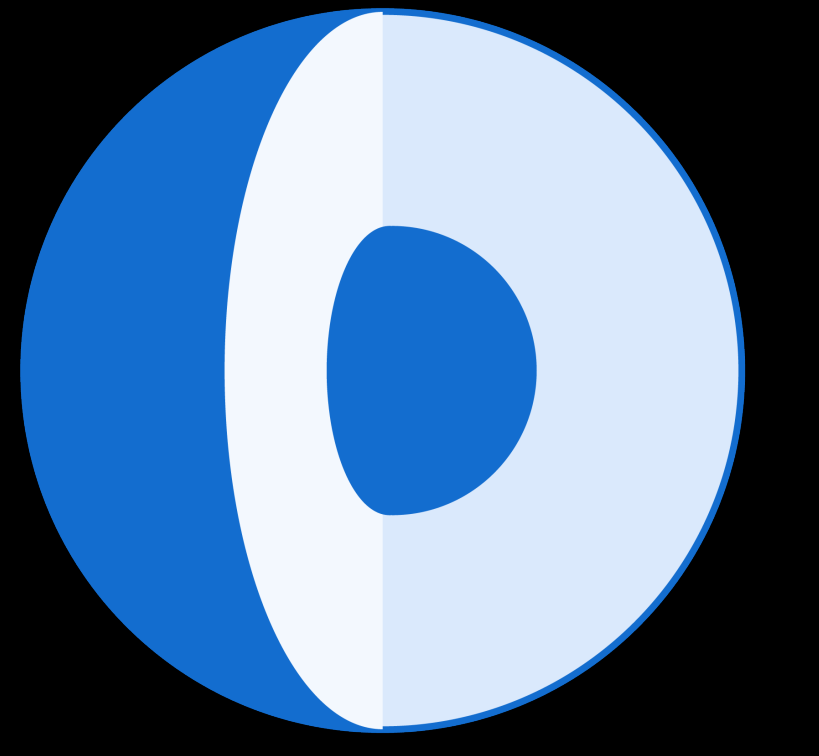
100+ schemas already

Contained in packages

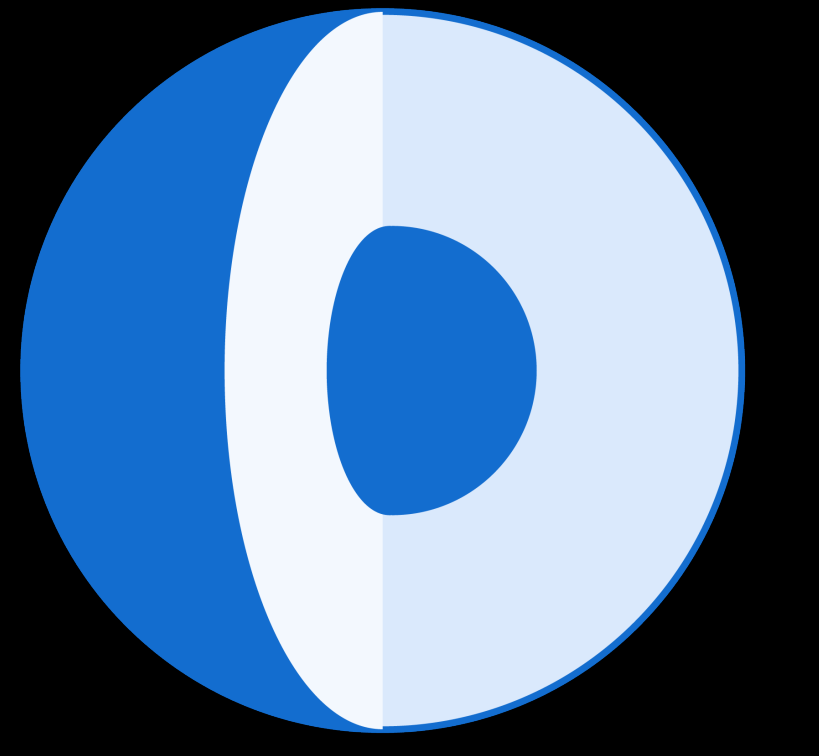
Link build setting

Building blocks

Modelers

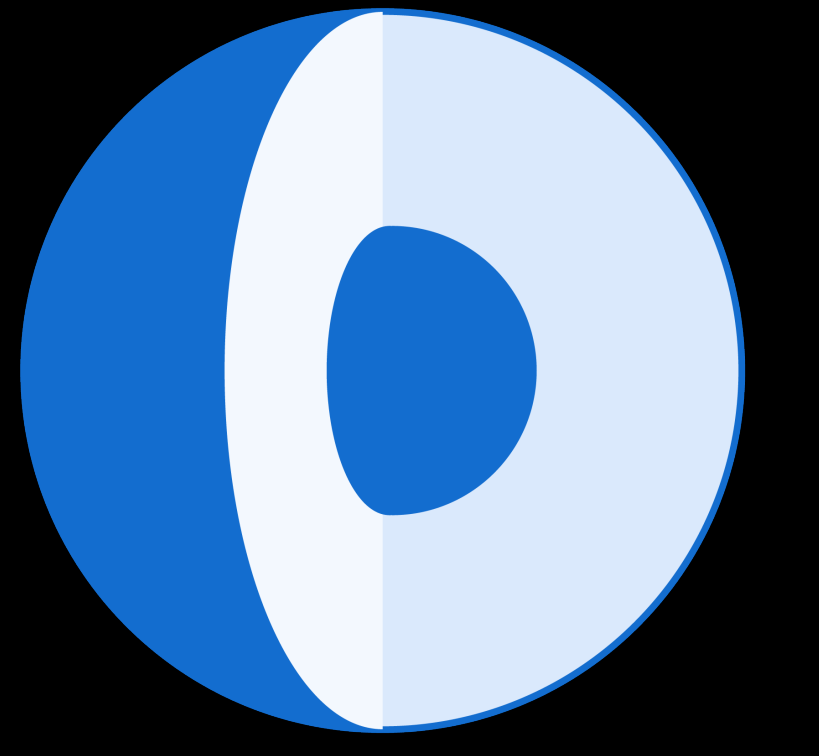


Modelers



<modeler>

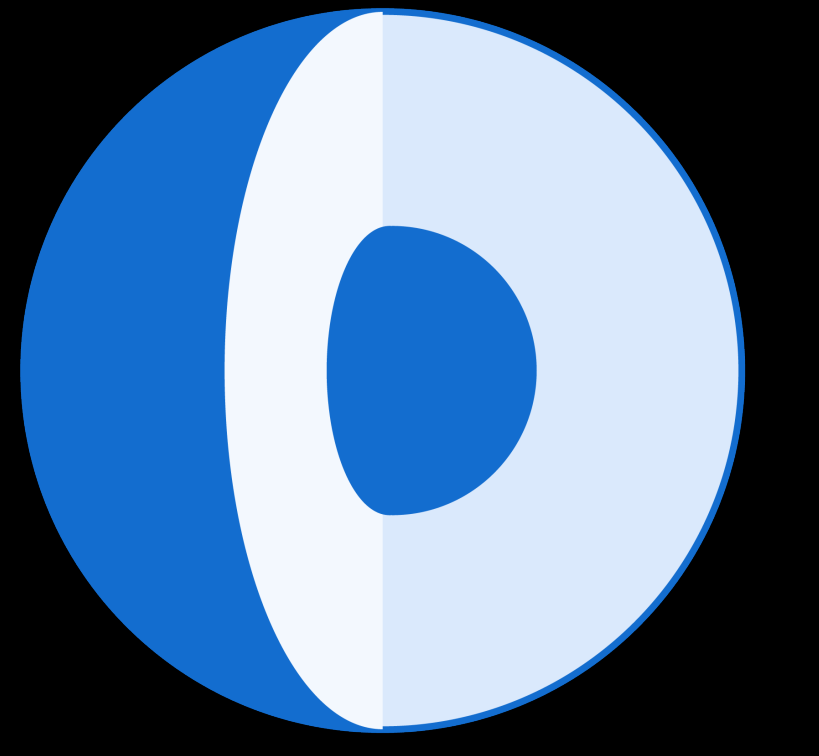
Modelers



```
<modeler>
```

```
<point-schema>
```

Modelers

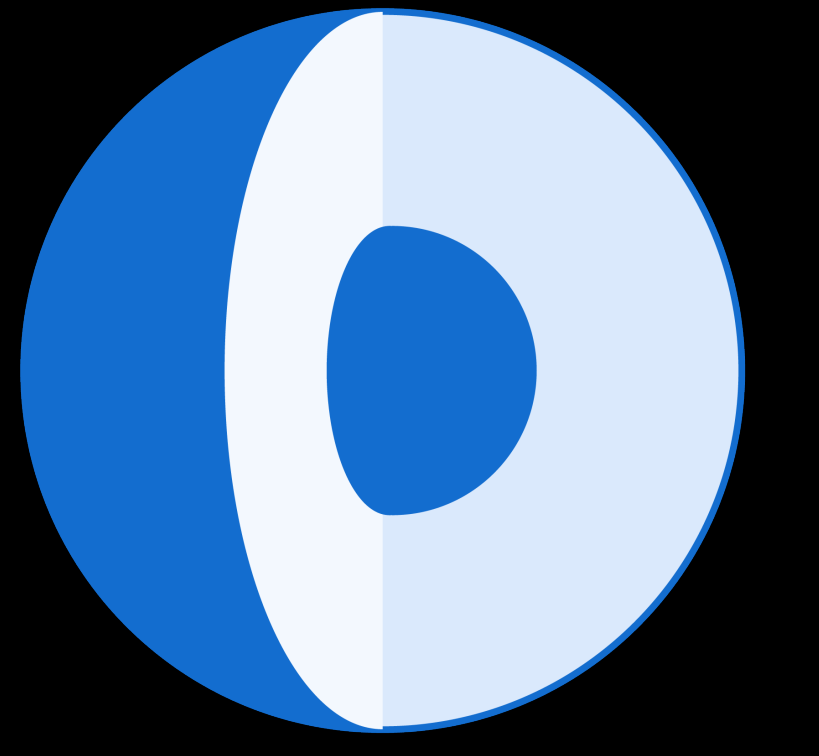


```
<modeler>
```

```
<point-schema>
```

```
<interval-schema>
```


Modelers



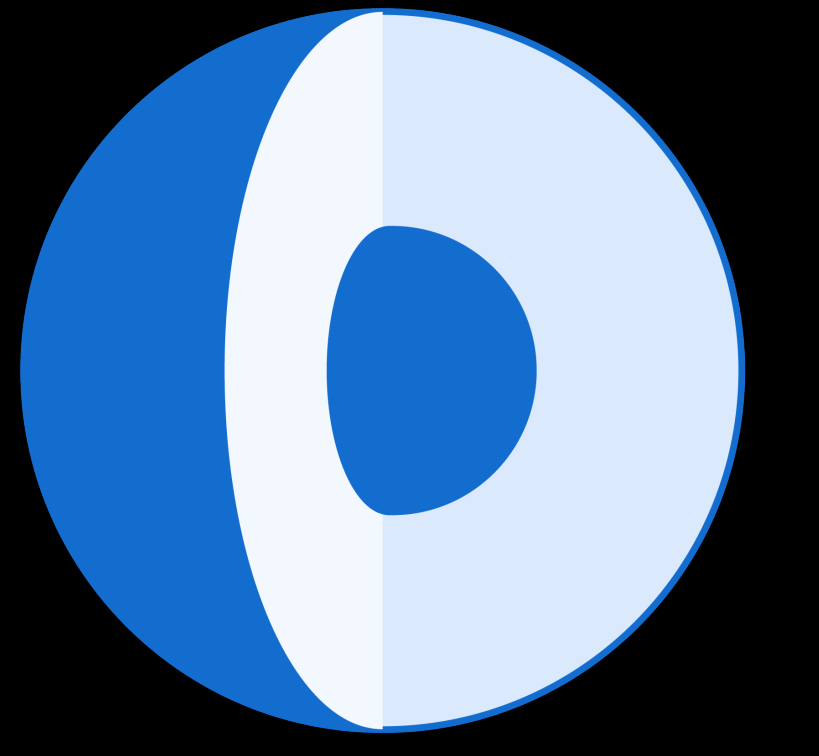
```
<modeler>
```

```
<point-schema>
```

```
<interval-schema>
```

Required inputs

Modelers



`<modeler>`

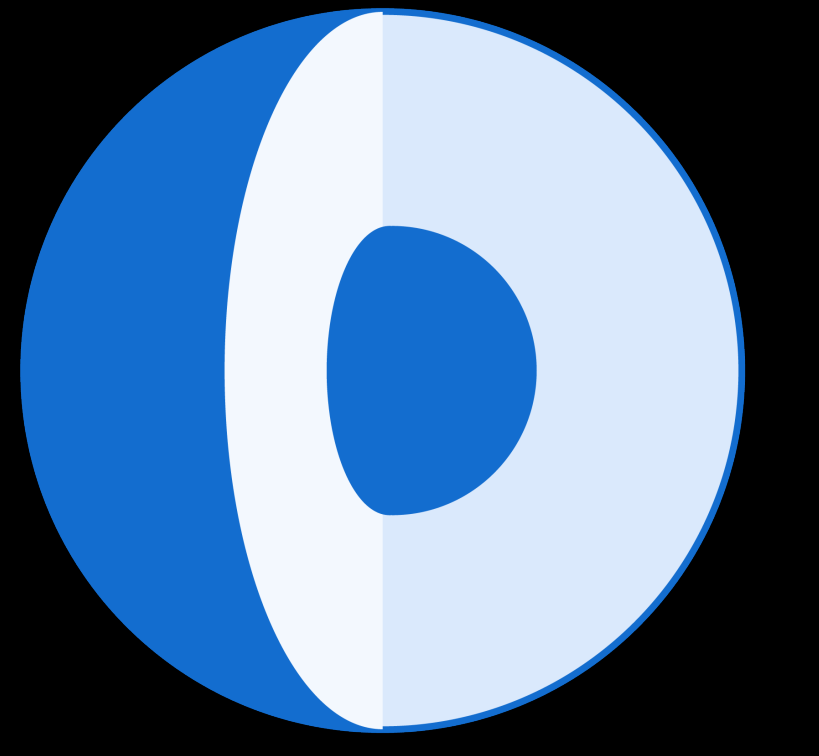
`<point-schema>`

`<interval-schema>`

Required inputs

Expert systems

Modelers



`<modeler>`

`<point-schema>`

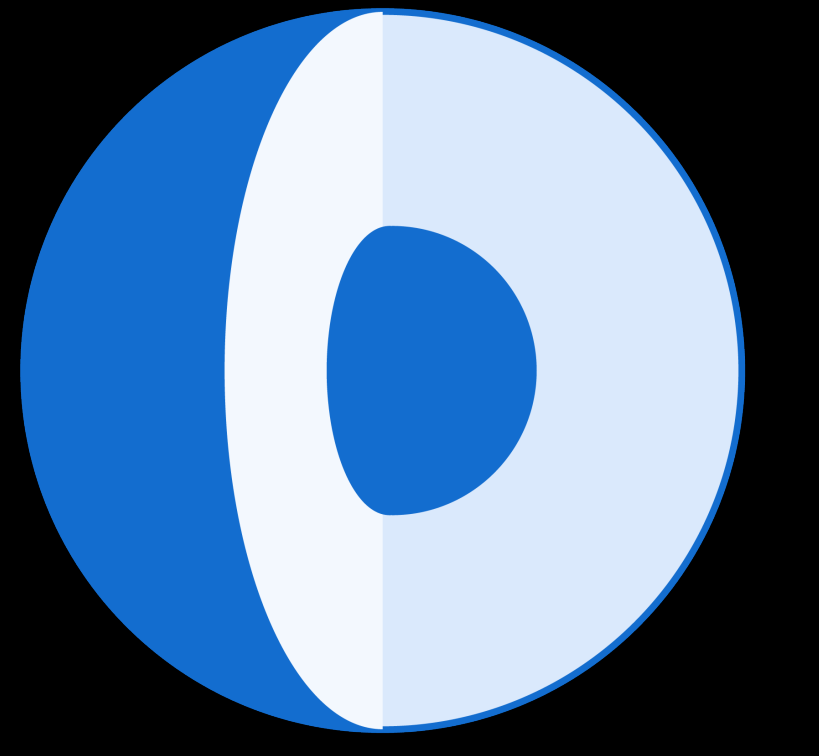
`<interval-schema>`

Required inputs

Expert systems

CLIPS

Modelers



`<modeler>`

`<point-schema>`

`<interval-schema>`

Required inputs

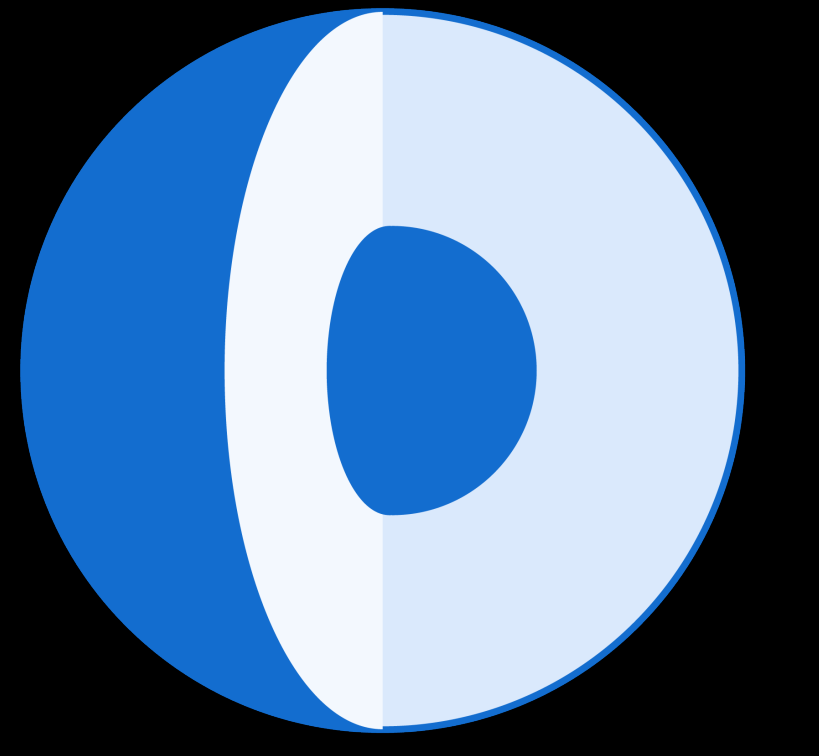
Expert systems

CLIPS

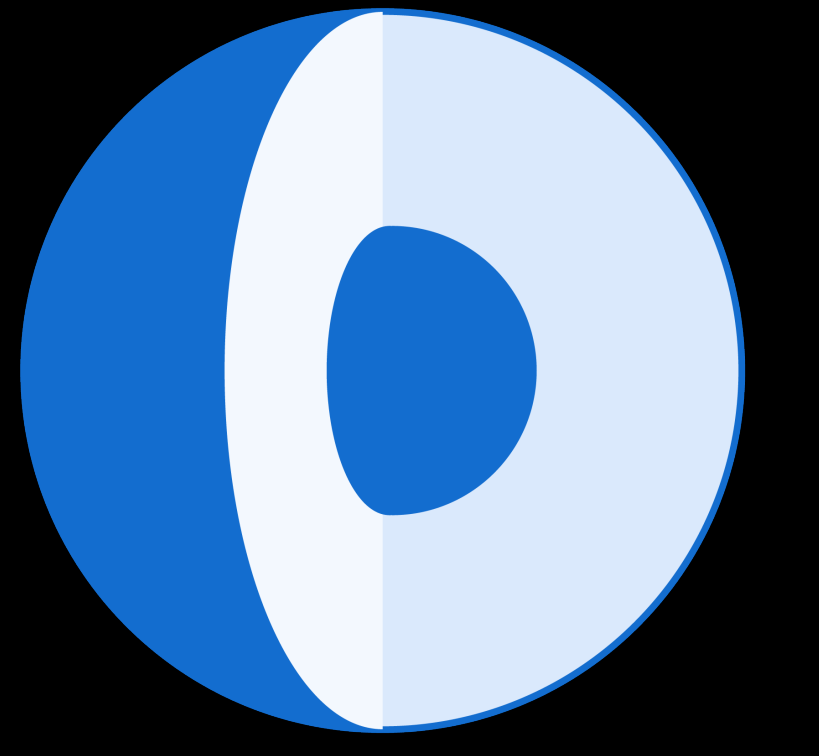
Advanced

However...

Automatic Modelers

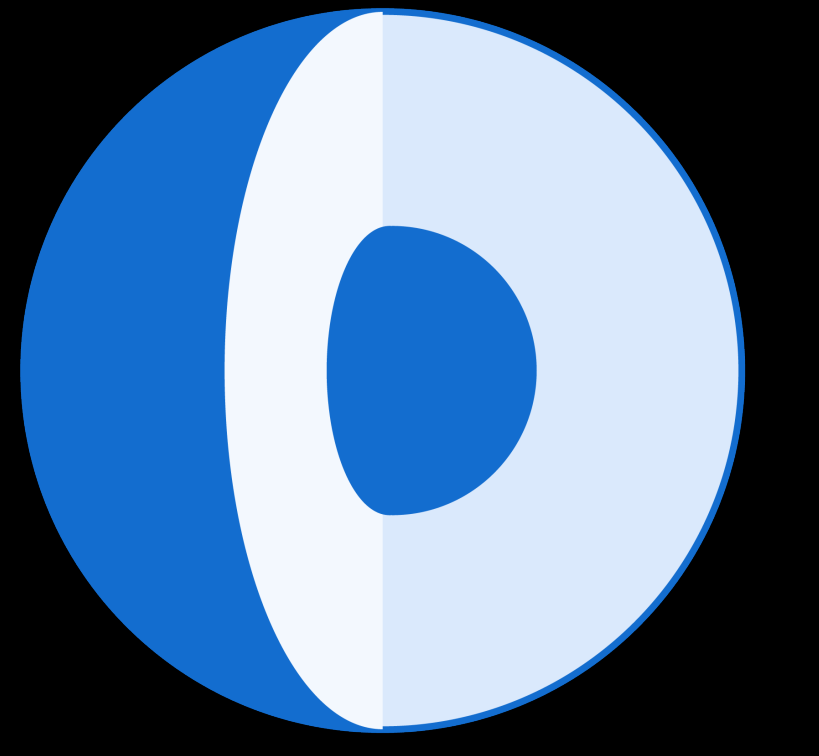


Automatic Modelers



```
<os-signpost-interval-schema>
```

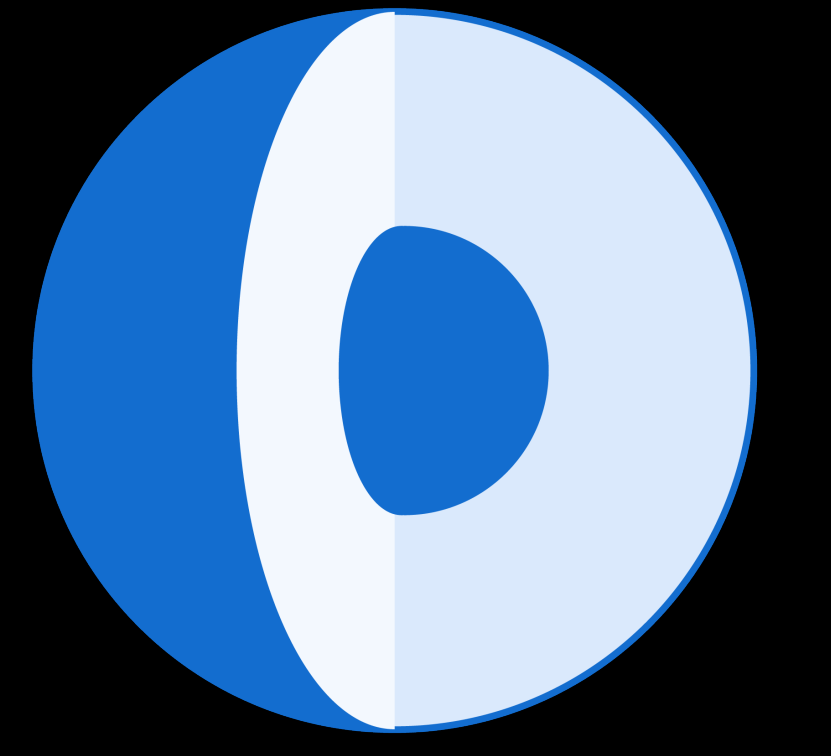
Automatic Modelers



```
<os-signpost-interval-schema>
```

Defines a schema

Automatic Modelers

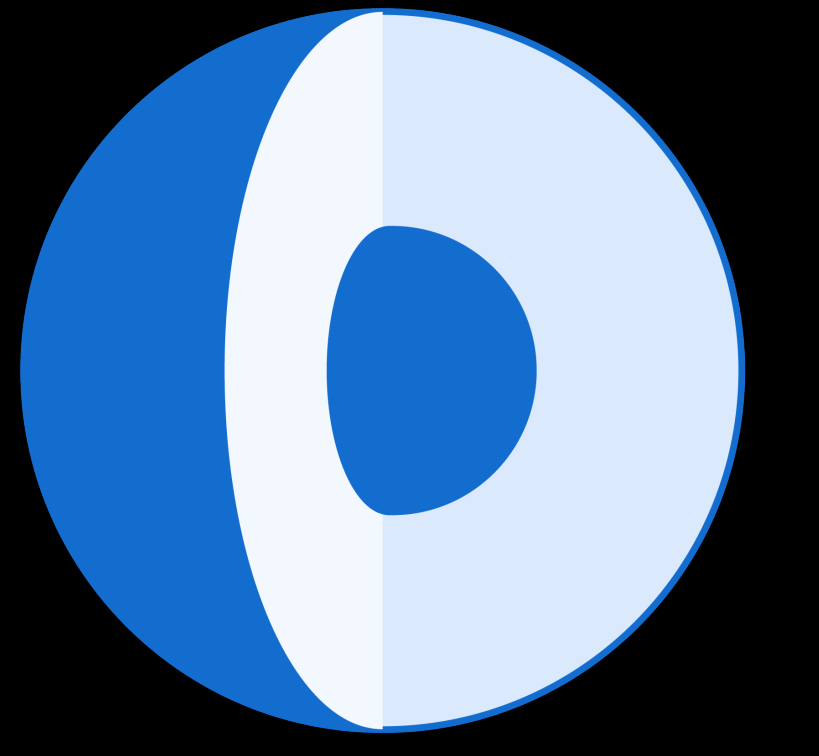


```
<os-signpost-interval-schema>
```

Defines a schema

Generates a modeler

Automatic Modelers



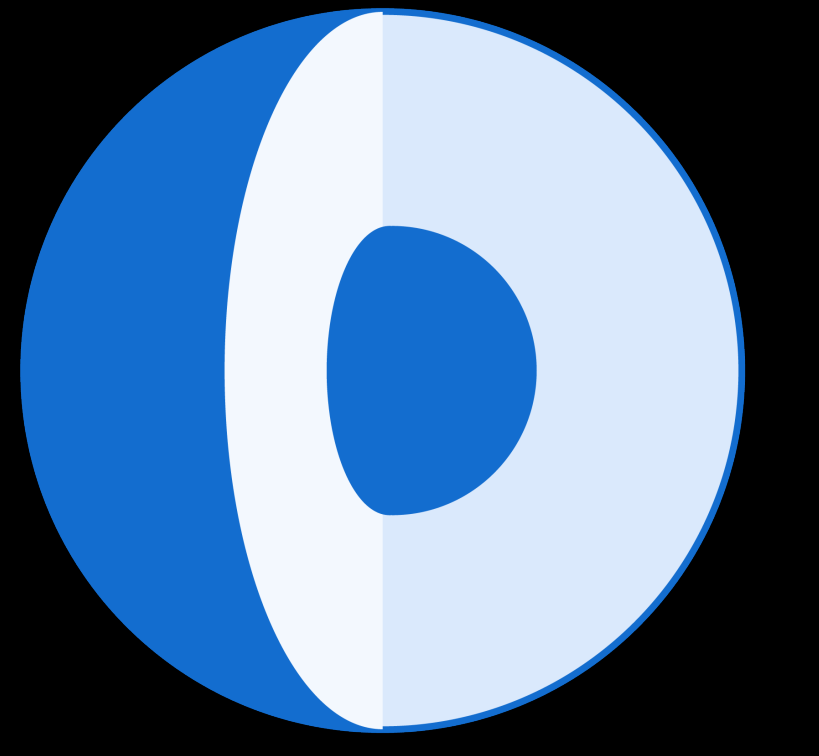
```
<os-signpost-interval-schema>
```

Defines a schema

Generates a modeler

Capture metadata

Automatic Modelers



```
<os-signpost-interval-schema>
```

Defines a schema

Generates a modeler

Capture metadata

Expressions

```
os_signpost(.begin, log: parsingLog, name: "Parsing", "Parsing started SIZE:%ld", data.count)
// Decode the JSON we just downloaded
let result = try jsonDecoder.decode(Trail.self, from: data)
os_signpost(.end, log: parsingLog, name: "Parsing", "Parsing finished")
```

```
os_signpost(.begin, log: parsingLog, name: "Parsing", "Parsing started SIZE:%ld", data.count)
// Decode the JSON we just downloaded
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let result = try jsonDecoder.decode(Trail.self, from: data)
os_signpost(.end, log: parsingLog, name: "Parsing", "Parsing finished")
```

```
<os-signpost-interval-schema>
  <id>json-parse</id>
  <title>Image Download</title>

  <subsystem>"com.apple.trailblazer"</subsystem>
  <category>"Networking"</category>
  <name>"Parsing"</name>

  <start-pattern>
    <message>"Parsing started SIZE:" ?data-size</message>
  </start-pattern>

  <column>
    <mnemonic>data-size</mnemonic>
    <title>JSON Data Size</title>
    <type>size-in-bytes</type>
    <expression>?data-size</expression>
  </column>
</os-signpost-interval-schema>
```



```
<os-signpost-interval-schema>
  <id>json-parse</id>
  <title>Image Download</title>

  <subsystem>"com.apple.trailblazer"</subsystem>
  <category>"Networking"</category>
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  <start-pattern>
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  <column>
    <mnemonic>data-size</mnemonic>
    <title>JSON Data Size</title>
    <type>size-in-bytes</type>
    <expression>?data-size</expression>
  </column>
</os-signpost-interval-schema>
```

```
<os-signpost-interval-schema>
  <id>json-parse</id>
  <title>Image Download</title>
```

```
  <subsystem>"com.apple.trailblazer"</subsystem>
  <category>"Networking"</category>
  <name>"Parsing"</name>
```

```
  <start-pattern>
    <message>"Parsing started SIZE:" ?data-size</message>
  </start-pattern>
```

```
  <column>
    <mnemonic>data-size</mnemonic>
    <title>JSON Data Size</title>
    <type>size-in-bytes</type>
    <expression>?data-size</expression>
  </column>
```

```
</os-signpost-interval-schema>
```

```
<os-signpost-interval-schema>
  <id>json-parse</id>
  <title>Image Download</title>

  <subsystem>"com.apple.trailblazer"</subsystem>
  <category>"Networking"</category>
  <name>"Parsing"</name>

  <start-pattern>
    <message>"Parsing started SIZE:" ?data-size</message>
  </start-pattern>

  <column>
    <mnemonic>data-size</mnemonic>
    <title>JSON Data Size</title>
    <type>size-in-bytes</type>
    <expression>?data-size</expression>
  </column>
</os-signpost-interval-schema>
```

```
<os-signpost-interval-schema>
  <id>json-parse</id>
  <title>Image Download</title>

  <subsystem>"com.apple.trailblazer"</subsystem>
  <category>"Networking"</category>
  <name>"Parsing"</name>

  <start-pattern>
    <message>"Parsing started SIZE:" ?data-size</message>
  </start-pattern>

  <column>
    <mnemonic>data-size</mnemonic>
    <title>JSON Data Size</title>
    <type>size-in-bytes</type>
    <expression>?data-size</expression>
  </column>
</os-signpost-interval-schema>
```

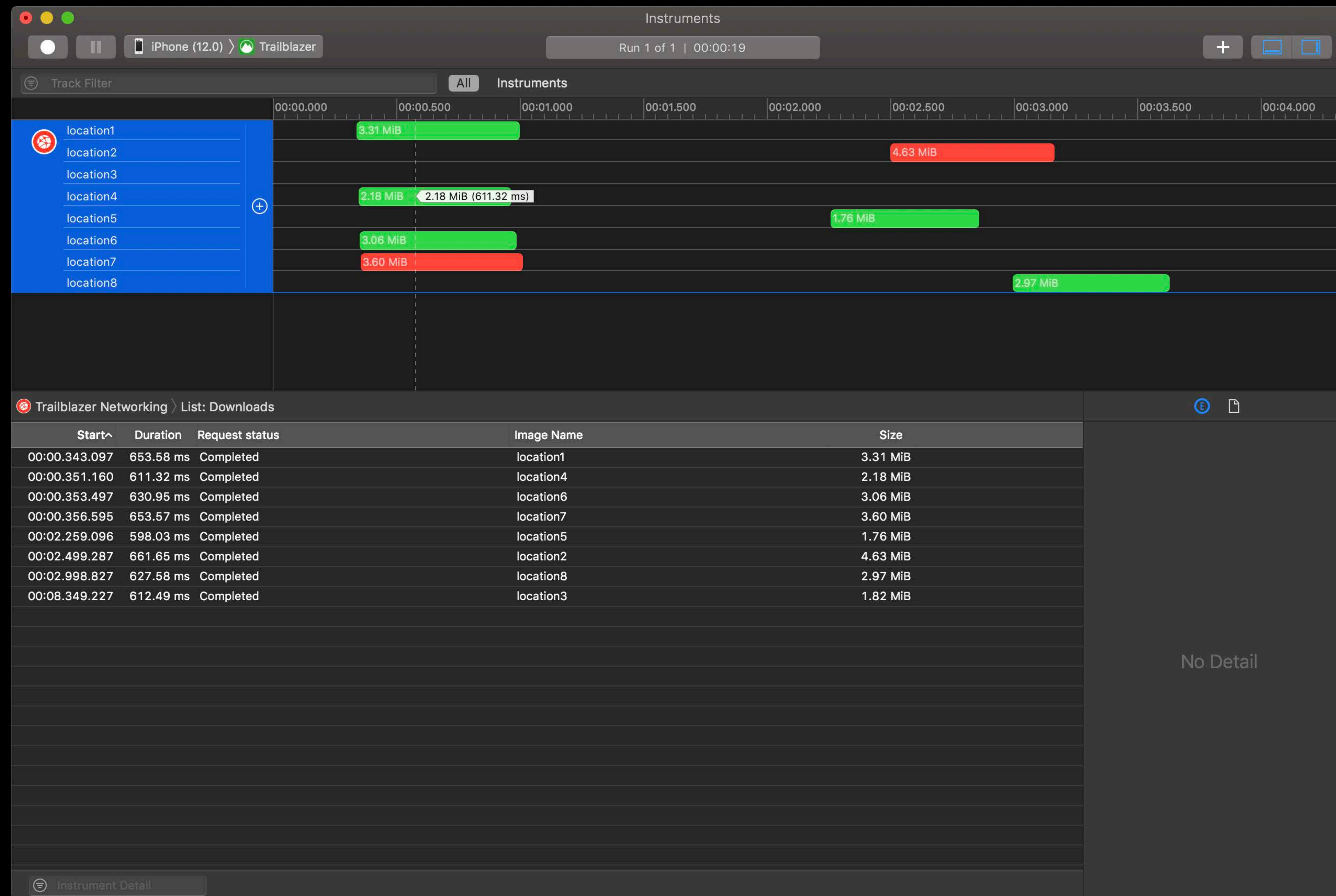
```
<os-signpost-interval-schema>
  <id>json-parse</id>
  <title>Image Download</title>

  <subsystem>"com.apple.trailblazer"</subsystem>
  <category>"Networking"</category>
  <name>"Parsing"</name>

  <start-pattern>
    <message>"Parsing started SIZE:" ?data-size</message>
  </start-pattern>

  <column>
    <mnemonic>data-size</mnemonic>
    <title>JSON Data Size</title>
    <type>size-in-bytes</type>
    <expression>?data-size</expression>
  </column>
</os-signpost-interval-schema>
```

Trailblazer Networking

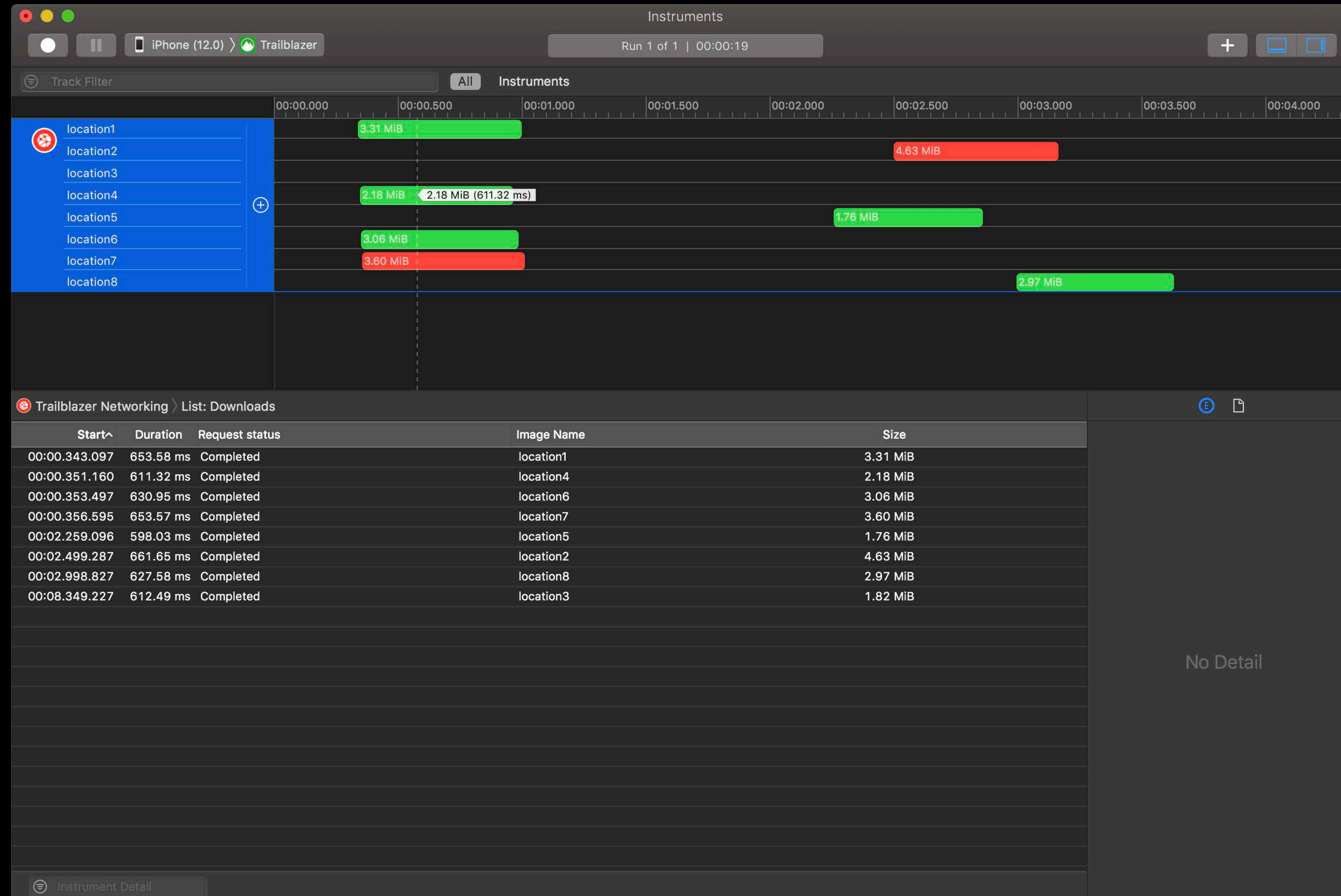


Demo

Intermediate-level instruments

Kacper Harasim, Performance Tools Engineer

Trailblazer Networking



Why create custom instruments

Architecture

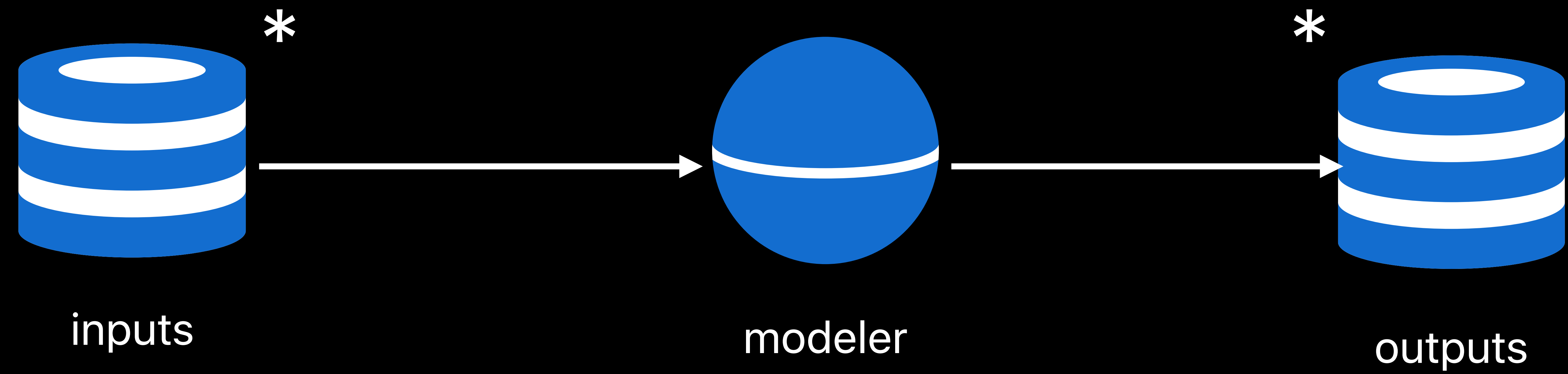
Getting started

Intermediate

Advanced

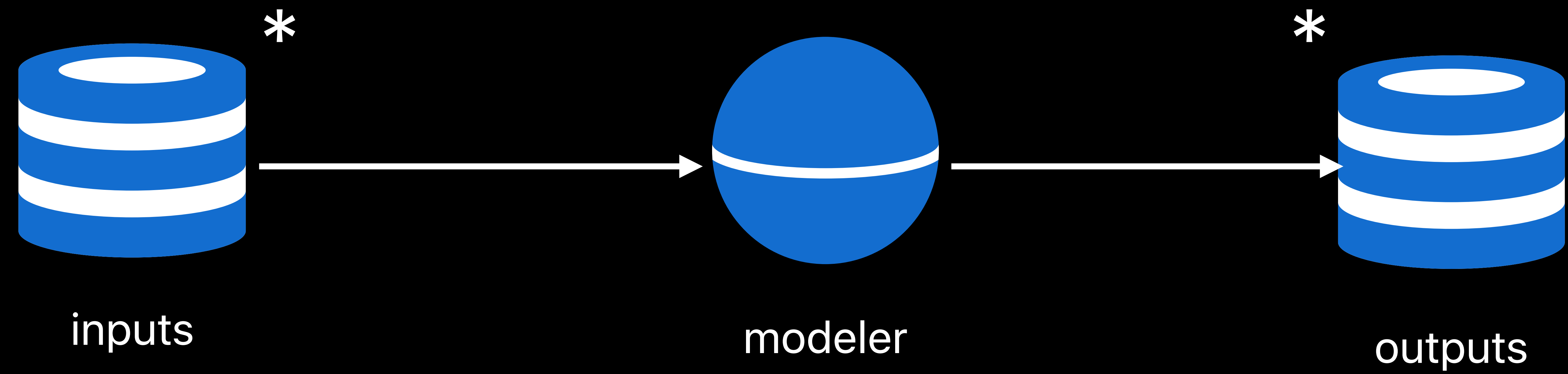
Best practices

Modelers



Modelers

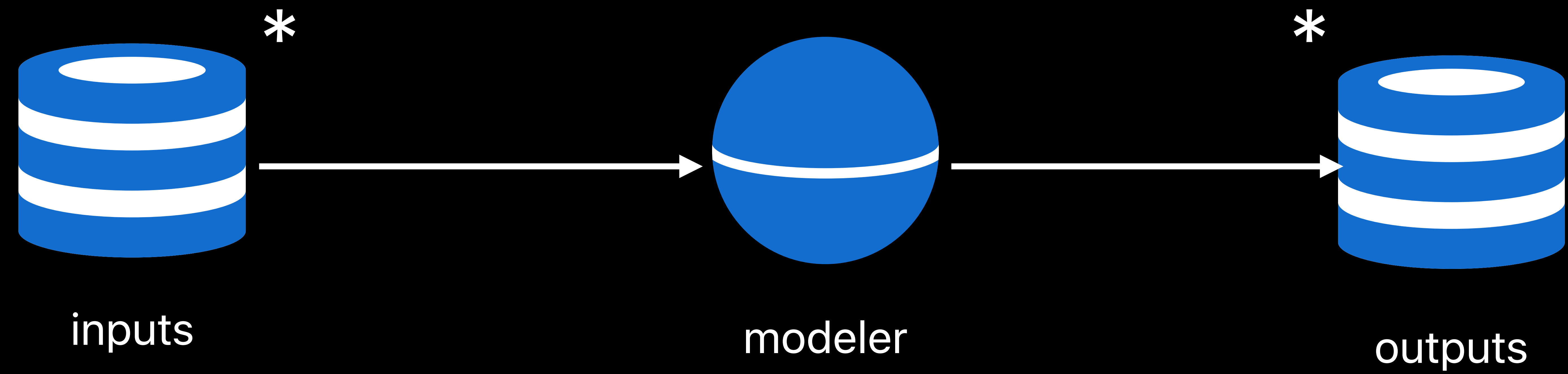
Time ordered



Modelers

Time ordered

Working memory

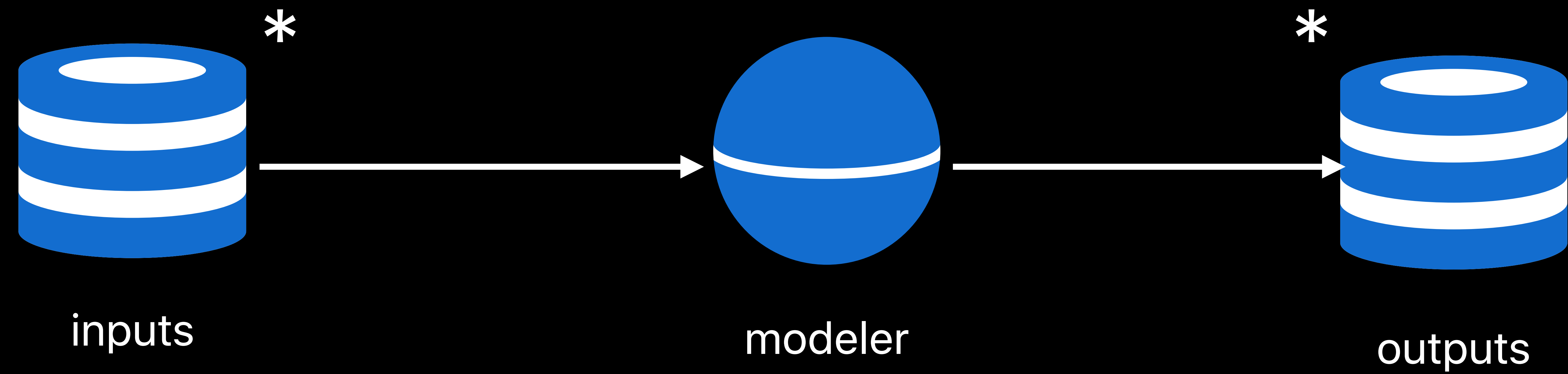


Modelers

Time ordered

Working memory

Inference



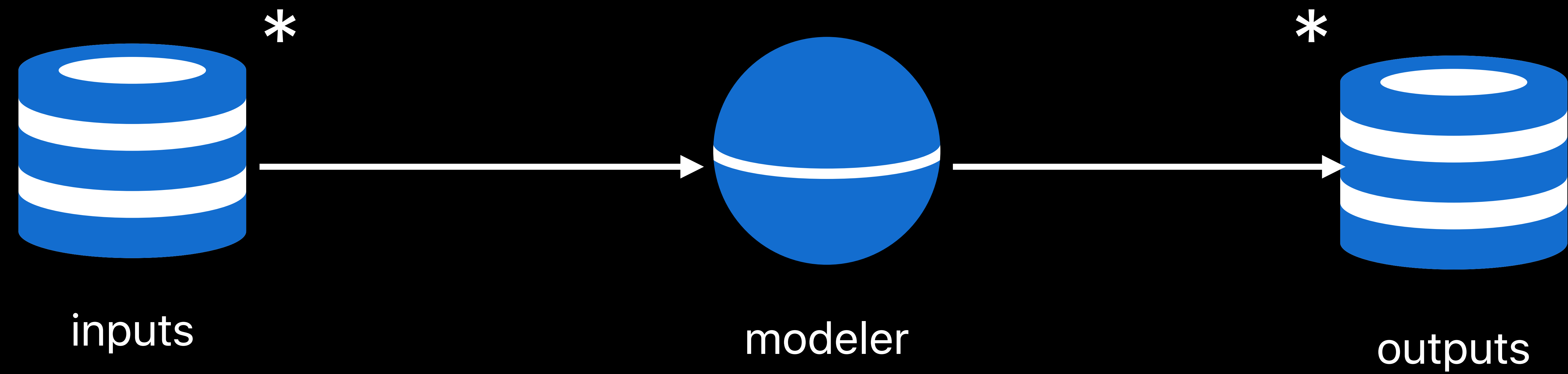
Modelers

Time ordered

Working memory

Inference

Output



Example

Example

playing-with-matches

```
<os-signpost-interval-schema>  
  <id>playing-with-matches</id>  
  <title>Playing with Matches</title>  
  
  <subsystem>"com.apple.trailblazer"</subsystem>  
  <category>"Advisory"</category>  
  <name>"Playing with Matches"</name>
```


Example

playing-with-matches

```
<os-signpost-interval-schema>  
  <id>playing-with-matches</id>  
  <title>Playing with Matches</title>  
  
  <subsystem>"com.apple.trailblazer"</subsystem>  
  <category>"Advisory"</category>  
  <name>"Playing with Matches"</name>
```

app-on-fire

```
<os-signpost-interval-schema>  
  <id>app-on-fire</id>  
  <title>Application on Fire!</title>  
  
  <subsystem>"com.apple.trailblazer"</subsystem>  
  <category>"Advisory"</category>  
  <name>"On Fire"</name>
```

Example

playing-with-matches

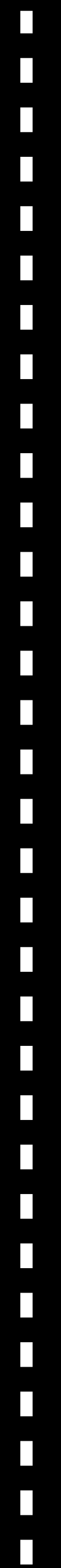
```
<os-signpost-interval-schema>  
  <id>playing-with-matches</id>  
  <title>Playing with Matches</title>  
  
  <subsystem>"com.apple.trailblazer"</subsystem>  
  <category>"Advisory"</category>  
  <name>"Playing with Matches"</name>
```

app-on-fire

```
<os-signpost-interval-schema>  
  <id>app-on-fire</id>  
  <title>Application on Fire!</title>  
  
  <subsystem>"com.apple.trailblazer"</subsystem>  
  <category>"Advisory"</category>  
  <name>"On Fire"</name>
```

started-a-fire

```
<point-schema>  
  <id>started-a-fire</id>  
  <title>Object started a fire!</title>
```



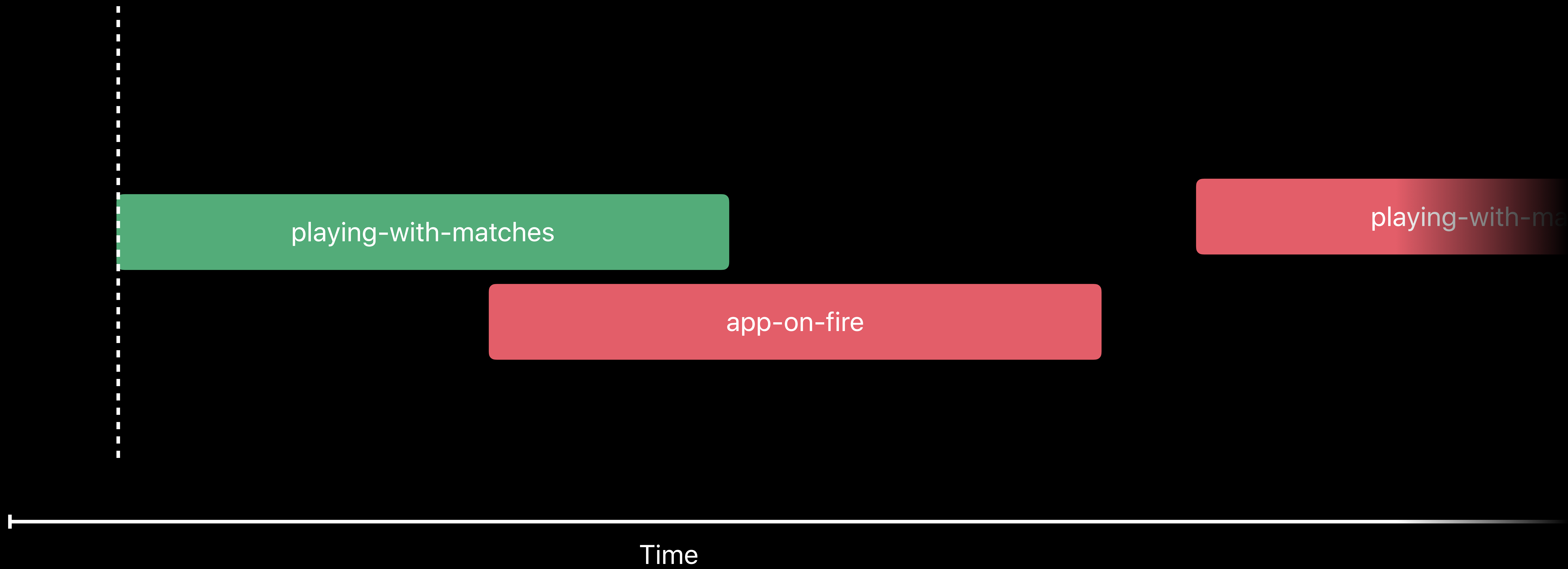
playing-with-matches

app-on-fire

playing-with-ma



Time



playing-with-matches

app-on-fire

playing-with-ma

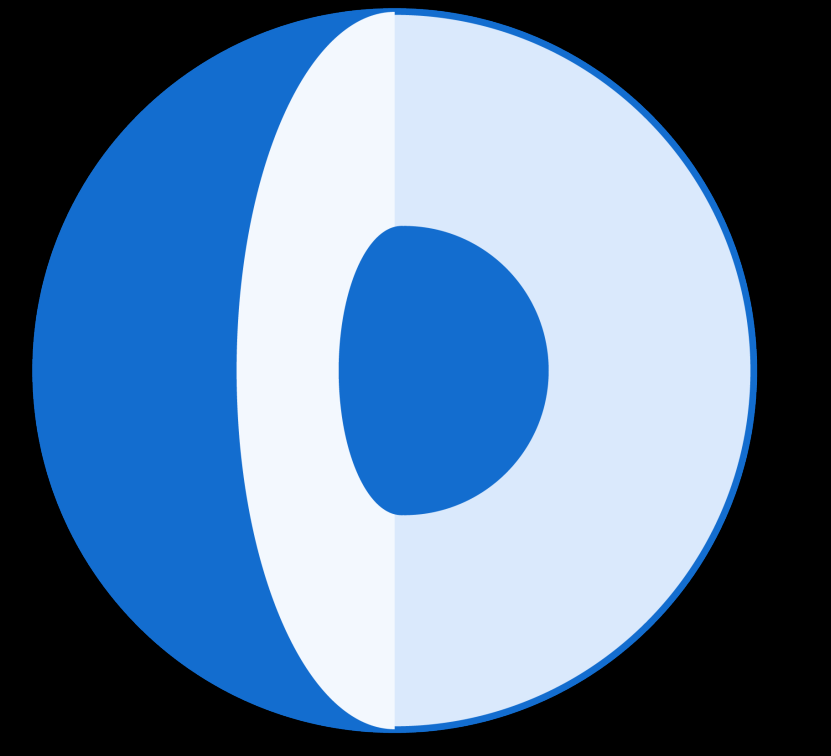


Time





Clock

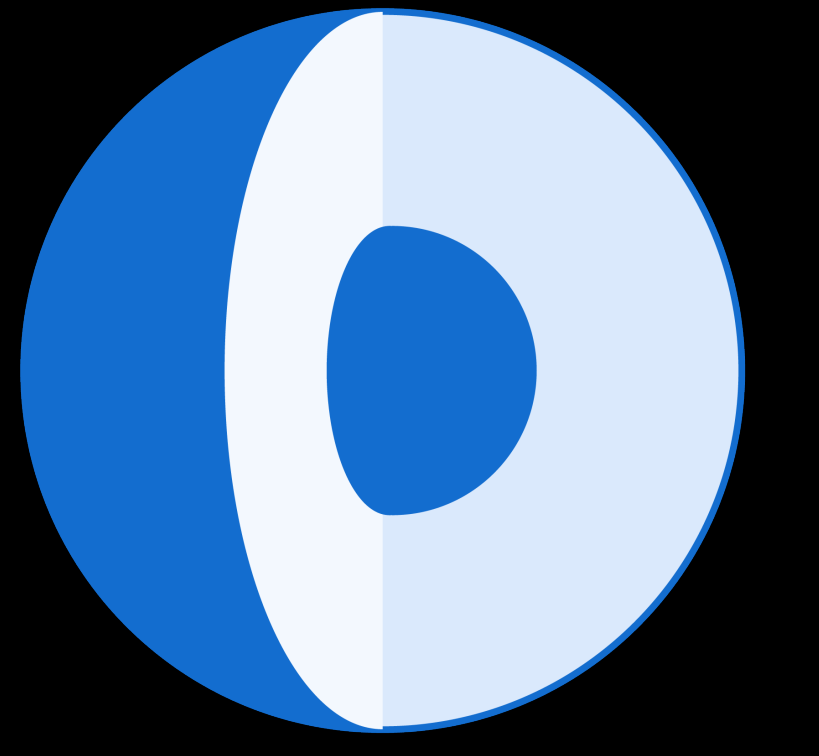


Current input timestamp

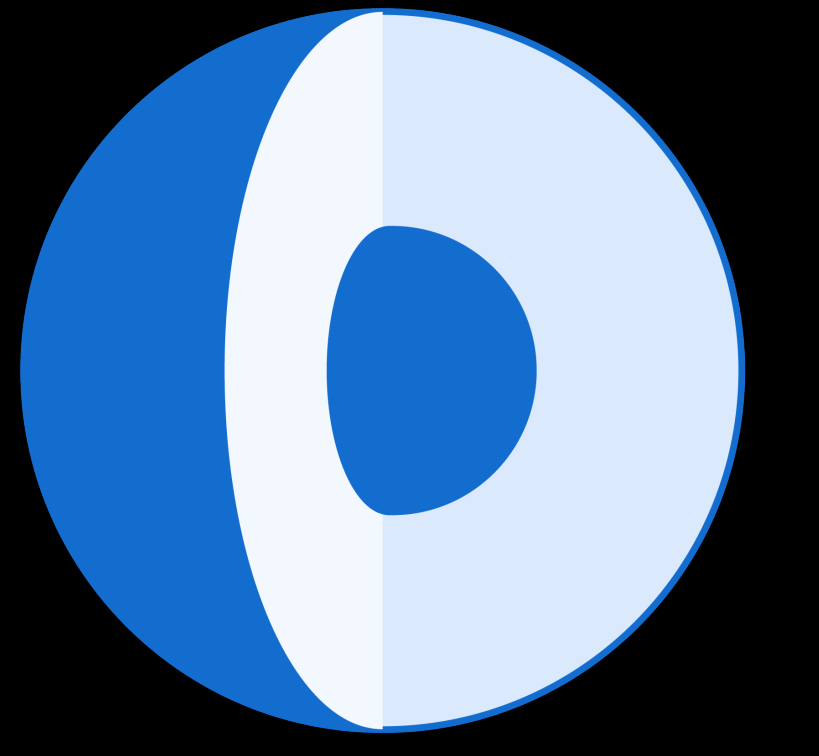
Input facts must intersect

Coincidence

Production System

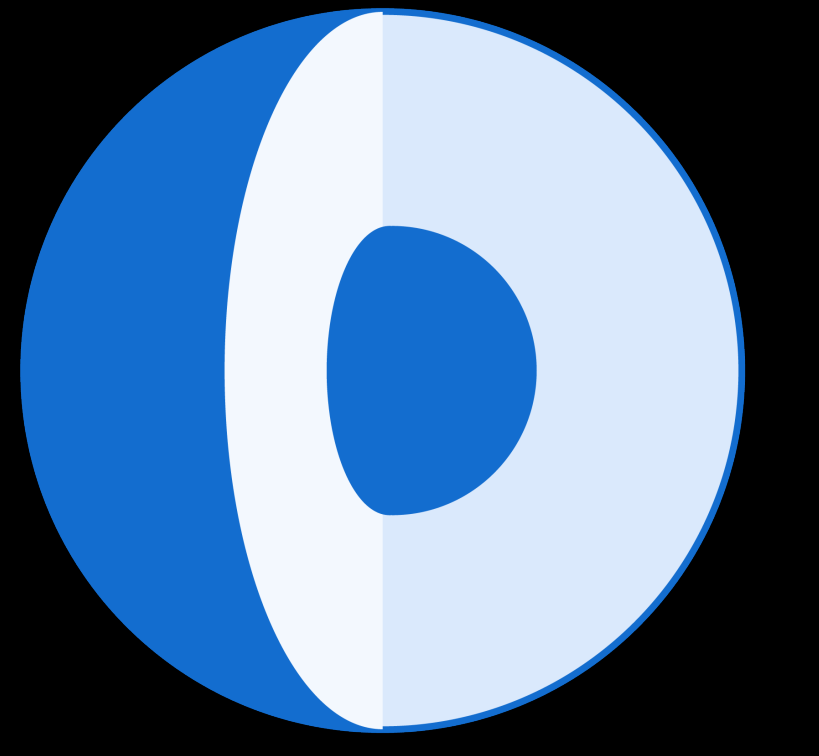


Production System



Facts

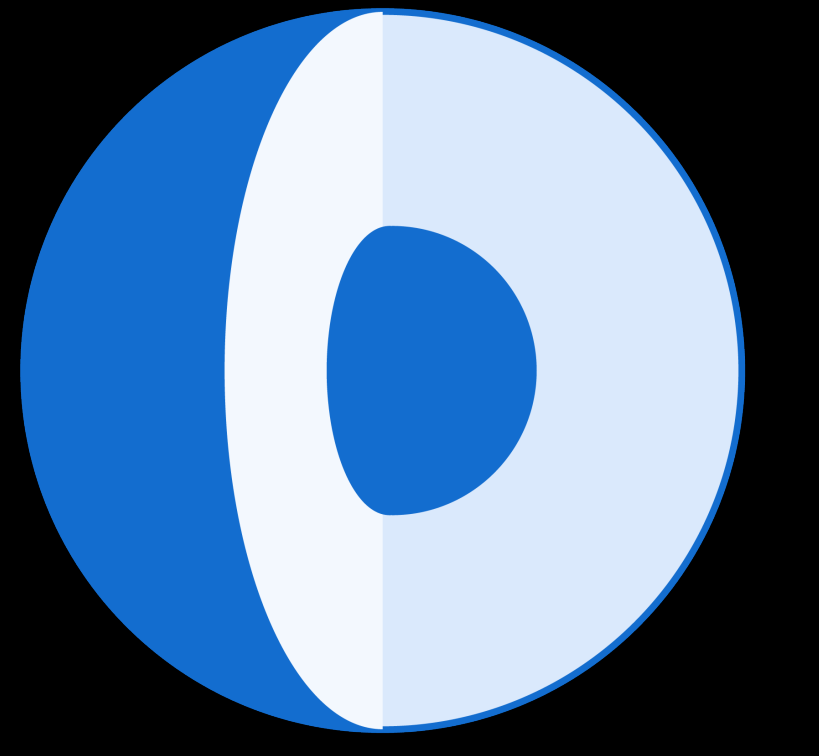
Production System



Facts

LHS \Rightarrow RHS

Production System

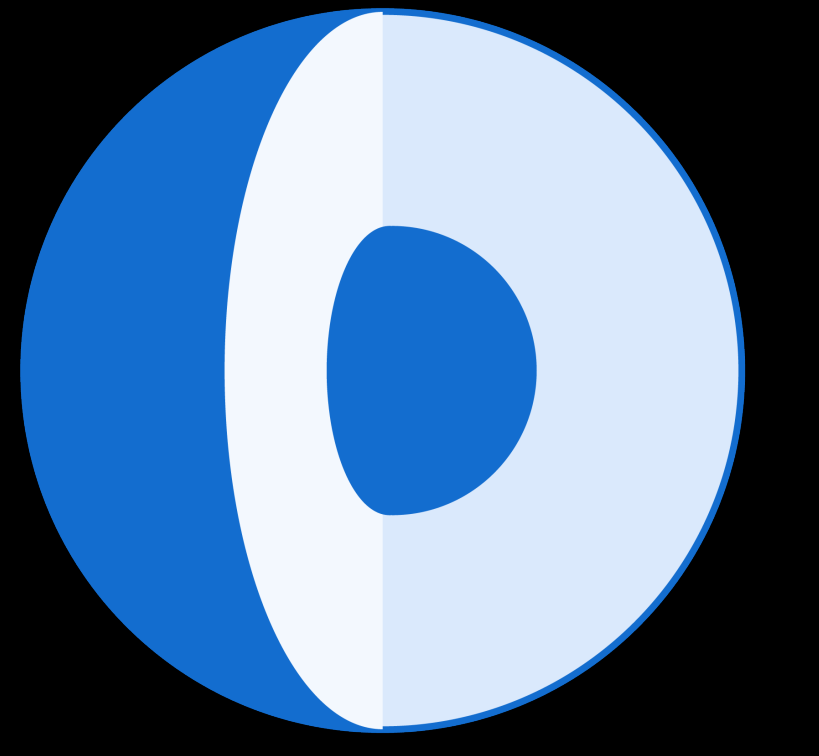


Facts

LHS \Rightarrow RHS

Pattern

Production System



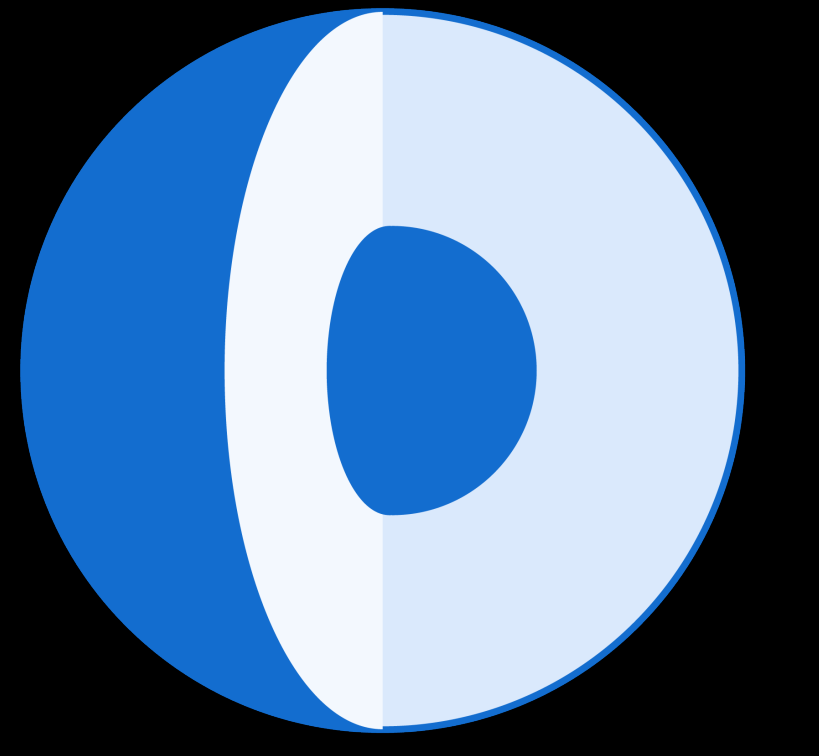
Facts

LHS \Rightarrow RHS

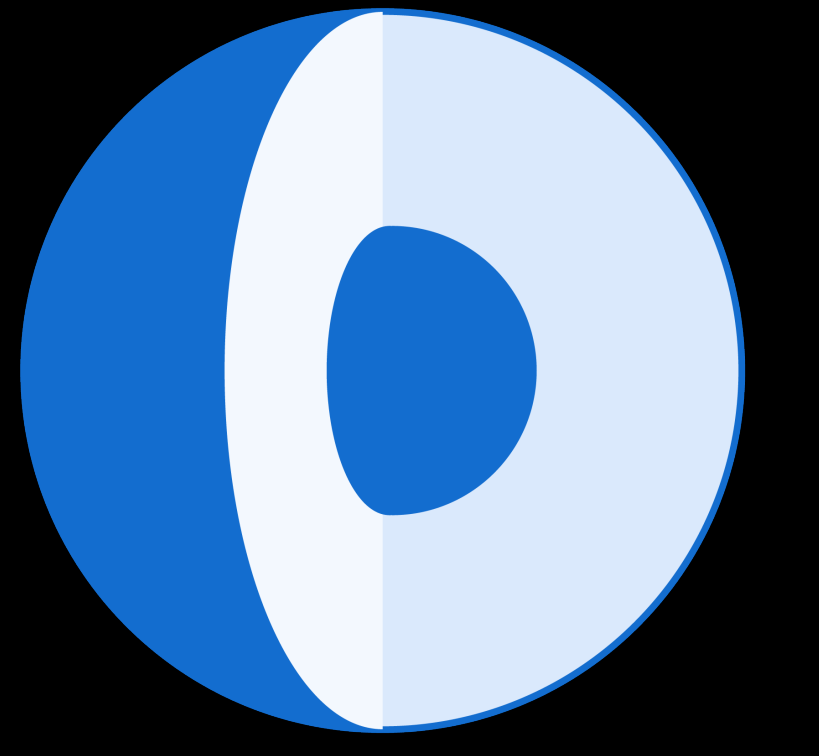
Pattern

Actions

Facts

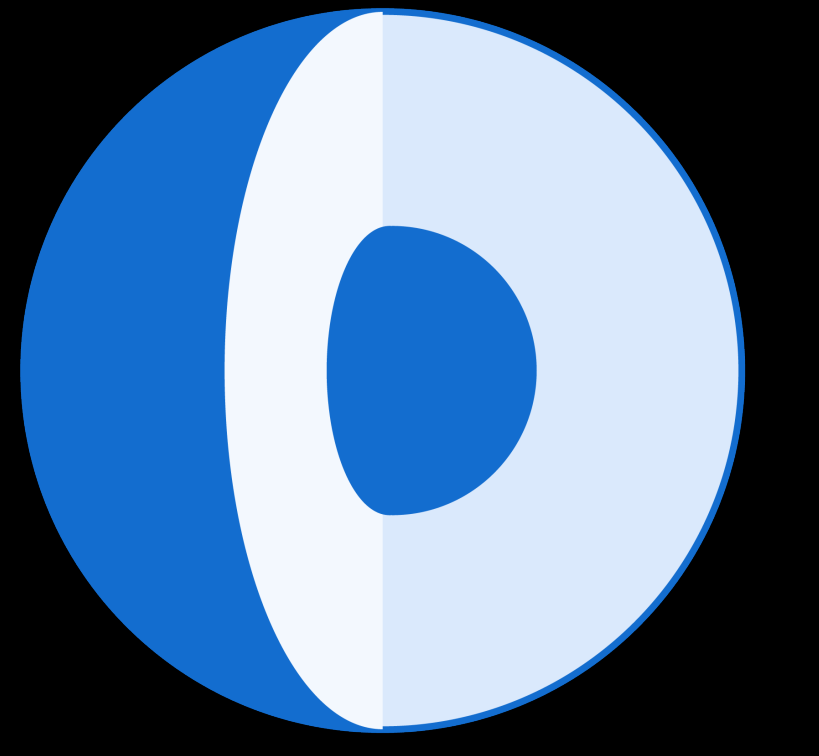


Facts



Input table

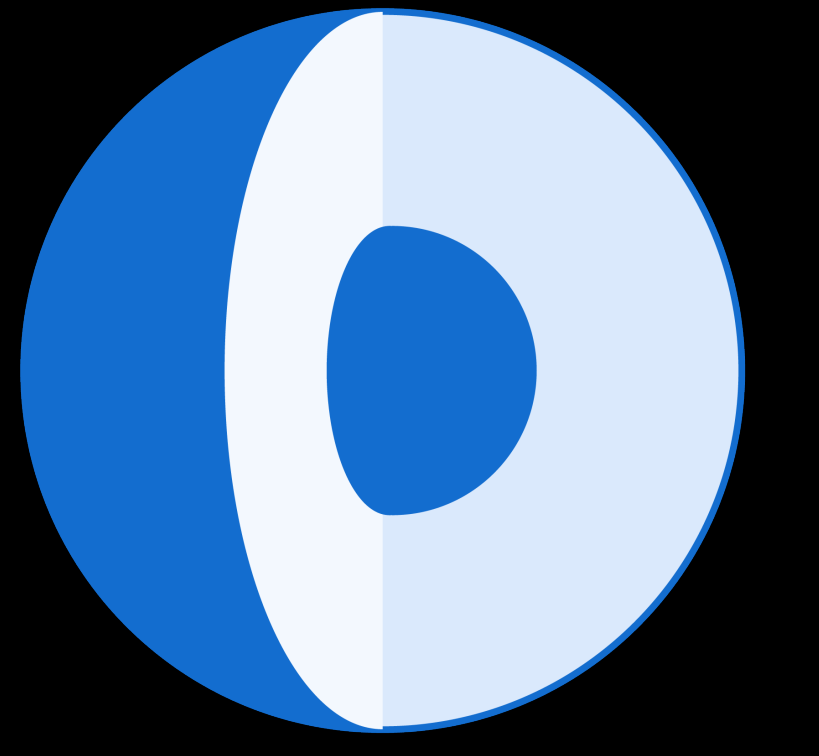
Facts



Input table

Assertions

Facts



Input table

Assertions

Template

```
(defrule MODELER::found-cause
  (playing-with-matches (start-time ?t1) (who ?object))
  (app-on-fire (start-time ?t2))
  (test (< ?t1 ?t2))
=>
  (assert (cause-of-fire (who ?object)))
)

(defrule RECORDER::record-cause
  (app-on-fire (start-time ?start))
  (cause-of-fire (who ?object))
  (table (table-id ?t) (side append))
  (table-attribute (table-id ?t) (has schema started-a-fire))
=>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
)
```

```
(defrule MODELER::found-cause
  (playing-with-matches (start-time ?t1) (who ?object))
  (app-on-fire (start-time ?t2))
  (test (< ?t1 ?t2))
=>
  (assert (cause-of-fire (who ?object)))
)
(defrule RECORDER::record-cause
  (app-on-fire (start-time ?start))
  (cause-of-fire (who ?object))
  (table (table-id ?t) (side append))
  (table-attribute (table-id ?t) (has schema started-a-fire))
=>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
)
```

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(defrule MODELER::found-cause
  (playing-with-matches (start-time ?t1) (who ?object))
  (app-on-fire (start-time ?t2))
  (test (< ?t1 ?t2))
  =>
  (assert (cause-of-fire (who ?object)))
)

(defrule RECORDER::record-cause
  (app-on-fire (start-time ?start))
  (cause-of-fire (who ?object))
  (table (table-id ?t) (side append))
  (table-attribute (table-id ?t) (has schema started-a-fire))
  =>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
)
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  (playing-with-matches (start-time ?t1) (who ?object))
  (app-on-fire (start-time ?t2))
  (test (< ?t1 ?t2))
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  (app-on-fire (start-time ?start))
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(defrule MODELER::found-cause
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  (app-on-fire (start-time ?t2))
  (test (< ?t1 ?t2))
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  (app-on-fire (start-time ?start))
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=>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
)
```

Modules

Modules

MODELER ::

Modules

MODELER ::

RECORDER ::

Modules

MODELER ::

RECORDER ::

Group rules

Modules

MODELER ::

RECORDER ::

Group rules

Orders execution

Logical Support

Logical Support

Inference

Logical Support

Inference

Automatically retracts assertions

Logical Support

Inference

Automatically retracts assertions

Limits working memory bloat

```
(defrule MODELER::found-cause
  (playing-with-matches (start-time ?t1) (who ?object))
  (app-on-fire (start-time ?t2))
  (test (< ?t1 ?t2))
=>
  (assert (cause-of-fire (who ?object)))
)

(defrule RECORDER::record-cause
  (app-on-fire (start-time ?start))
  (cause-of-fire (who ?object))
  (table (table-id ?t) (side append))
  (table-attribute (table-id ?t) (has schema started-a-fire))
=>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
)
```

```
(defrule MODELER::found-cause
  (logical (playing-with-matches (start-time ?t1) (who ?object))
           (app-on-fire (start-time ?t2)))
  )
  (test (< ?t1 ?t2))
  =>
  (assert (cause-of-fire (who ?object)))
  )
(defrule RECORDER::record-cause
  (app-on-fire (start-time ?start))
  (cause-of-fire (who ?object))
  (table (table-id ?t) (side append))
  (table-attribute (table-id ?t) (has schema started-a-fire))
  =>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
  )
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  (logical (playing-with-matches (start-time ?t1) (who ?object))
           (app-on-fire (start-time ?t2))
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  (create-row ?t)
  (set-column time ?start)
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  (logical (playing-with-matches (start-time ?t1) (who ?object))
           (app-on-fire (start-time ?t2)))
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  (assert (cause-of-fire (who ?object)))
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(defrule RECORDER::record-cause
  (app-on-fire (start-time ?start))
  (cause-of-fire (who ?object))
  (table (table-id ?t) (side append))
  (table-attribute (table-id ?t) (has schema started-a-fire))
  =>
  (create-row ?t)
  (set-column time ?start)
  (set-column who ?object)
  )
```

Demo

Advanced instruments

Kacper Harasim, Performance Tools Engineer

Why create custom instruments

Architecture

Getting started

Intermediate

Advanced

Best practices

Write more than one instrument

Immediate mode is hard

Last 5s mode is the most efficient

More Information

<https://developer.apple.com/wwdc18/410>

Measuring Performance Using Logging

WWDC 2018

Custom Instruments Lab

Technology Lab 8

Thursday 3:00PM

 **WWDC18**