System Trace in Depth

Explore the deep end of the Instruments pool

Session 411

Chad Woolf Performance Tools Engineer
Joe Grzywacz Performance Tools Engineer

Last Year…

Session 412 - Time Profiling in Depth

Last Year…

Session 412 - Time Profiling in Depth

WWDC 2015

Multi-core

Multi-core

Get more done

Multi-core

Get more done

System load changes performance

Multi-core

Get more done

System load changes performance

High system load increases

- Preemption
- Lock contention
- Virtual memory activity

System Trace in Depth

Agenda

System tracing in depth

Agenda

System tracing in depth

System Trace for Apps

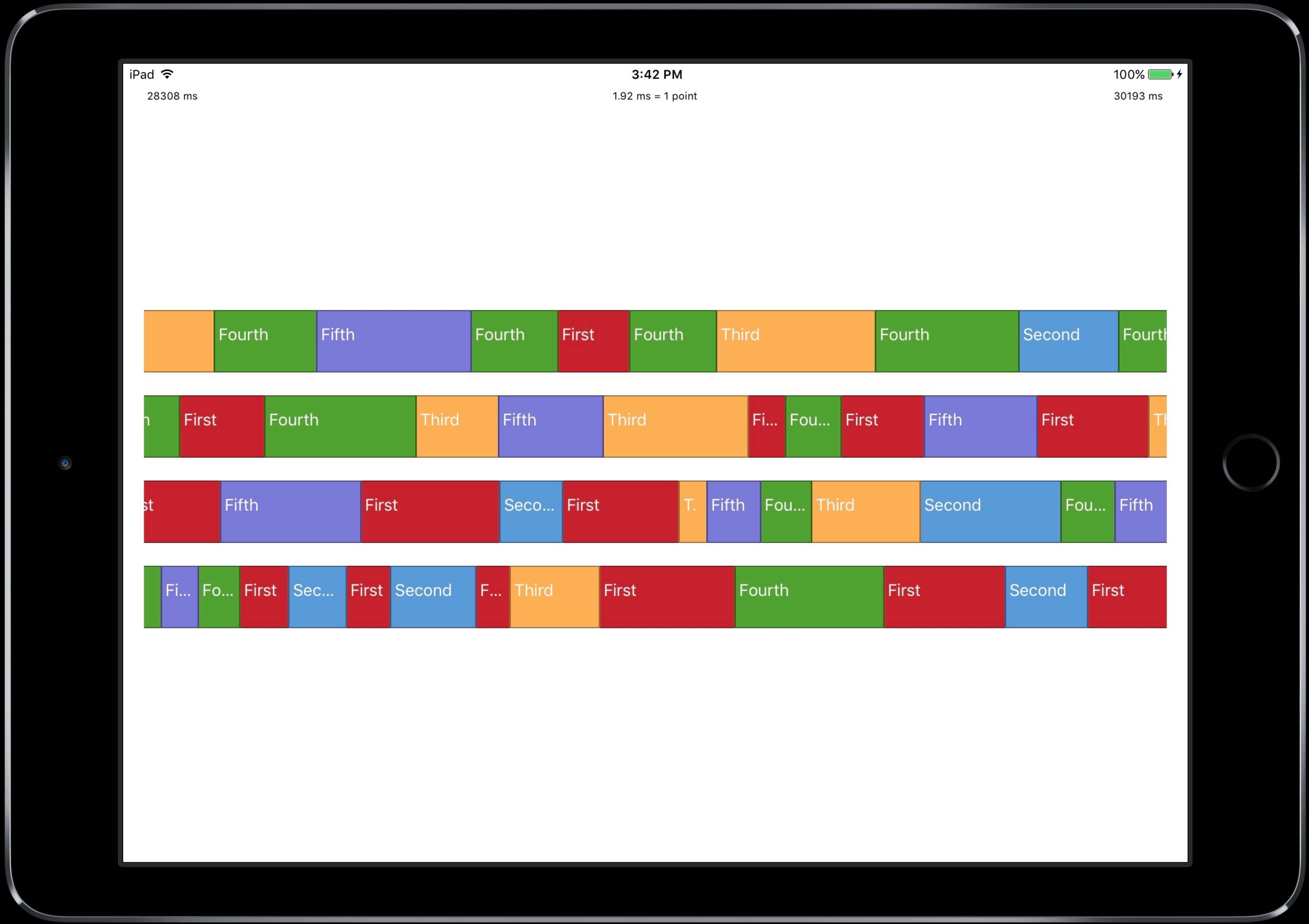
Agenda

System tracing in depth

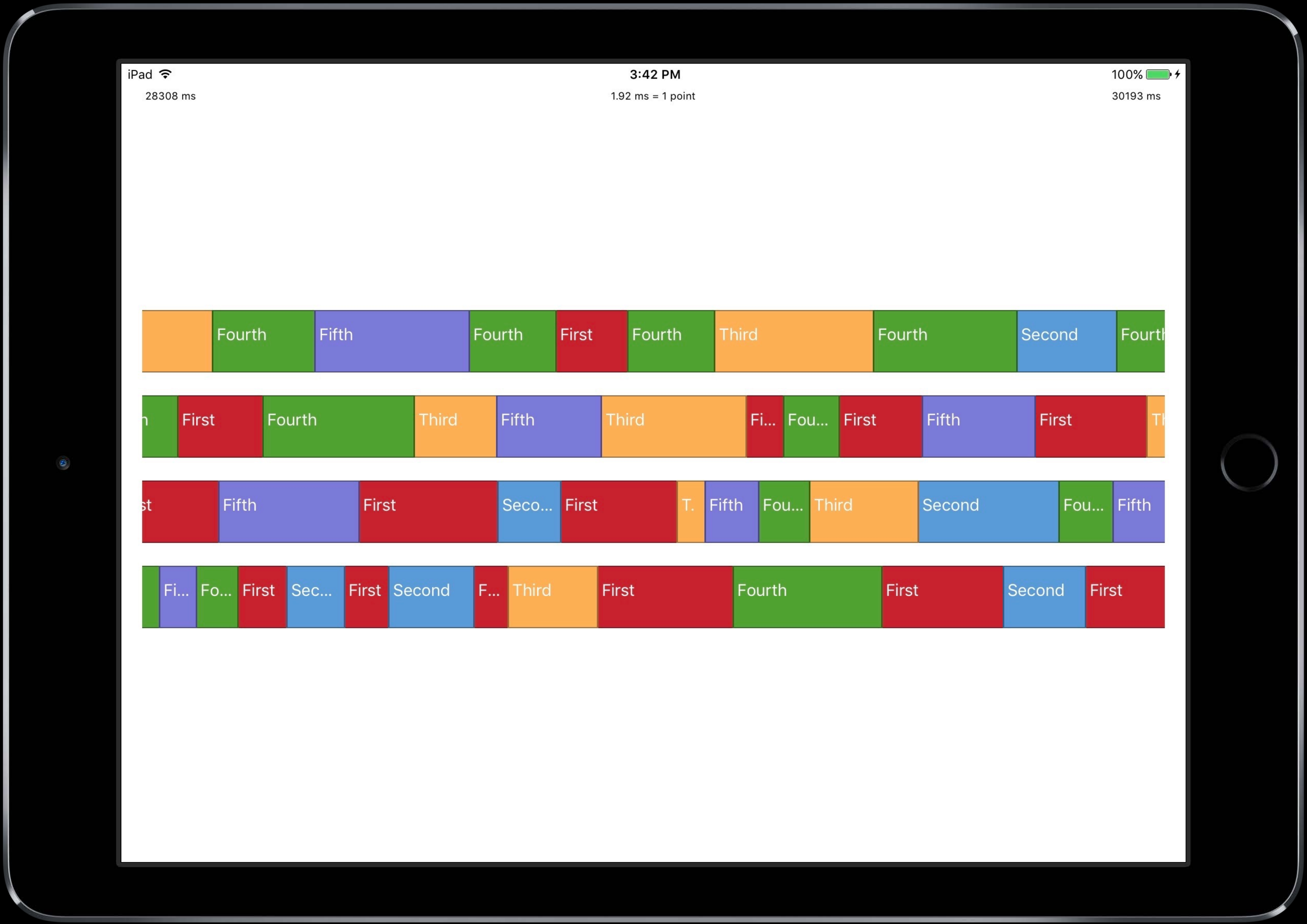
System Trace for Apps

Using System Trace

- Theading
- Signposts
- Virtual Memory
- Best Practices


iPad
3:42 PM
100%
28308 ms
1.92 ms = 1 point
30193 ms
Fourth
Fifth
Fourth
First
Fourth
Third
Fourth
Second
First
Fourth
Third
Fifth
Third
Fi...
Fou...
First
Fifth
First
Fifth
First
Seco...
First
T.
Fifth
Fou...
Third
Second
Fou...
Fifth
Fi...
Fo...
First
Sec...
First
Second
F...
Third
First
Fourth
First
Second
First

locationd
mach
aggregated
notifyd
Graphasaurus 2
SpringBoard
wifid
backboardd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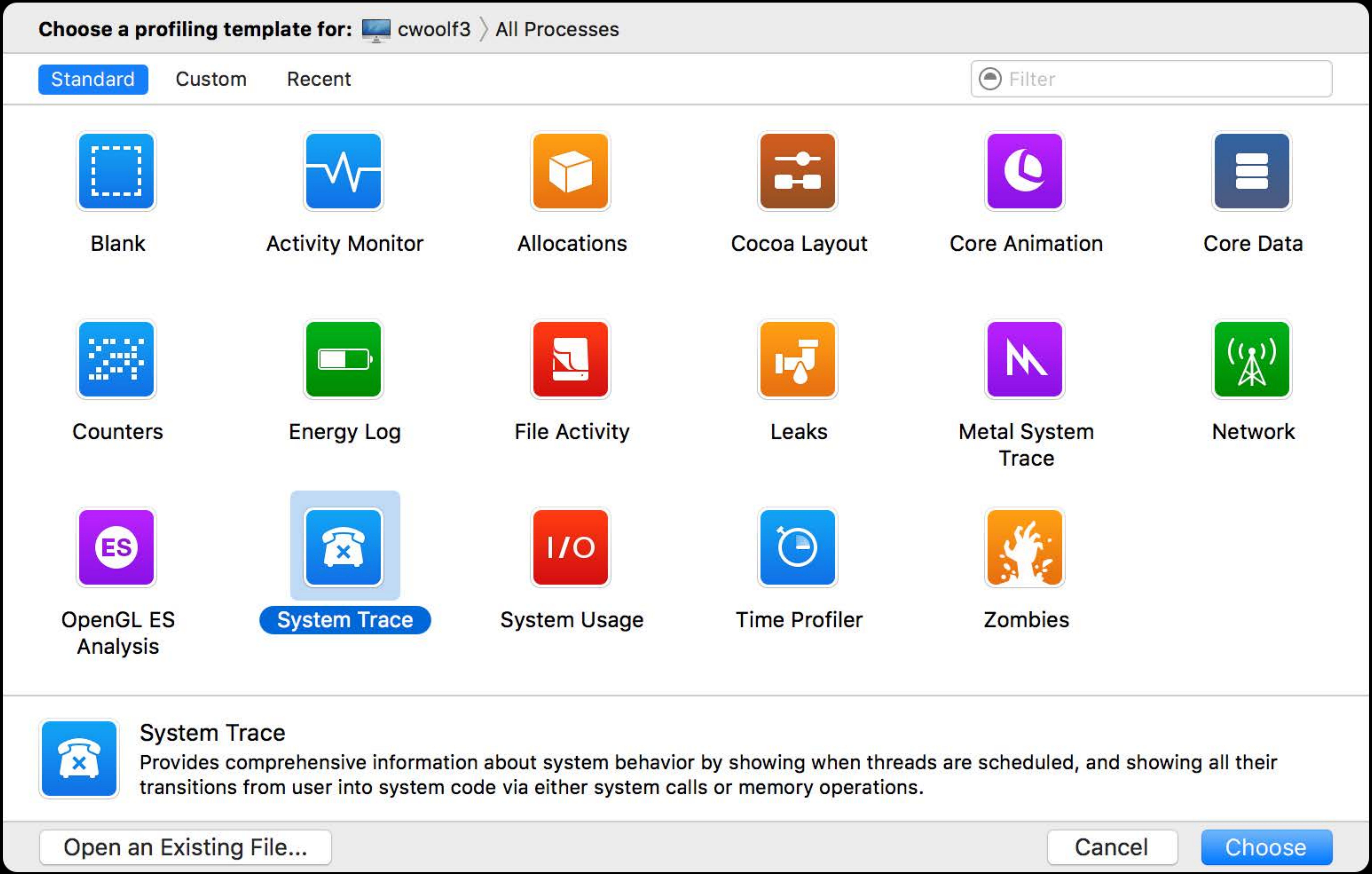
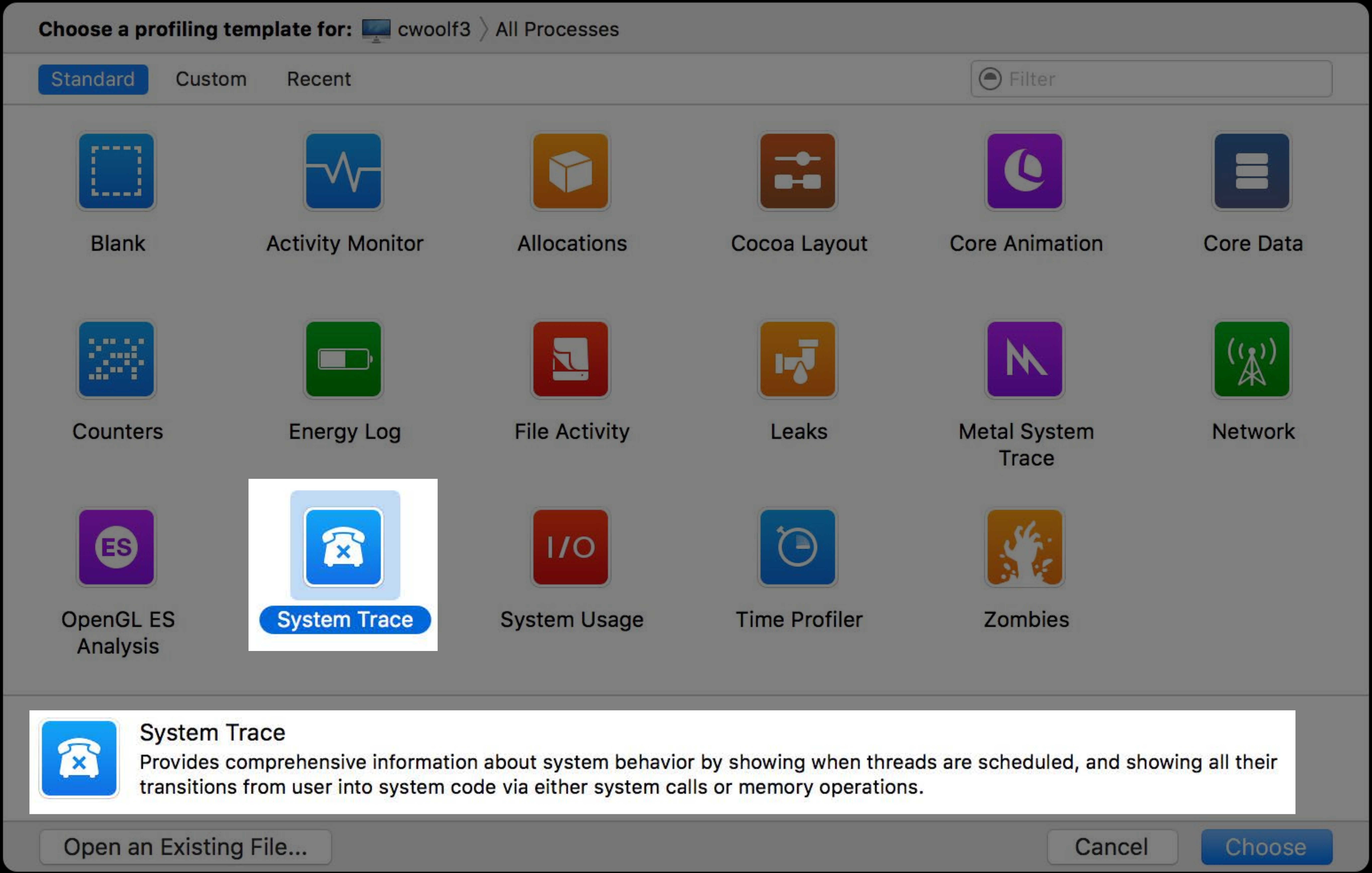
Fourth
First
Second
First



System Trace

Provides comprehensive information about system behavior by showing when threads are scheduled, and showing all their transitions from user into system code via either system calls or memory operations.



System Trace
Provides comprehensive information about system behavior by showing when threads are scheduled, and showing all their transitions from user into system code via either system calls or memory operations.

System Trace

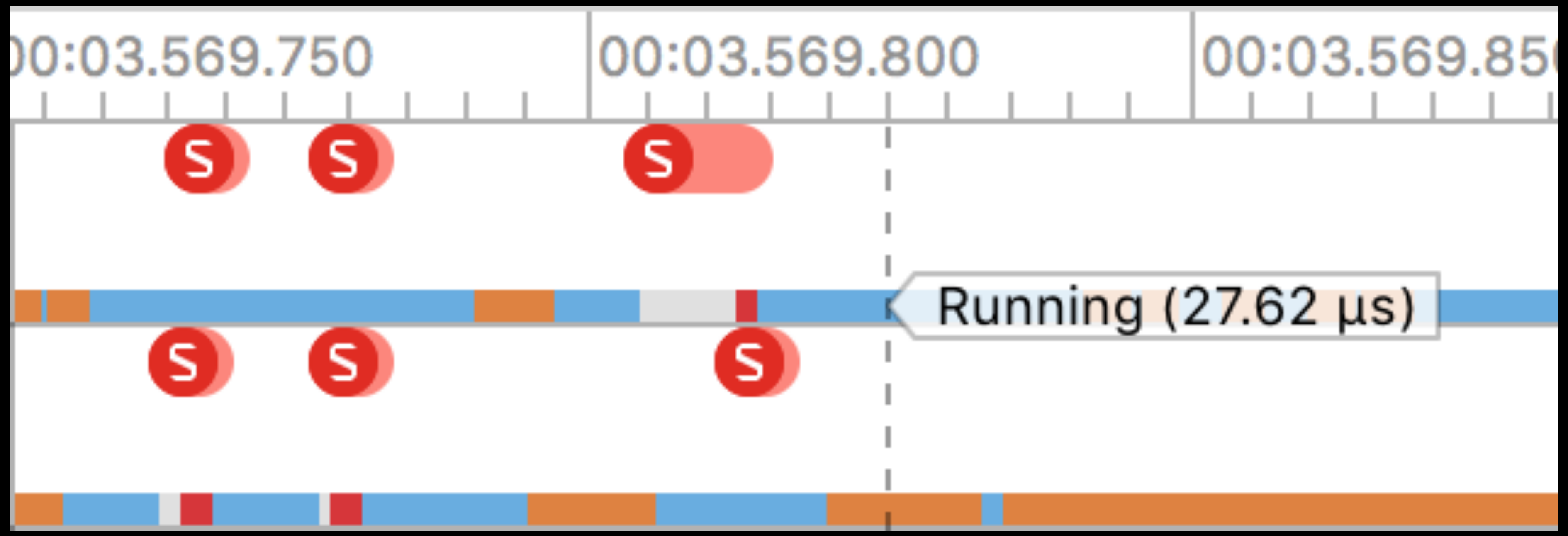
System Trace

Records a kernel trace

System Trace

Records a kernel trace

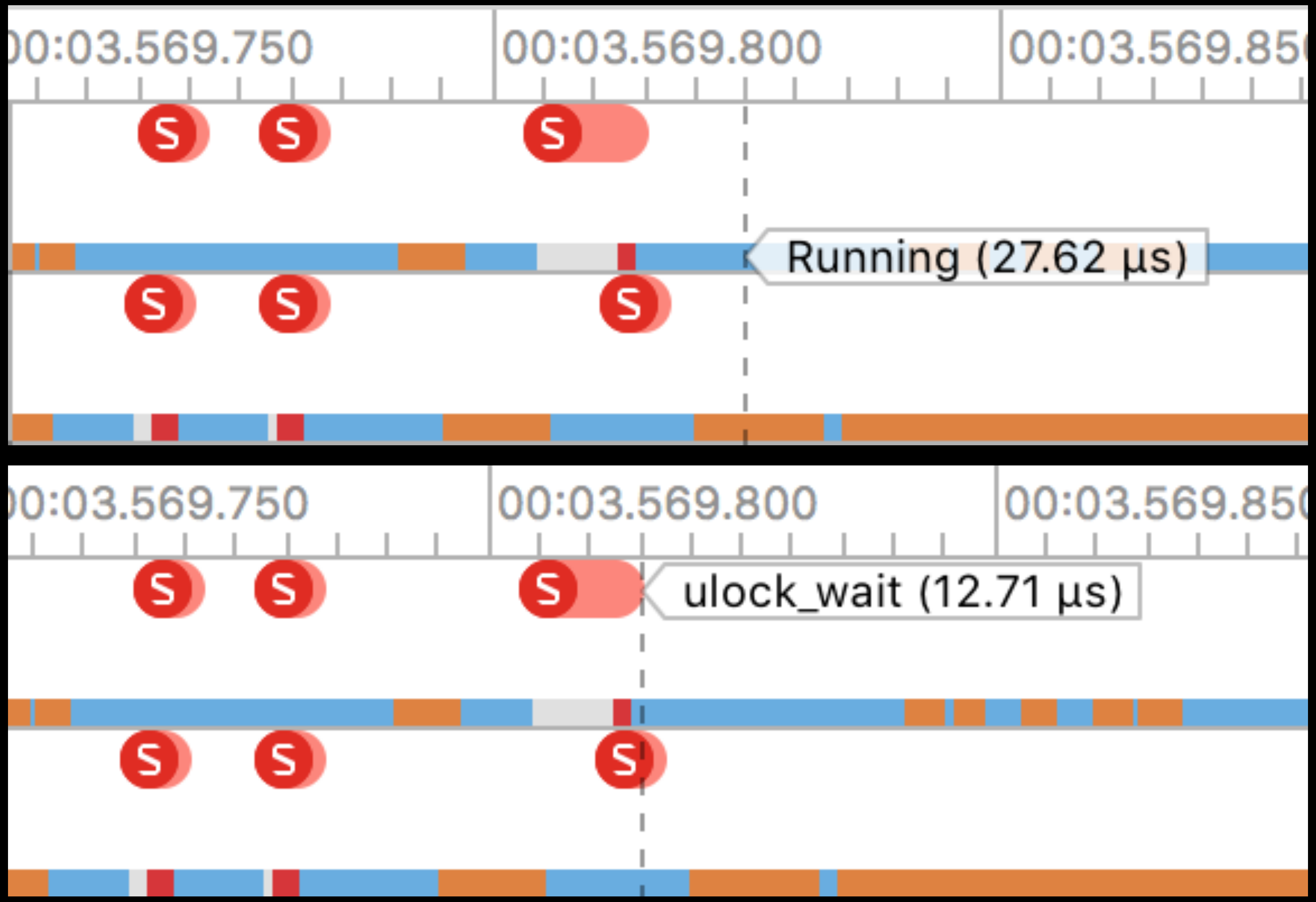
- Scheduling activity



System Trace

Records a kernel trace

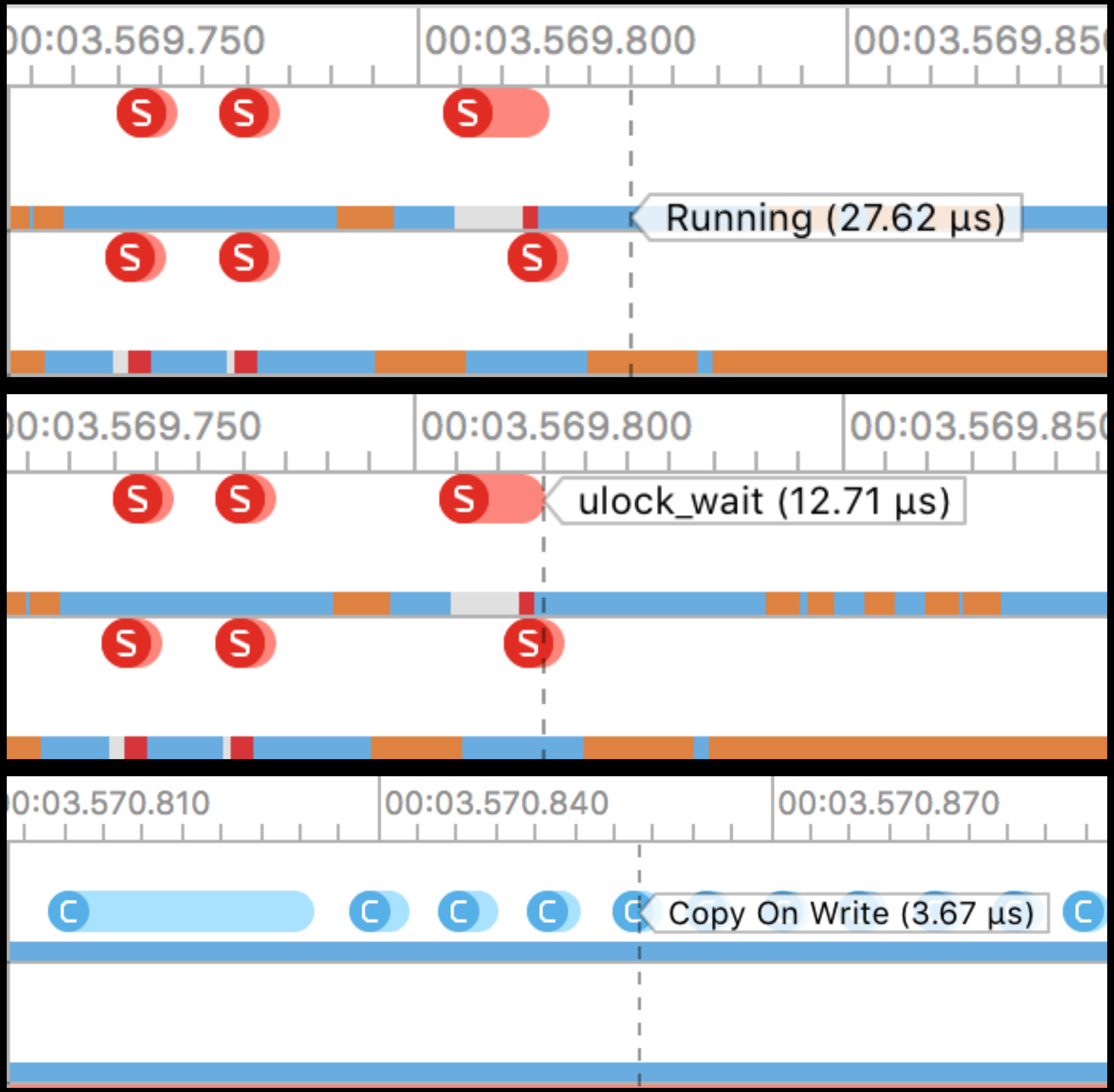
- Scheduling activity
- System calls



System Trace

Records a kernel trace

- Scheduling activity
- System calls
- Virtual memory operations



System Trace

Records a kernel trace

- Scheduling activity
- System calls
- Virtual memory operations

System Trace

NEW

Records a kernel trace

- Scheduling activity
- System calls
- Virtual memory operations

Windowed Mode in Instruments 8

System Trace

NEW

Records a kernel trace

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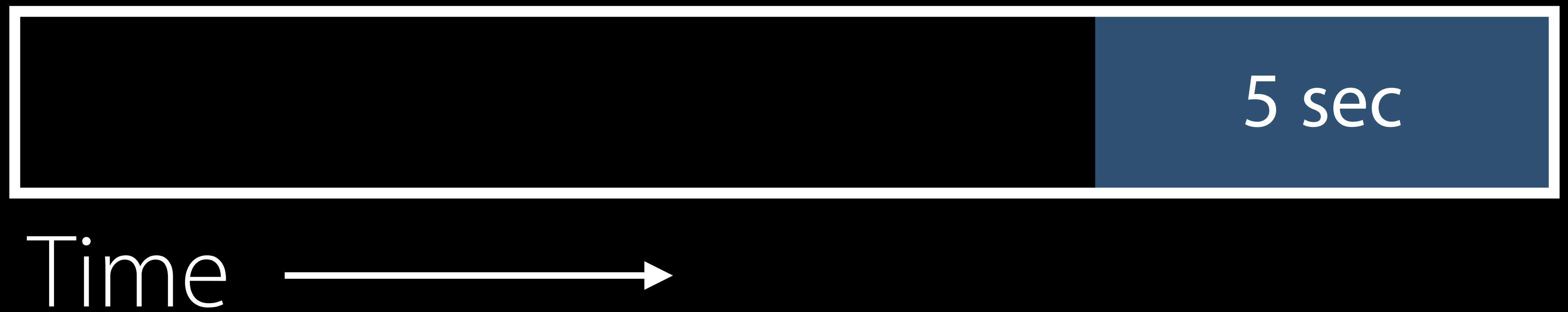
- System calls
- Virtual memory operations

Windowed Mode in Instruments 8

- Keeps last ~5 sec of data



System Trace

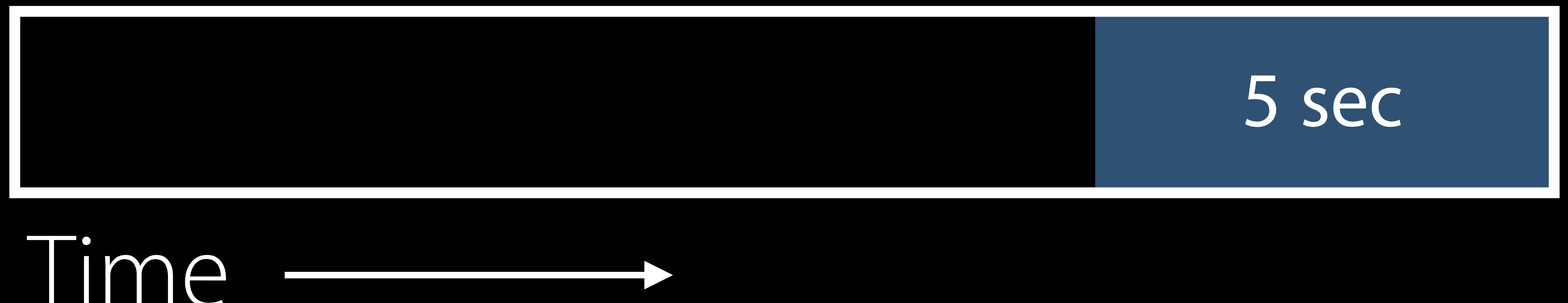
NEW

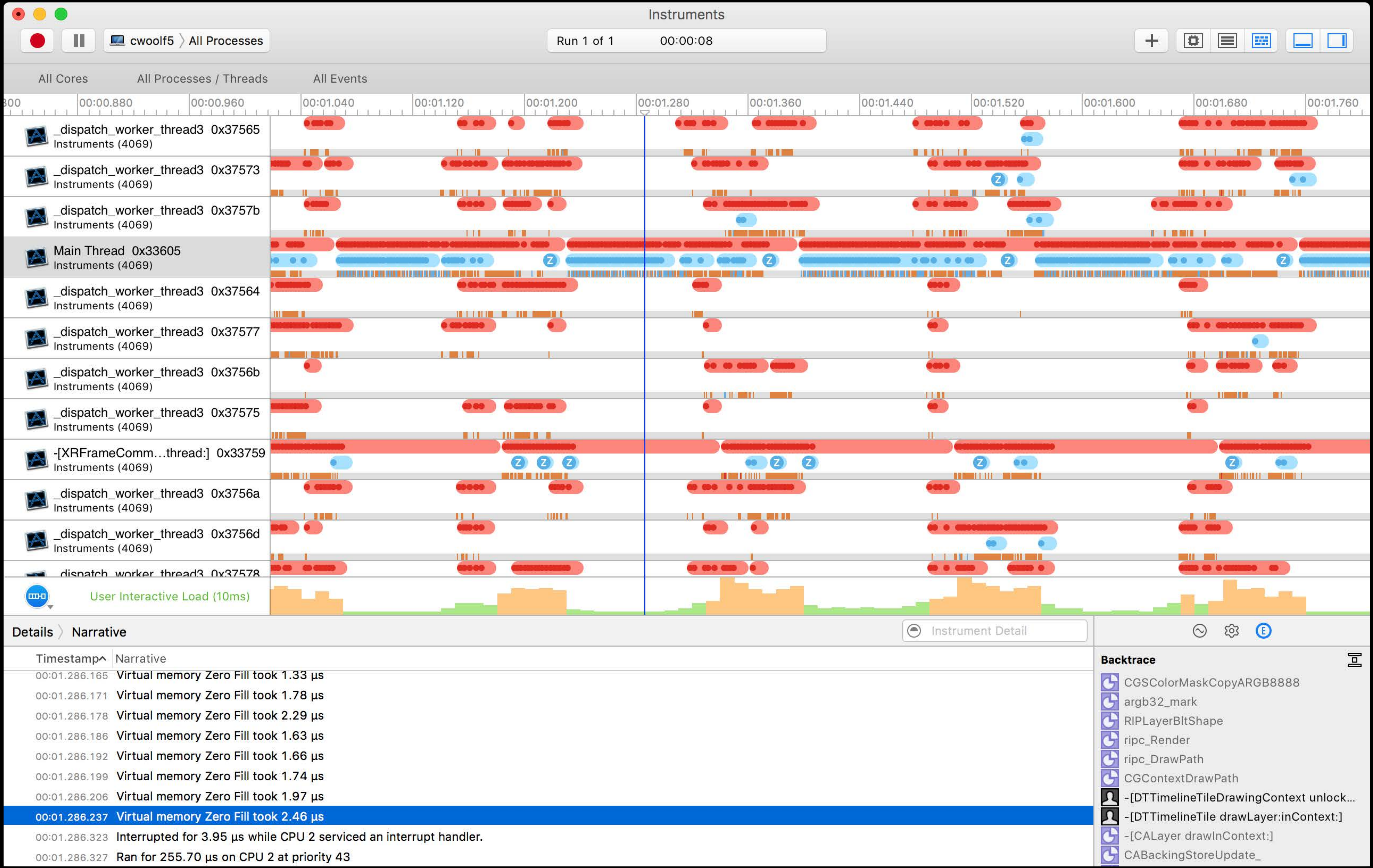
Records a kernel trace

- Scheduling activity
- System calls
- Virtual memory operations

Windowed Mode in Instruments 8

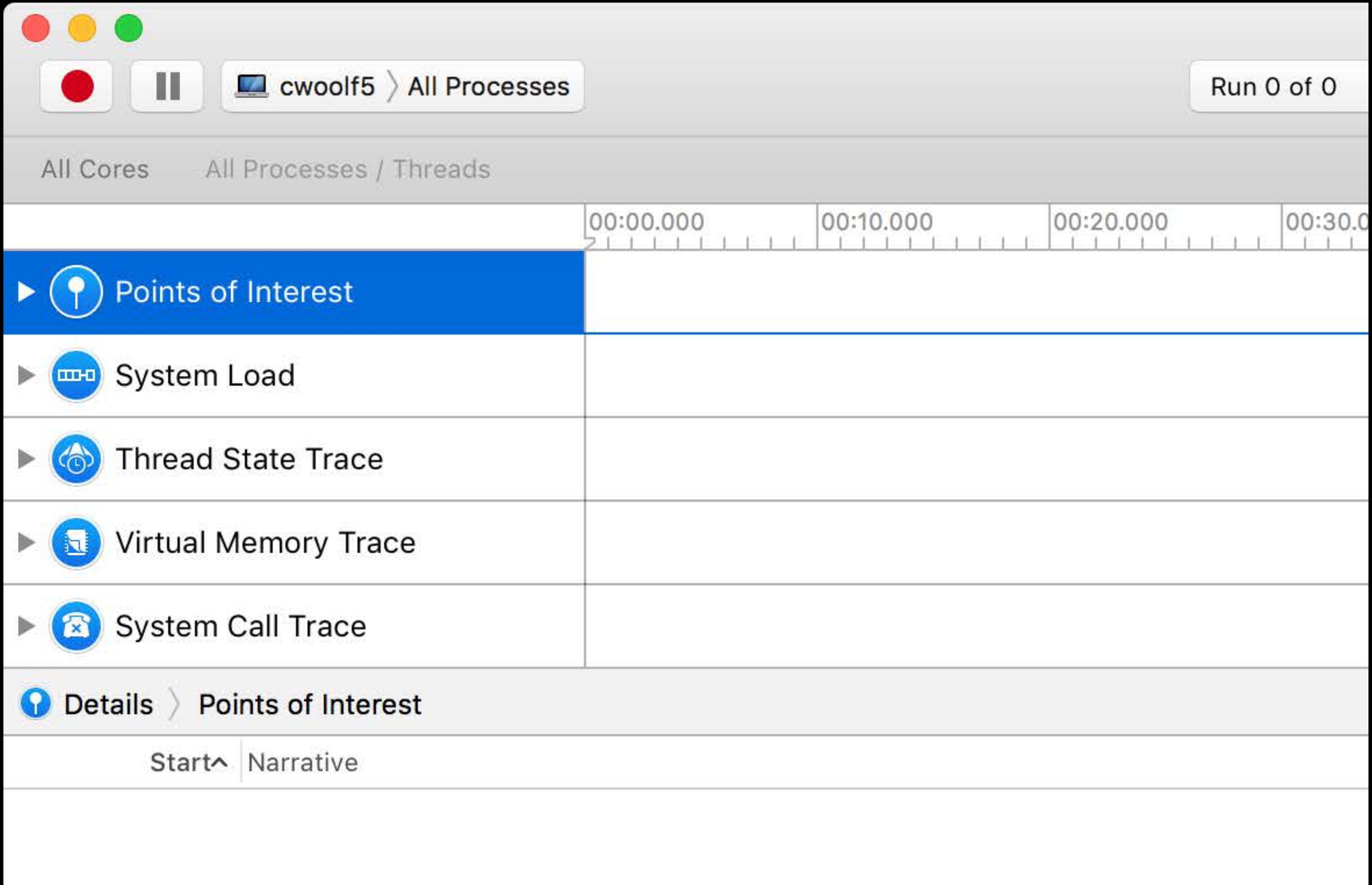
- Keeps last ~5 sec of data
- Gives you more time to reproduce




Instruments
cwoolf5 〉 All Processes
Run 1 of 1 00:00:08
All Cores
All Processes / Threads
All Events
_dispatch_worker_thread3 0x37565 Instruments (4069)
_dispatch_worker_thread3 0x37573 Instruments (4069)
_dispatch_worker_thread3 0x3757b Instruments (4069)
Main Thread 0x33605 Instruments (4069)
_dispatch_worker_thread3 0x37564 Instruments (4069)
_dispatch_worker_thread3 0x37577 Instruments (4069)
_dispatch_worker_thread3 0x3756b Instruments (4069)
_dispatch_worker_thread3 0x37575 Instruments (4069)
-[XRFrameComm…thread:] 0x33759 Instruments (4069)
_dispatch_worker_thread3 0x3756a Instruments (4069)
_dispatch_worker_thread3 0x3756d Instruments (4069)
_dispatch_worker_thread3 0x37578
User Interactive Load (10ms)
Details 〉 Narrative
Instrument Detail
Backtrace

Timestamp	Narrative
00:01.286.165	Virtual memory Zero Fill took 1.33 µs
00:01.286.171	Virtual memory Zero Fill took 1.78 µs
00:01.286.178	Virtual memory Zero Fill took 2.29 µs
00:01.286.186	Virtual memory Zero Fill took 1.63 µs
00:01.286.192	Virtual memory Zero Fill took 1.66 µs
00:01.286.199	Virtual memory Zero Fill took 1.74 µs
00:01.286.206	Virtual memory Zero Fill took 1.97 µs
00:01.286.237	Virtual memory Zero Fill took 2.46 µs
00:01.286.323	Interrupted for 3.95 µs while CPU 2 serviced an interrupt handler.
00:01.286.327	Ran for 255.70 µs on CPU 2 at priority 43

```
CGSColorMaskCopyARGB8888
argb32_mark
RIPLayerBltShape
ripc_Render
ripc_DrawPath
CGContextDrawPath
-[DTTimelineTileDrawingContext unlock...
-[DTTimelineTile drawLayer:inContext:]
-[CALayer drawInContext:]
CABackingStoreUpdate_
```



cwoolf5 〉 All Processes

Run 0 of 0

All Cores   All Processes / Threads

00:00.000 | 00:10.000 | 00:20.000 | 00:30.0

- Points of Interest
- System Load
- Thread State Trace
- Virtual Memory Trace
- System Call Trace

Details 〉 Points of Interest

Start	Narrative

Points of Interest

NEW

Points of Interest

NEW

You tell Instruments what's interesting

Points of Interest

NEW

You tell Instruments what's interesting

Signposts

Points of Interest

NEW

You tell Instruments what’s interesting

Signposts

Classic:

```
syscall(SYS_kdebug_trace, ...)
```

Points of Interest

NEW

You tell Instruments what's interesting

Signposts

Classic:

```
syscall(SYS_kdebug_trace, ...)
```

iOS 10 / macOS Sierra / tvOS 10/ watchOS 3:

```
kdebug_signpost
kdebug_signpost_start
kdebug_signpost_end
```

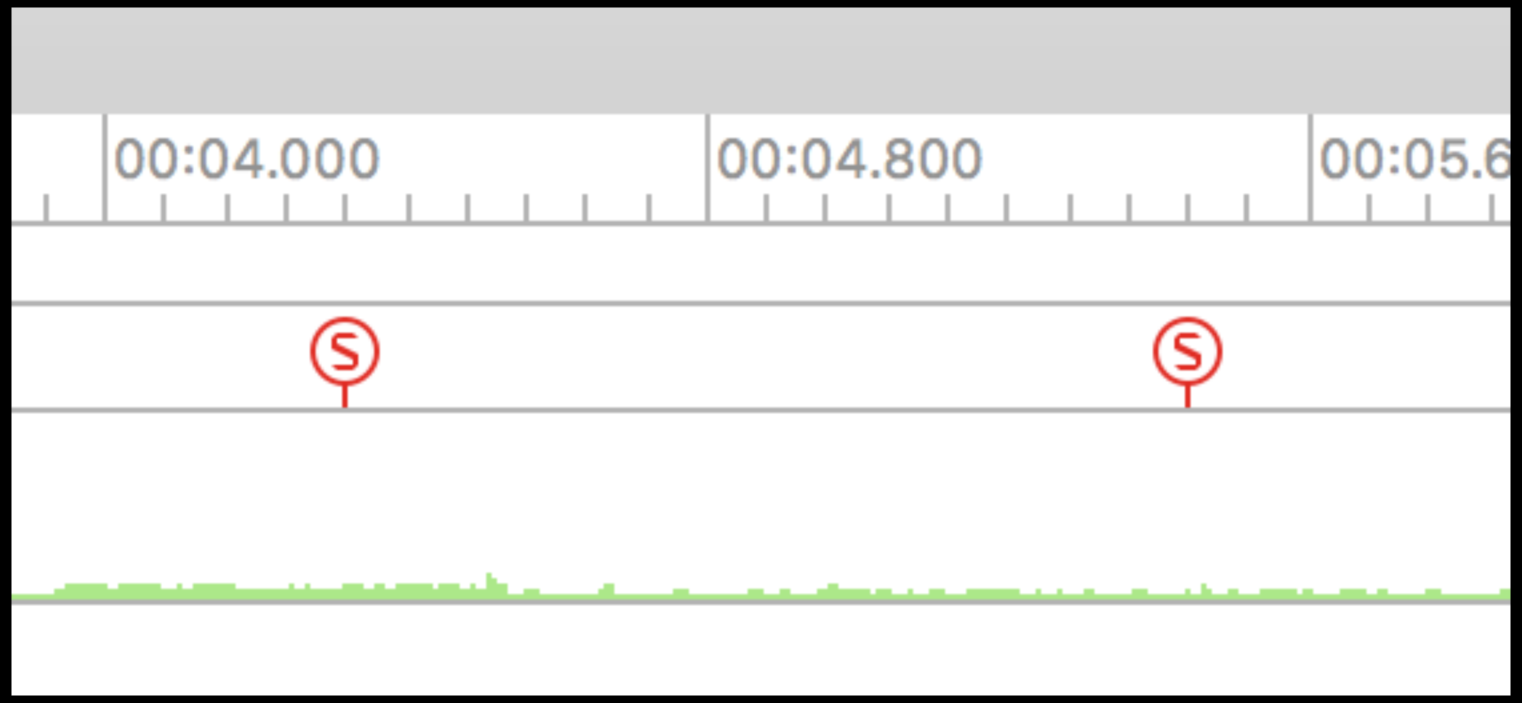
Points of Interest

Events

Indicate an interesting point in time

Arbitrary code (0 - 16383)

4 uintptr_t arguments



```
// Point of Interest
func mouseDown(_ event: NSEvent) {
    // Emit a signpost for Instruments
    kdebug_signpost(5, 0, 0, 0, 0)


}
```

Points of Interest

Events

Indicate an interesting point in time

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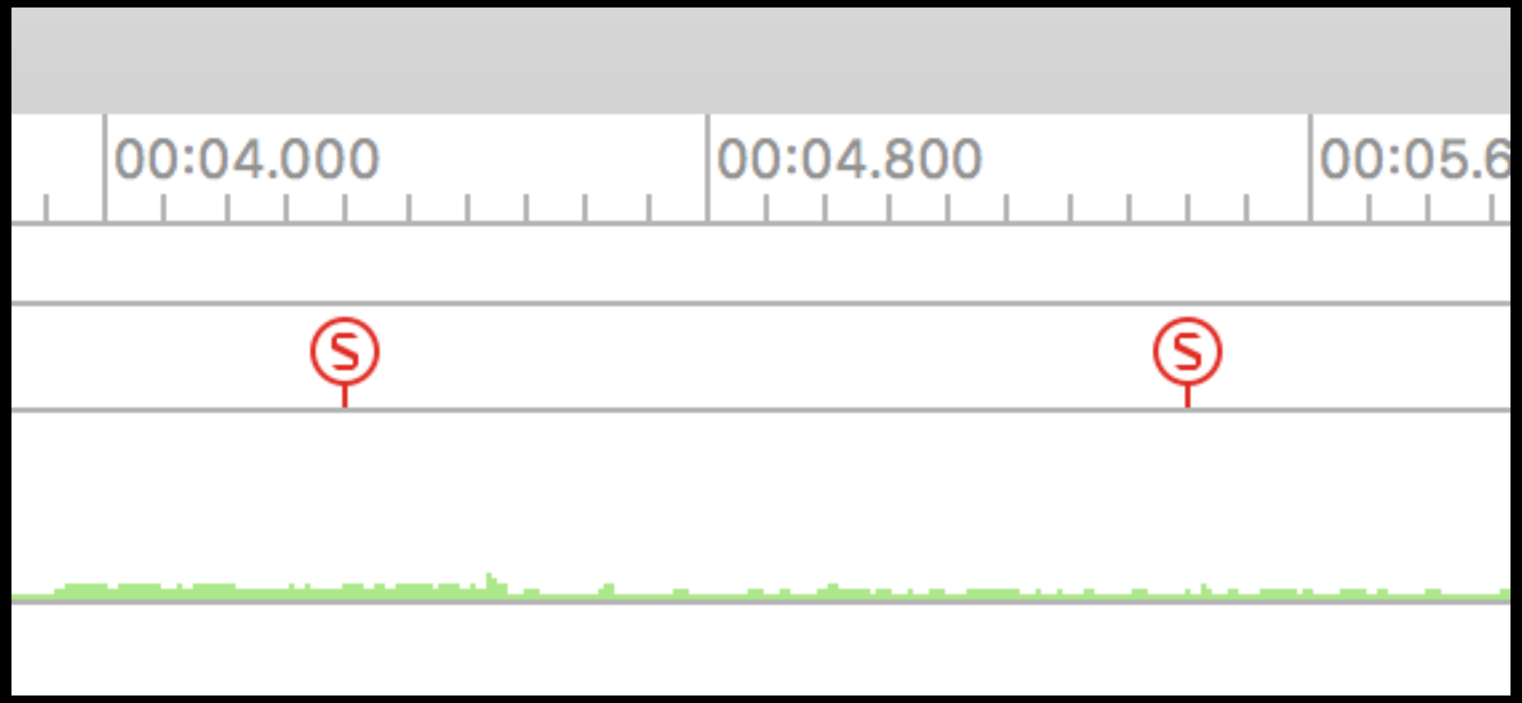

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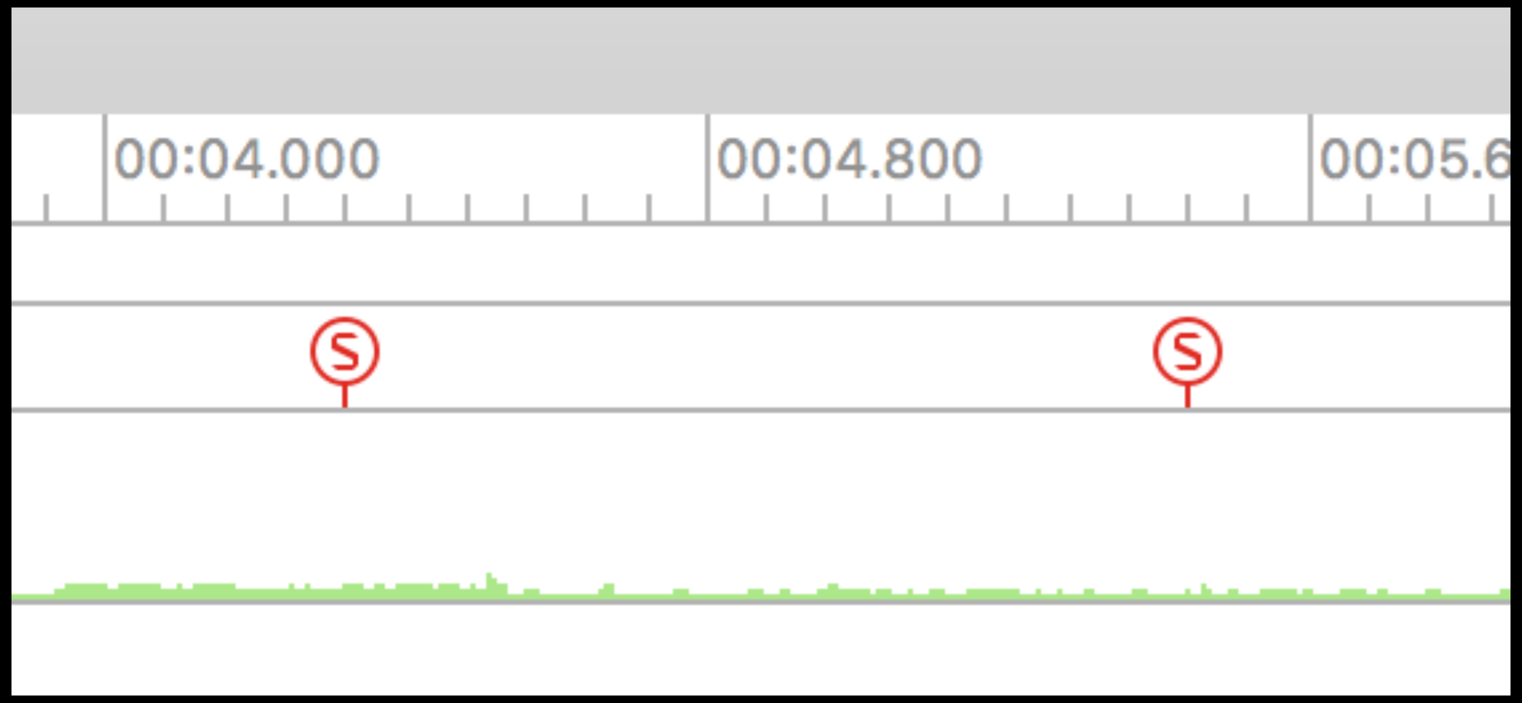

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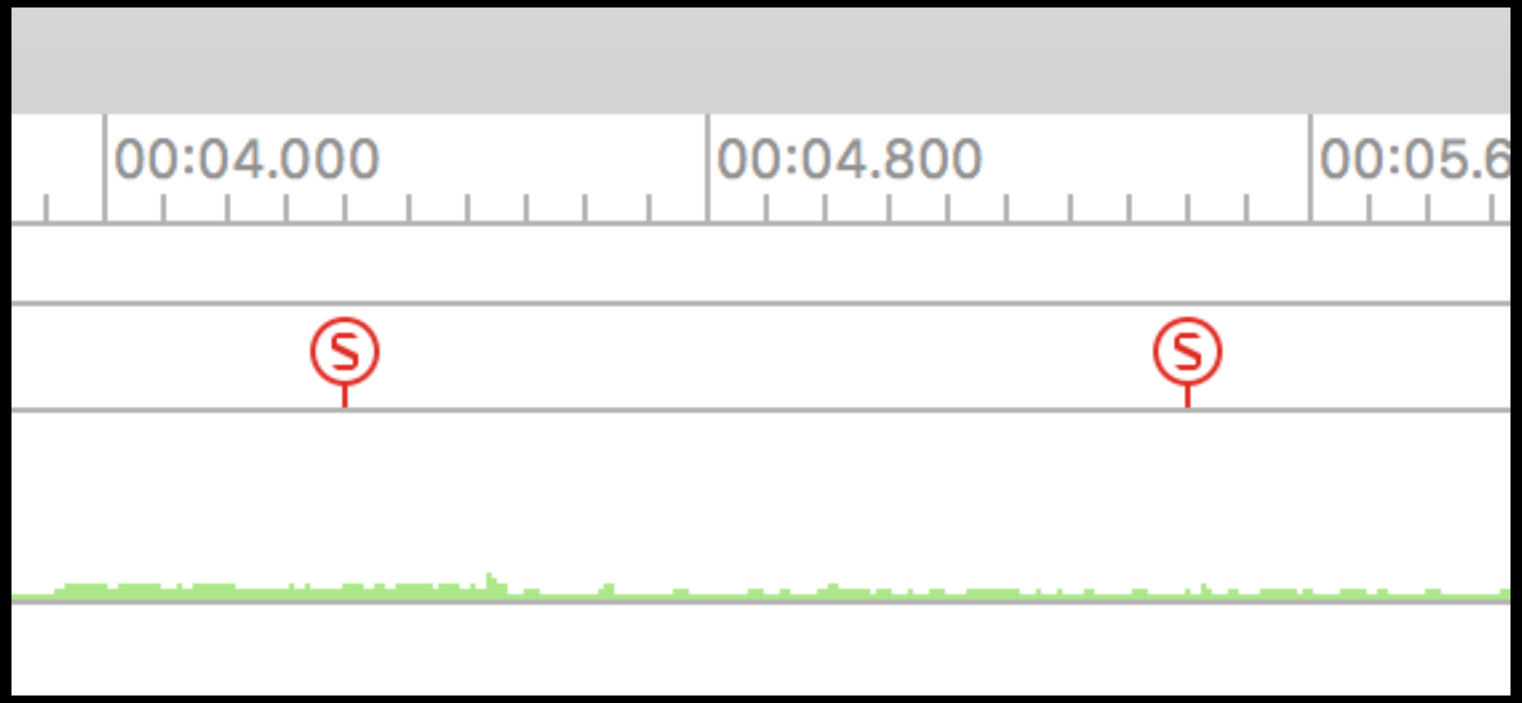

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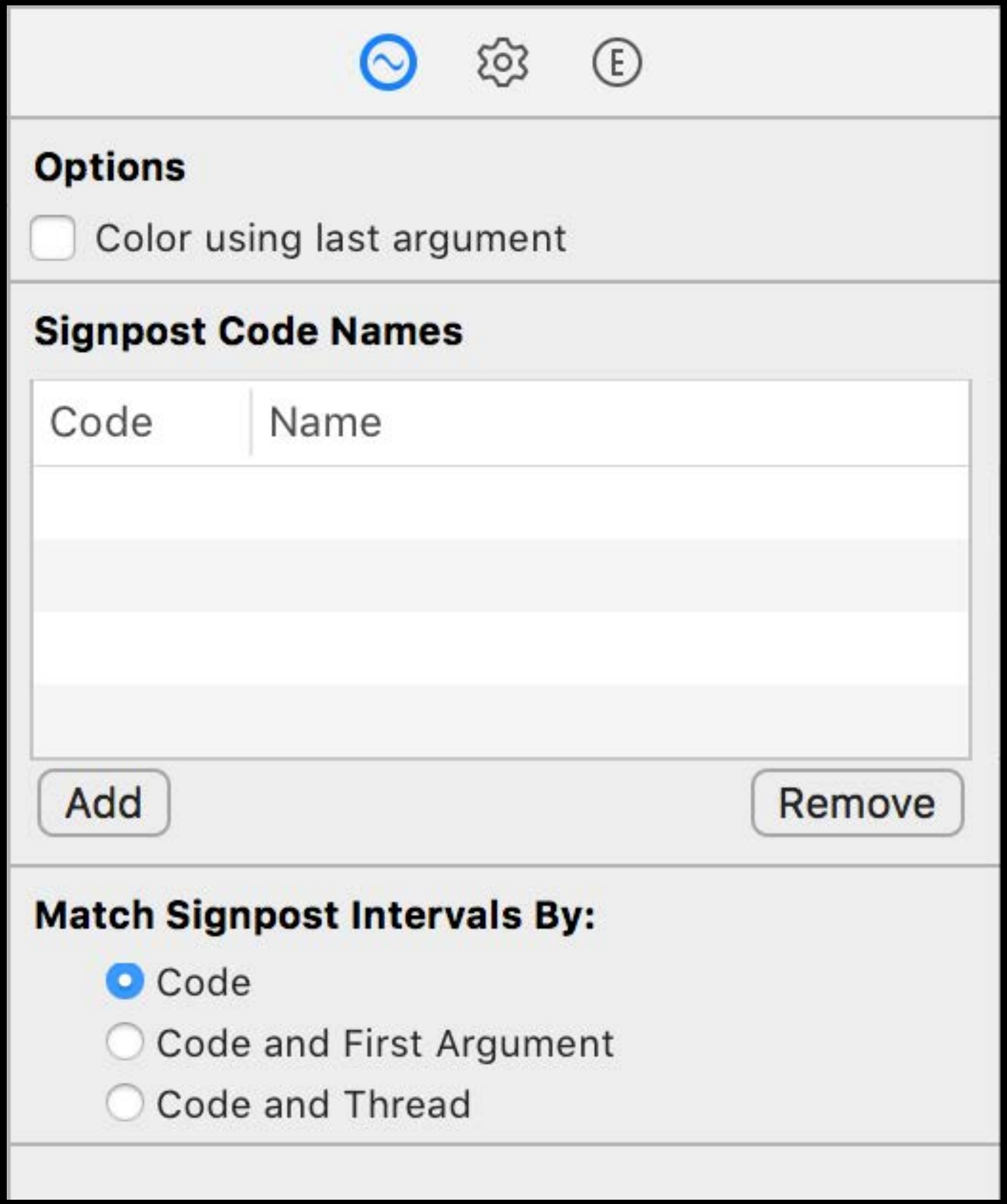
Points of Interest

Named codes

NEW



Options

☐ Color using last argument

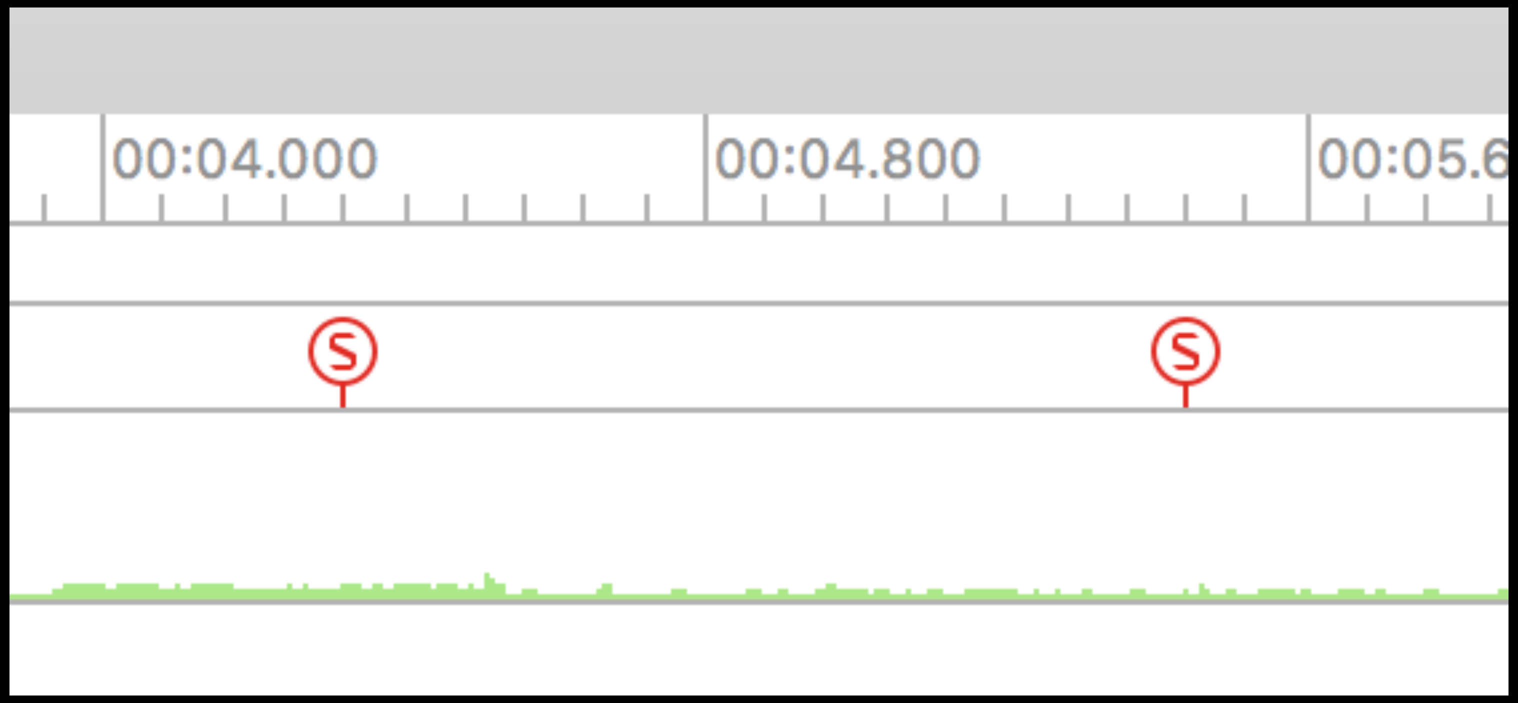
Signpost Code Names

Code	Name

Add   Remove

Match Signpost Intervals By:

[✓ Code]
Code and First Argument
Code and Thread



Points of Interest

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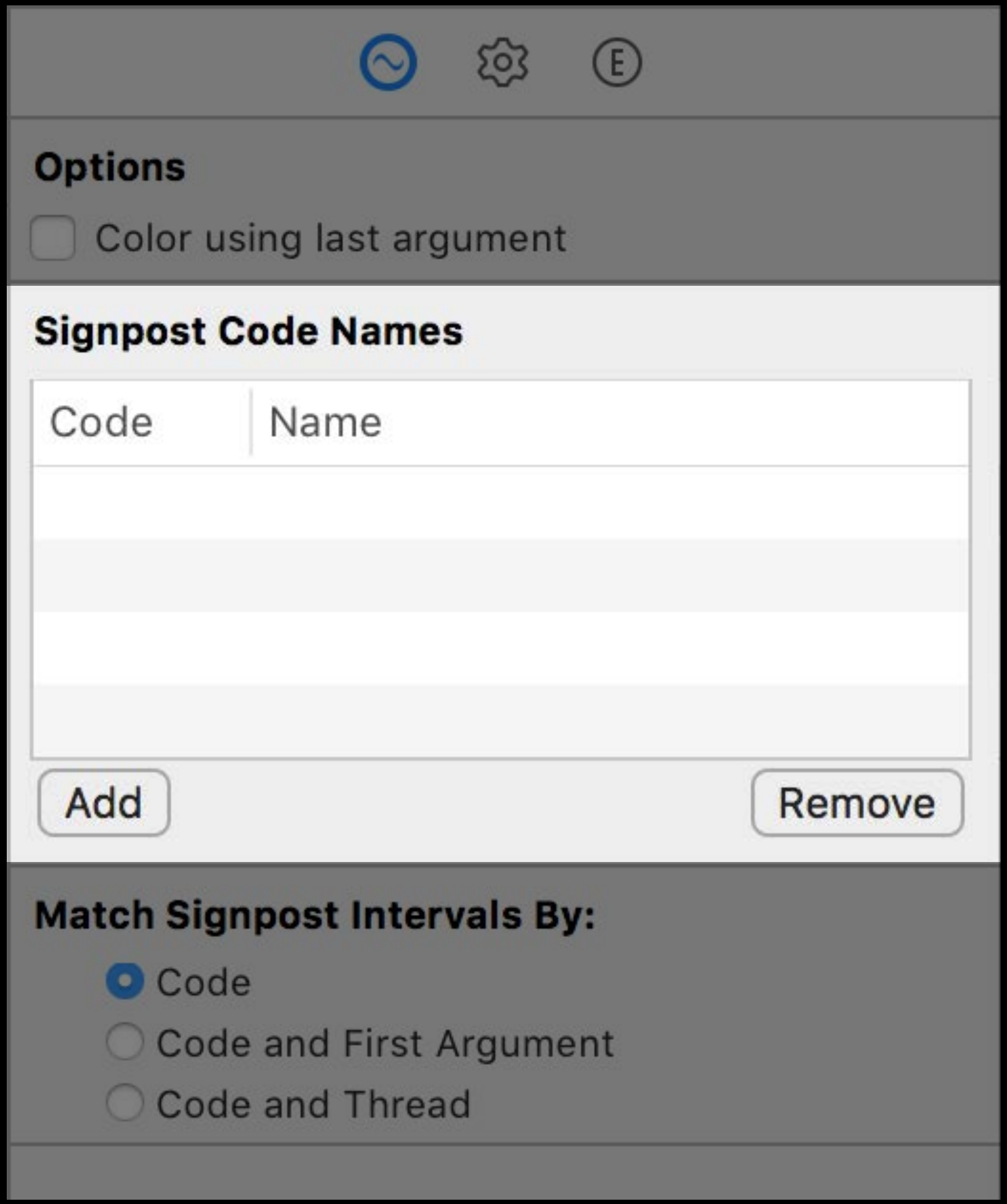

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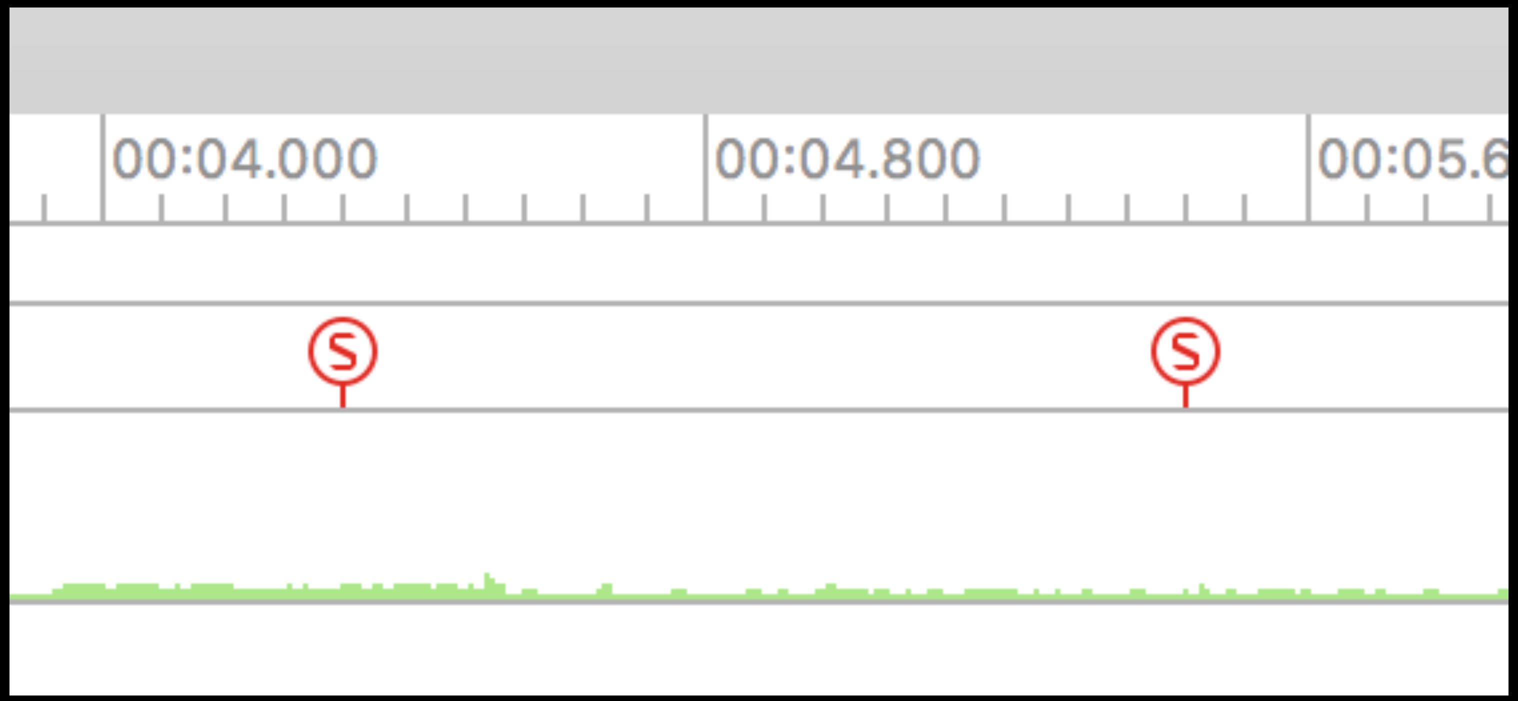

Points of Interest

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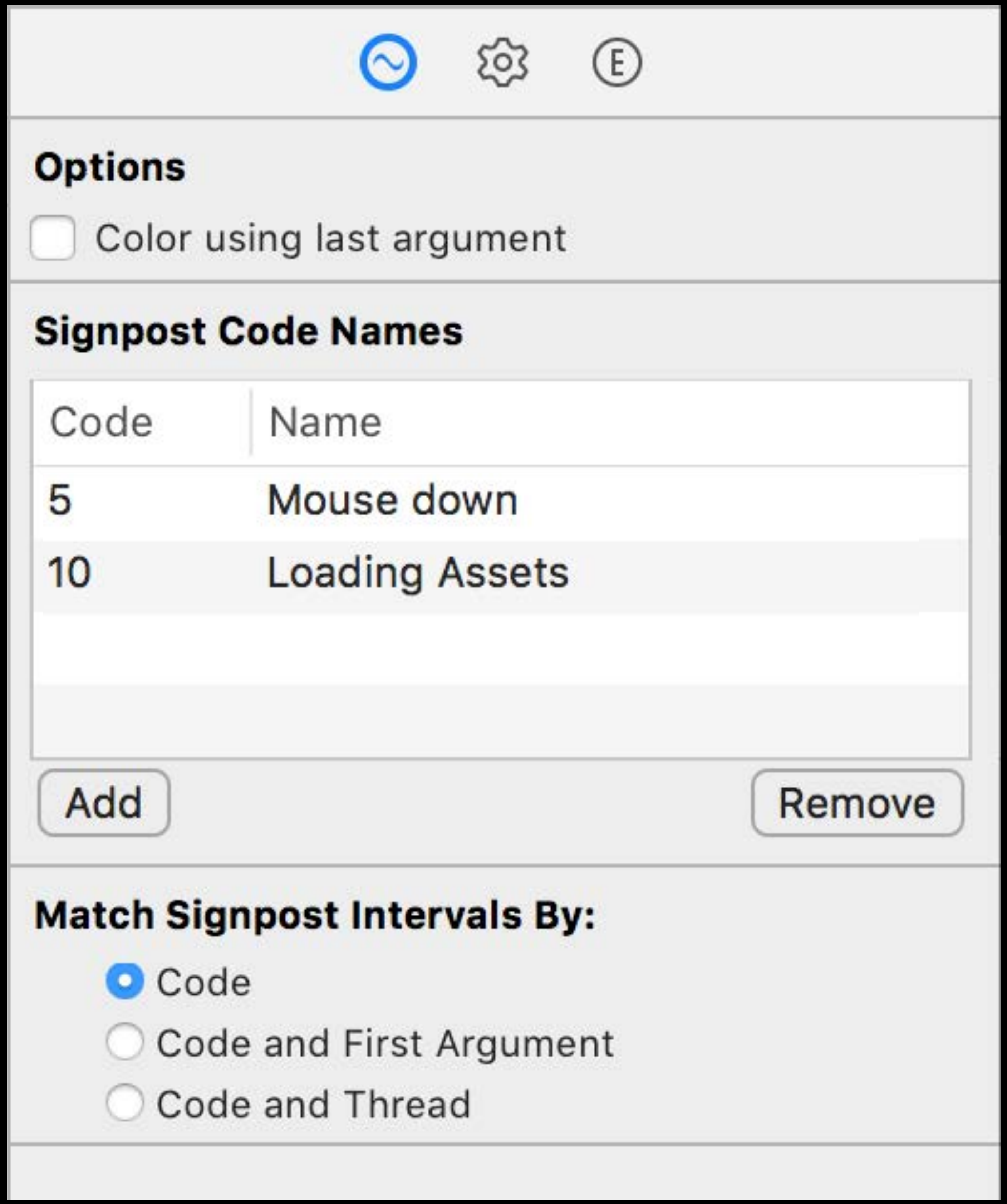

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10	Loading Assets

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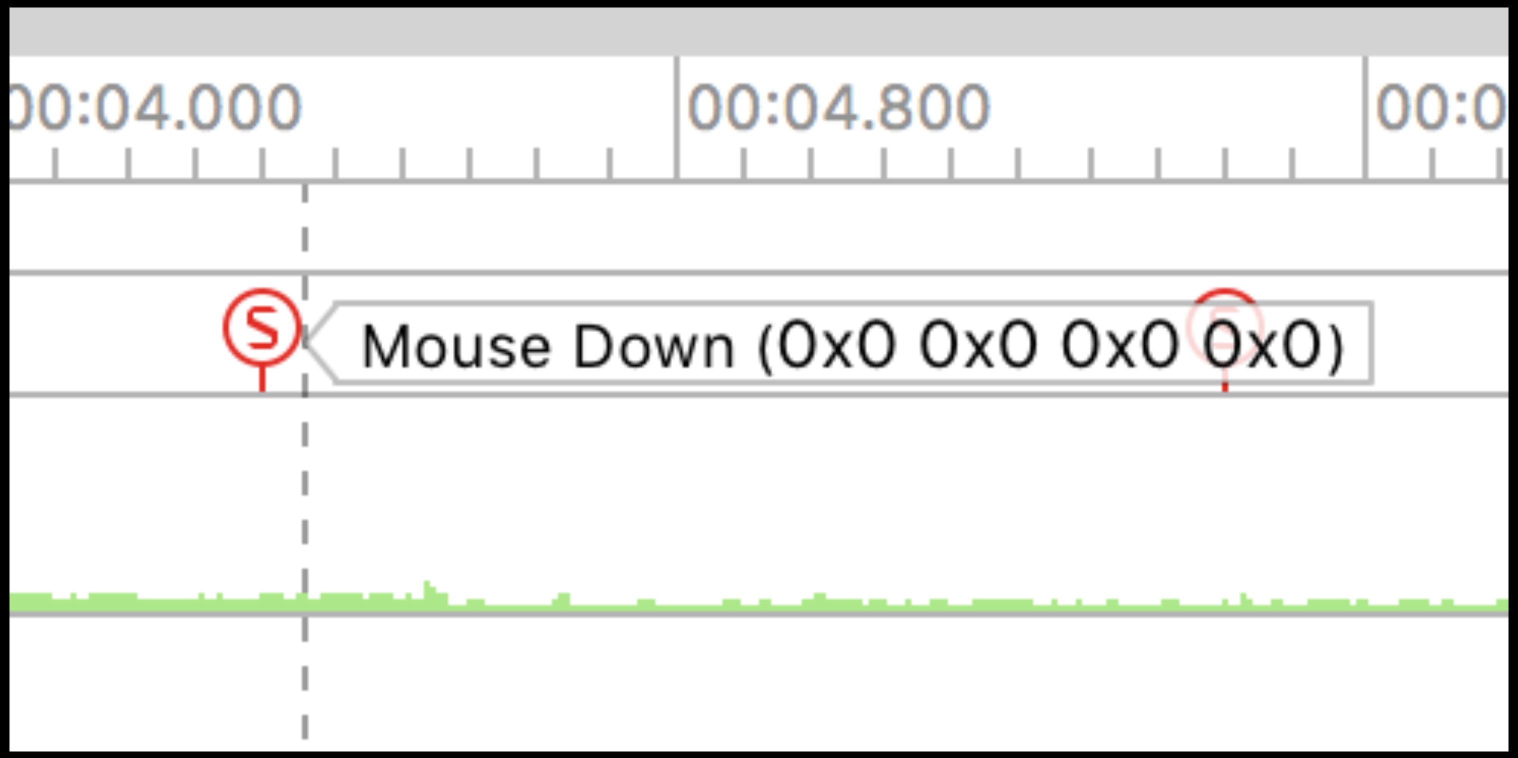


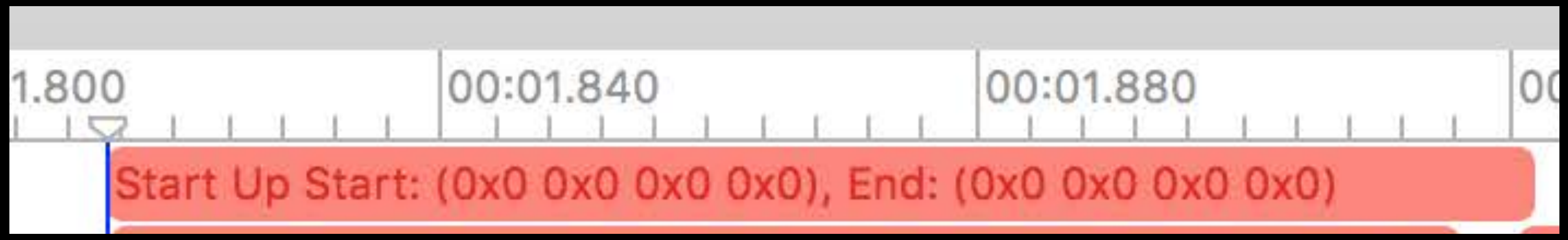
Regions of Interest

States or actions

Indicate an interesting range of time

Arbitrary code

Four integer/pointer arguments at start and end



Start Up Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0x0)

```
// Timing an activity (code 10 – "Start Up")
- (void)applicationDidFinishLaunching:(NSNotification *)aNotification
{
    kdebug_signpost_start(10, 0, 0, 0, 0);
    [self loadAssets];
    kdebug_signpost_end(10, 0, 0, 0, 0);
}
```

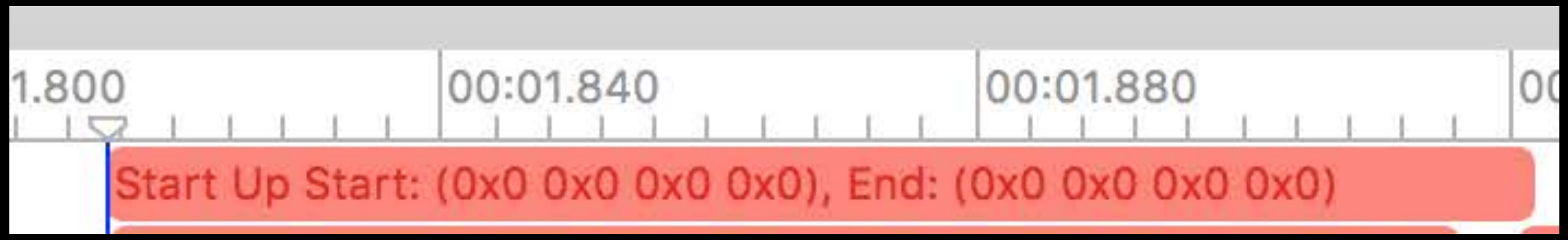
Regions of Interest

States or actions

Indicate an interesting range of time

Arbitrary code

Four integer/pointer arguments at start and end



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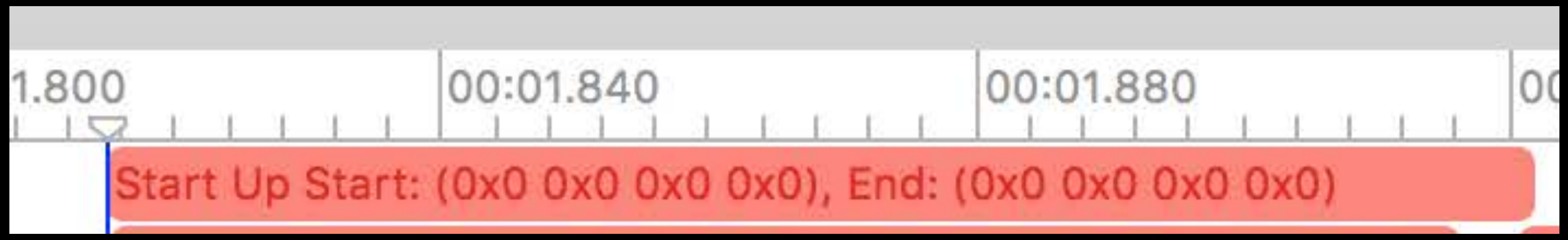

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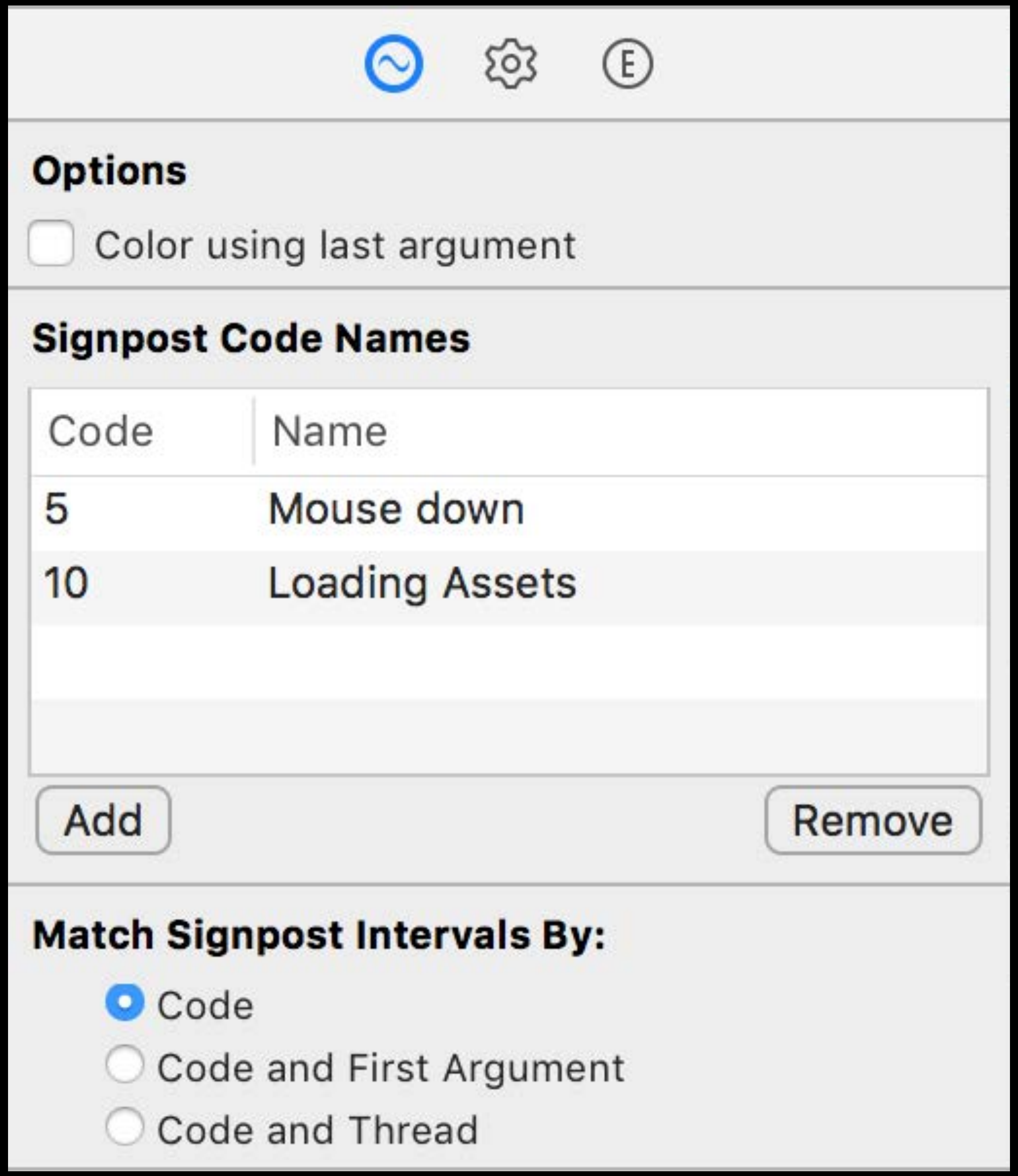

Options

☐ Color using last argument

Signpost Code Names

Code	Name
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10	Loading Assets

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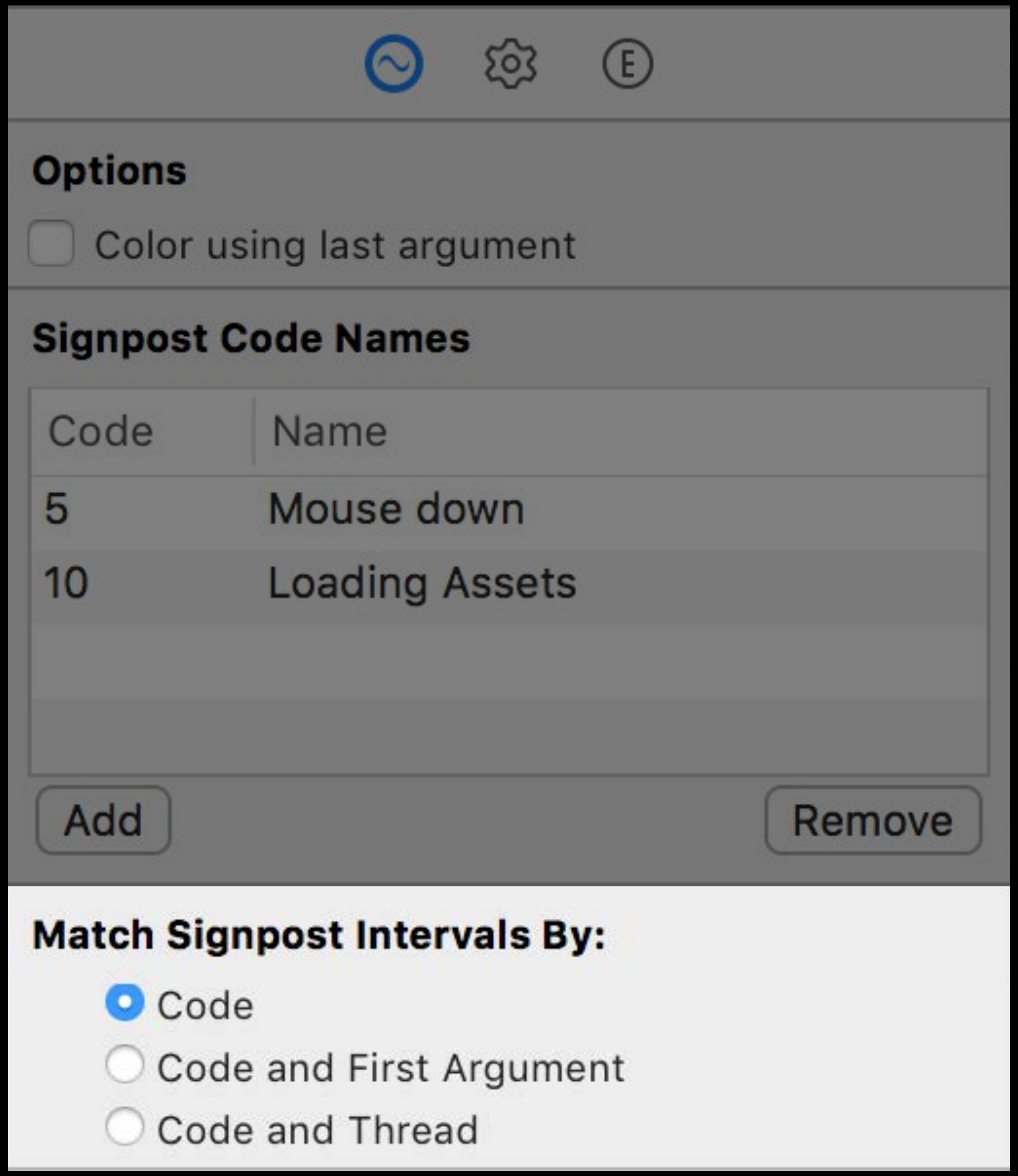
[✓ Code]
Code and First Argument
Code and Thread



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Match Signpost Intervals By:

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Code and First Argument
Code and Thread

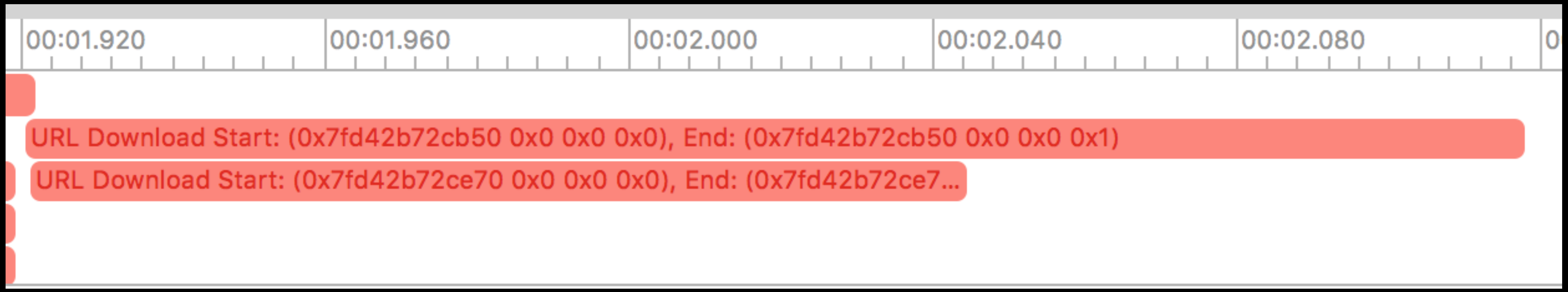
NEW

Points of Interest

Matching rule: Code and First Argument

Concurrent

Asynchronous



URL Download Start: (0x7fd42b72cb50 0x0 0x0 0x0), End: (0x7fd42b72cb50 0x0 0x0 0x1)
URL Download Start: (0x7fd42b72ce70 0x0 0x0 0x0), End: (0x7fd42b72ce7...

```
// Start the download (code 20 - "URL Download")
- (NSURLSessionDownloadTask *)startURLDownload: (NSURL *) url {
    NSURLSessionDownloadTask *dlTask = [_urlSession downloadTaskWithURL:url];
    kdebug_signpost_start(20, (uintptr_t)dlTask, 0, 0, 0);
    [dlTask resume];
    return dlTask;
}
- (void)URLSession:(NSURLSession *)session task:(NSURLSessionTask *)dlTask
                          didCompleteWithError:(nullable NSError *)error {
    kdebug_signpost_end(20, (uintptr_t)dlTask, 0, 0, 0);
}
```

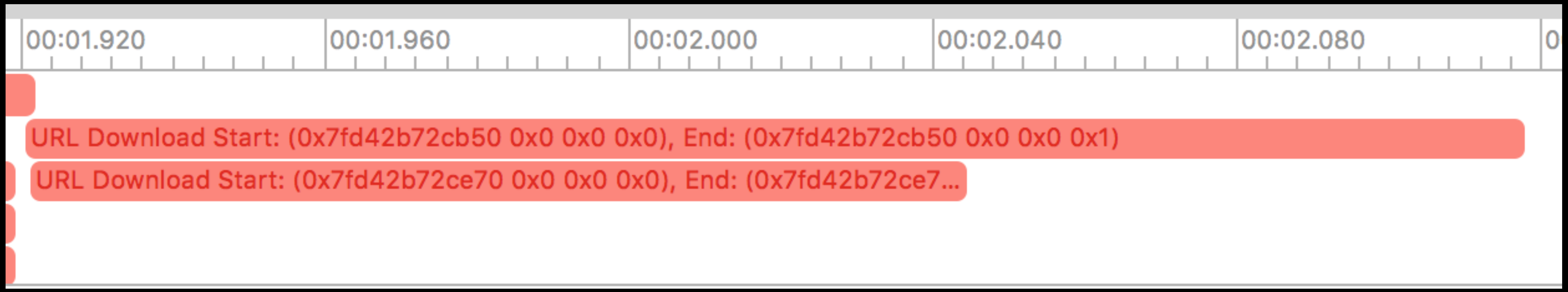
Points of Interest

NEW

Matching rule: Code and First Argument

Concurrent

Asynchronous



URL Download Start: (0x7fd42b72cb50 0x0 0x0 0x0), End: (0x7fd42b72cb50 0x0 0x0 0x1)
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    [dlTask resume];
    return dlTask;
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                           didCompleteWithError:(nullable NSError *)error {
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}
```

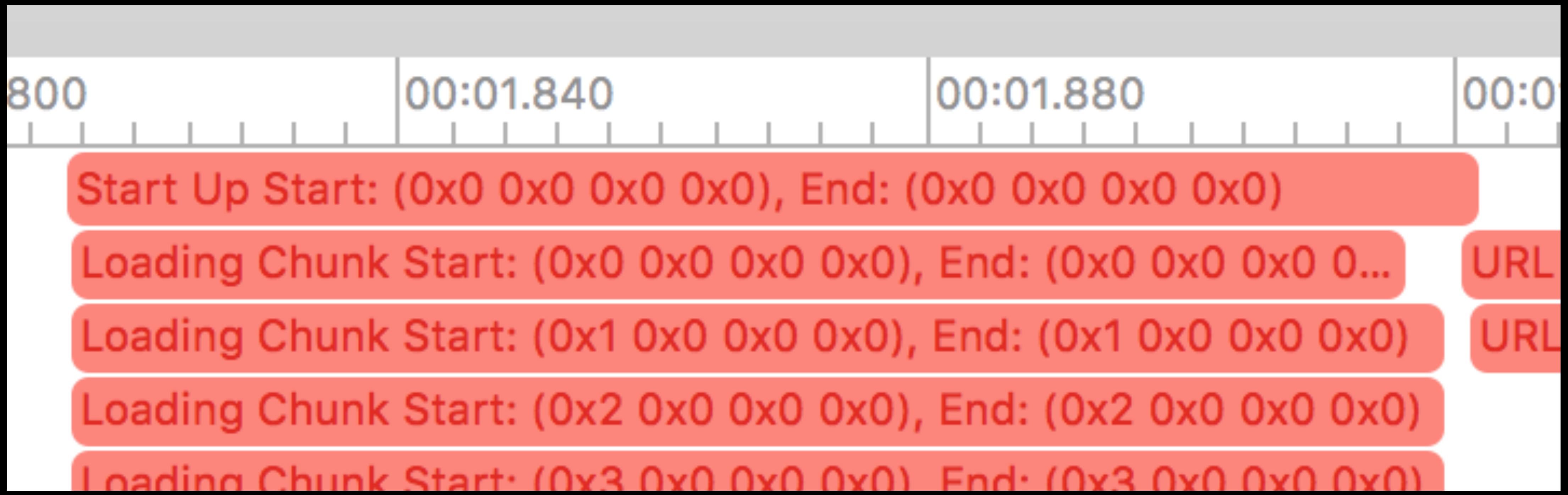
Points of Interest

Matching rule: Code and Thread

NEW

Concurrent

"Loop" timing



Start Up Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0x0)
Loading Chunk Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0...
URL
Loading Chunk Start: (0x1 0x0 0x0 0x0), End: (0x1 0x0 0x0 0x0)
URL
Loading Chunk Start: (0x2 0x0 0x0 0x0), End: (0x2 0x0 0x0 0x0)
Loading Chunk Start: (0x3 0x0 0x0 0x0), End: (0x3 0x0 0x0 0x0)

```
// Timing concurrent "loops" (code 30 - "Loading Chunk")
- (void)loadAssets {
    dispatch_apply(4, dispatch_get_global_queue(QOS_CLASS_USER_INITIATED, 0), ^(size_t i) {
        kdebug_signpost_start(30, 0, 0, 0, 0);
       _loadAssetChunk(i);
        kdebug_signpost_end(30, 0, 0, 0, 0);
    });
}
```

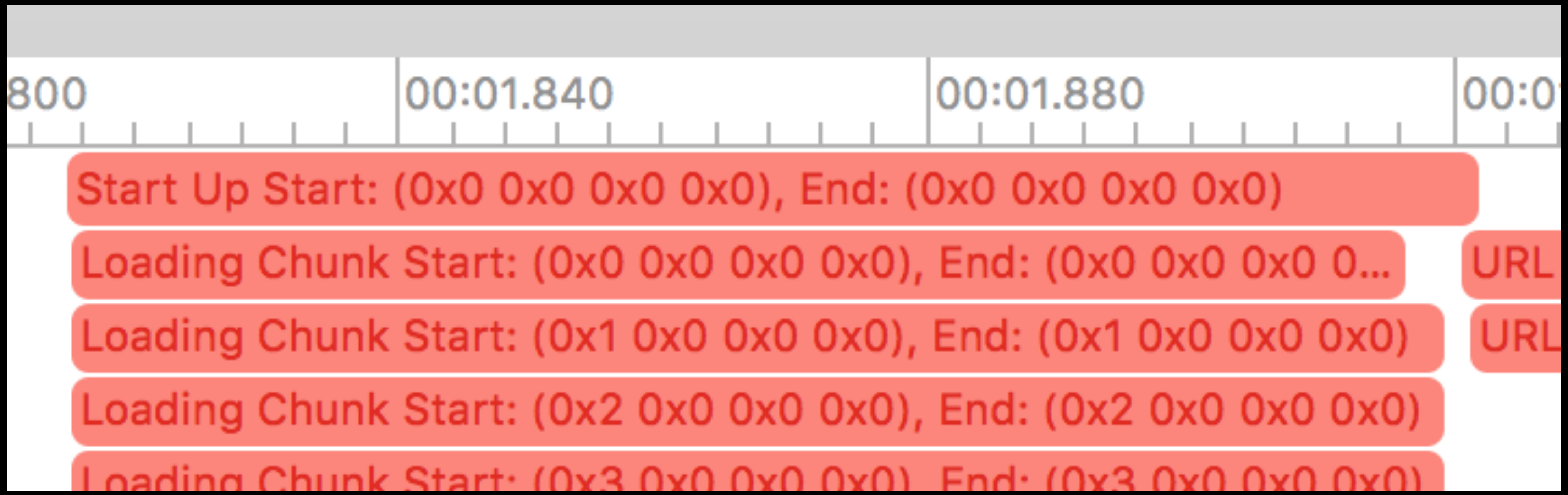
Points of Interest

Matching rule: Code and Thread

NEW

Concurrent

"Loop" timing


800 | 00:01.840 | 00:01.880 | 00:0

Start Up Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0x0)
Loading Chunk Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0...   URL
Loading Chunk Start: (0x1 0x0 0x0 0x0), End: (0x1 0x0 0x0 0x0)   URL
Loading Chunk Start: (0x2 0x0 0x0 0x0), End: (0x2 0x0 0x0 0x0)
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Points of Interest

Matching rule: Code and Thread

NEW

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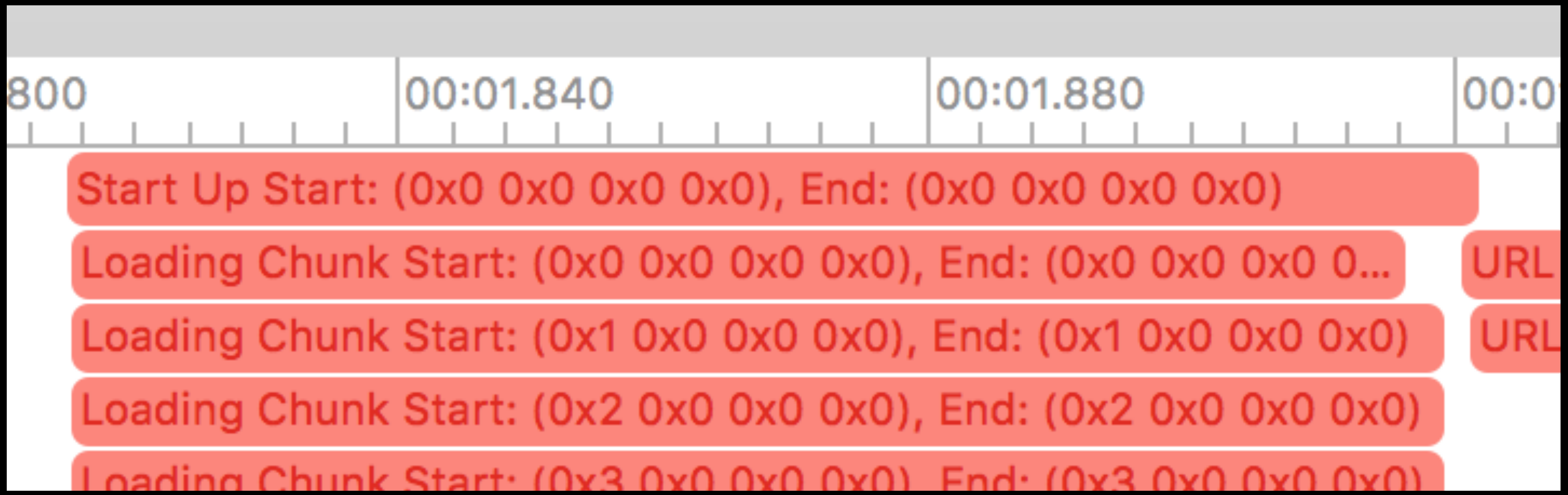

Start Up Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0x0)
Loading Chunk Start: (0x0 0x0 0x0 0x0), End: (0x0 0x0 0x0 0...
URL
Loading Chunk Start: (0x1 0x0 0x0 0x0), End: (0x1 0x0 0x0 0x0)
URL
Loading Chunk Start: (0x2 0x0 0x0 0x0), End: (0x2 0x0 0x0 0x0)
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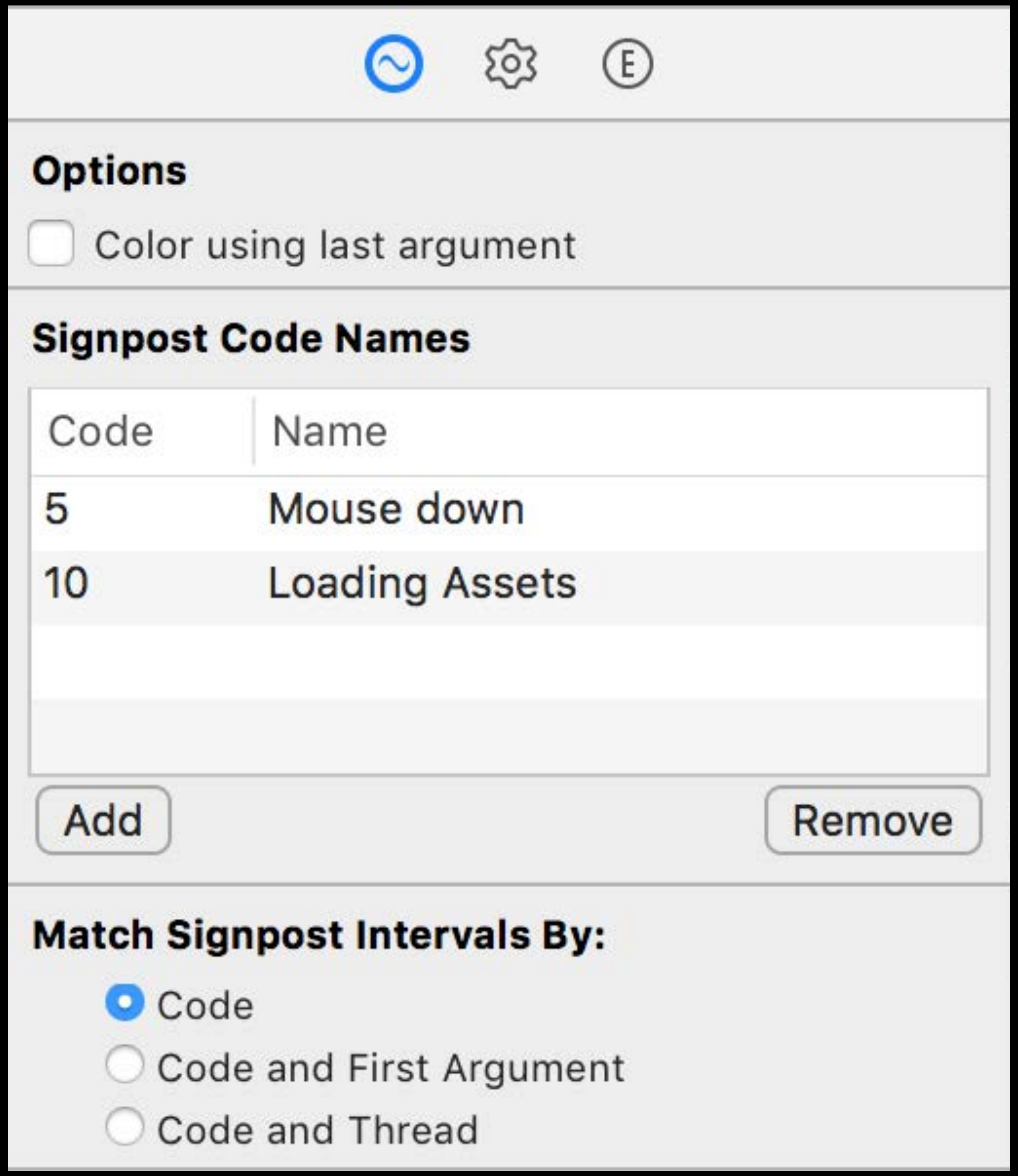


Options

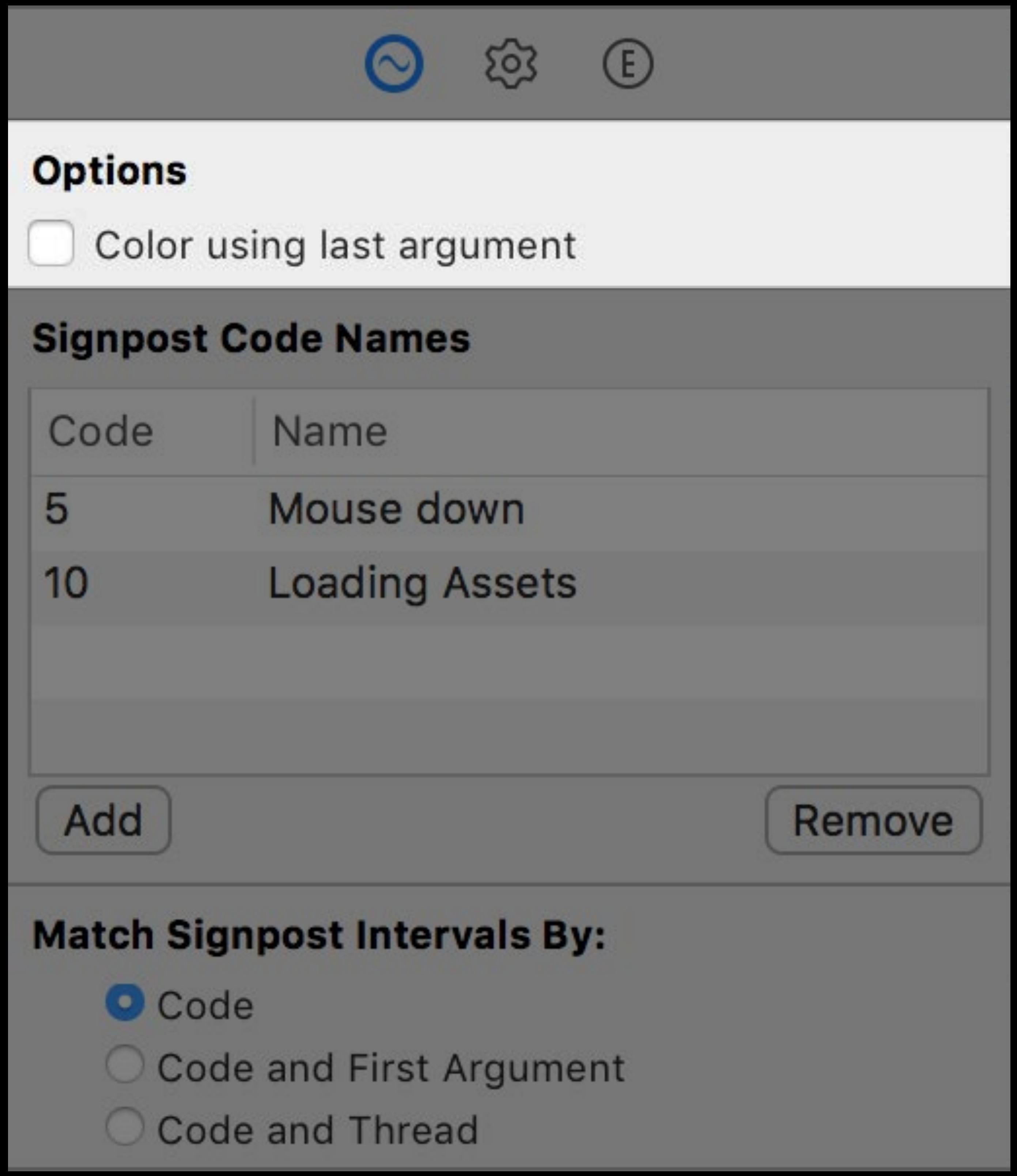
☐ Color using last argument

Signpost Code Names

Code	Name
5	Mouse down
10	Loading Assets

Match Signpost Intervals By:

[✓ Code]
Code and First Argument
Code and Thread



Options

[ ] Color using last argument

Signpost Code Names

Code	Name
5	Mouse down
10	Loading Assets

Match Signpost Intervals By:

[✓ Code]
Code and First Argument
Code and Thread

Points of Interest

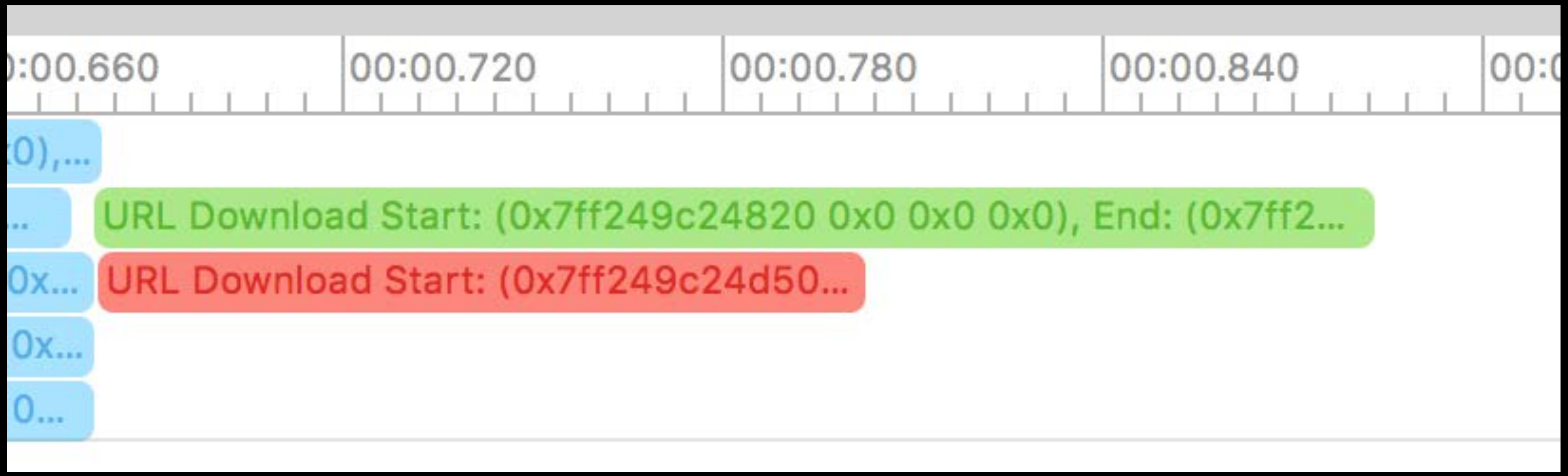
Color using last argument

NEW

Pass/Fail

Frame overrun

Differentiation



URL Download Start: (0x7ff249c24820 0x0 0x0 0x0), End: (0x7ff2...

URL Download Start: (0x7ff249c24d50...

```
// Color by last argument
// 0 - Blue, 1 - Green, 2 - Purple, 3 - Orange, 4 - Red
-(void)URLSession:(NSURLSession *)session task:(NSURLSessionTask *)task
                          didCompleteWithError:(nullable NSError *)error {
    kdebug_signpost_end(20,(uintptr_t)task, 0, 0, (error) ? 4 : 1);
}
```

Points of Interest

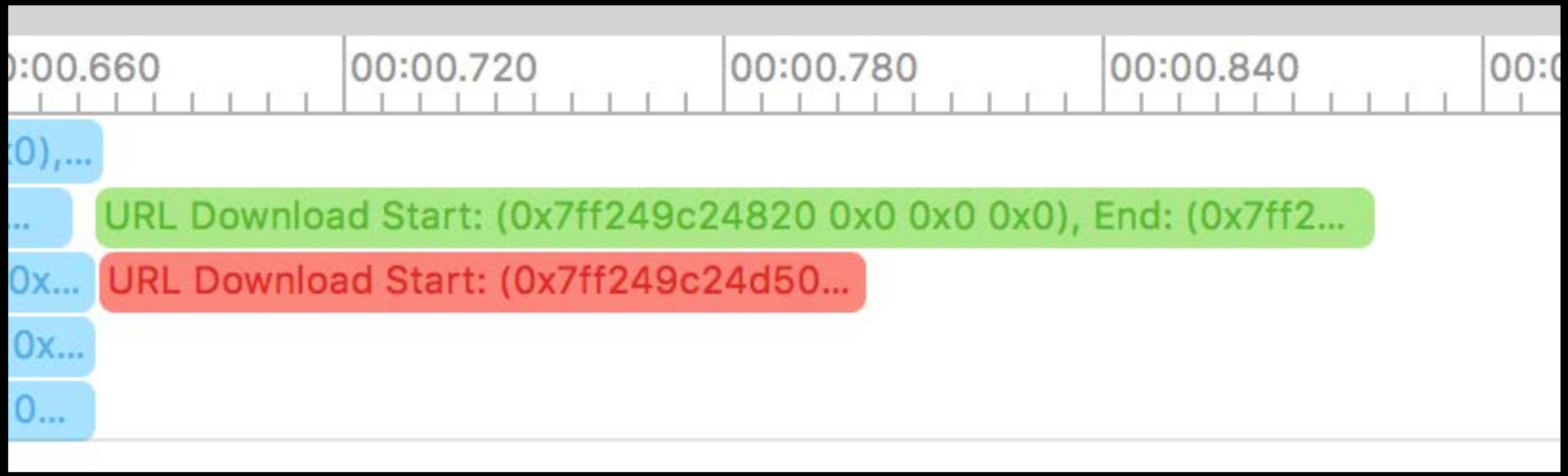
Color using last argument

NEW

Pass/Fail

Frame overrun

Differentiation



URL Download Start: (0x7ff249c24820 0x0 0x0 0x0), End: (0x7ff2...

URL Download Start: (0x7ff249c24d50...

```
// Color by last argument
// 0 - Blue, 1 - Green, 2 - Purple, 3 - Orange, 4 - Red
-(void)URLSession:(NSURLSession *)session task:(NSURLSessionTask *)task
                          didCompleteWithError:(nullable NSError *)error {
    kdebug_signpost_end(20,(uintptr_t)task, 0, 0, (error) ? 4 : 1);
}
```

Points of Interest

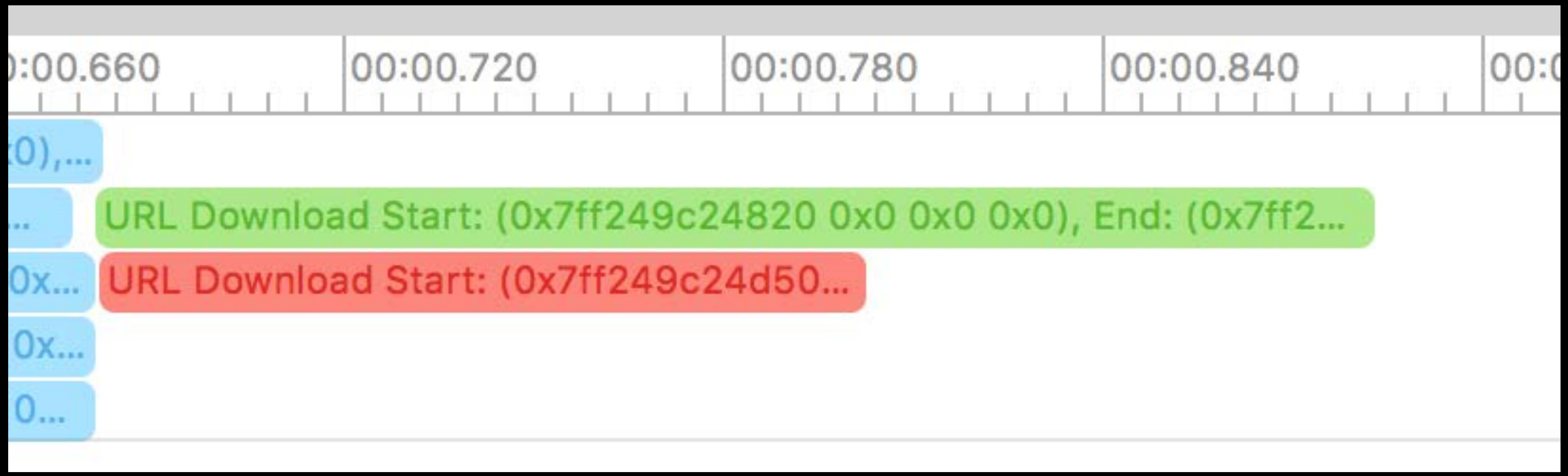
Color using last argument

NEW

Pass/Fail

Frame overrun

Differentiation

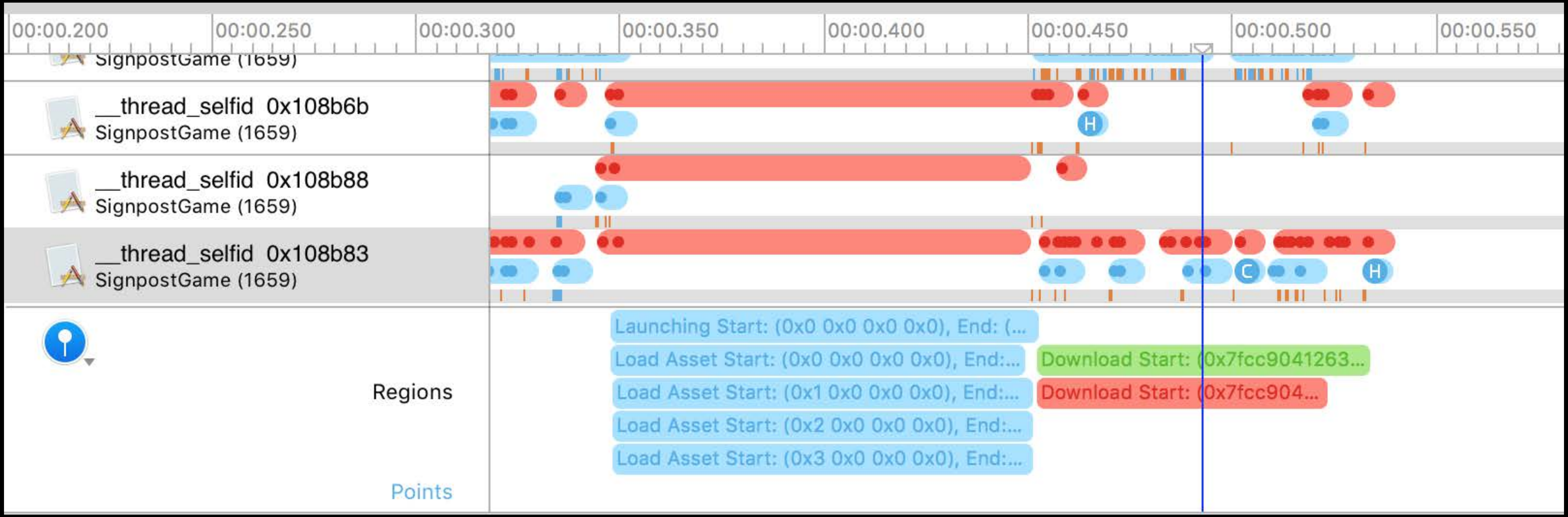

:00.660
00:00.720
00:00.780
00:00.840
00:0
0),...
URL Download Start: (0x7ff249c24820 0x0 0x0 0x0), End: (0x7ff2...
0x...
URL Download Start: (0x7ff249c24d50...
0x...
0...

```
// Color by last argument
// 0 - Blue, 1 - Green, 2 - Purple, 3 - Orange, 4 - Red
-(void)URLSession:(NSURLSession *)session task:(NSURLSessionTask *)task
                          didCompleteWithError:(nullable NSError *)error {
    kdebug_signpost_end(20,(uintptr_t)task, 0, 0, (error) ? 4 : 1);
}
```

Points of Interest

Correlation

NEW

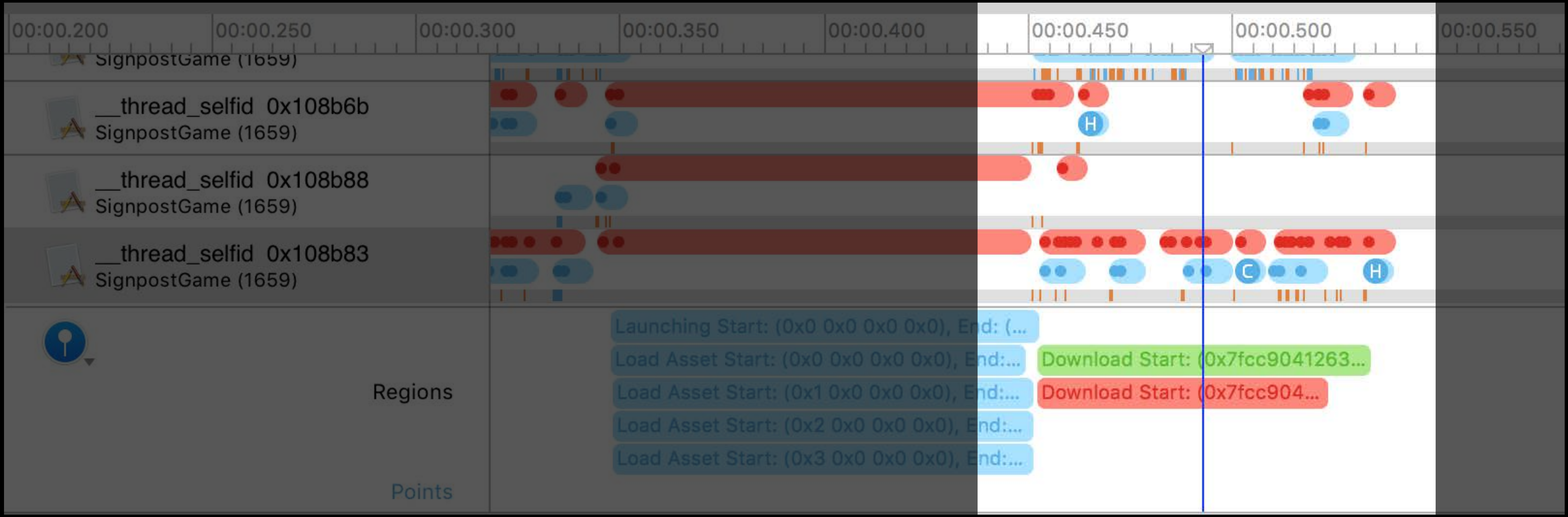


Launching Start: (0x0 0x0 0x0 0x0), End: (...
Load Asset Start: (0x0 0x0 0x0 0x0), End:...
Load Asset Start: (0x1 0x0 0x0 0x0), End:...
Load Asset Start: (0x2 0x0 0x0 0x0), End:...
Load Asset Start: (0x3 0x0 0x0 0x0), End:...
Download Start: (0x7fcc9041263...
Download Start: (0x7fcc904...

Points of Interest

Correlation

NEW



00:00.200 00:00.250 00:00.300 00:00.350 00:00.400 00:00.450 00:00.500 00:00.550

SignpostGame (1659)

__thread_selfid 0x108b6b
SignpostGame (1659)

__thread_selfid 0x108b88
SignpostGame (1659)

__thread_selfid 0x108b83
SignpostGame (1659)

Regions

Points

Launching Start: (0x0 0x0 0x0 0x0), End: (...
Load Asset Start: (0x0 0x0 0x0 0x0), End:...
Load Asset Start: (0x1 0x0 0x0 0x0), End:...
Load Asset Start: (0x2 0x0 0x0 0x0), End:...
Load Asset Start: (0x3 0x0 0x0 0x0), End:...
Download Start: (0x7fcc9041263...
Download Start: (0x7fcc904...

Graphasaurus 2

A legacy, reborn

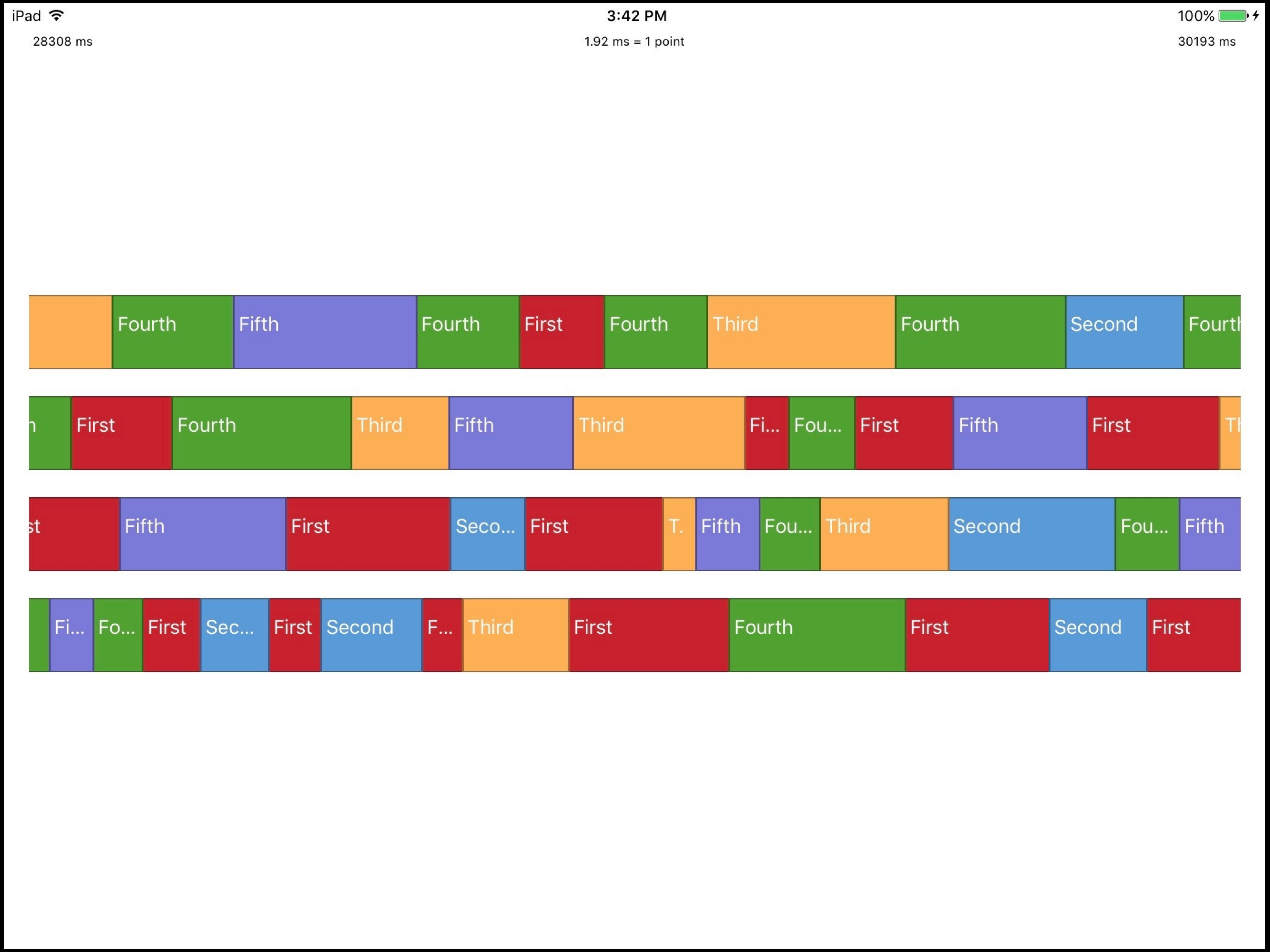
Real world problems

New graphing style

Time profiled

Needs parallelism

- 5 ms per row
- Four rows
- 20 ms > 16 ms (60 fps)



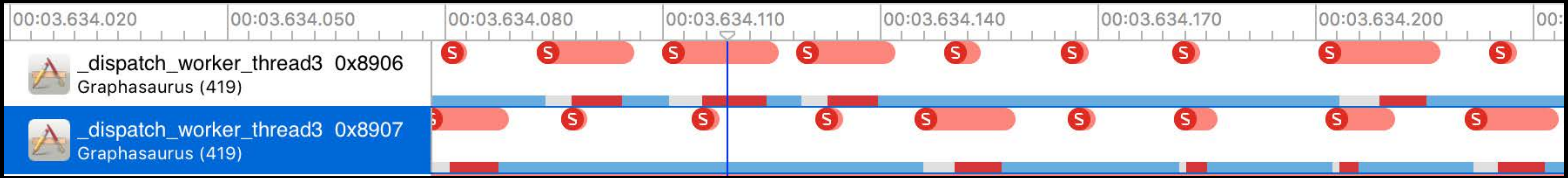
Demo

Graphasaurus 2

Joe Grzywacz

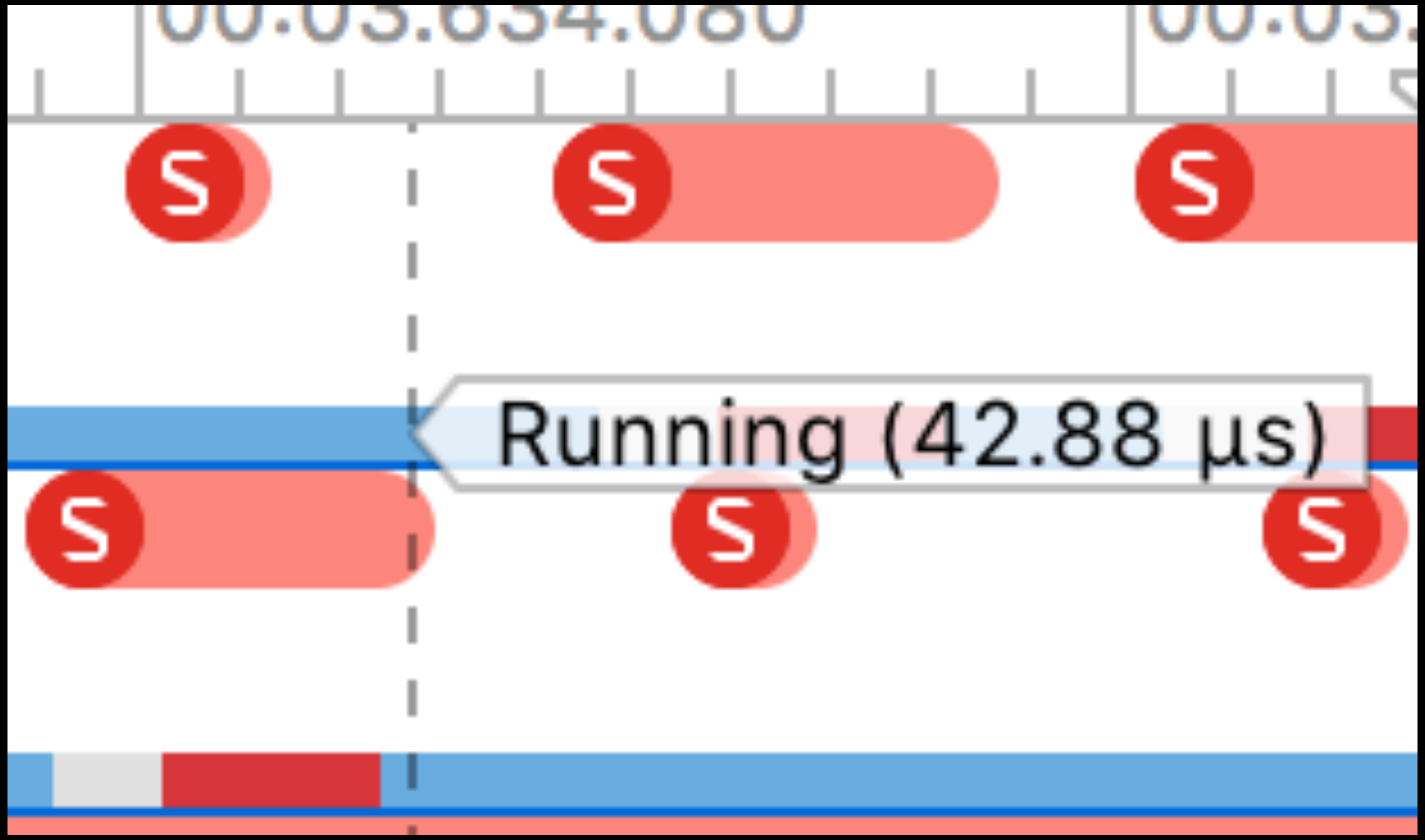
Lock Contention

A side effect of system load



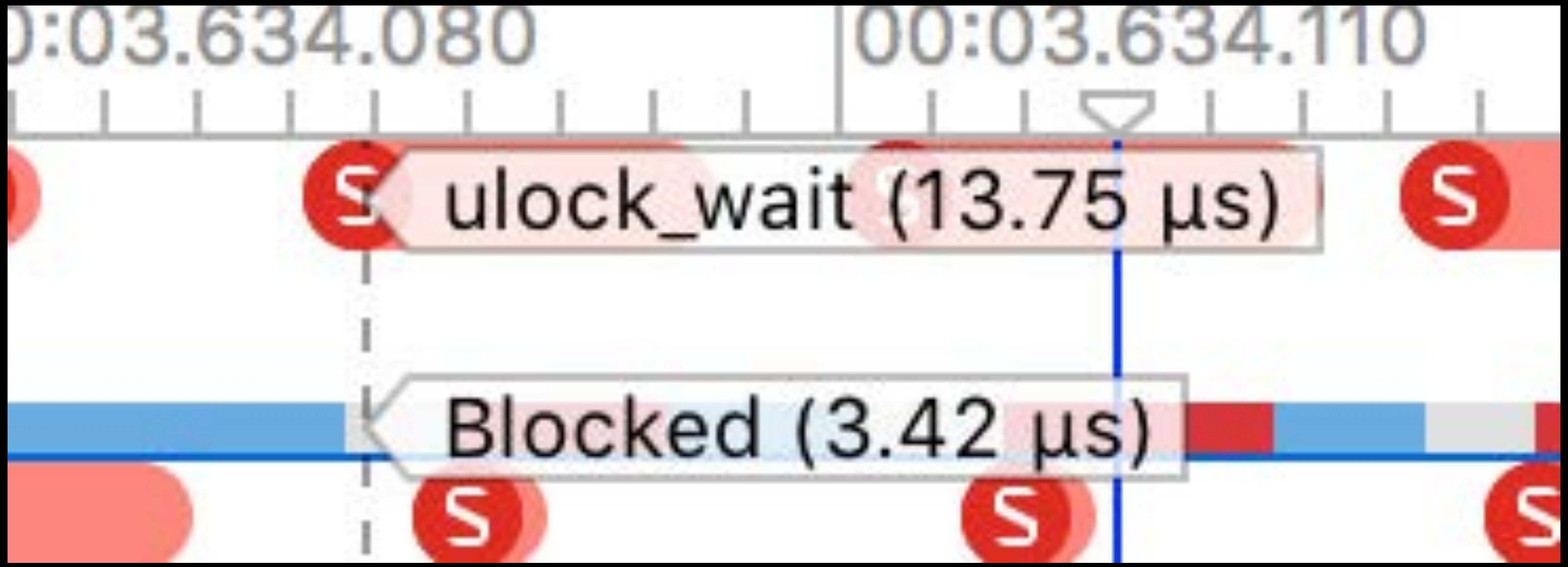
Lock Contention

Running



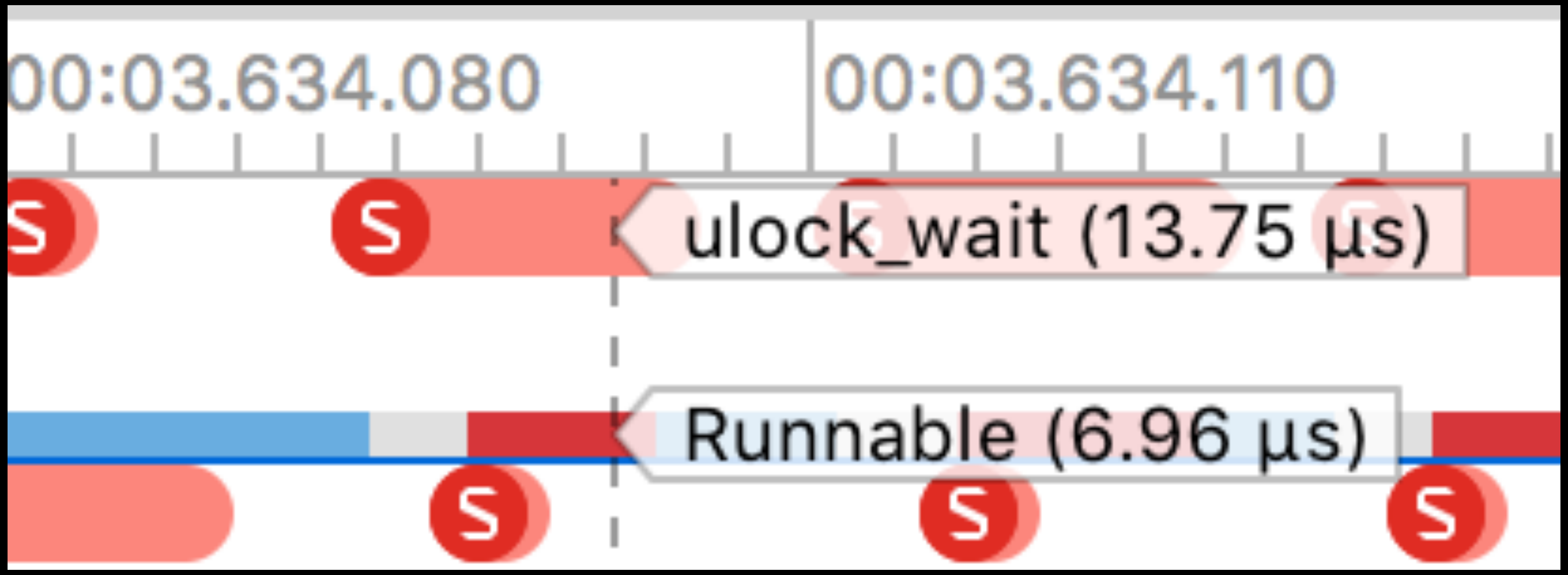
Lock Contention

Blocking



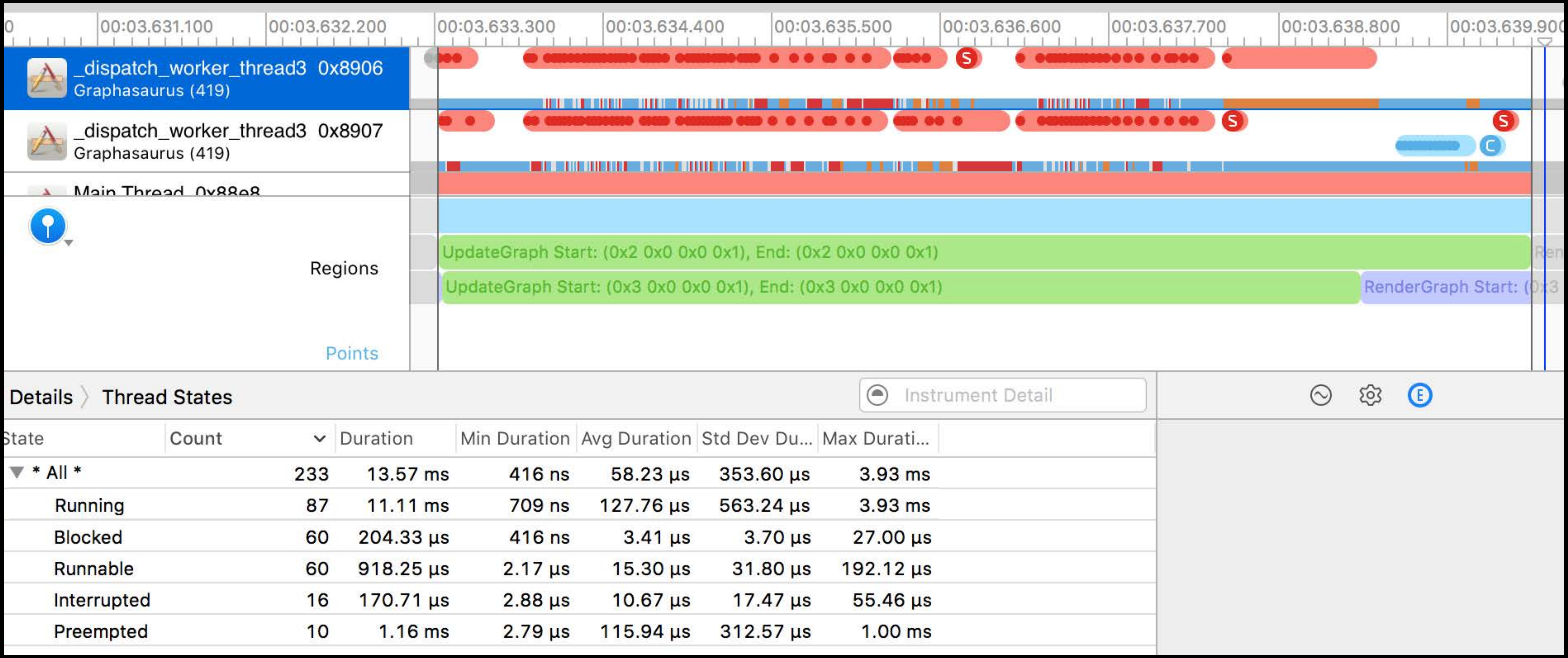
Lock Contention

Runnable



Lock Contention

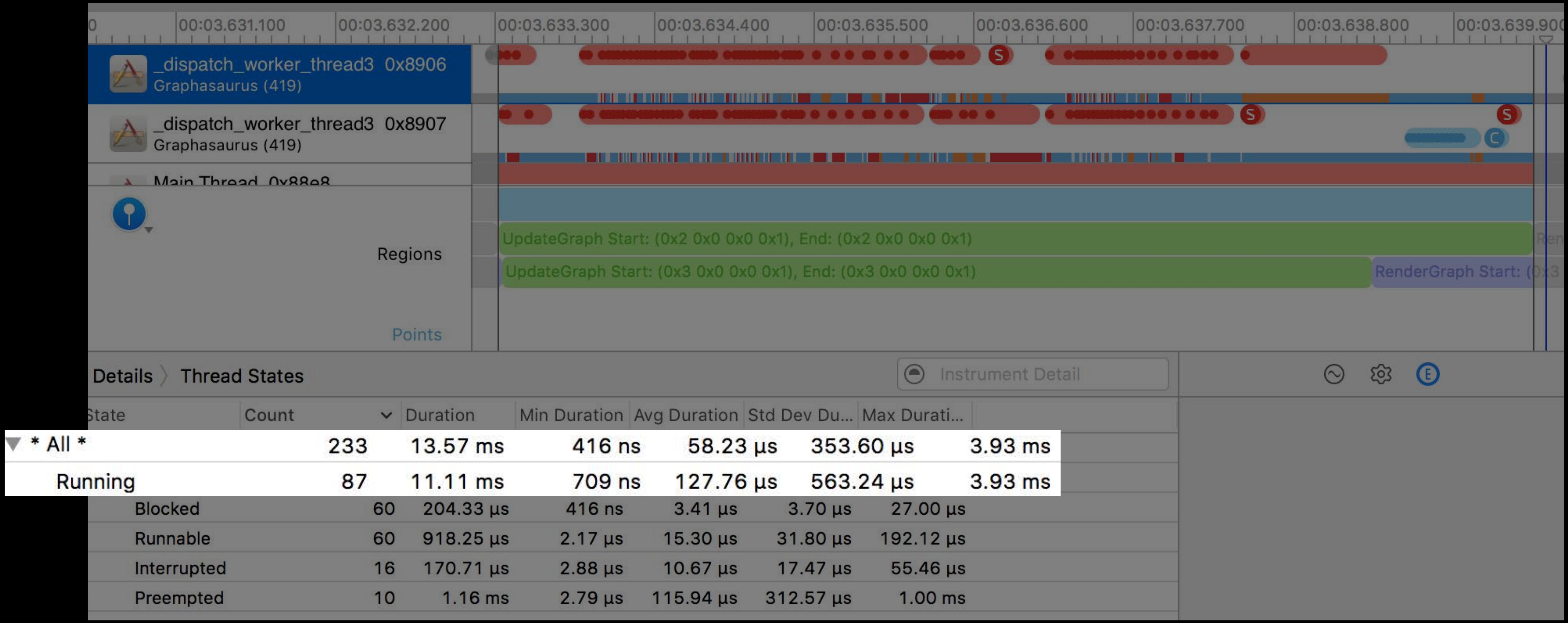
Overhead



State	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
* All *	233	13.57 ms	416 ns	58.23 µs	353.60 µs	3.93 ms
Running	87	11.11 ms	709 ns	127.76 µs	563.24 µs	3.93 ms
Blocked	60	204.33 µs	416 ns	3.41 µs	3.70 µs	27.00 µs
Runnable	60	918.25 µs	2.17 µs	15.30 µs	31.80 µs	192.12 µs
Interrupted	16	170.71 µs	2.88 µs	10.67 µs	17.47 µs	55.46 µs
Preempted	10	1.16 ms	2.79 µs	115.94 µs	312.57 µs	1.00 ms

Lock Contention

Overhead



State	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
▼ * All *	233	13.57 ms	416 ns	58.23 µs	353.60 µs	3.93 ms
Running	87	11.11 ms	709 ns	127.76 µs	563.24 µs	3.93 ms
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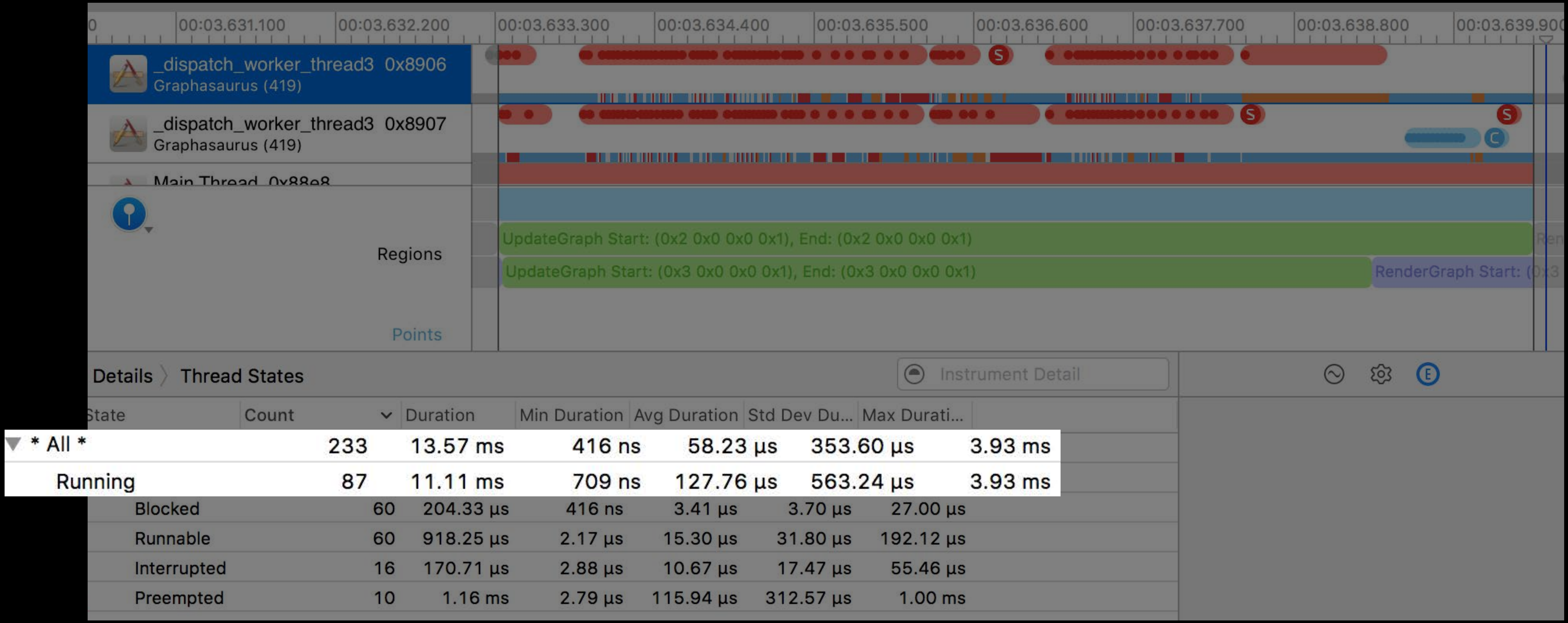
Preempted	10	1.16 ms	2.79 µs	115.94 µs	312.57 µs	1.00 ms

Lock Contention

Overhead


_dispatch_worker_thread3 0x8906
Graphasaurus (419)
_dispatch_worker_thread3 0x8907
Graphasaurus (419)
Main Thread 0x88e8
Regions
Points
UpdateGraph Start: (0x2 0x0 0x0 0x1), End: (0x2 0x0 0x0 0x1)
UpdateGraph Start: (0x3 0x0 0x0 0x1), End: (0x3 0x0 0x0 0x1)
RenderGraph Start:
Details
Thread States
Instrument Detail

State	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
* All *	233	13.57 ms	416 ns	58.23 µs	353.60 µs	3.93 ms
Running	87	11.11 ms	709 ns	127.76 µs	563.24 µs	3.93 ms
Blocked	60	204.33 µs	416 ns	3.41 µs	3.70 µs	27.00 µs
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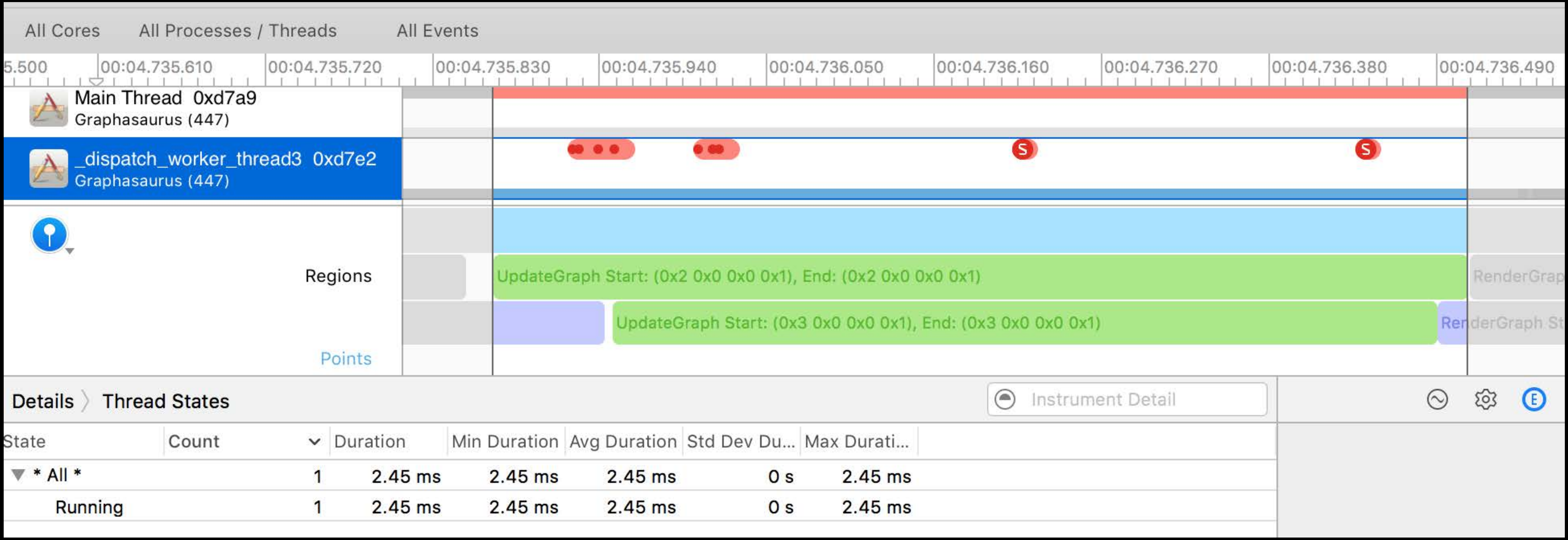
Preempted	10	1.16 ms	2.79 µs	115.94 µs	312.57 µs	1.00 ms

Only 82% in Running

Lock Contention

Fixed



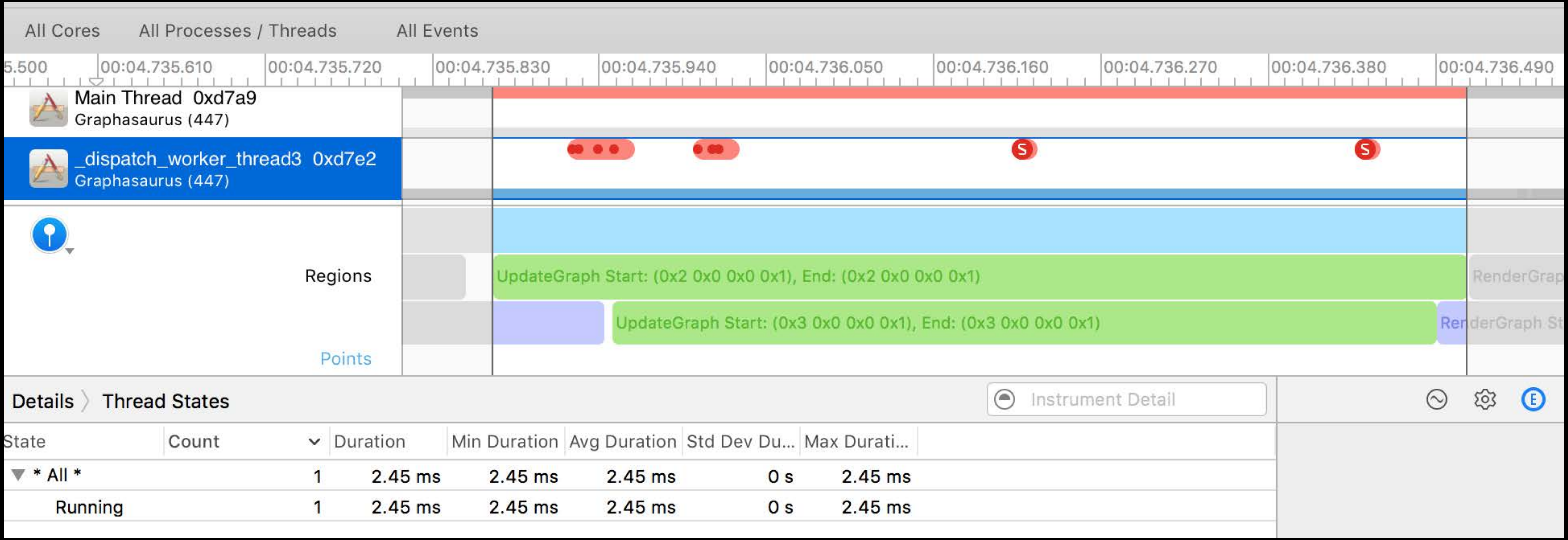
UpdateGraph Start: (0x2 0x0 0x0 0x1), End: (0x2 0x0 0x0 0x1)

UpdateGraph Start: (0x3 0x0 0x0 0x1), End: (0x3 0x0 0x0 0x1)

State	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
▼ * All *	1	2.45 ms	2.45 ms	2.45 ms	0 s	2.45 ms
Running	1	2.45 ms	2.45 ms	2.45 ms	0 s	2.45 ms

Lock Contention

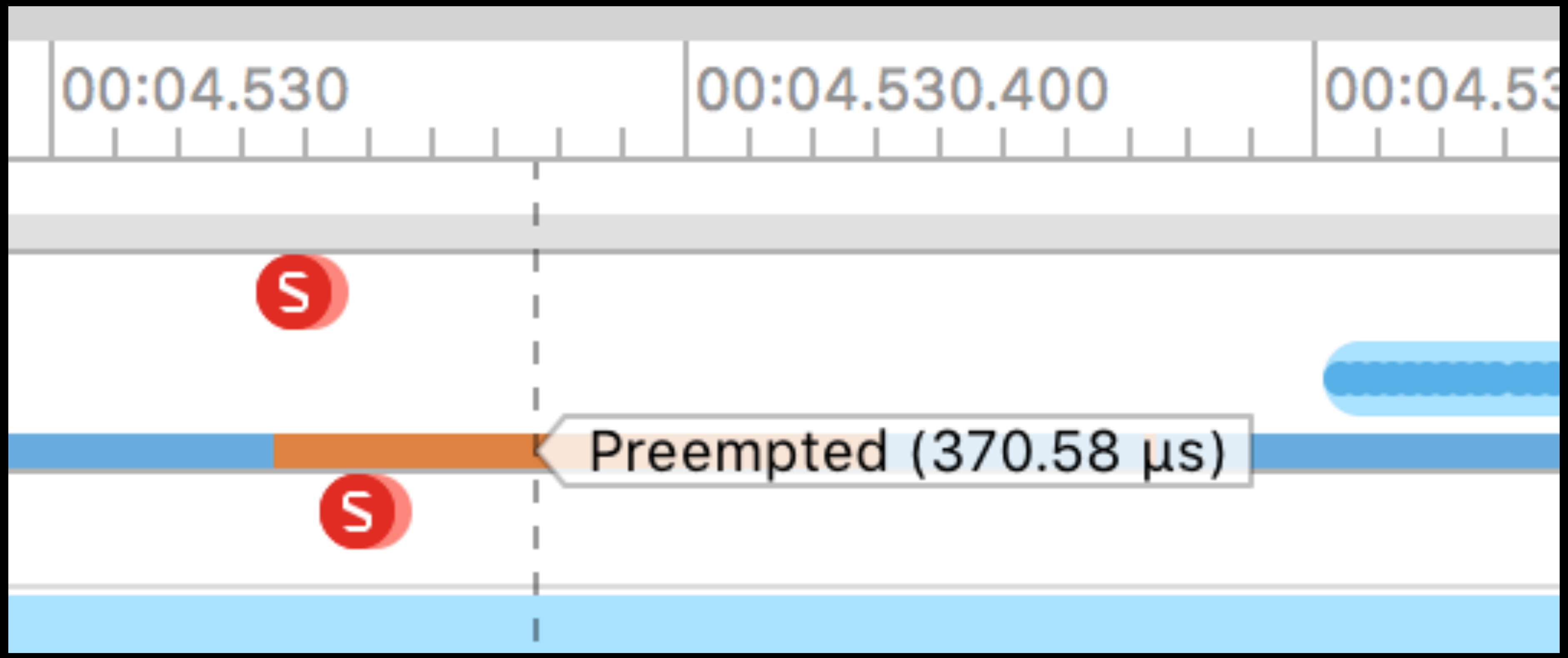
Fixed



State	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
▼ * All *	1	2.45 ms	2.45 ms	2.45 ms	0 s	2.45 ms
Running	1	2.45 ms	2.45 ms	2.45 ms	0 s	2.45 ms

100% in Running

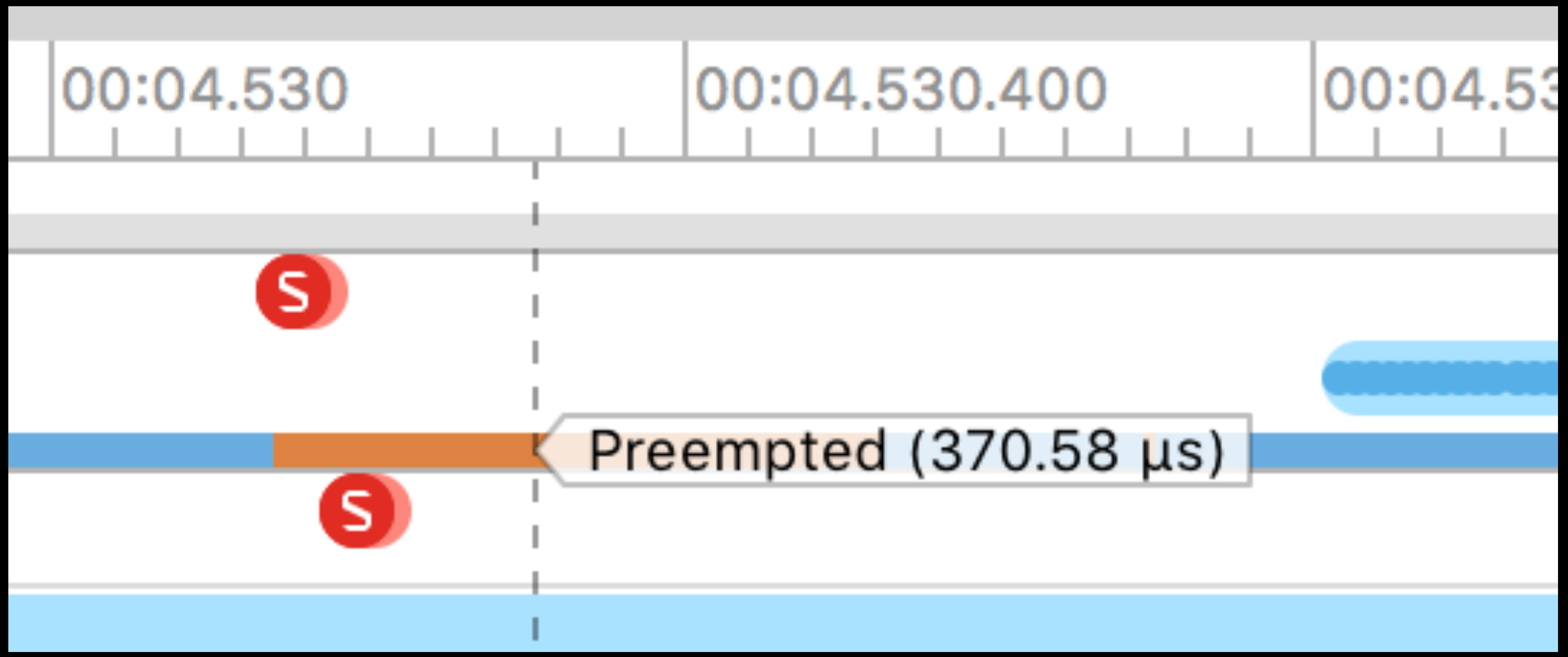
Preempted



Preempted

Involuntary

- Priority decayed
- High priority work runnable



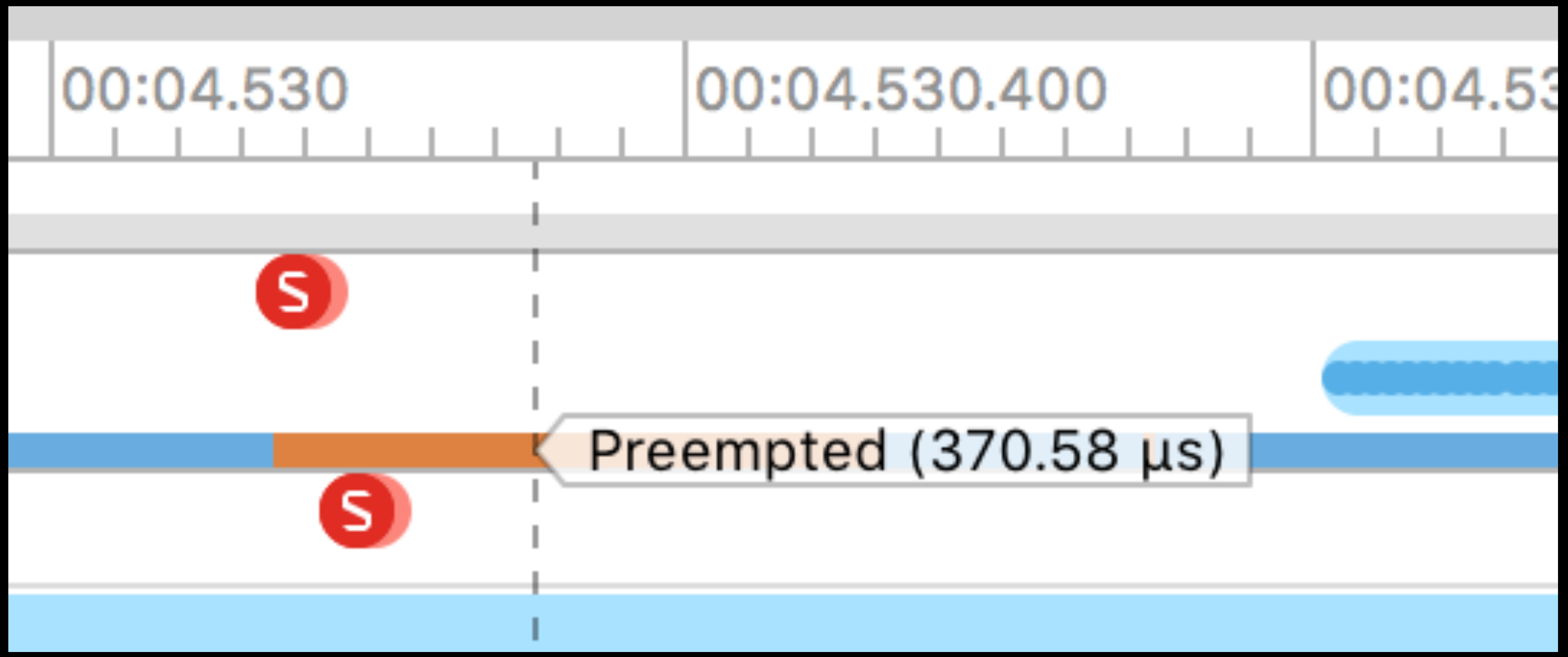
Preempted

Involuntary

- Priority decayed
- High priority work runnable

Voluntary

- Spin locks
- thread_switch



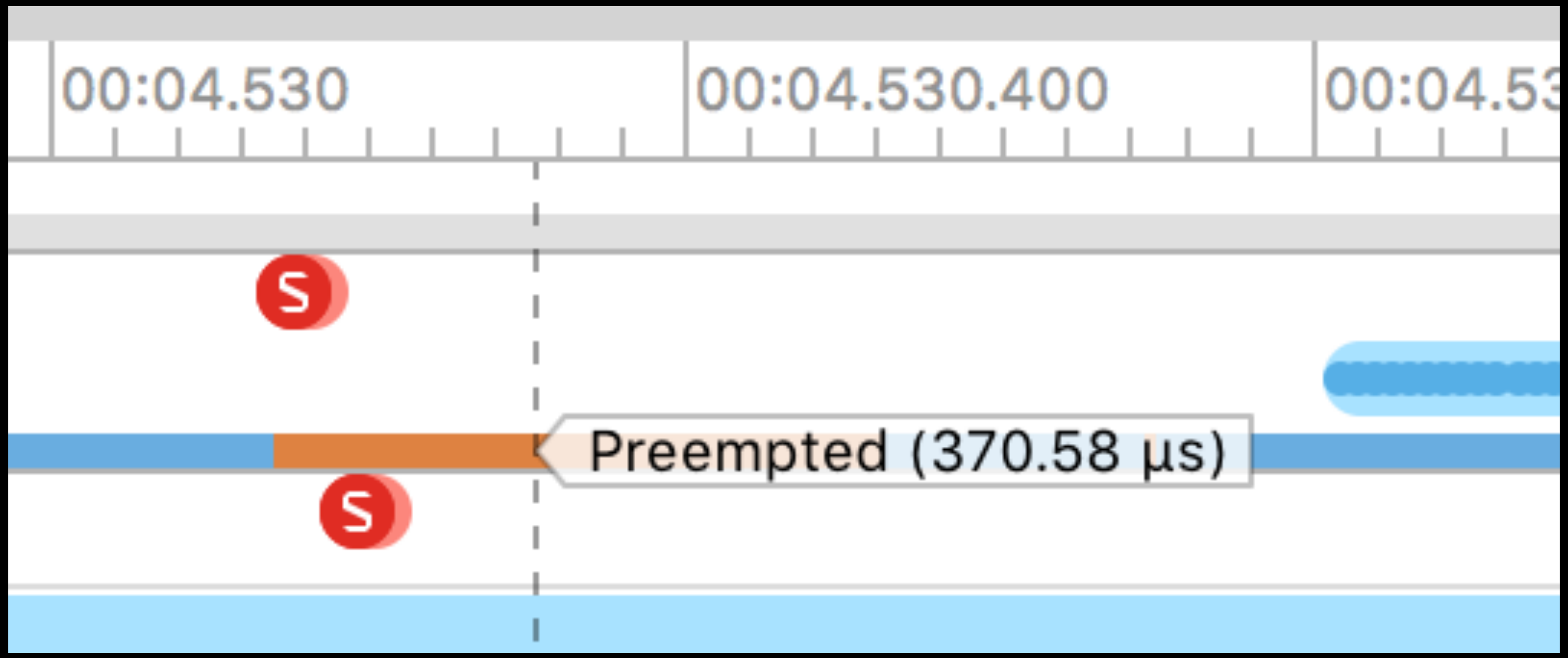
Preempted

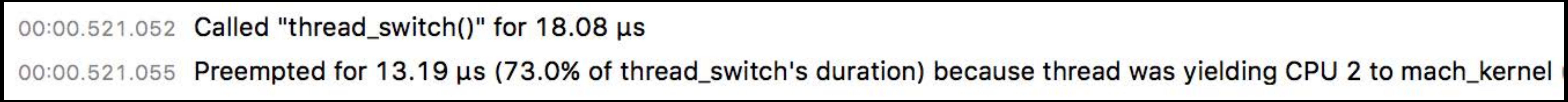
Involuntary

- Priority decayed
- High priority work runnable

Voluntary

- Spin locks
- thread_switch





```
00:00.521.052  Called "thread_switch()" for 18.08 µs
00:00.521.055  Preempted for 13.19 µs (73.0% of thread_switch's duration) because thread was yielding CPU 2 to mach_kernel
```

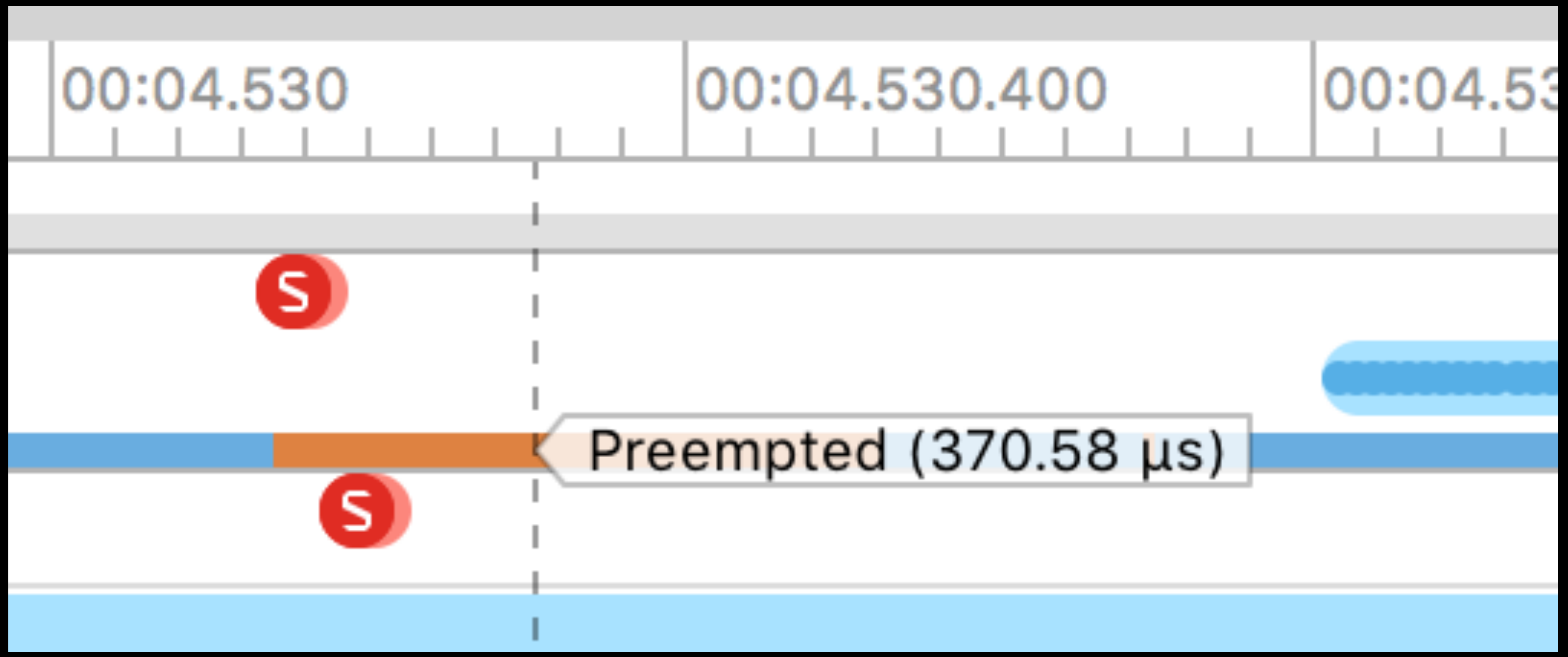
Preempted

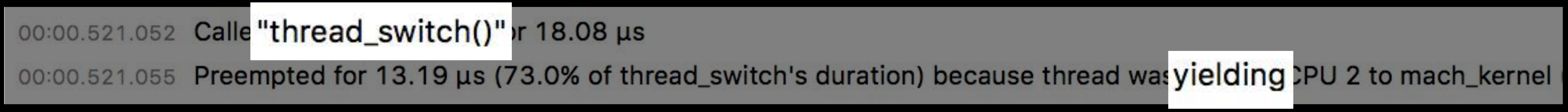
Involuntary

- Priority decayed
- High priority work runnable

Voluntary

- Spin locks
- thread_switch





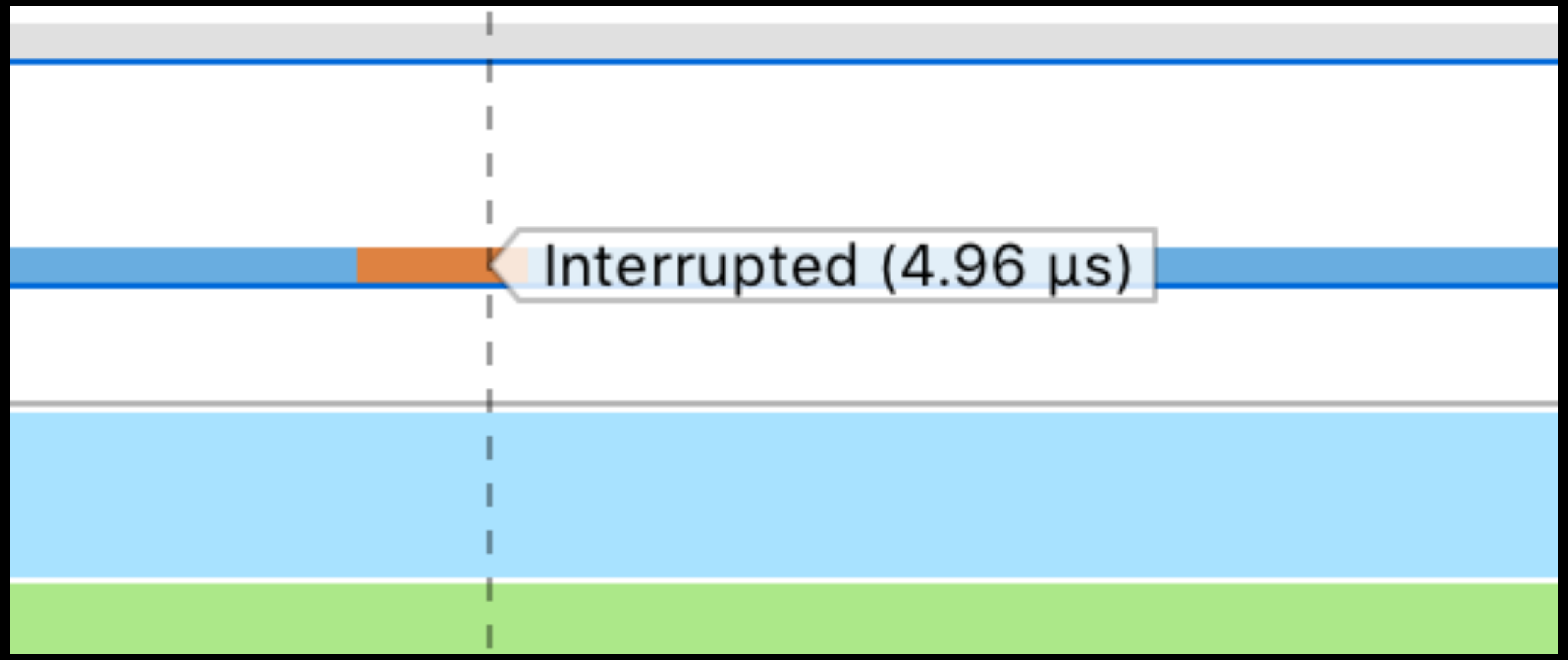
```
00:00.521.052  Calle "thread_switch()" r 18.08 µs
00:00.521.055  Preempted for 13.19 µs (73.0% of thread_switch's duration) because thread was yielding CPU 2 to mach_kernel
```

Interrupted

Interrupt handler

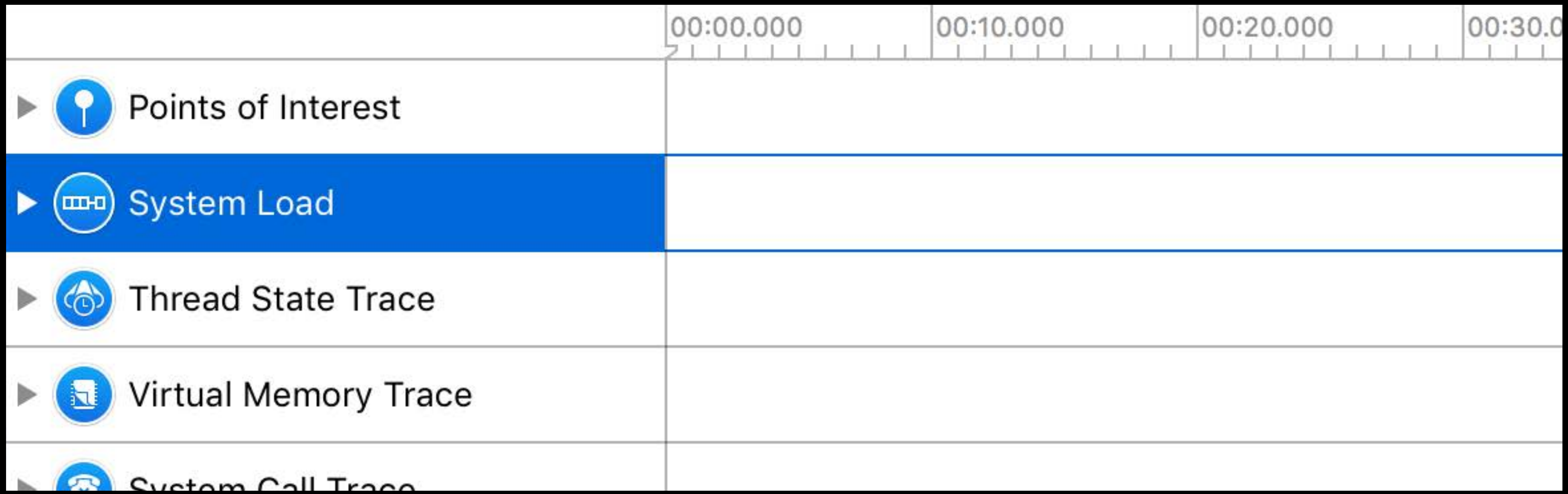
Priority doesn't matter

Brief



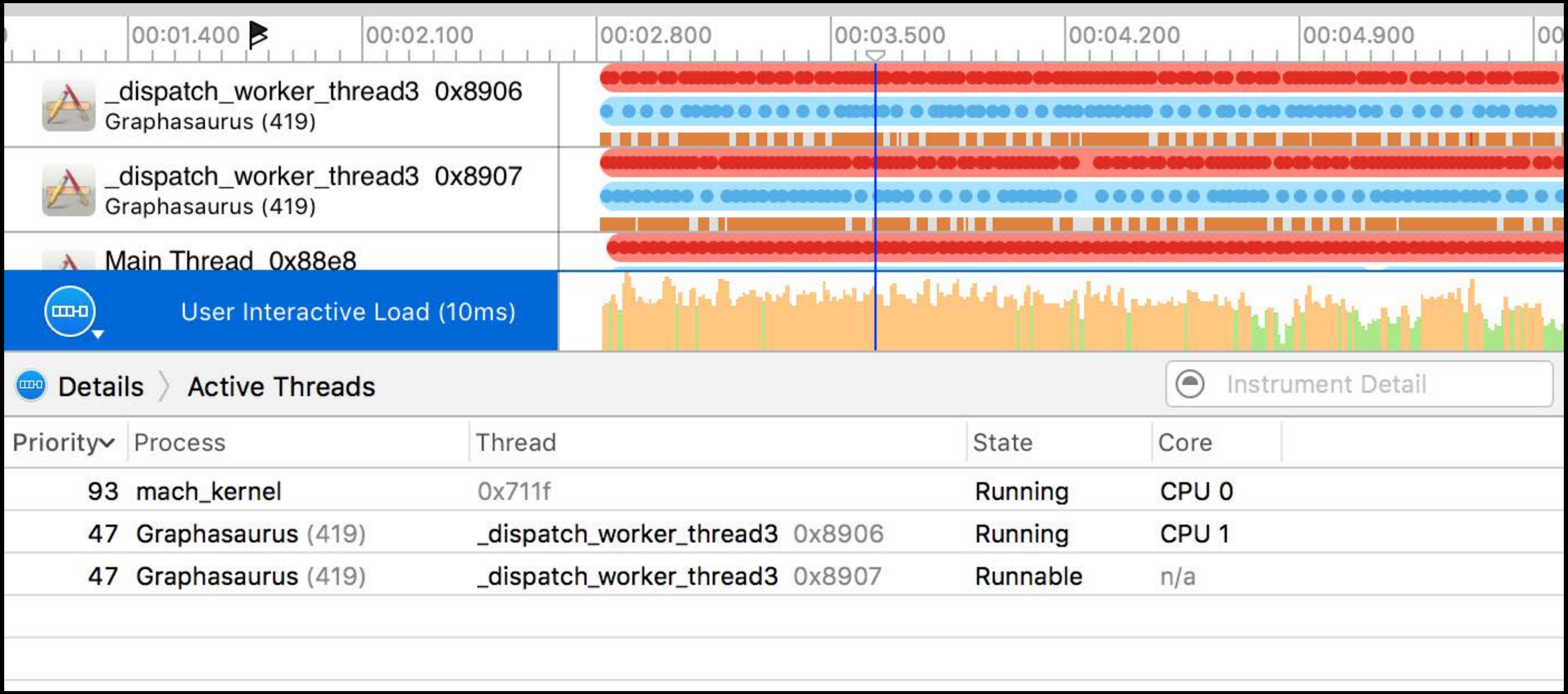
System Load

NEW



System Load

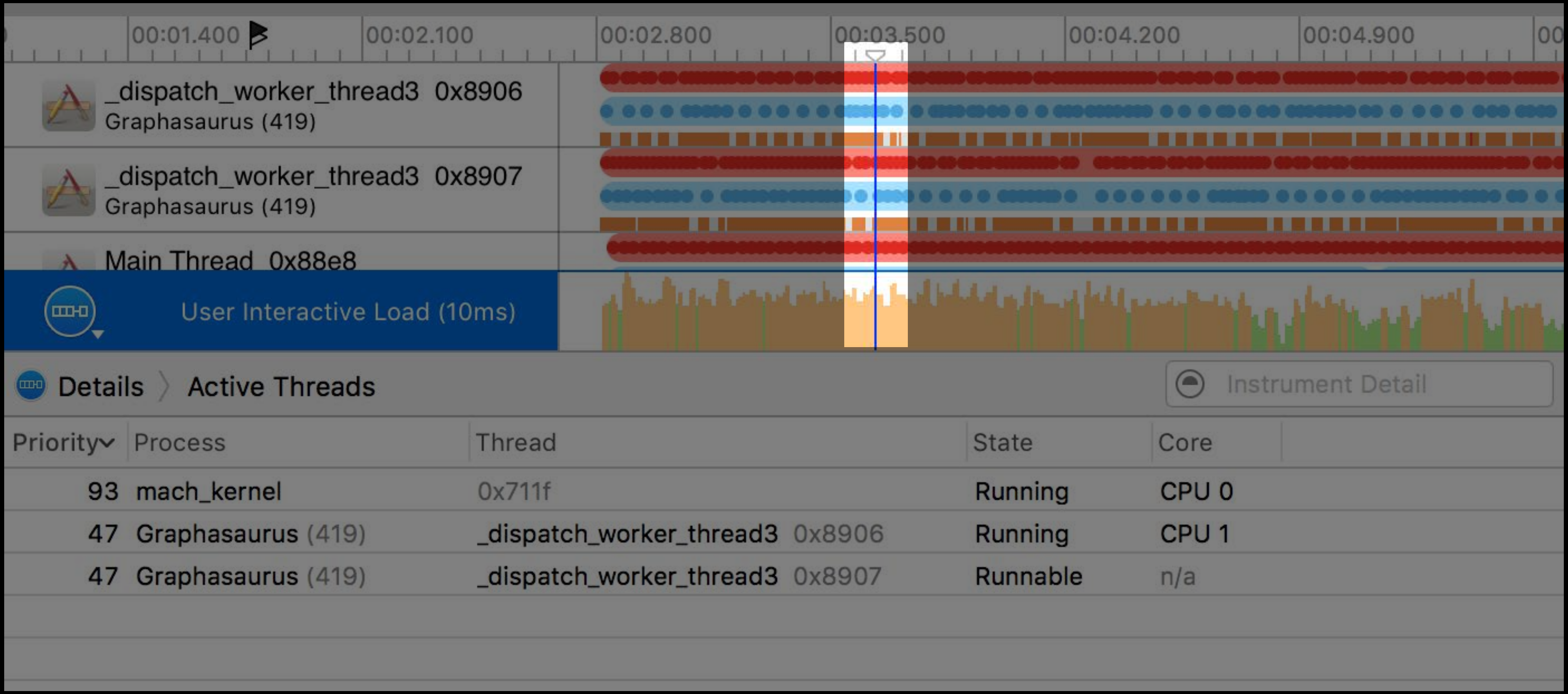
NEW



Priority	Process	Thread	State	Core
93	mach_kernel	0x711f	Running	CPU 0
47	Graphasaurus (419)	_dispatch_worker_thread3 0x8906	Running	CPU 1
47	Graphasaurus (419)	_dispatch_worker_thread3 0x8907	Runnable	n/a

System Load

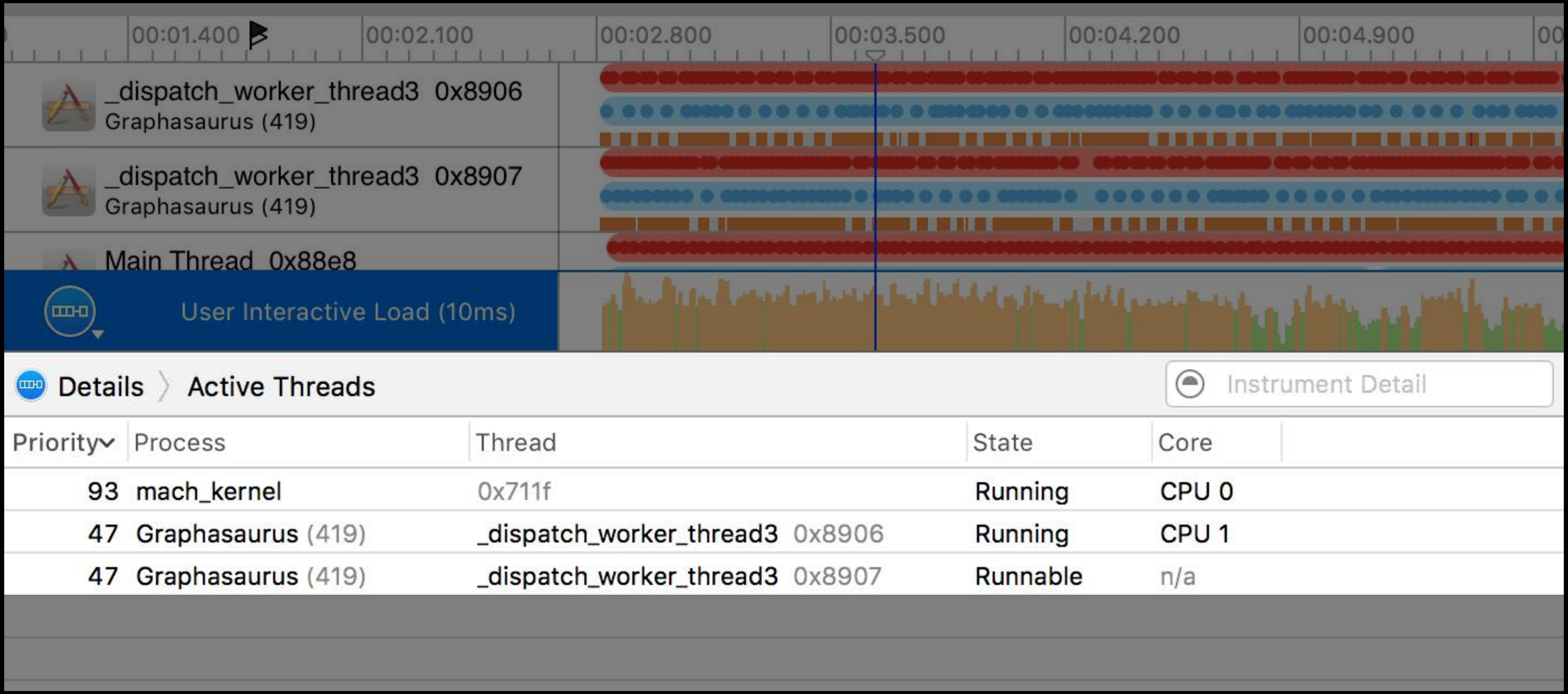
NEW



Priority	Process	Thread	State	Core
93	mach_kernel	0x711f	Running	CPU 0
47	Graphasaurus (419)	_dispatch_worker_thread3 0x8906	Running	CPU 1
47	Graphasaurus (419)	_dispatch_worker_thread3 0x8907	Runnable	n/a

System Load

NEW



Priority	Process	Thread	State	Core
93	mach_kernel	0x711f	Running	CPU 0
47	Graphasaurus (419)	_dispatch_worker_thread3 0x8906	Running	CPU 1
47	Graphasaurus (419)	_dispatch_worker_thread3 0x8907	Runnable	n/a

User Interactive Load Average

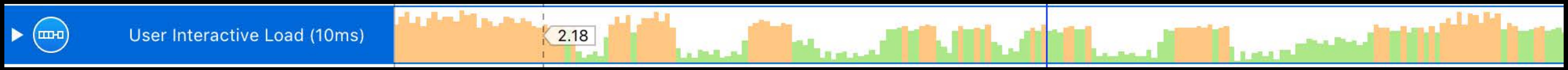
NEW

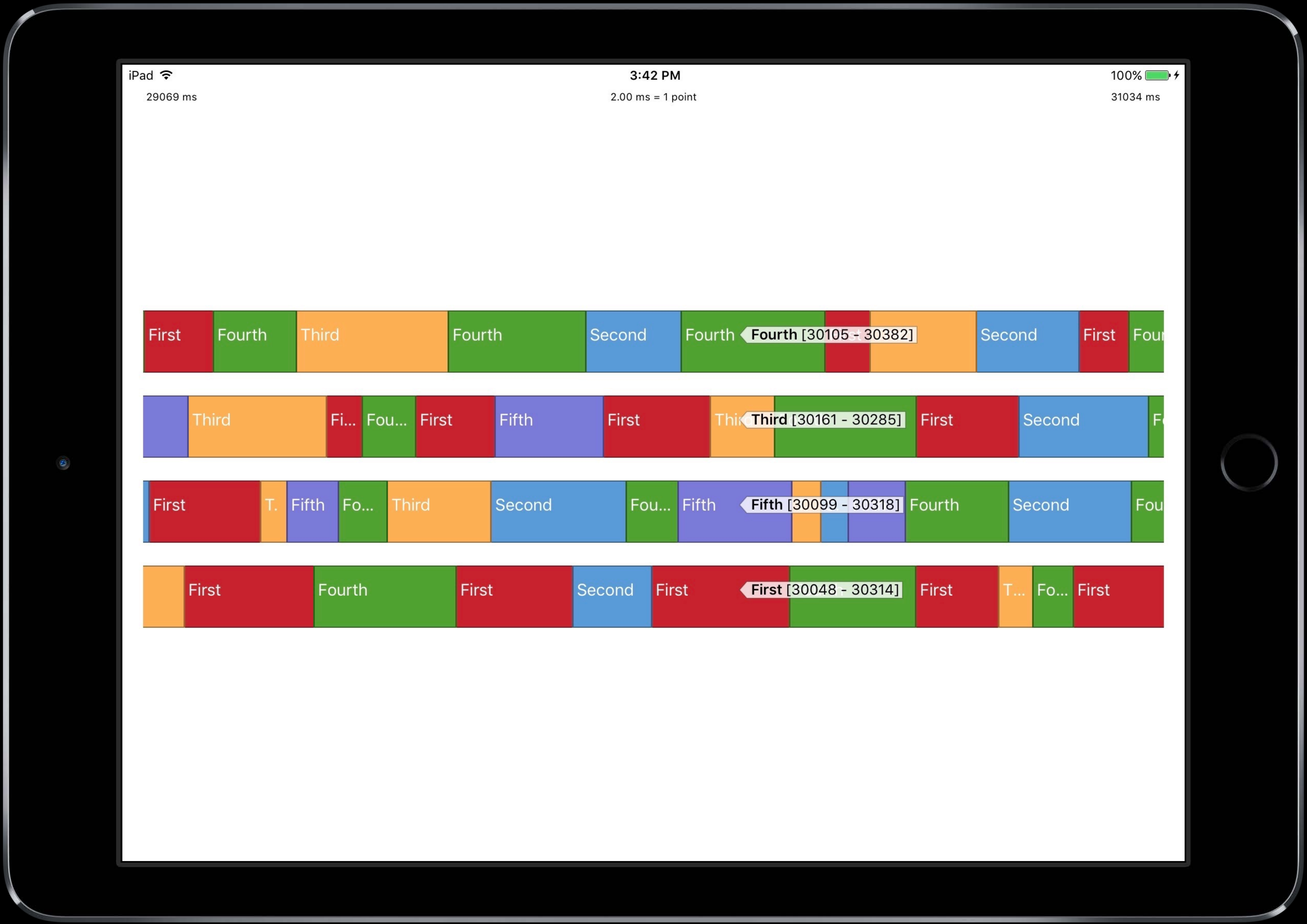
Average active threads over a 10 ms period

Priority >= 33

User Interactive Class (QoS)

Orange when load exceeds hardware




iPad
3:42 PM
100%
29069 ms
2.00 ms = 1 point
31034 ms
First
Fourth
Third
Fourth
Second
Fourth
Fourth [30105 - 30382]
Second
First
Third
Fi...
Fou...
First
Fifth
First
Third [30161 - 30285]
First
Second
First
T.
Fifth
Fo...
Third
Second
Fou...
Fifth
Fifth [30099 - 30318]
Fourth
Second
First
Fourth
First
Second
First
First [30048 - 30314]
First
T...
Fo...
First

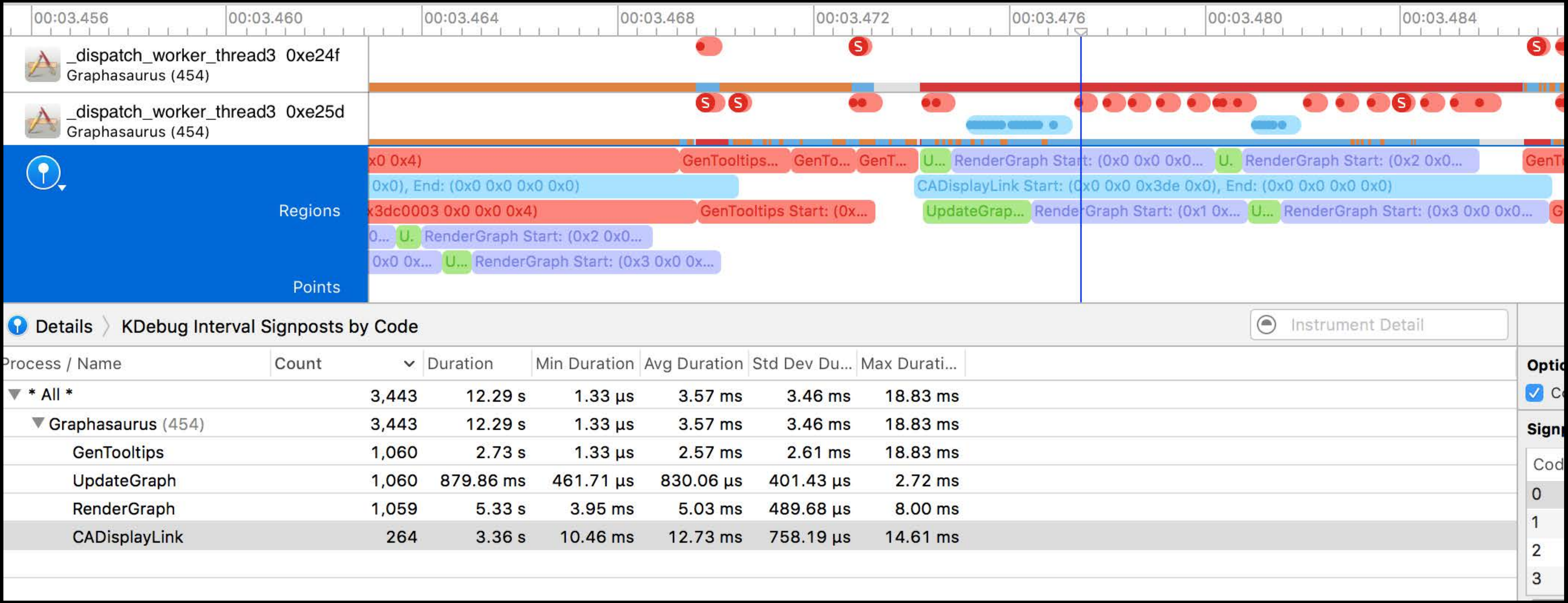
Demo

Priorities

Joe Grzywacz

Quality of Service

Prioritizing your threads


00:03.456
00:03.460
00:03.464
00:03.468
00:03.472
00:03.476
00:03.480
00:03.484
_dispatch_worker_thread3 0xe24f
Graphasaurus (454)
_dispatch_worker_thread3 0xe25d
Graphasaurus (454)
Regions
Points
x0 0x4)
GenTooltips...
GenTo...
GenT...
U...
RenderGraph Start: (0x0 0x0 0x0...
U.
RenderGraph Start: (0x2 0x0...
0x0), End: (0x0 0x0 0x0 0x0)
CADisplayLink Start: (0x0 0x0 0x3de 0x0), End: (0x0 0x0 0x0 0x0)
x3dc0003 0x0 0x0 0x4)
GenTooltips Start: (0x...
UpdateGrap...
RenderGraph Start: (0x1 0x...
RenderGraph Start: (0x3 0x0 0x0...
RenderGraph Start: (0x2 0x0...
0x0 0x...
RenderGraph Start: (0x3 0x0 0x...
Instrument Detail

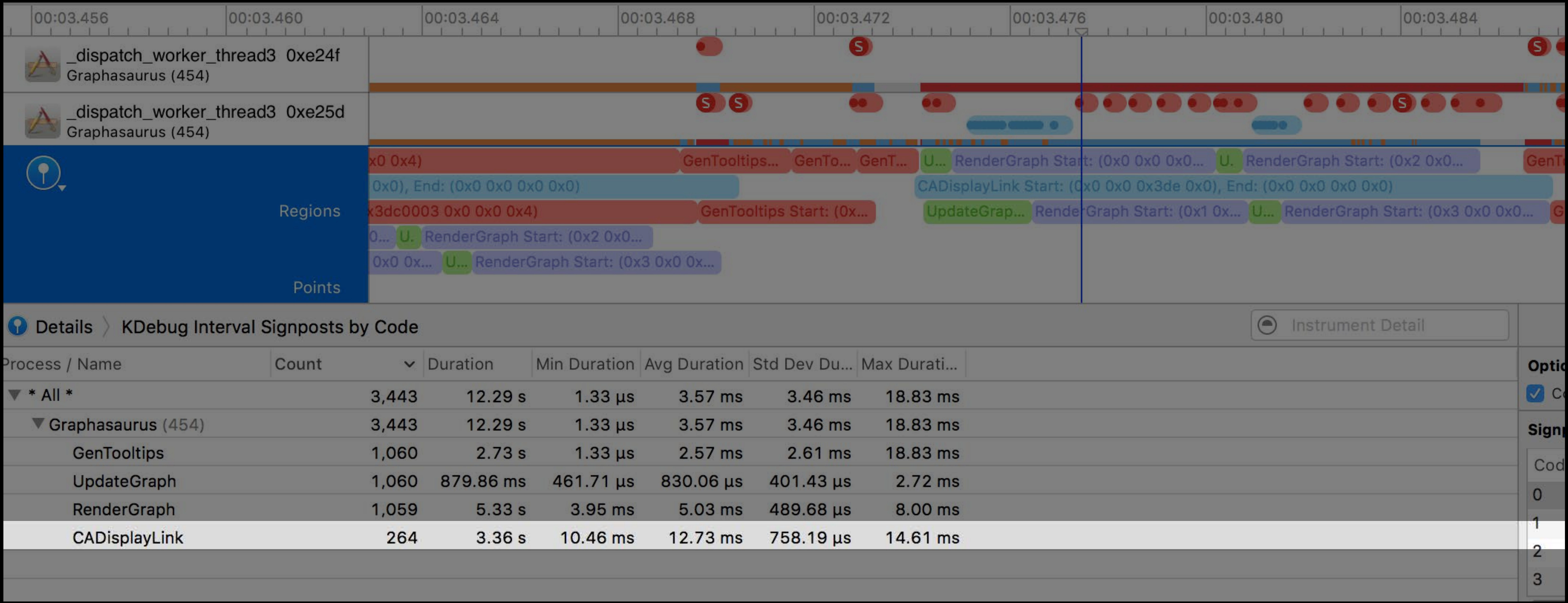
Details 〉 KDebug Interval Signposts by Code

Process / Name	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
▼ * All *	3,443	12.29 s	1.33 µs	3.57 ms	3.46 ms	18.83 ms
▼ Graphasaurus (454)	3,443	12.29 s	1.33 µs	3.57 ms	3.46 ms	18.83 ms
GenTooltips	1,060	2.73 s	1.33 µs	2.57 ms	2.61 ms	18.83 ms
UpdateGraph	1,060	879.86 ms	461.71 µs	830.06 µs	401.43 µs	2.72 ms
RenderGraph	1,059	5.33 s	3.95 ms	5.03 ms	489.68 µs	8.00 ms
CADisplayLink	264	3.36 s	10.46 ms	12.73 ms	758.19 µs	14.61 ms

Optic
✓ Co
Sign
Cod
0
1
2
3

Quality of Service

Prioritizing your threads



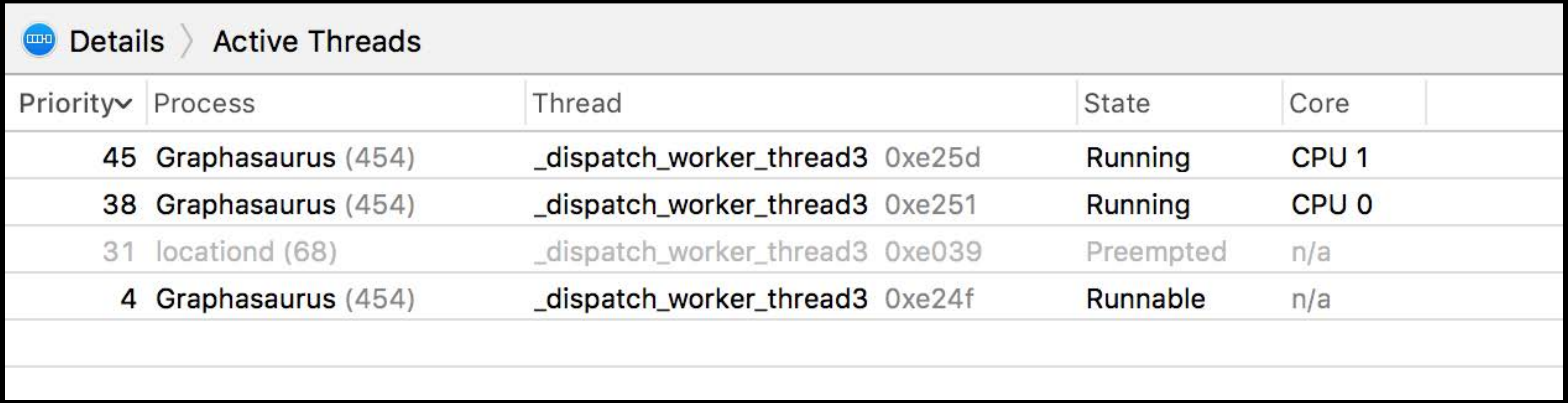
00:03.456
00:03.460
00:03.464
00:03.468
00:03.472
00:03.476
00:03.480
00:03.484
_dispatch_worker_thread3 0xe24f
Graphasaurus (454)
_dispatch_worker_thread3 0xe25d
Graphasaurus (454)
Regions
Points
GenTooltips…
RenderGraph Start: (0x2 0x0…
CADisplayLink Start: (0x0 0x0 0x3de 0x0), End: (0x0 0x0 0x0 0x0)
GenTooltips Start: (0x…
UpdateGrap…
RenderGraph Start: (0x1 0x…
RenderGraph Start: (0x3 0x0 0x0…
Instrument Detail

Details 〉 KDebug Interval Signposts by Code

Process / Name	Count	Duration	Min Duration	Avg Duration	Std Dev Du...	Max Durati...
▼ * All *	3,443	12.29 s	1.33 µs	3.57 ms	3.46 ms	18.83 ms
▼ Graphasaurus (454)	3,443	12.29 s	1.33 µs	3.57 ms	3.46 ms	18.83 ms
GenTooltips	1,060	2.73 s	1.33 µs	2.57 ms	2.61 ms	18.83 ms
UpdateGraph	1,060	879.86 ms	461.71 µs	830.06 µs	401.43 µs	2.72 ms
RenderGraph	1,059	5.33 s	3.95 ms	5.03 ms	489.68 µs	8.00 ms
CADisplayLink	264	3.36 s	10.46 ms	12.73 ms	758.19 µs	14.61 ms

Quality of Service

Prioritizing your threads

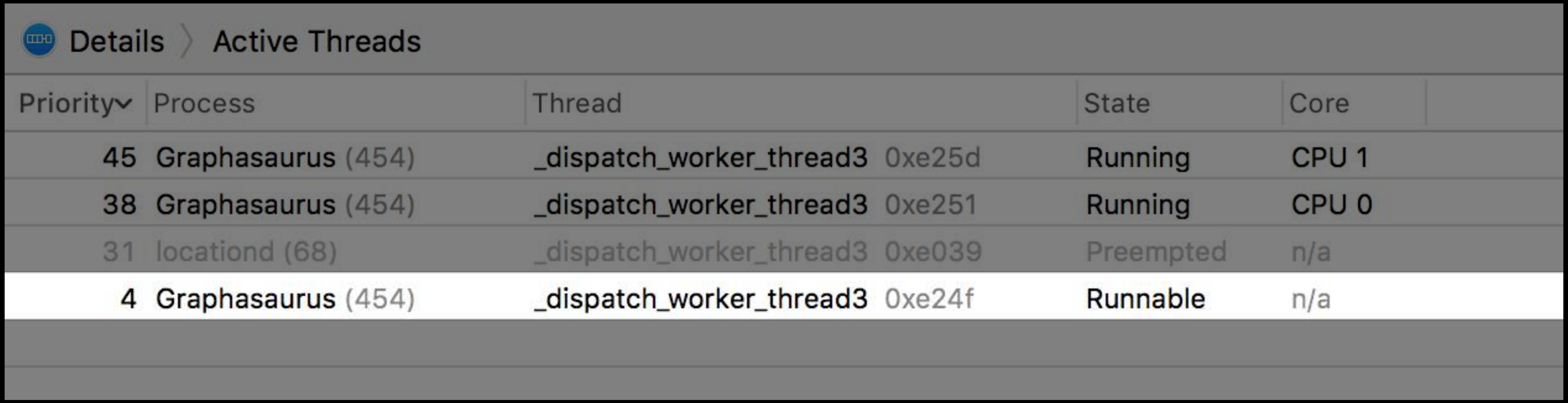


Details 〉 Active Threads

Priority	Process	Thread	State	Core
45	Graphasaurus (454)	_dispatch_worker_thread3 0xe25d	Running	CPU 1
38	Graphasaurus (454)	_dispatch_worker_thread3 0xe251	Running	CPU 0
31	locationd (68)	_dispatch_worker_thread3 0xe039	Preempted	n/a
4	Graphasaurus (454)	_dispatch_worker_thread3 0xe24f	Runnable	n/a

Quality of Service

Prioritizing your threads



Details 〉 Active Threads

Priority	Process	Thread	State	Core
45	Graphasaurus (454)	_dispatch_worker_thread3 0xe25d	Running	CPU 1
38	Graphasaurus (454)	_dispatch_worker_thread3 0xe251	Running	CPU 0
31	locationd (68)	_dispatch_worker_thread3 0xe039	Preempted	n/a
4	Graphasaurus (454)	_dispatch_worker_thread3 0xe24f	Runnable	n/a

Quality of Service

Prioritizing your threads

- Attribute of blocks, queues, threads
- Constrains the priority range
- Throttles I/O
- Throttles CPU frequency

Virtual Memory

Faults

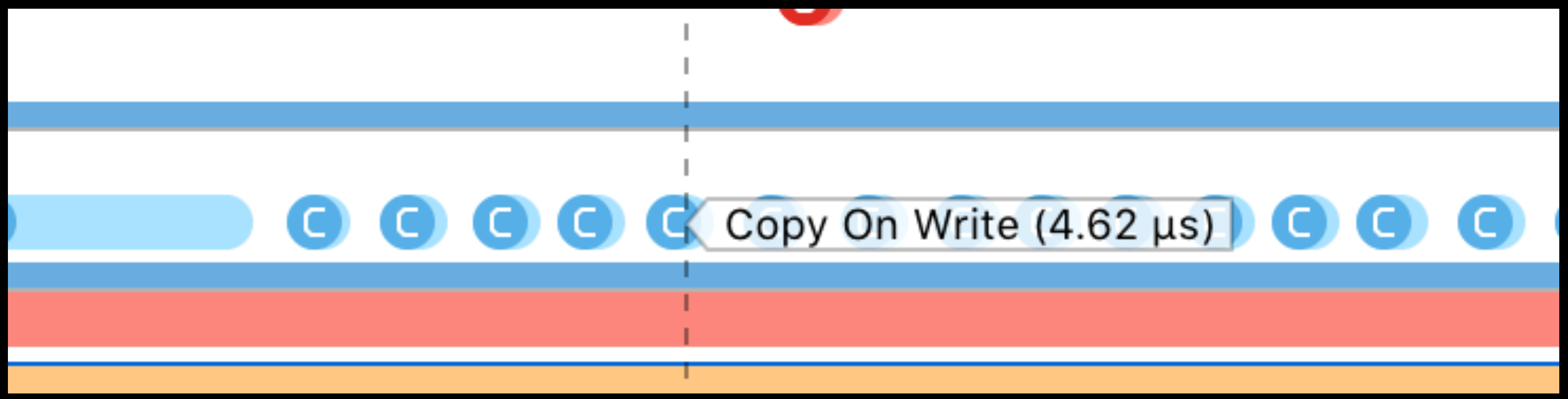
Affect performance

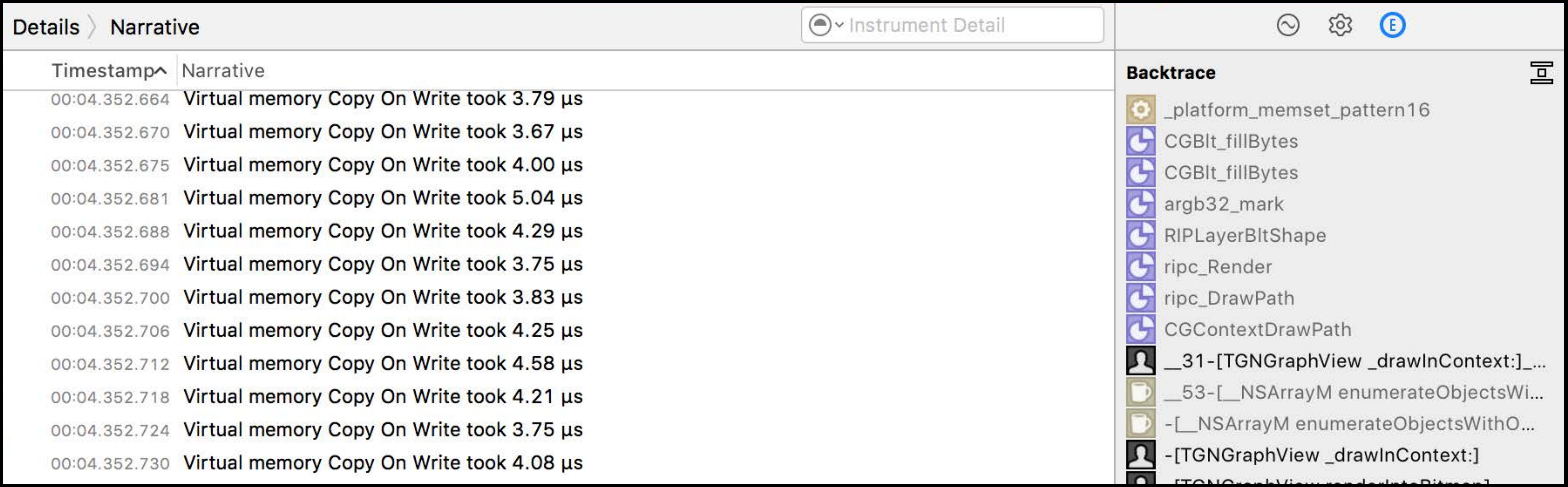
Worse under a load

Manageable

System Trace

Has the tools




Details 〉 Narrative

Instrument Detail

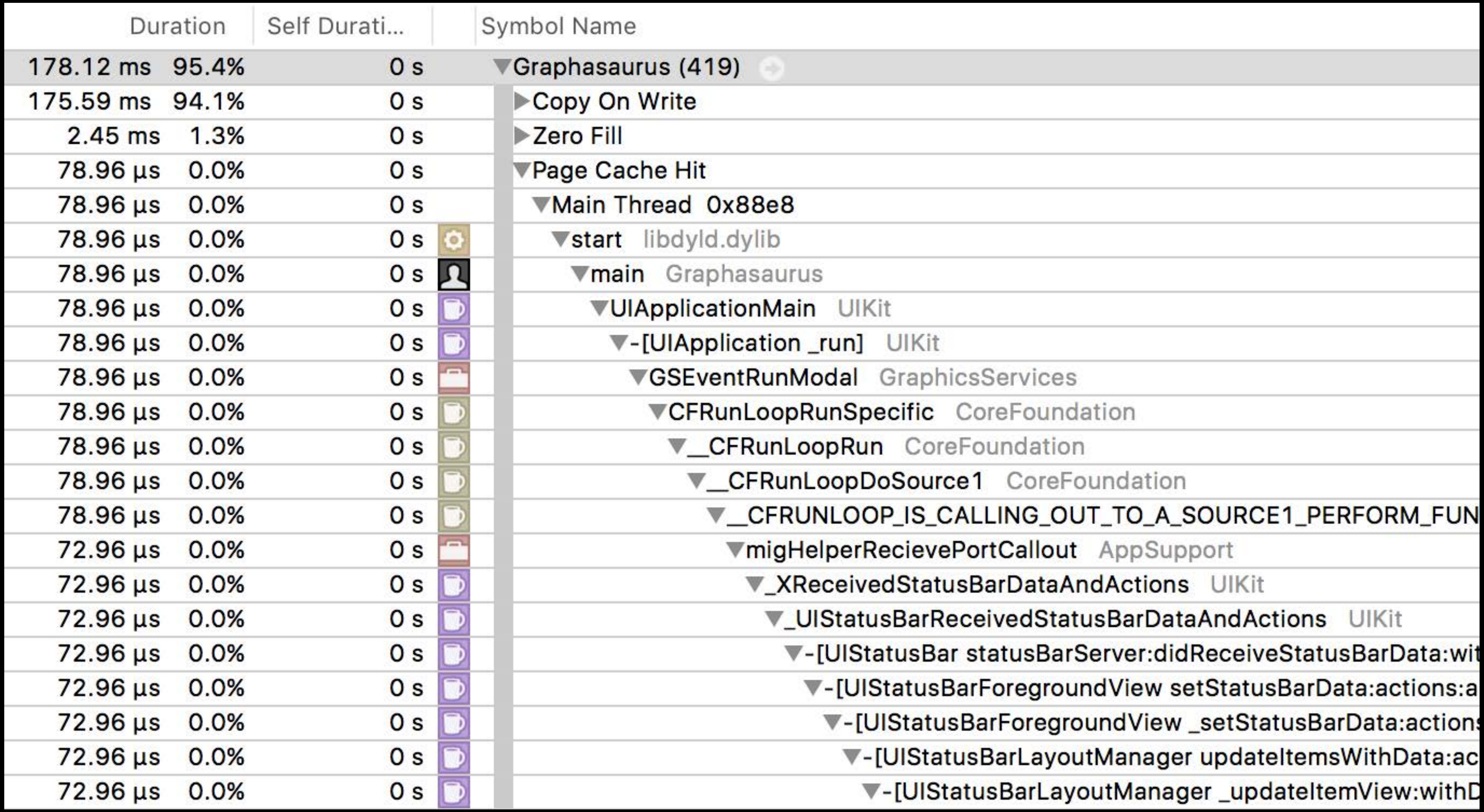
Timestamp	Narrative
00:04.352.664	Virtual memory Copy On Write took 3.79 µs
00:04.352.670	Virtual memory Copy On Write took 3.67 µs
00:04.352.675	Virtual memory Copy On Write took 4.00 µs
00:04.352.681	Virtual memory Copy On Write took 5.04 µs
00:04.352.688	Virtual memory Copy On Write took 4.29 µs
00:04.352.694	Virtual memory Copy On Write took 3.75 µs
00:04.352.700	Virtual memory Copy On Write took 3.83 µs
00:04.352.706	Virtual memory Copy On Write took 4.25 µs
00:04.352.712	Virtual memory Copy On Write took 4.58 µs
00:04.352.718	Virtual memory Copy On Write took 4.21 µs
00:04.352.724	Virtual memory Copy On Write took 3.75 µs
00:04.352.730	Virtual memory Copy On Write took 4.08 µs

Backtrace

```
_platform_memset_pattern16
CGBlt_fillBytes
CGBlt_fillBytes
argb32_mark
RIPLayerBltShape
ripc_Render
ripc_DrawPath
CGContextDrawPath
__31-[TGNGraphView _drawInContext:]_...
__53-[__NSArrayM enumerateObjectsWi...
-[__NSArrayM enumerateObjectsWithO...
-[TGNGraphView _drawInContext:]
```

System Trace

Has the tools



Duration		Self Durati...	Symbol Name
178.12 ms	95.4%	0 s	▼Graphasaurus (419)
175.59 ms	94.1%	0 s	▶Copy On Write
2.45 ms	1.3%	0 s	▶Zero Fill
78.96 µs	0.0%	0 s	▼Page Cache Hit
78.96 µs	0.0%	0 s	▼Main Thread 0x88e8
78.96 µs	0.0%	0 s	▼start libdyld.dylib
78.96 µs	0.0%	0 s	▼main Graphasaurus
78.96 µs	0.0%	0 s	▼UIApplicationMain UIKit
78.96 µs	0.0%	0 s	▼-[UIApplication _run] UIKit
78.96 µs	0.0%	0 s	▼GSEventRunModal GraphicsServices
78.96 µs	0.0%	0 s	▼CFRunLoopRunSpecific CoreFoundation
78.96 µs	0.0%	0 s	▼__CFRunLoopRun CoreFoundation
78.96 µs	0.0%	0 s	▼__CFRunLoopDoSource1 CoreFoundation
78.96 µs	0.0%	0 s	▼__CFRUNLOOP_IS_CALLING_OUT_TO_A_SOURCE1_PERFORM_FUN
72.96 µs	0.0%	0 s	▼migHelperRecievePortCallout AppSupport
72.96 µs	0.0%	0 s	▼_XReceivedStatusBarDataAndActions UIKit
72.96 µs	0.0%	0 s	▼_UIStatusBarReceivedStatusBarDataAndActions UIKit
72.96 µs	0.0%	0 s	▼-[UIStatusBar statusBarServer:didReceiveStatusBarData:wit
72.96 µs	0.0%	0 s	▼-[UIStatusBarForegroundView setStatusBarData:actions:a
72.96 µs	0.0%	0 s	▼-[UIStatusBarForegroundView _setStatusBarData:action
72.96 µs	0.0%	0 s	▼-[UIStatusBarLayoutManager updateItemsWithData:ac
72.96 µs	0.0%	0 s	▼-[UIStatusBarLayoutManager _updateItemView:withD

Fault on Access

Allocations are quick

First access causes fault

Resolved Inline

No explicit call

Access any byte in the page

Just-in-time mapping to physical memory

Mitigation

Mitigation

Absorb them

- Leave room for faulting in your budget
- More resilient under a load

Mitigation

Absorb them

- Leave room for faulting in your budget
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Fault pages on a background thread

- dispatch_async
- Avoids stutters when showing new content

Summary

Companion to the Time Profiler

Applications that scale well under heavy loads

Try it out on your app

Many new features in Instruments 8

More Information

https://developer.apple.com/wwdc16/411

Related Sessions

Optimizing App Startup Time	Mission	Wednesday 10:00AM
Using Time Profiler in Intruments	Nob Hill	Friday 3:00PM
Concurrent Programming with GCD in Swift 3	Pacific Heights	Friday 4:00PM

Labs

System Trace Q&A Lab	Fort Mason	Thursday 10:00PM
Xcode Open Hours	Developer Tools Lab C	Thursday 12:00PM
Profiling and Debugging Lab	Developer Tools Lab C	Friday 3:00PM
Xcode Open Hours	Developer Tools Lab B	Friday 3:00PM

WWDC16