NodeCompass: A new Paragdigm for Peformance Evaluation in Event-based Node.js

Progress Report Meeting

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Polytechnique Montréal

Département de Génie Informatique et Génie Logiciel

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1. Introduction

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2. Architecture

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3. Use Cases

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NodeCompass: A new Paradigm?

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Focus on High Level of Granularity in the Perf. Analysis

Uncover Bugs, Bottlenecks, Root causes, Race conditions either in Node.js internals or in JavaScript land

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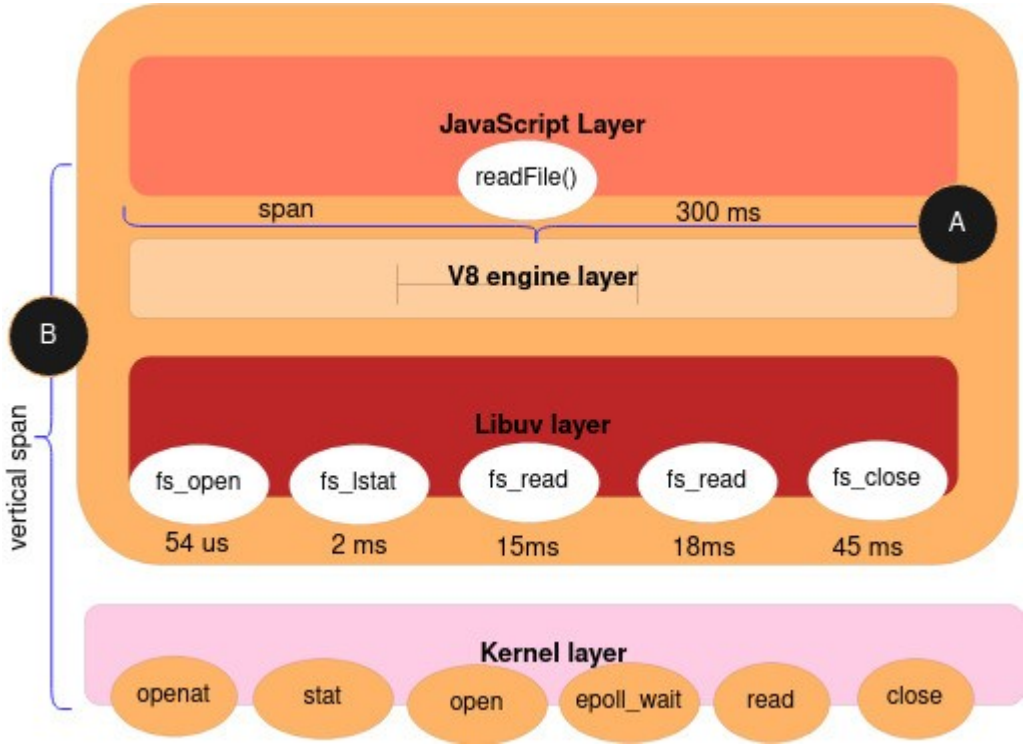
Why is NodeCompass different?

Current approaches :



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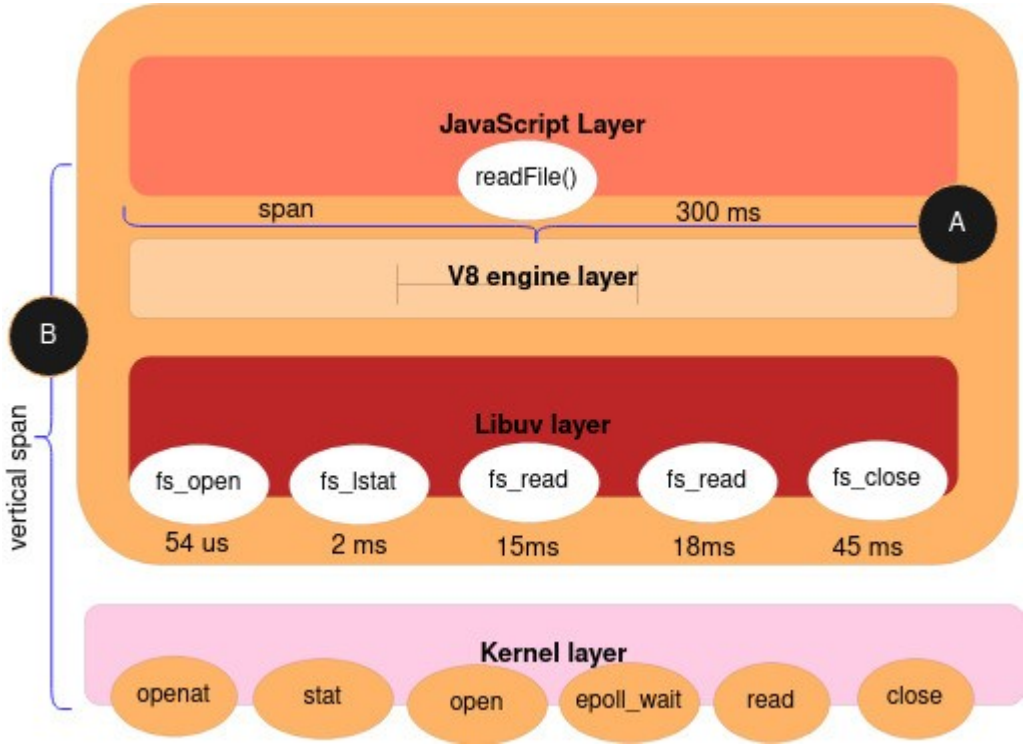

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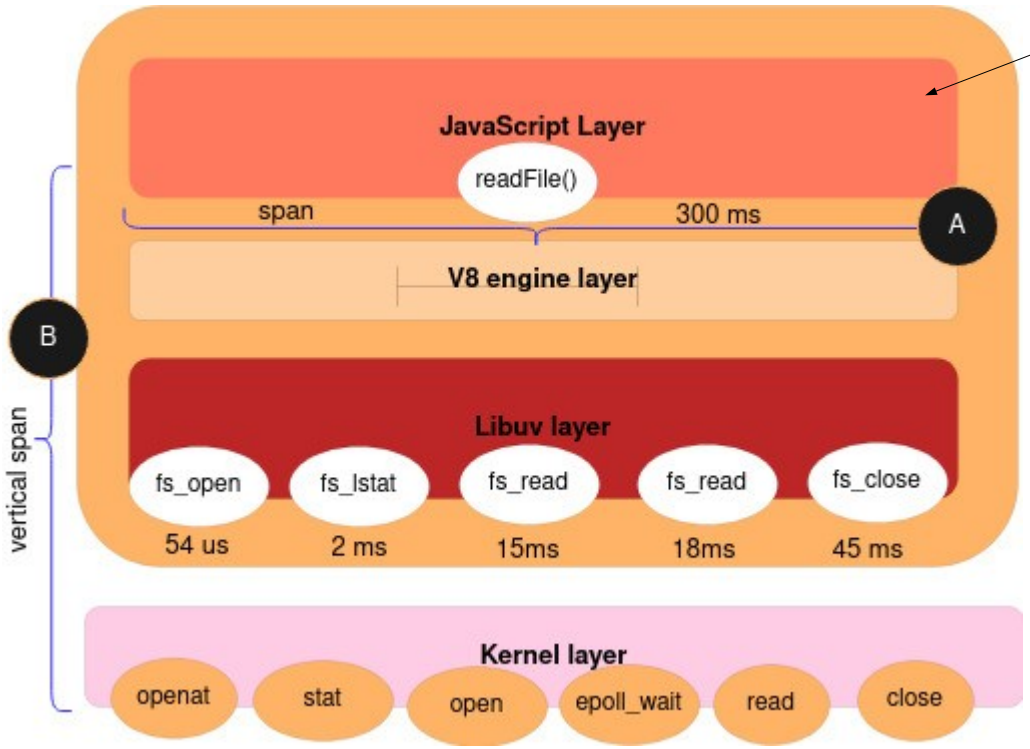

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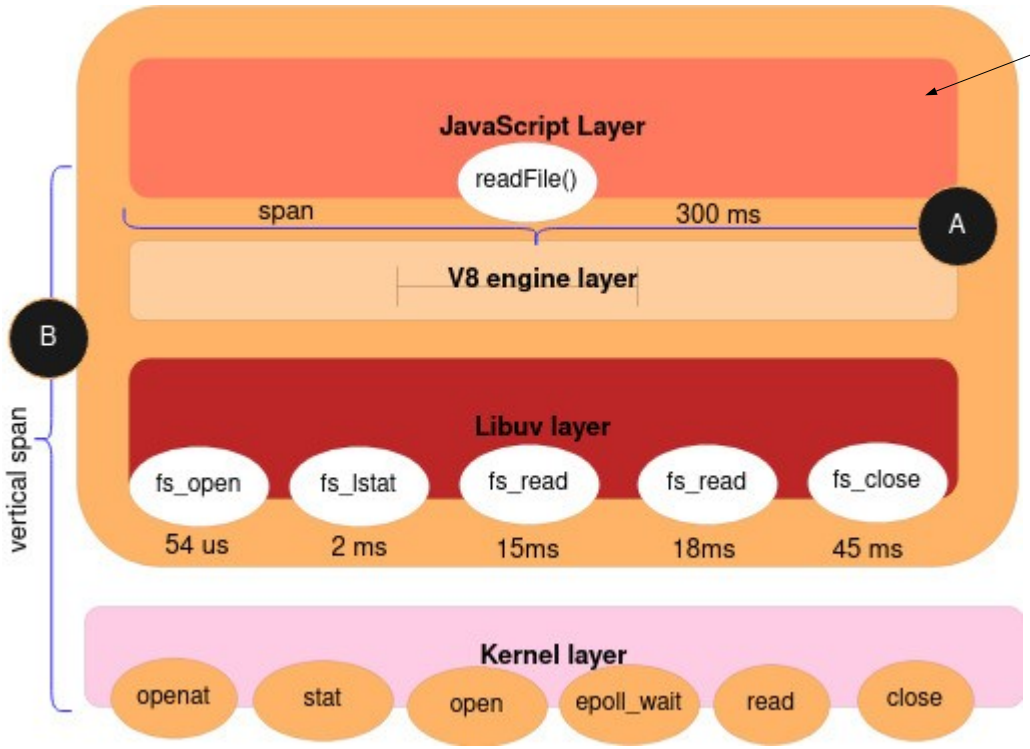

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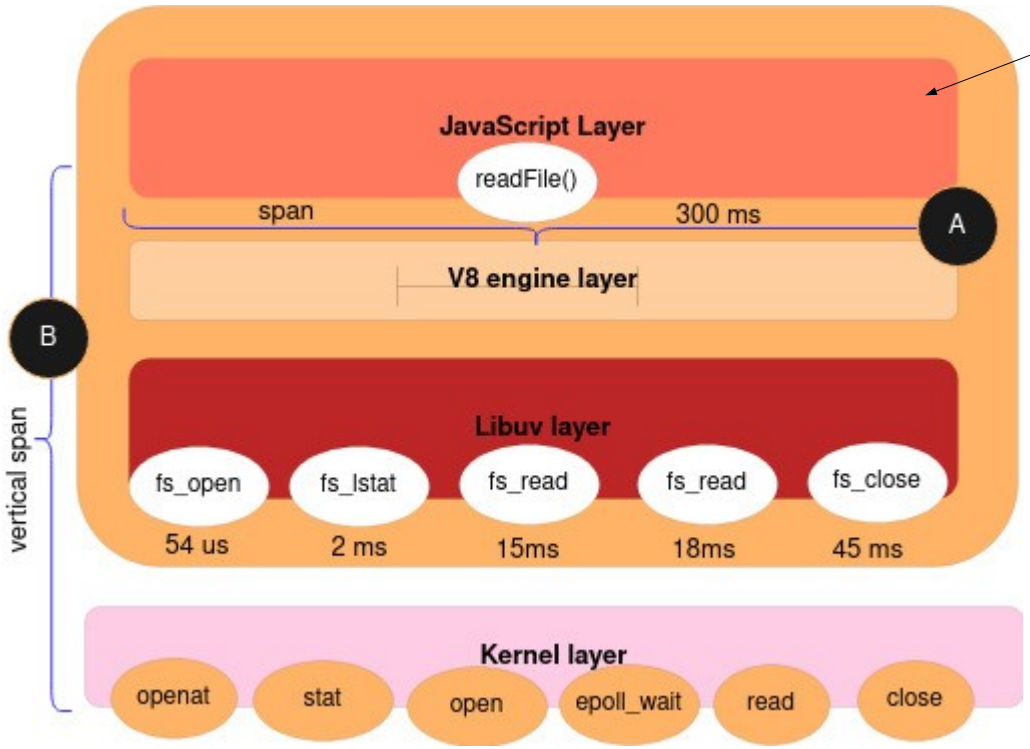

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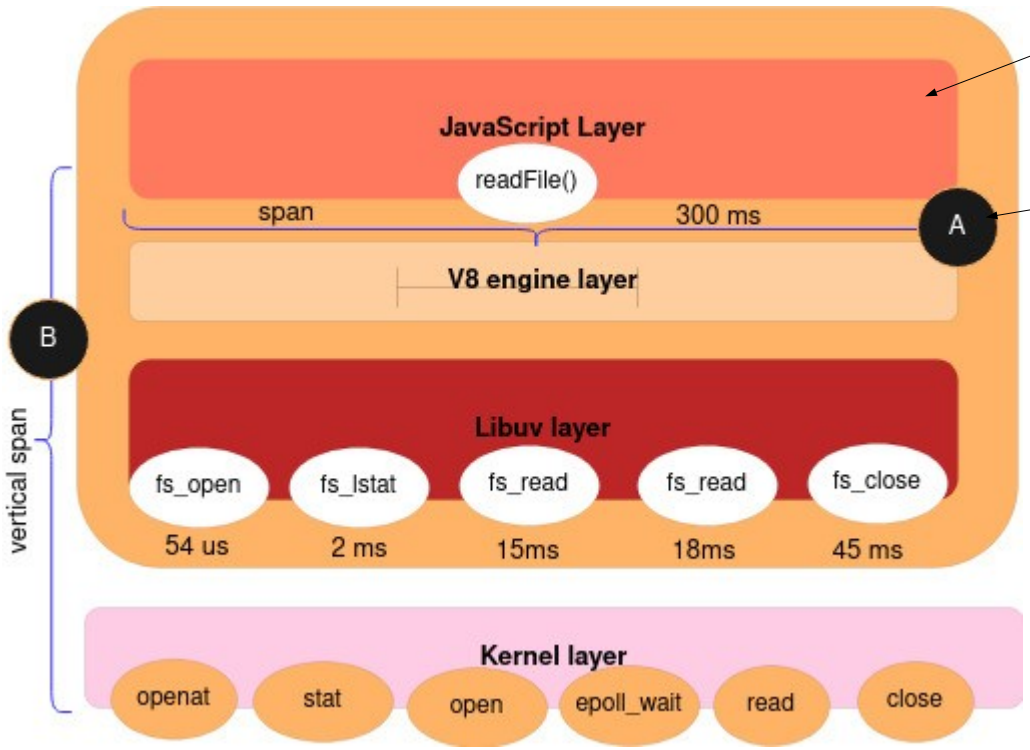

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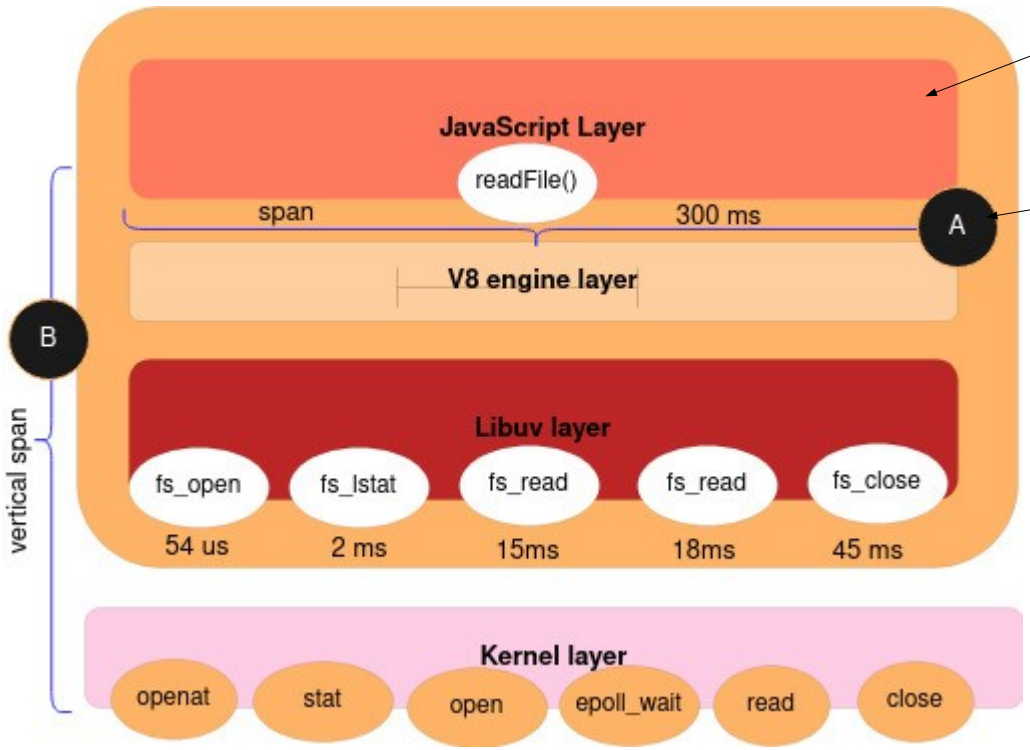

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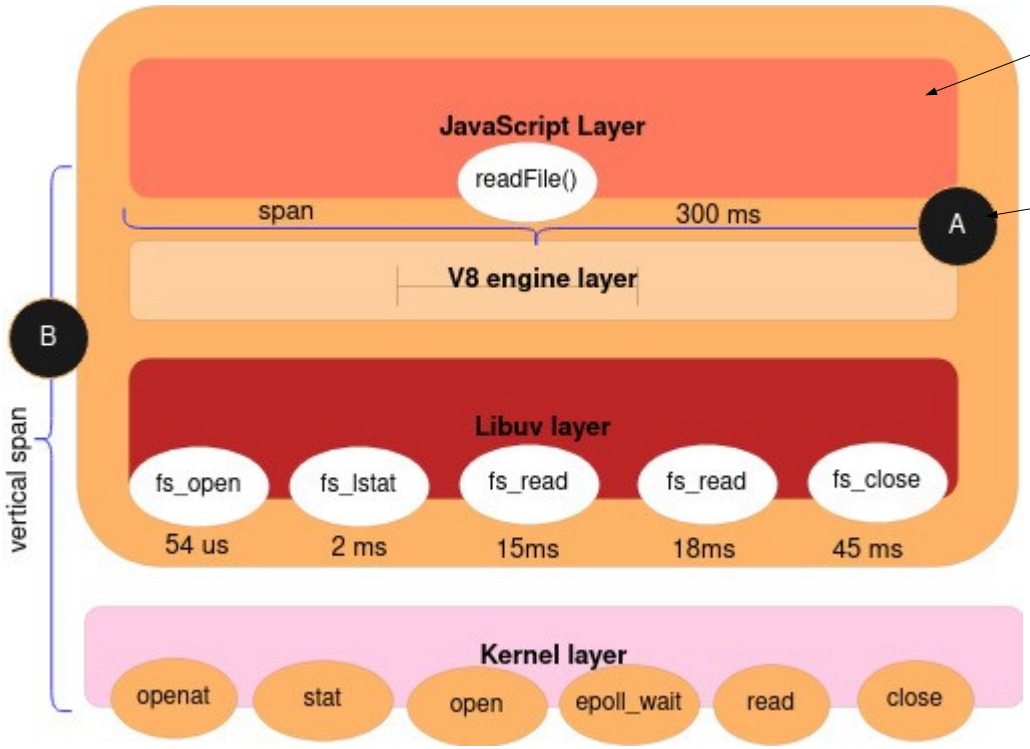

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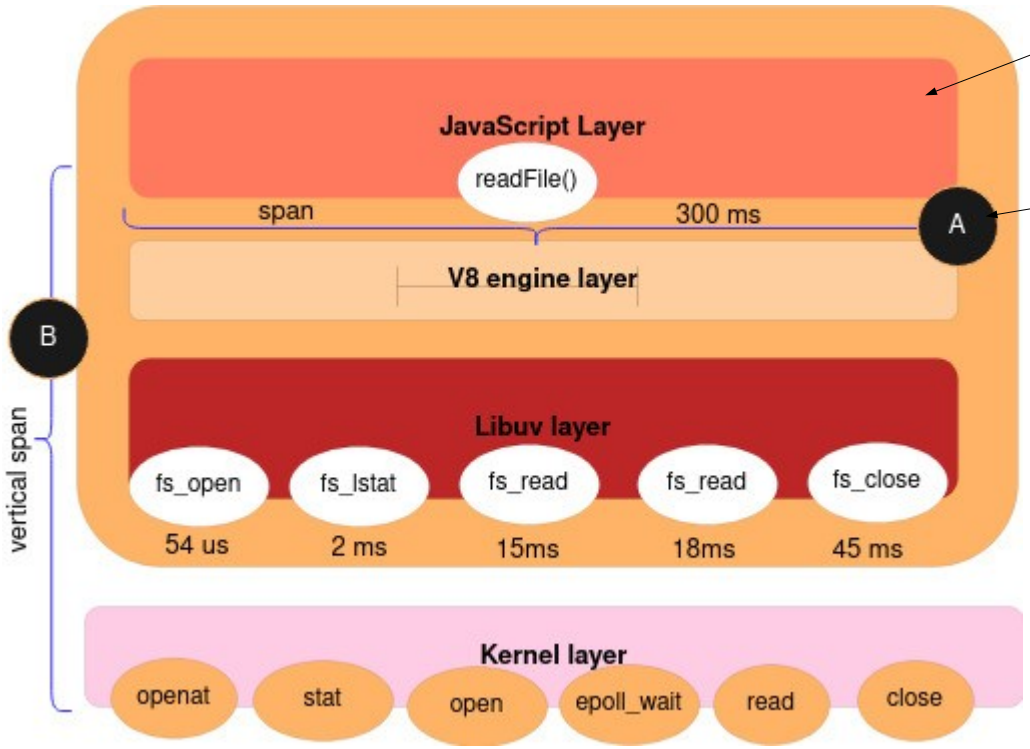

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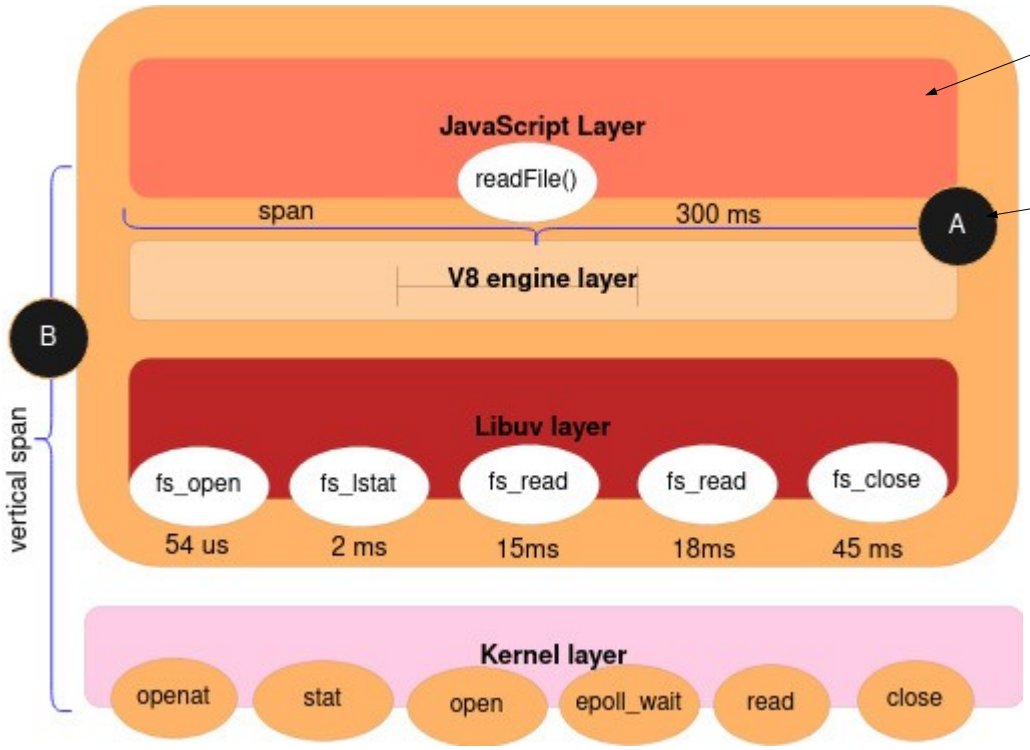

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- Lack granularity
- Too much effort to understand the root cause based on the given information

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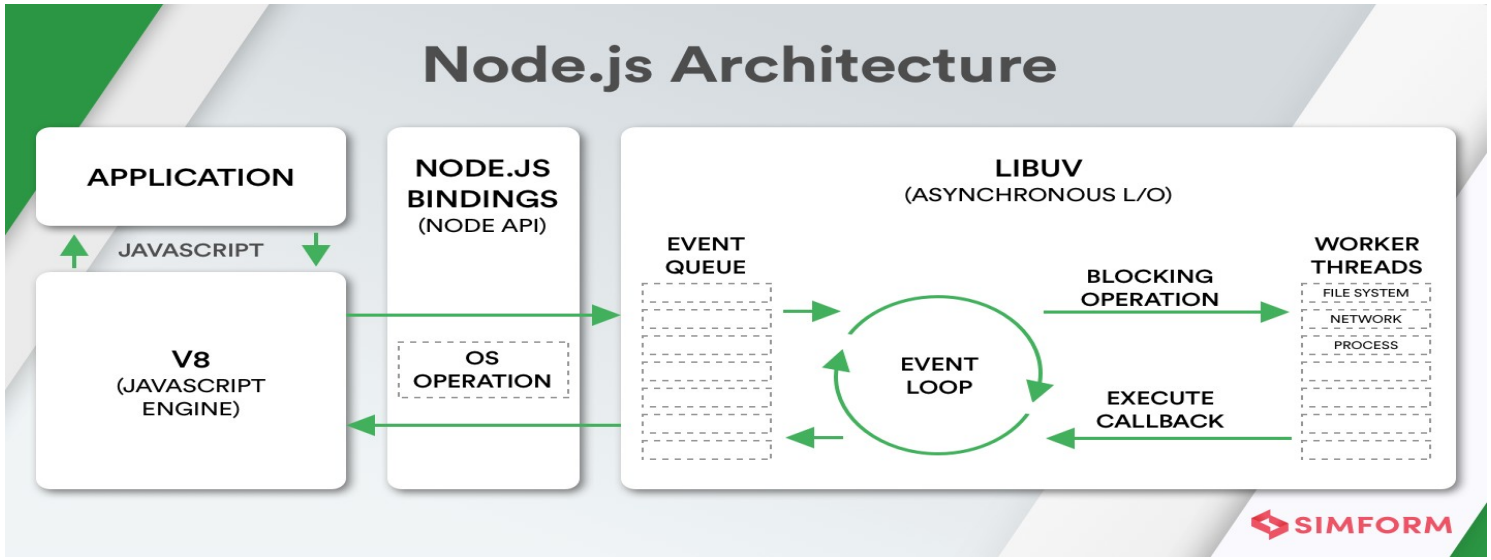
NodeCompass approach for Perf. Analysis



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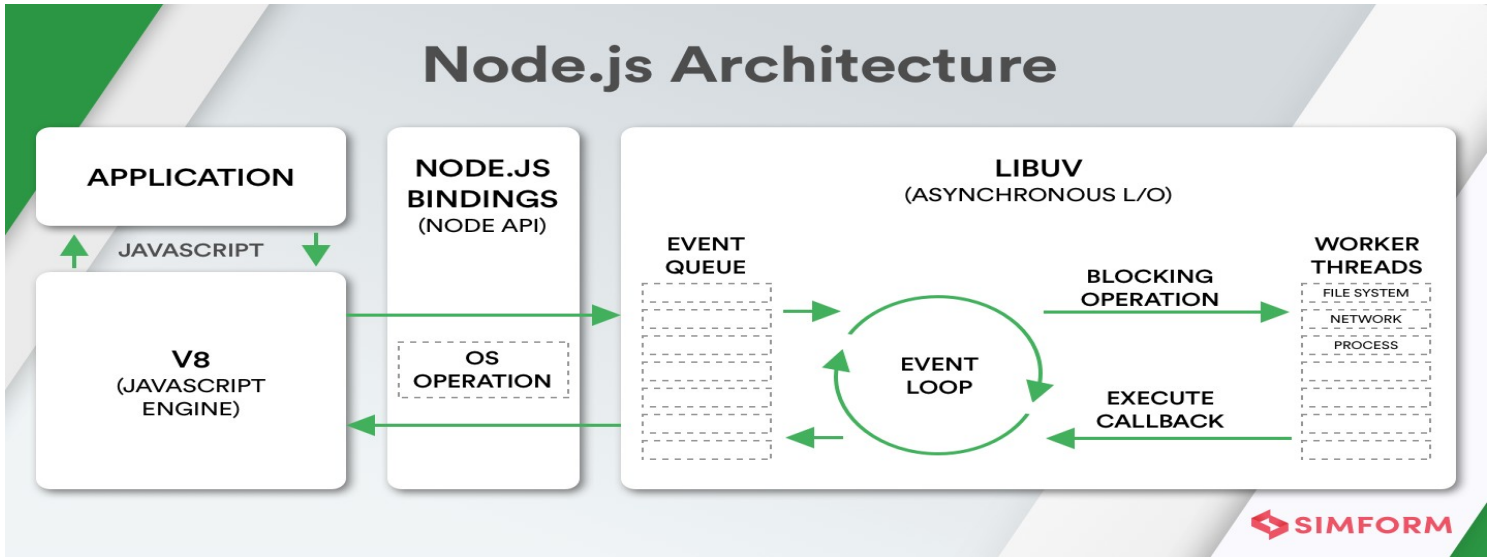

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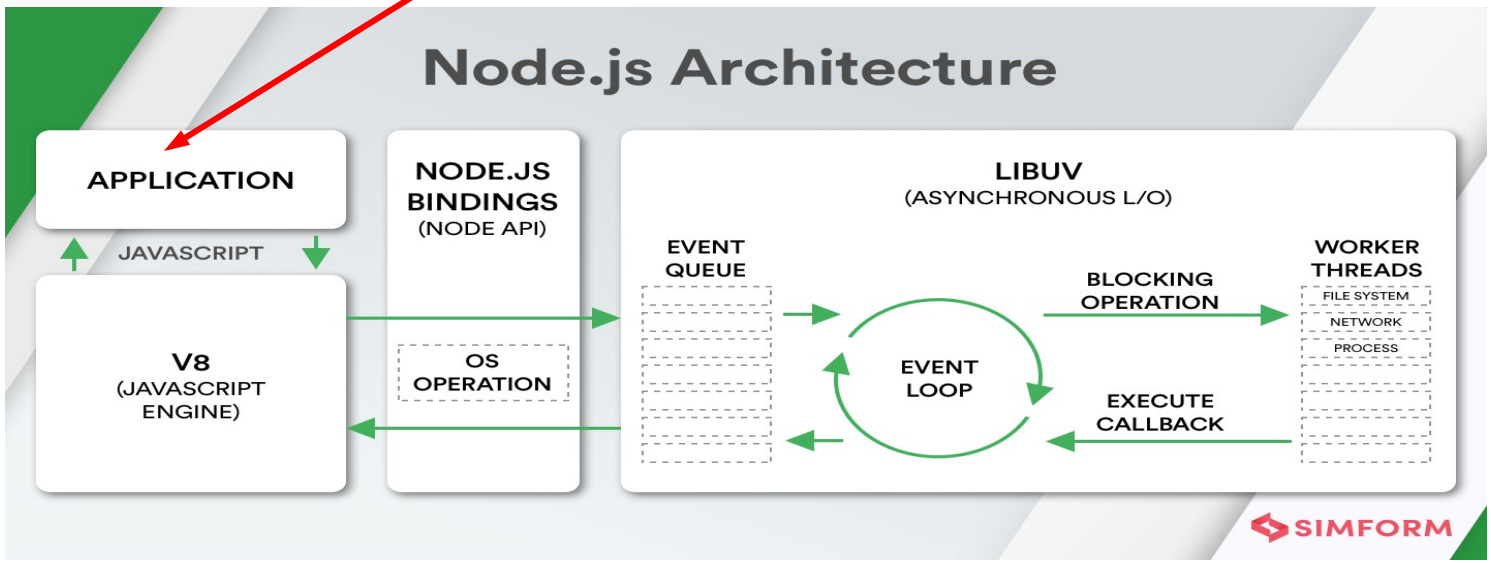

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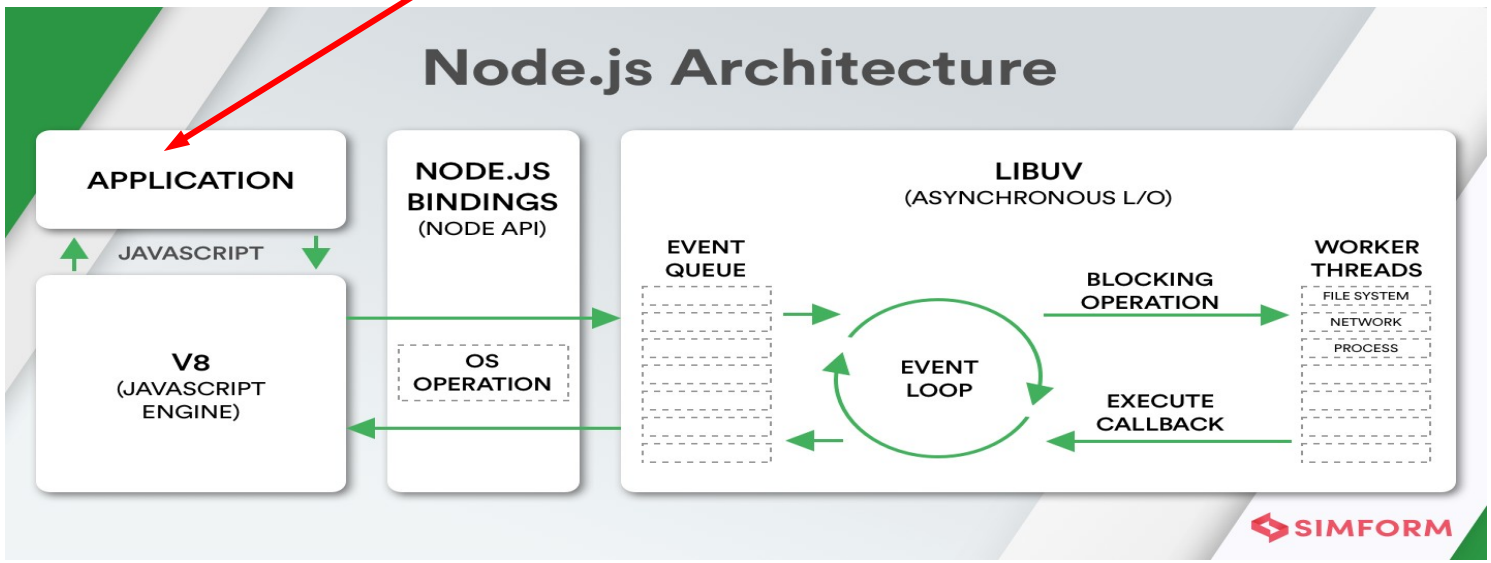

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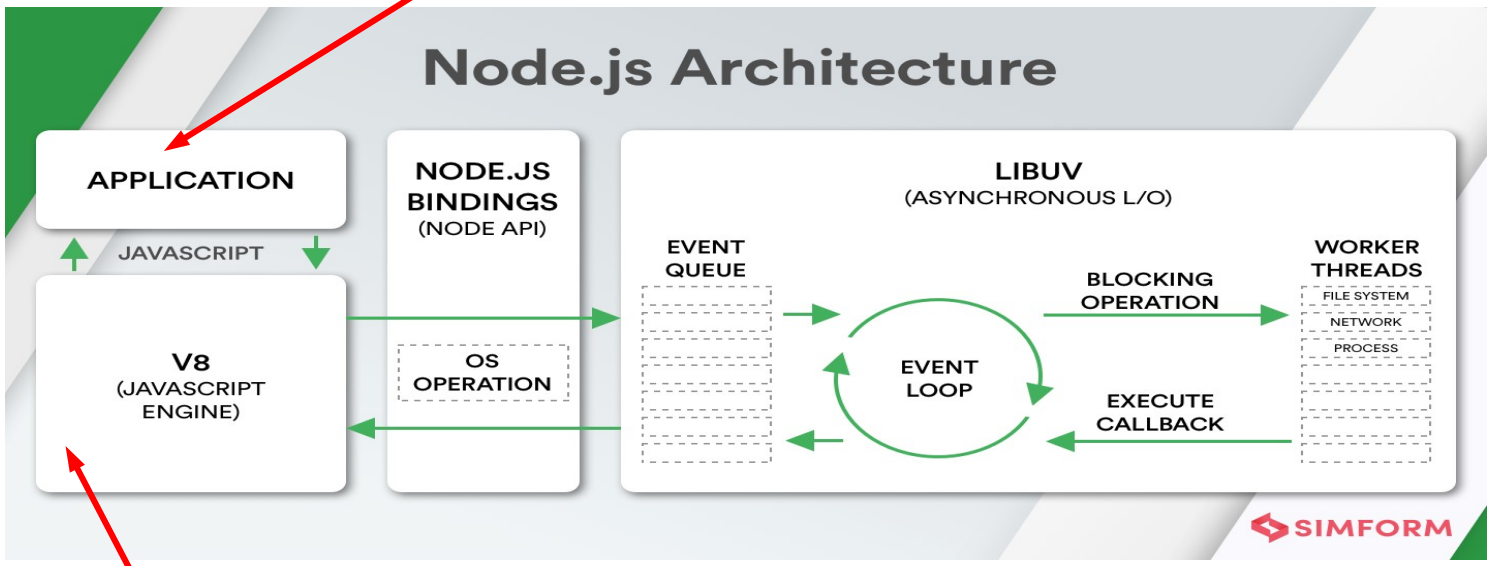

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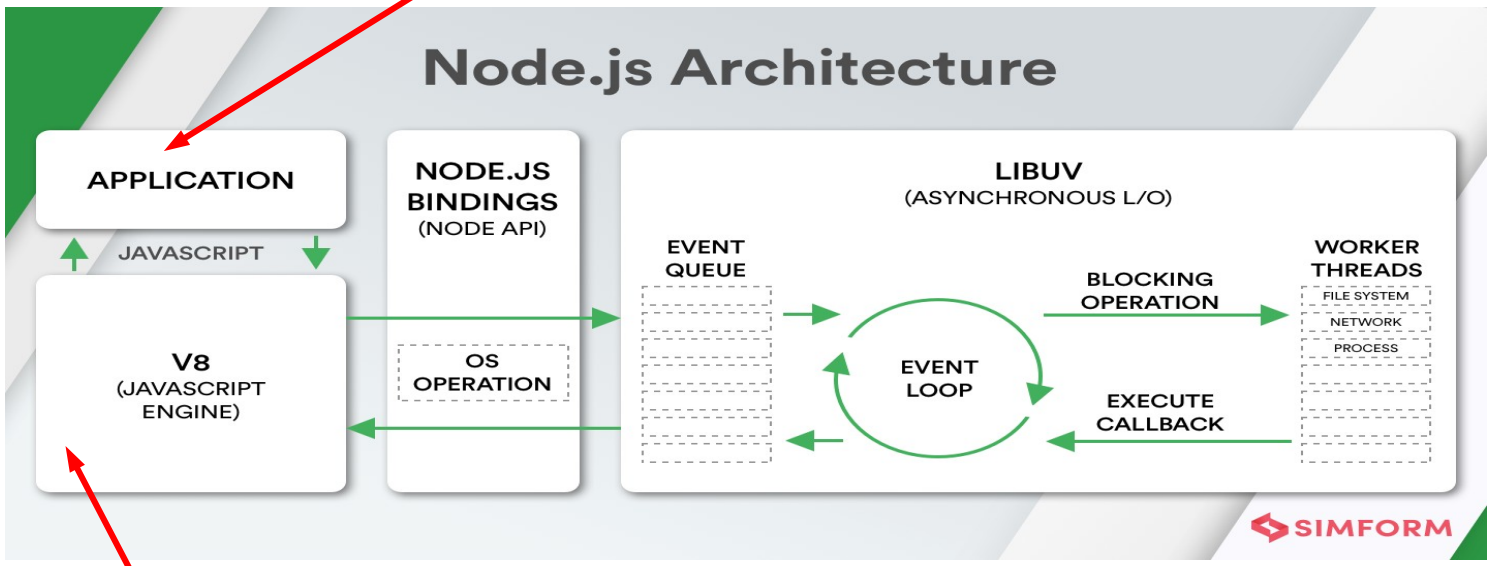

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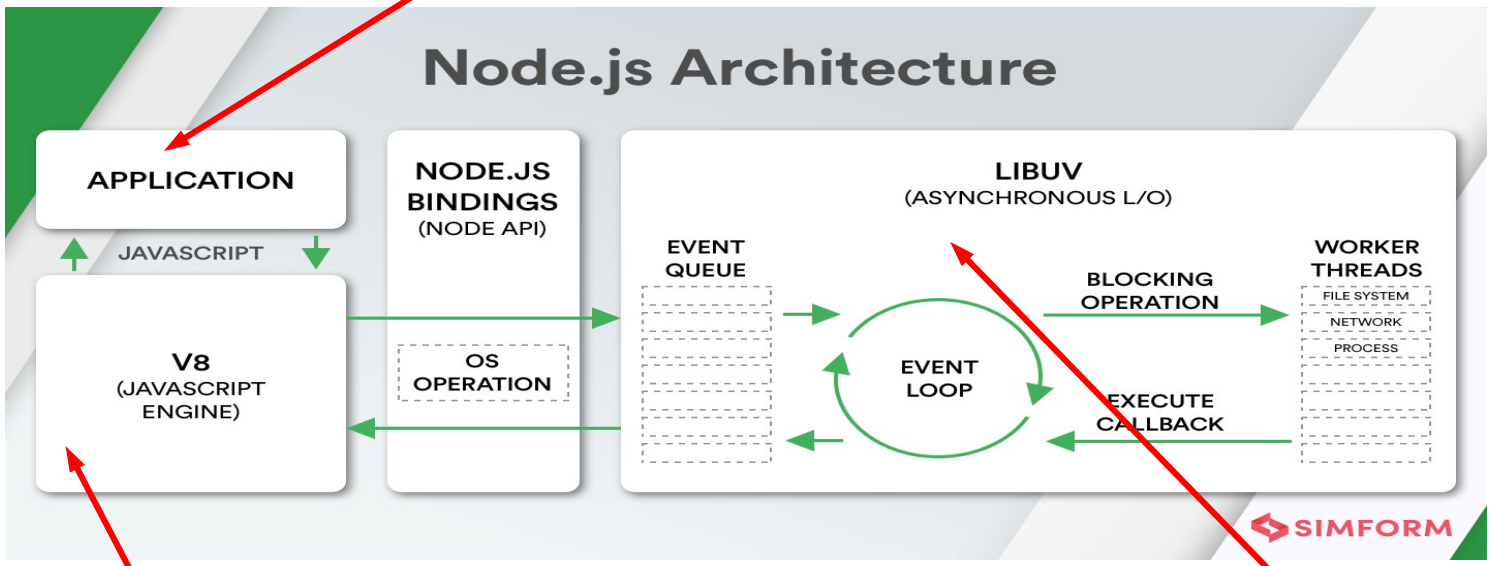

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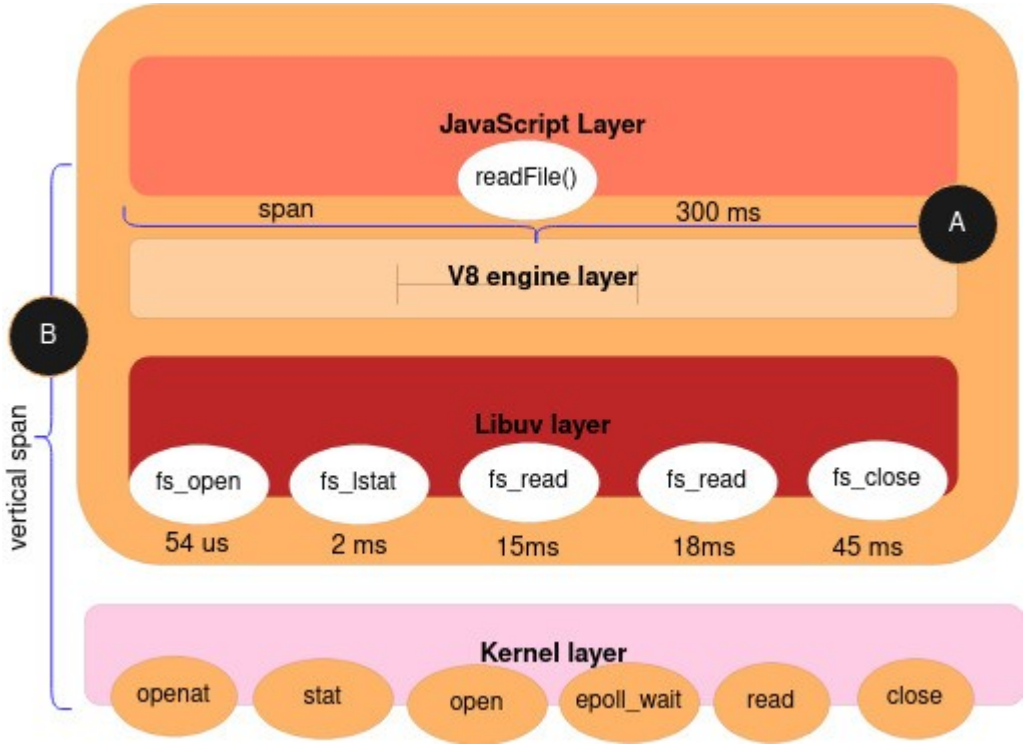

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NodeCompass approach

New paradigm:

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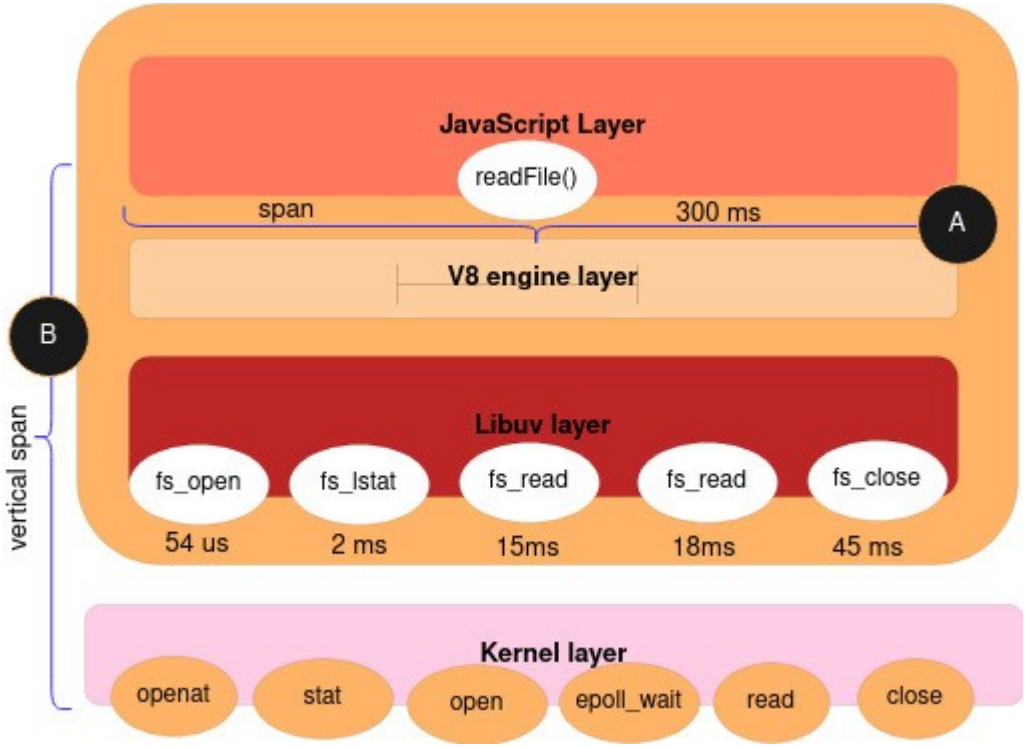

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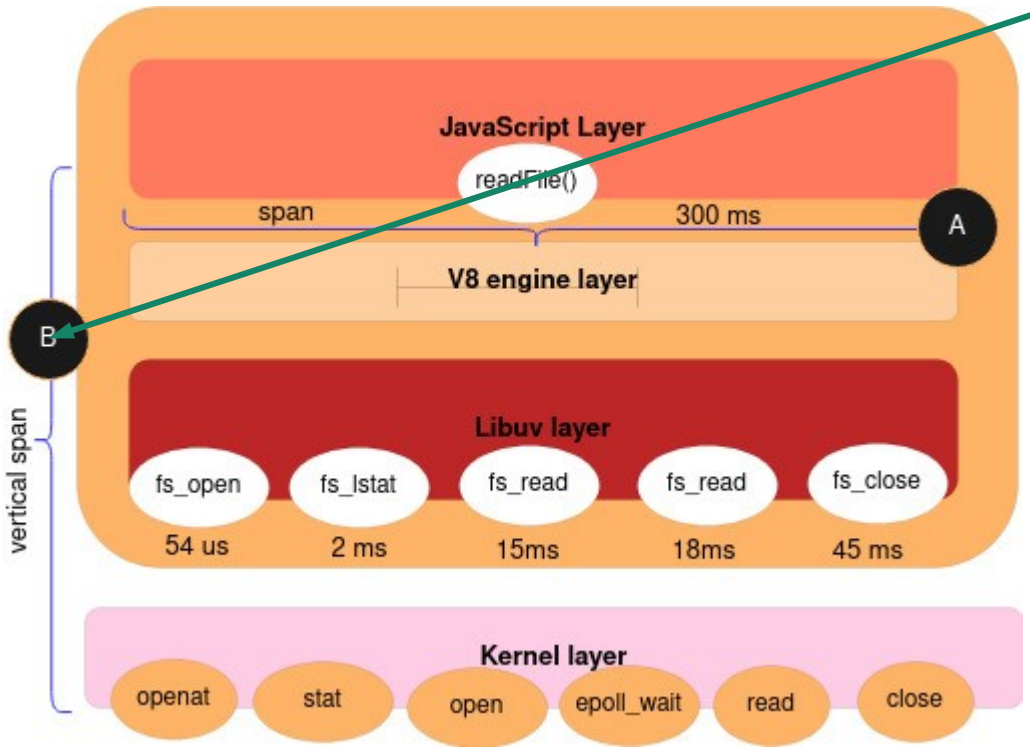

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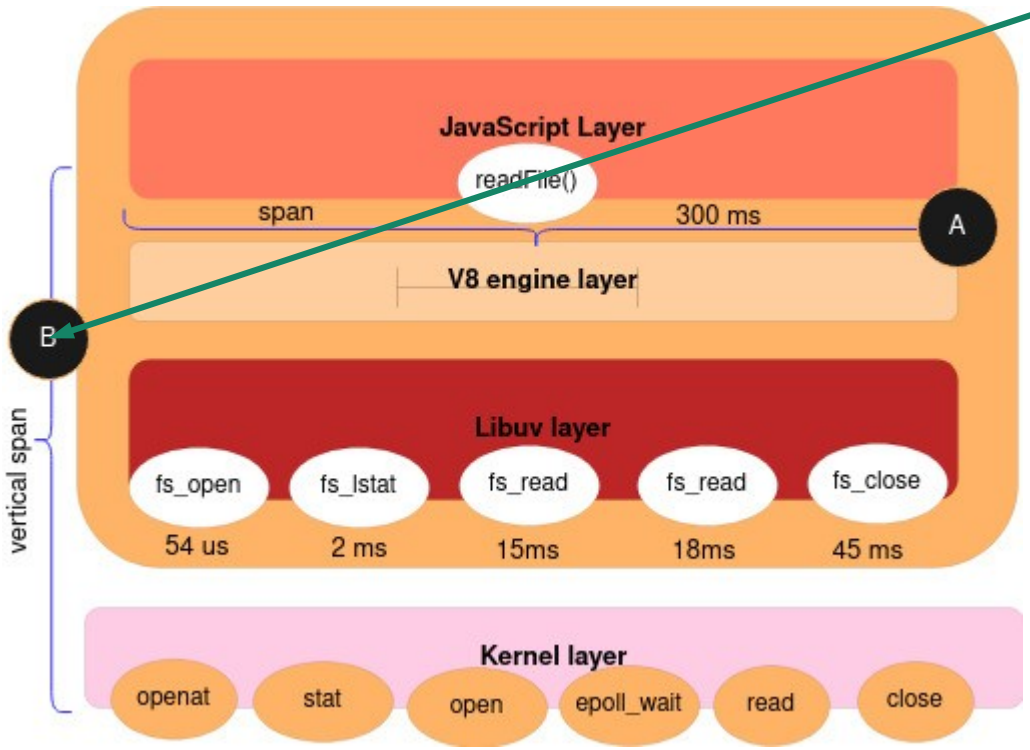

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Consider atomic operations in Node

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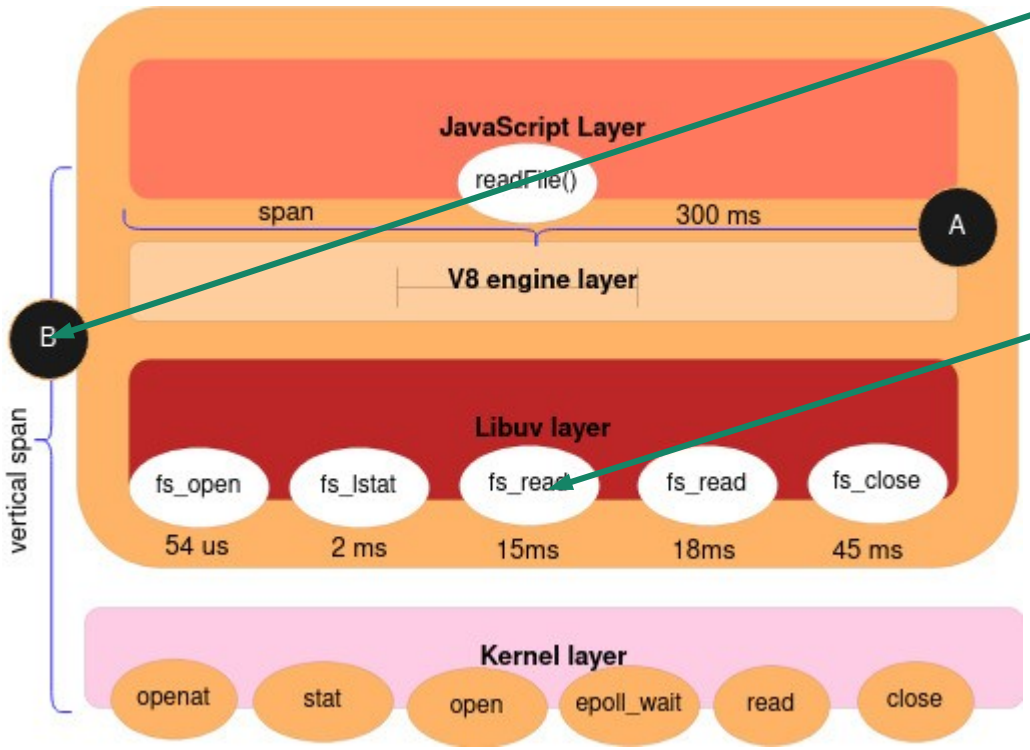

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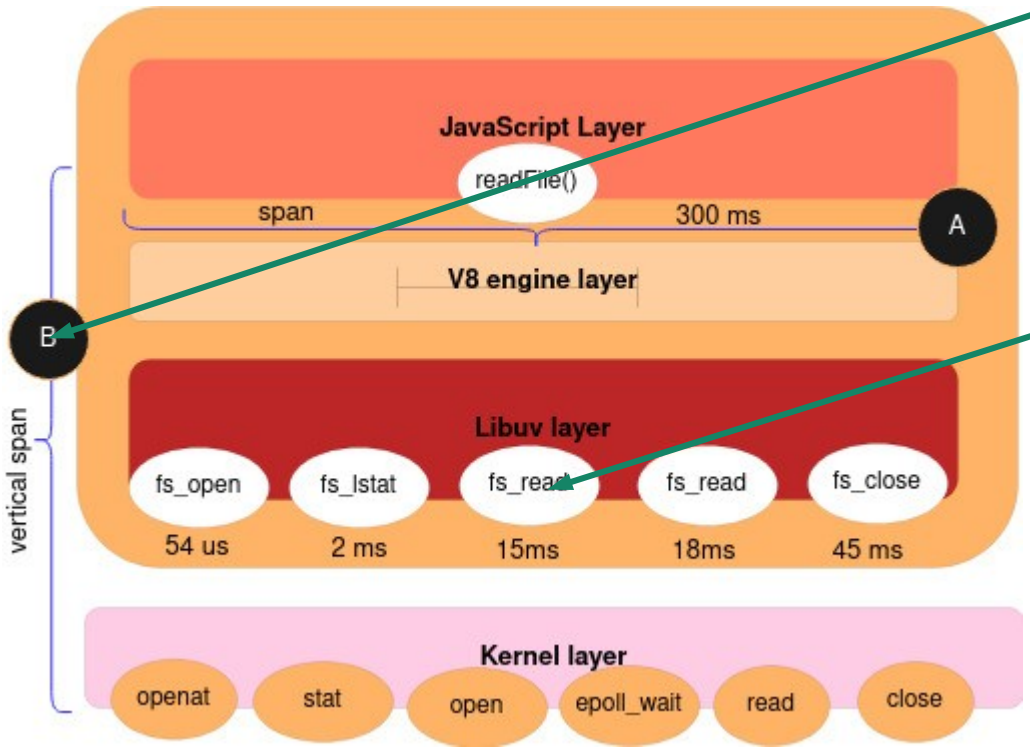

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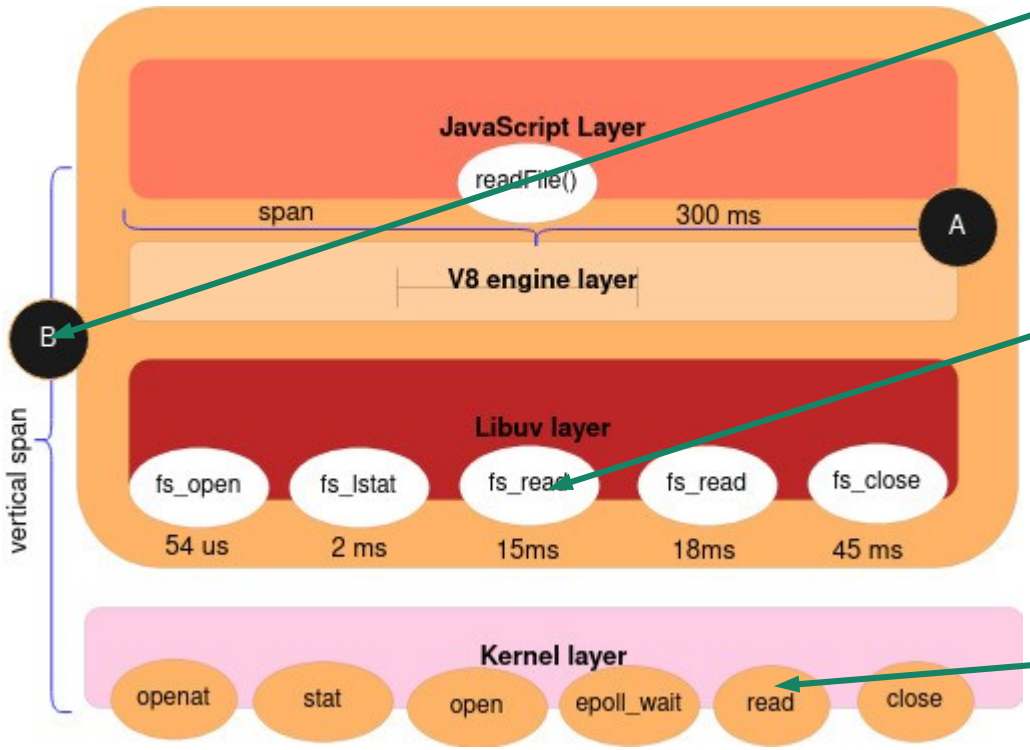

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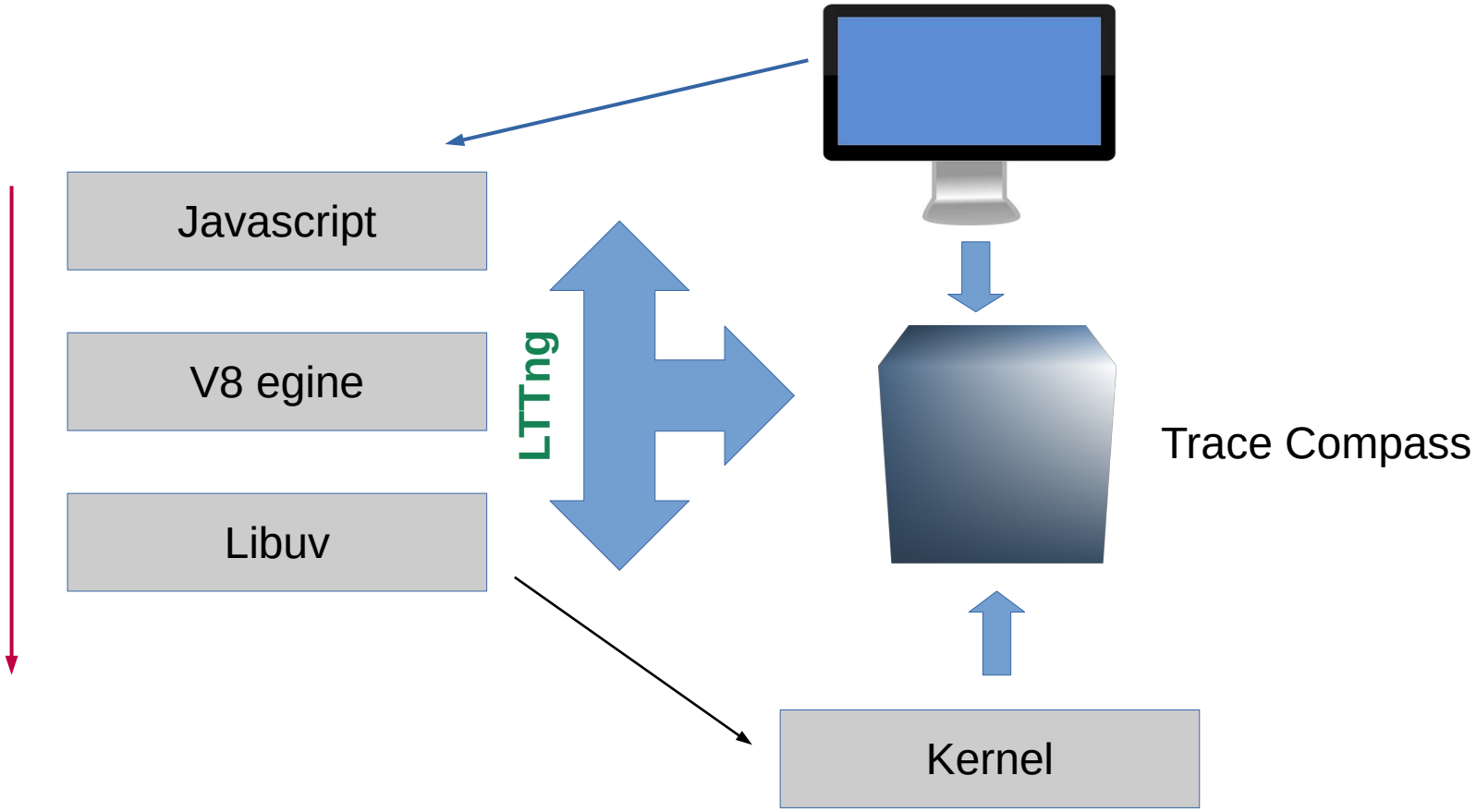
Expose race Conditions in Node.js

Introduction

- **System Architecture**



Architecture

User level-Instrumentation Example

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calcula                                  Aa ab .*  7 of 12
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566     function traceSendingRequest(message) {
567         if (trace === Trace.Off || !tracer) {
568             return;
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570         if (traceFormat === TraceFormat.Text) {
571             let data = undefined;
572             if (trace === Trace.Verbose && message.params) {
573                 data = `Params: ${JSON.stringify(message.params, null, 4)}\n\n`;
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576             calculate.send_event(message.id, async_hooks.executionAsyncId(), "js_open_" + message.method + '$server');
577         }
578         else {
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A second client ***B*** contacting continuously the server at the route /checkState

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Nextick Performance degradation scenario

An express server contacted on the rout /nexttick

A client ***A*** contacting continuously the server at the route /nexttick

A second client ***B*** contacting continuously the server at the route /checkState

After a few seconds the server stops responding to B. A performance issue appears

Use case 1

Resulting flow:

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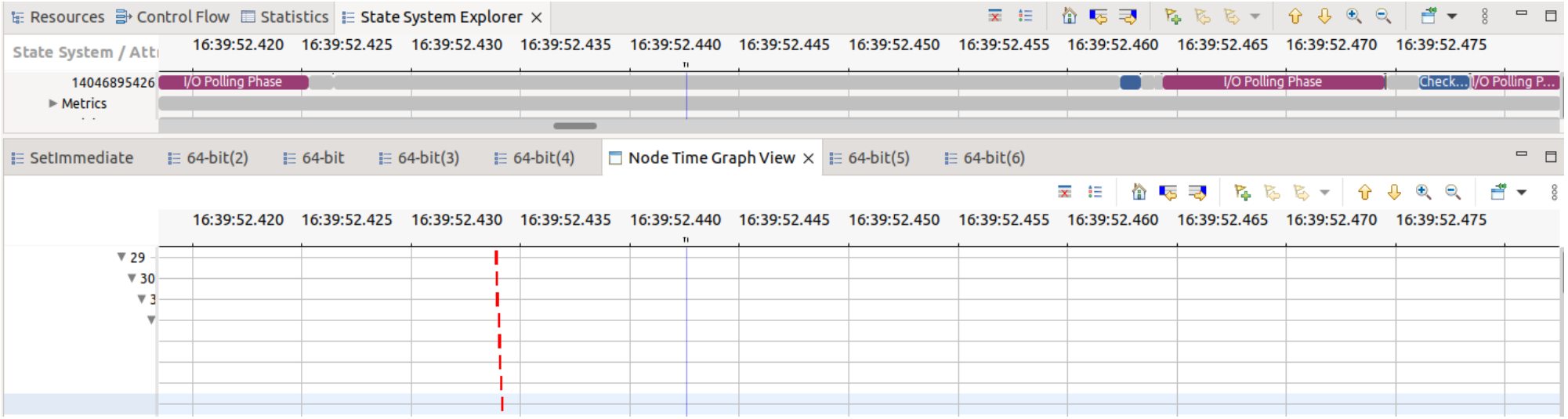
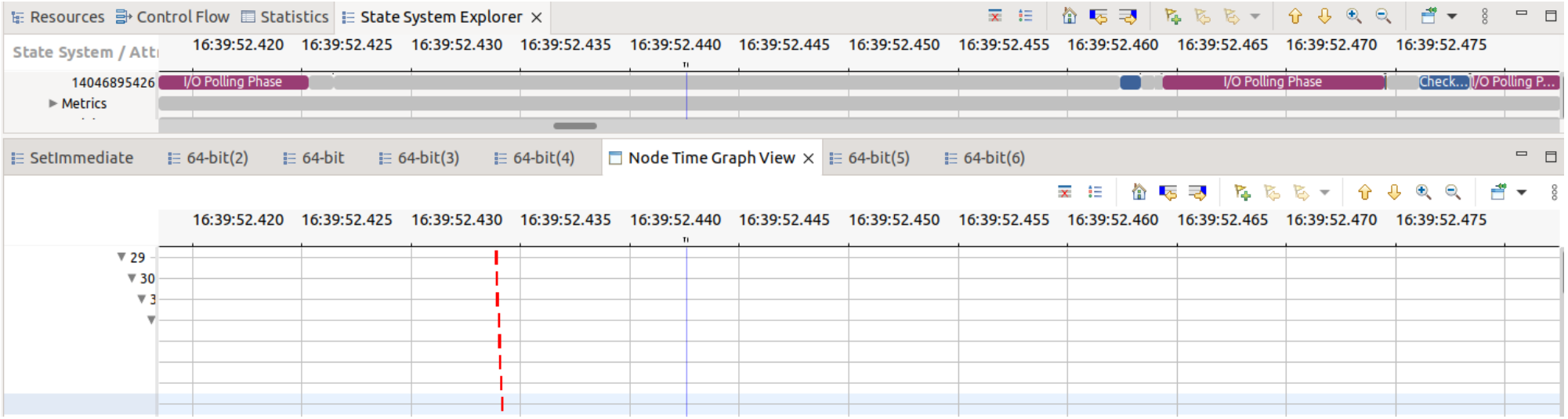


Use case 1

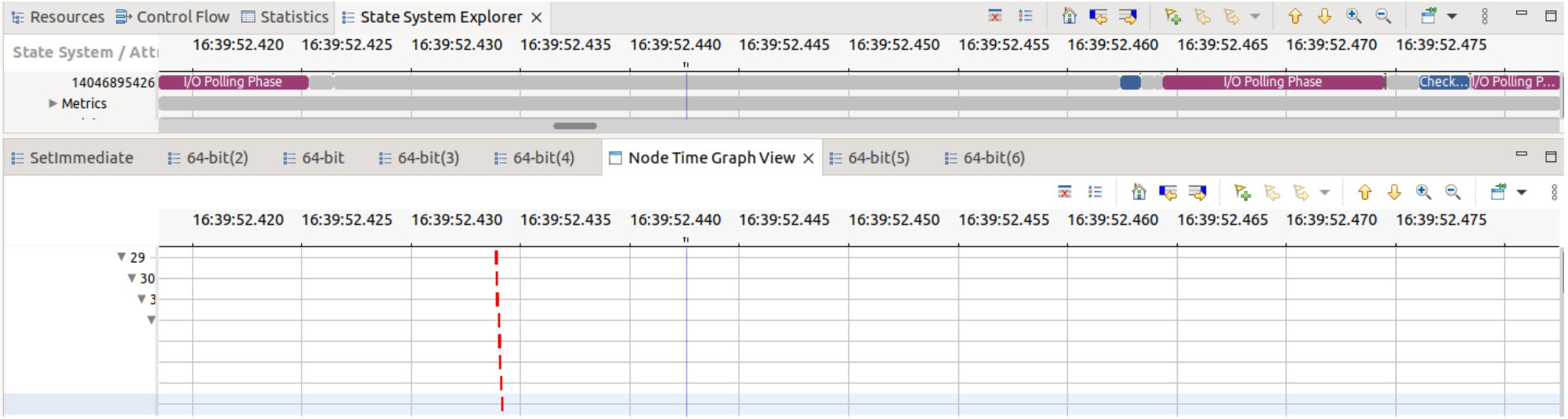
Resulting flow:



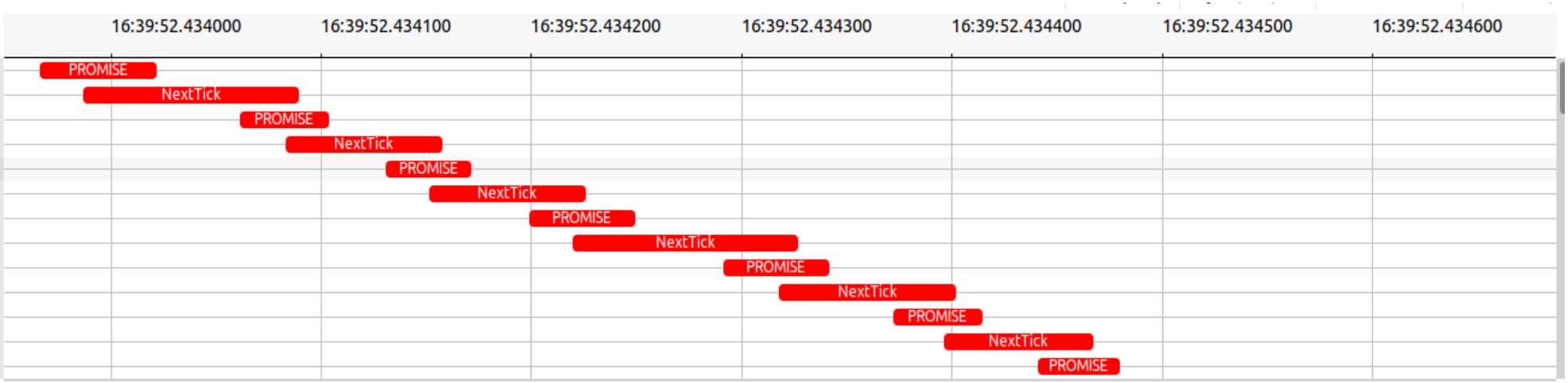
Let zoom on the view

Use case 1

Resulting flow:



Let zoom on the view

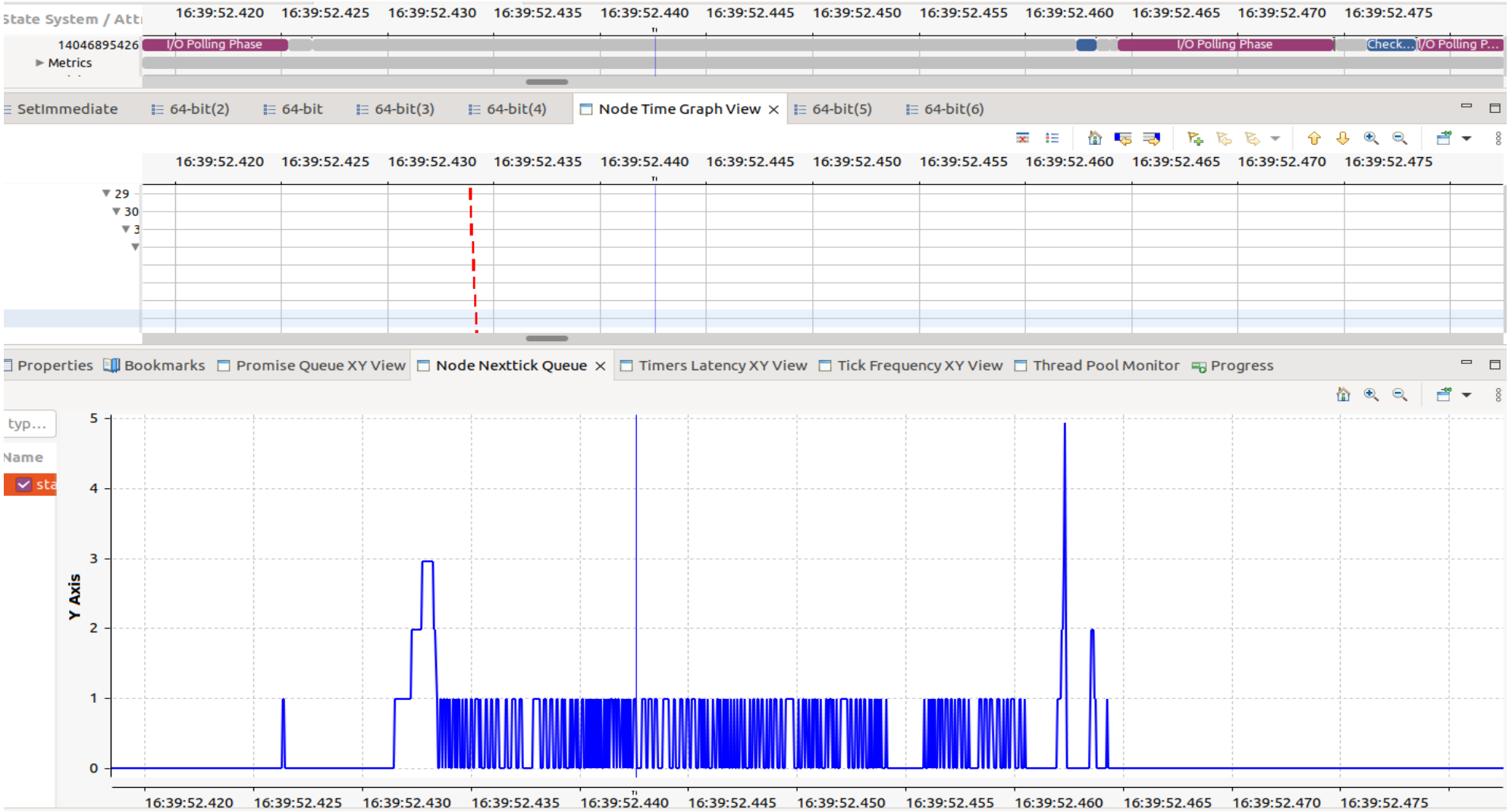


Use case 1

Results Interpretation

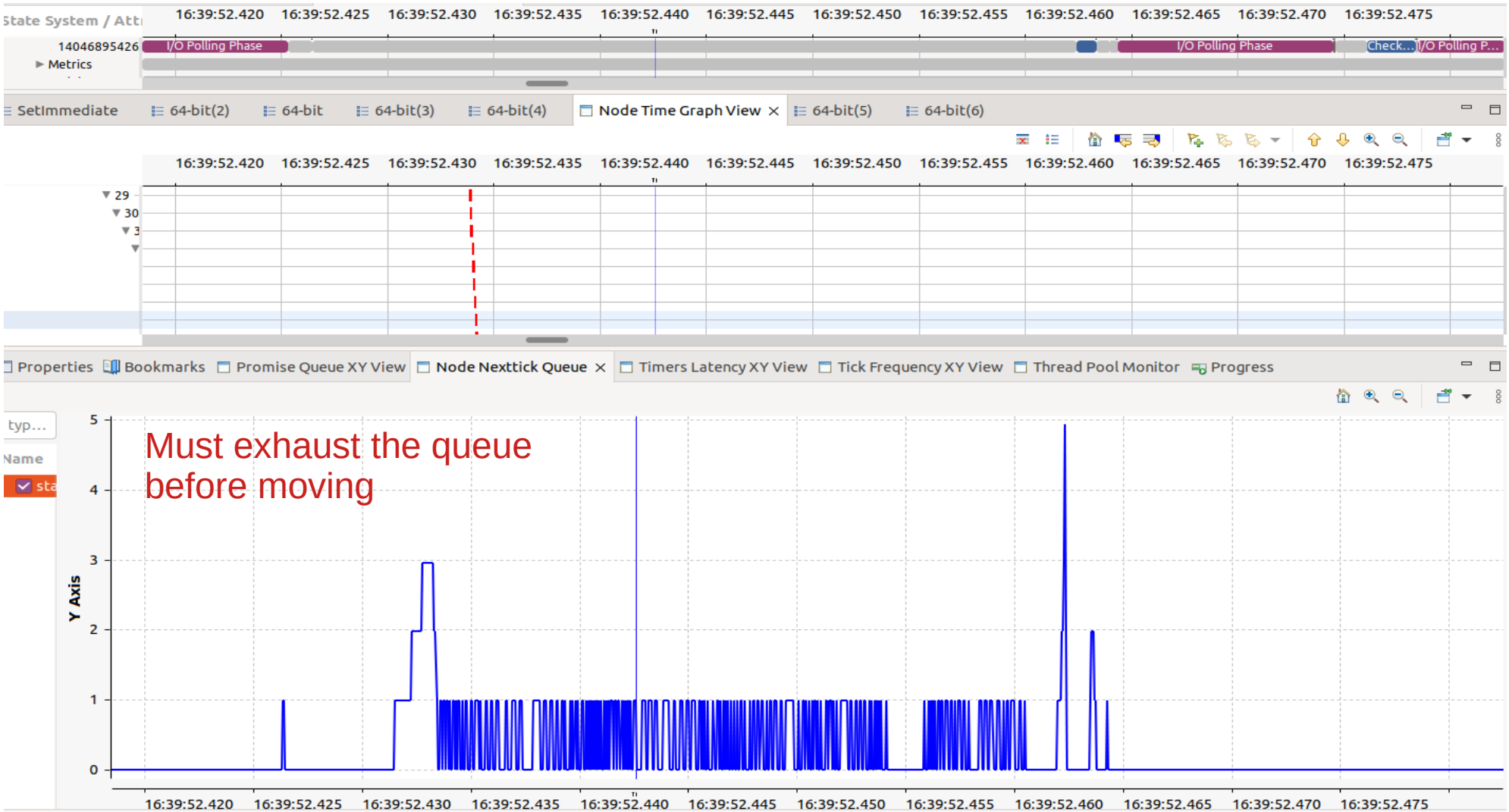
Use case 1

Results Interpretation



Use case 1

Results Interpretation

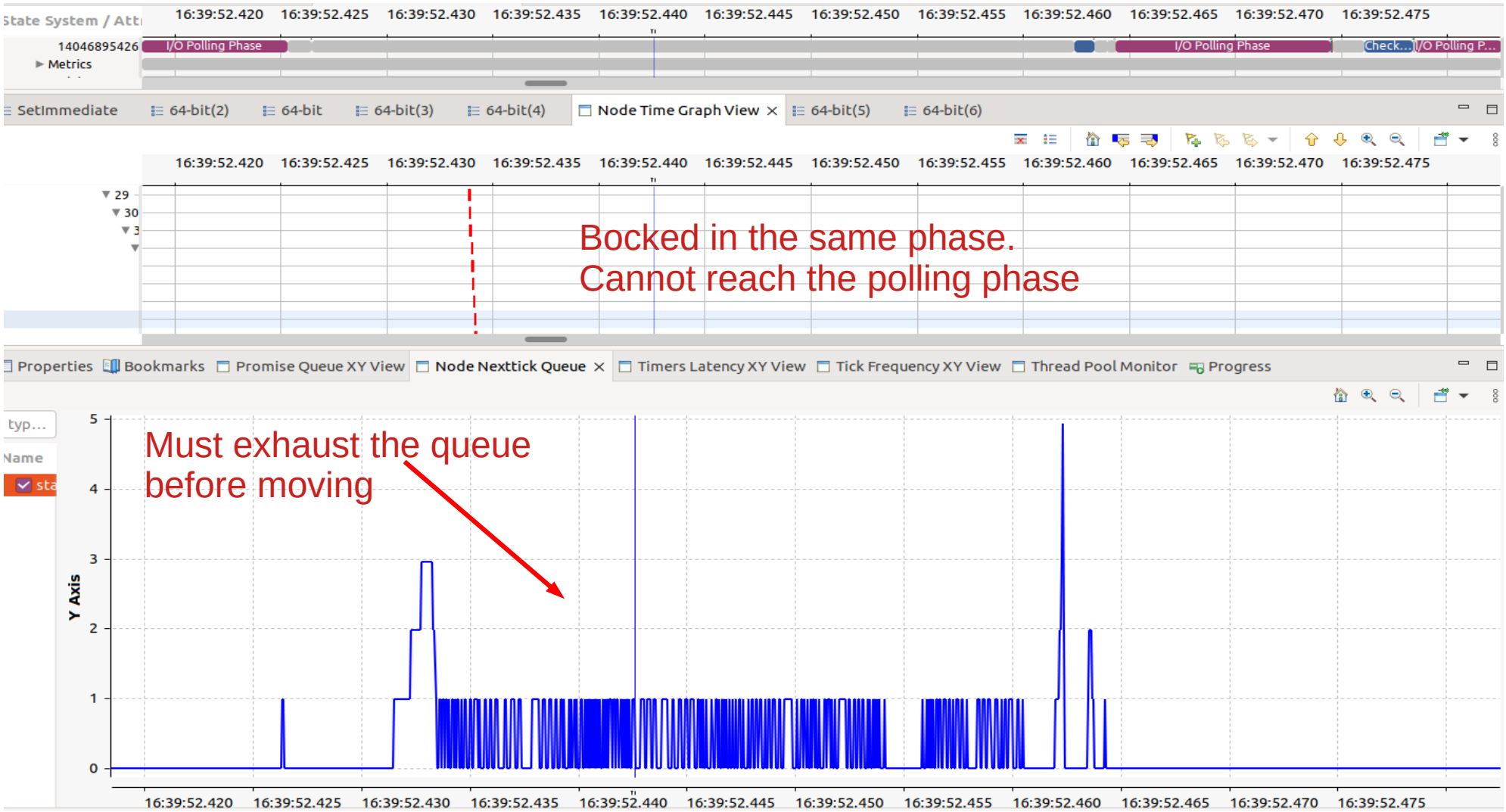


Use case 1

Results Interpretation

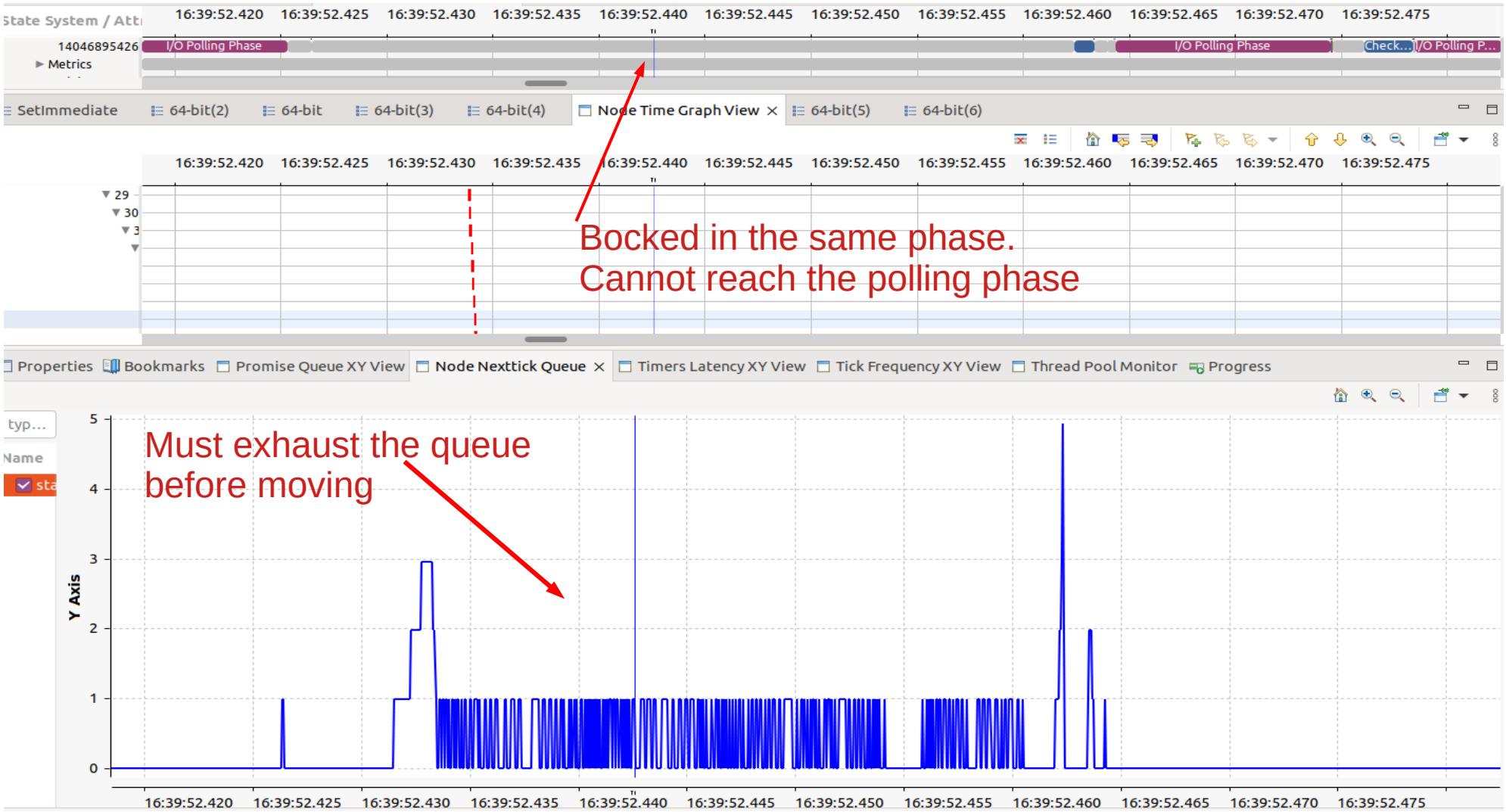
Use case 1

Results Interpretation



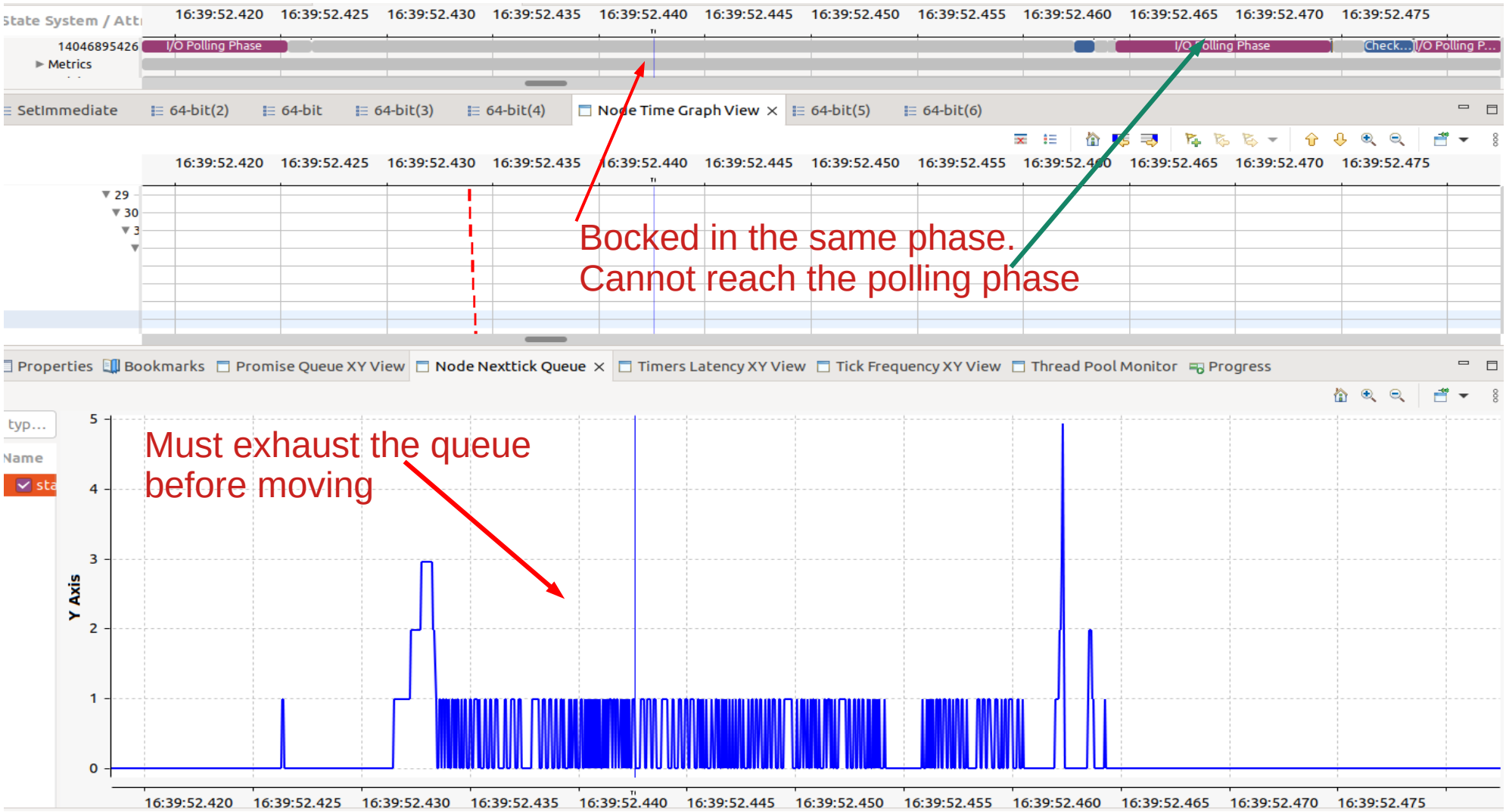
Use case 1

Results Interpretation



Use case 1

Results Interpretation



Use case 2

Asynchronous resources destruction bug

Use case 2

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Each asynchronous resource has a lifetime

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Internal mechanisms in Node.js track async. resources and destroy them after used

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“Destroy” callback is invoked when cleaning the system from the resource

Test scenario

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Internal mechanisms in Node.js track async. resources and destroy them after used

“Destroy” callback is invoked when cleaning the system from the resource

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An express server contacted at the route /test

Use case 2

Asynchronous resources destruction bug

Each asynchronous resource has a lifetime

Internal mechanisms in Node.js track async. resources and destroy them after used

“Destroy” callback is invoked when cleaning the system from the resource

Test scenario

An express server contacted at the route /test

A client ***A*** contacting continuously the server on the route /test

Use case 2

Asynchronous resources destruction bug

Each asynchronous resource has a lifetime

Internal mechanisms in Node.js track async. resources and destroy them after used

“Destroy” callback is invoked when cleaning the system from the resource

Test scenario

An express server contacted at the route /test

A client ***A*** contacting continuously the server on the route /test

When contacted by A, the server calls the ***fs.promise.readFile()*** of the file system API

Use case 2

Resulting Flow

Use case 2

Resulting Flow

Resources | Control Flow | Statistics | State System Explorer

State Syst

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

14 — Checking Phase

Met

SetImmediate | 64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5)

CPU	Event type	Contents
<srch>	<srch>	id=9544
3	uv_provider:uv_send_event	id=7923, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
3	uv_provider:uv_send_event	id=7906, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
3	uv_provider:uv_send_event	id=7905, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
3	uv_provider:uv_send_event	id=7912, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_

Properties | Bookmarks | Node Time Graph Vie | Promise Queue XY Vie | Node Nexttick Queue | Timers Latency XY Vie | Tick Frequency XY Vie | Thread Pool Monitor | Progress

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

PROMISE

PROMISE

PR...

fs_read

Trace	9545
Date	2022-05-04
Start Time	16:47:40.694818529
Stop Time	16:47:40.699026325
Duration	0.004207796s (4,2 ms)

Use case 2

Resulting Flow

Resources | Control Flow | Statistics | State System Explorer

State Syst

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

14 — Checking Phase

SetImmediate | 64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5)

CPU	Event type	Contents
<srch>	<srch>	id=9544
3	uv_provider:uv_send_event	id=7923, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
3	uv_provider:uv_send_event	id=7906, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
3	uv_provider:uv_send_event	id=7905, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
3	uv_provider:uv_send_event	id=7912, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_

Properties | Bookmarks | Node Time Graph Vie | Promise Queue XY Vie | Node Nexttick Queue | Timers Latency XY Vie | Tick Frequency XY Vie | Thread Pool Monitor | Progress

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

PROMISE

PROMISE

PR...

fs_read

Trace	9545
Date	2022-05-04
Start Time	16:47:40.694818529
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Duration	0.004207796s (4,2 ms)

Atomic read operation

Use case 2

Resulting Flow

Resources | Control Flow | Statistics | State System Explorer

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

Checking Phase

SetImmediate | 64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5)

CPU	Event type	Contents
<srch>	<srch>	id=9544
3	uv_provider:uv_send_event	id=7923, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
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PROMISE

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PR...

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Atomic read operation

Use case 2

Results interpretation

Use case 2

Results interpretation

Resources | Control Flow | Statistics | State System Explorer

State Syst

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

14 — Checking Phase

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CPU	Event type	Contents
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PROMISE

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Use case 2

Results interpretation

Resources | Control Flow | Statistics | State System Explorer

State Syst

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

14 — Checking Phase

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SetImmediate | 64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5)

CPU	Event type	Contents
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PROMISE

PROMISE

PR...

fs_read

Trace	9545
Date	2022-05-04
Start Time	16:47:40.694818529
Stop Time	16:47:40.699026325
Duration	0.004207796s (4,2 ms)

Abnormal behavior

Use case 2

Results interpretation

Resources | Control Flow | Statistics | State System Explorer

State Syst

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

14 — Checking Phase

Met

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Properties | Bookmarks | Node Time Graph Vie | Promise Queue XY Vie | Node Nexttick Queue | Timers Latency XY Vie | Tick Frequency XY Vie | Thread Pool Monitor | Progress

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PROMISE

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PR...

fs_read

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Stop Time	16:47:40.699026325
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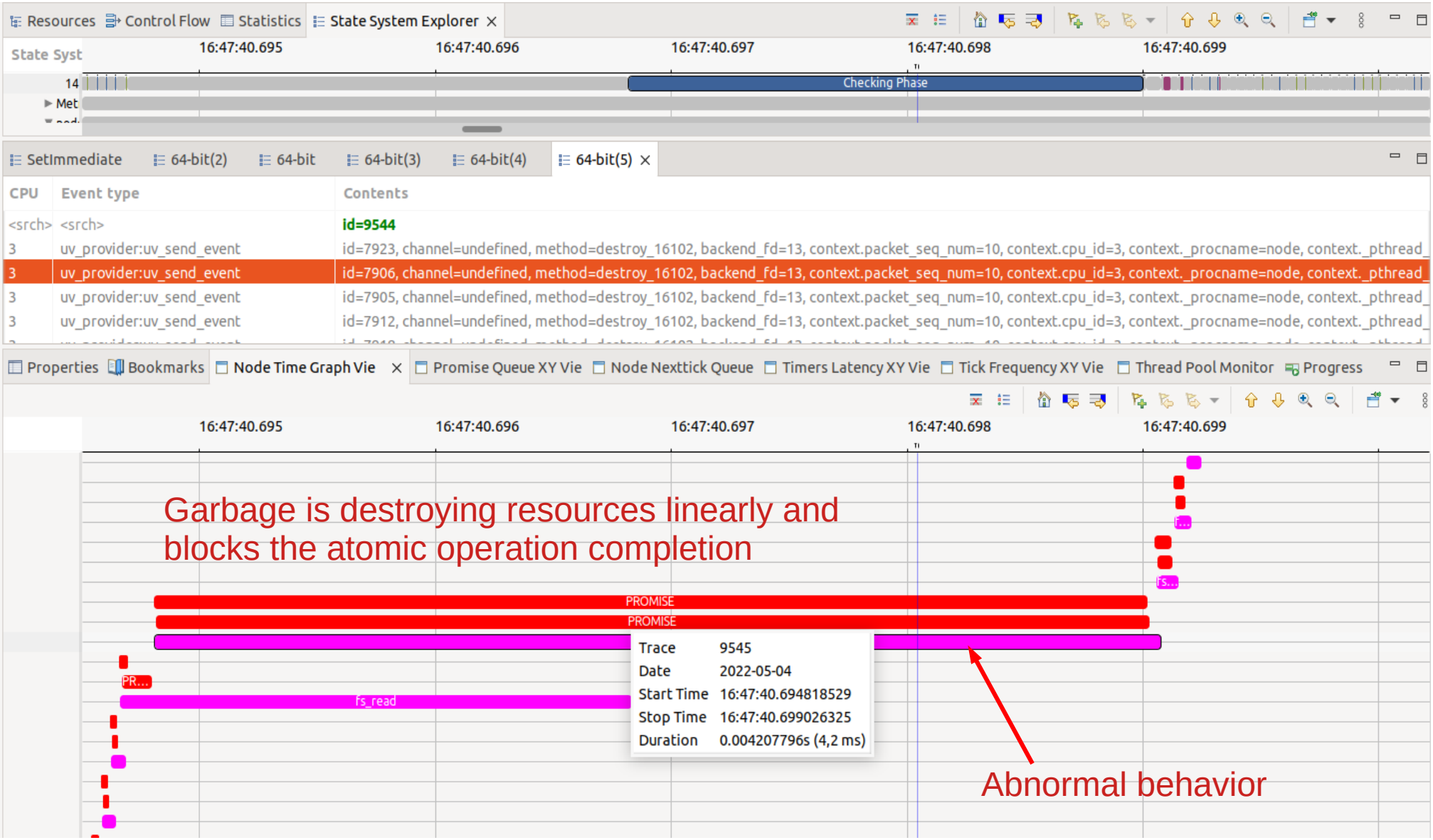
Abnormal behavior

Use case 2

Results interpretation



Use case 2

Results interpretation

Resources | Control Flow | Statistics | State System Explorer

State Syst

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

14 — Checking Phase

Met

SetImmediate | 64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5)

CPU	Event type	Contents
<srch>	<srch>	id=9544
3	uv_provider:uv_send_event	id=7923, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_
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3	uv_provider:uv_send_event	id=7912, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cpu_id=3, context._procname=node, context._pthread_

Properties | Bookmarks | Node Time Graph Vie | Promise Queue XY Vie | Node Nexttick Queue | Timers Latency XY Vie | Tick Frequency XY Vie | Thread Pool Monitor | Progress

16:47:40.695 16:47:40.696 16:47:40.697 16:47:40.698 16:47:40.699

Garbage is destroying resources linearly and blocks the atomic operation completion

PROMISE

PROMISE

PR...

fs_read

Trace	9545
Date	2022-05-04
Start Time	16:47:40.694818529
Stop Time	16:47:40.699026325
Duration	0.004207796s (4,2 ms)

Abnormal behavior

Use case 3

Race conditions detection

Use case 3

Race conditions detection

Atomic operation may access the same resource

Use case 3

Race conditions detection

Atomic operation may access the same resource

Two or more processes may access a shared resource

Use case 3

Race conditions detection

Atomic operation may access the same resource

Two or more processes may access a shared resource

The resource may be altered, locked, deleted or modified before the other accesses it

Test scenario

Use case 3

Race conditions detection

Atomic operation may access the same resource

Two or more processes may access a shared resource

The resource may be altered, locked, deleted or modified before the other accesses it

Test scenario

An express server contacted at the route /race

Use case 3

Race conditions detection

Atomic operation may access the same resource

Two or more processes may access a shared resource

The resource may be altered, locked, deleted or modified before the other accesses it

Test scenario

An express server contacted at the route /race

A client ***A*** contacting continuously the server on the route /race

Use case 3

Race conditions detection

Atomic operation may access the same resource

Two or more processes may access a shared resource

The resource may be altered, locked, deleted or modified before the other accesses it

Test scenario

An express server contacted at the route /race

A client ***A*** contacting continuously the server on the route /race

When contacted, the server calls a function that creates the file “test.txt”, then calls a function to read the file, and call another function to delete the file

Use case 3

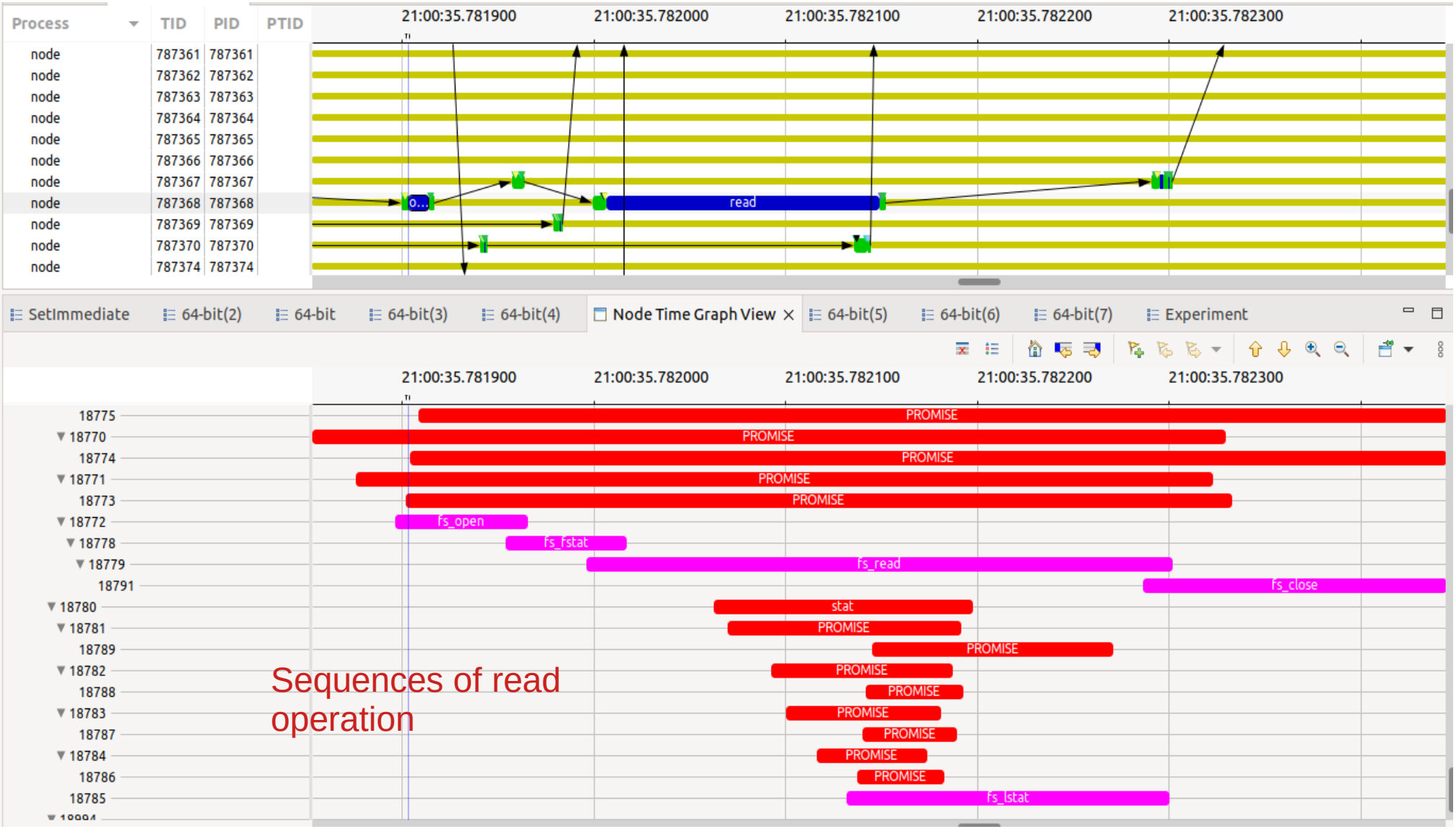
Resulting flow

Use case 3

Resulting flow

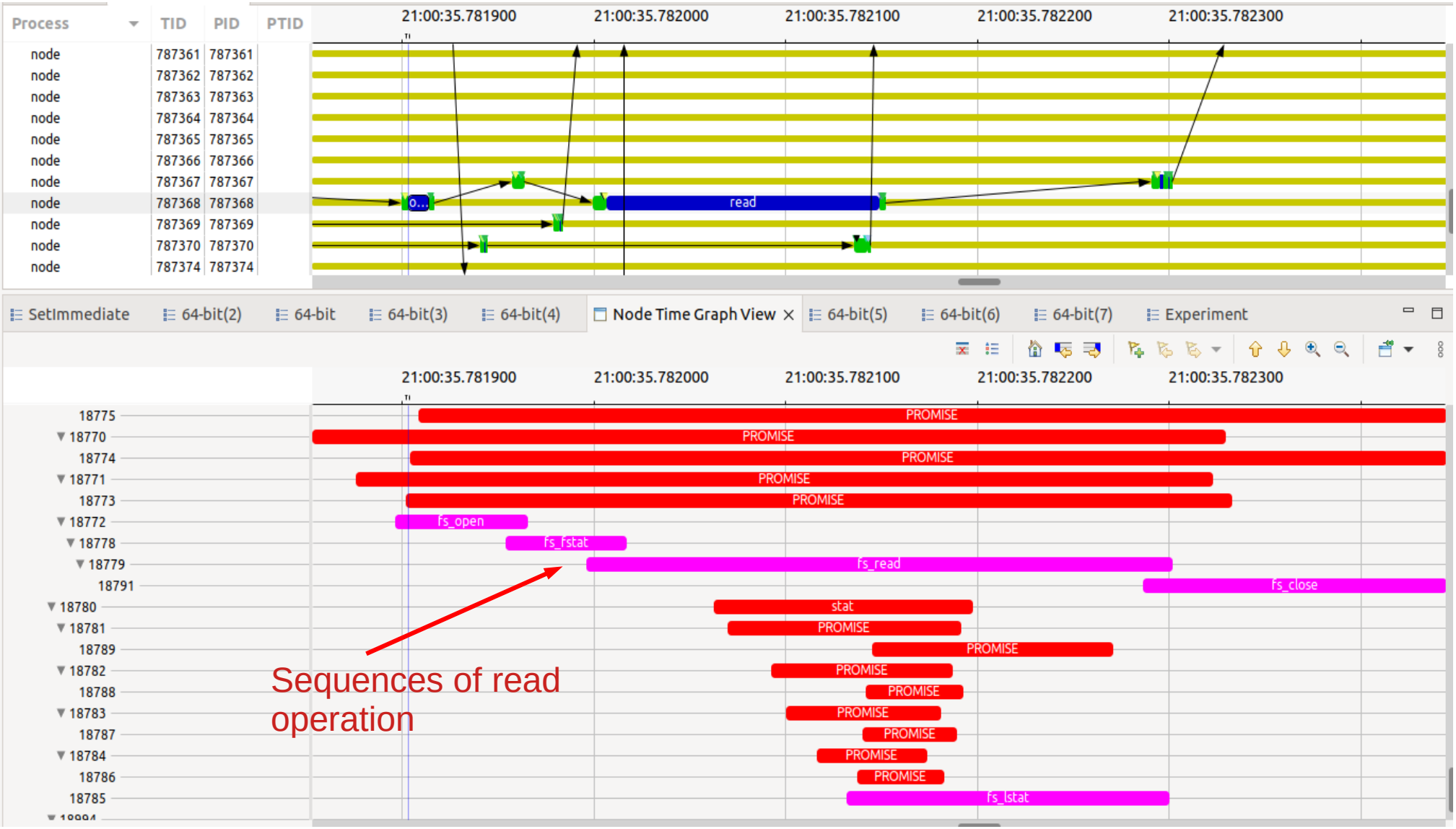
Use case 3

Resulting flow



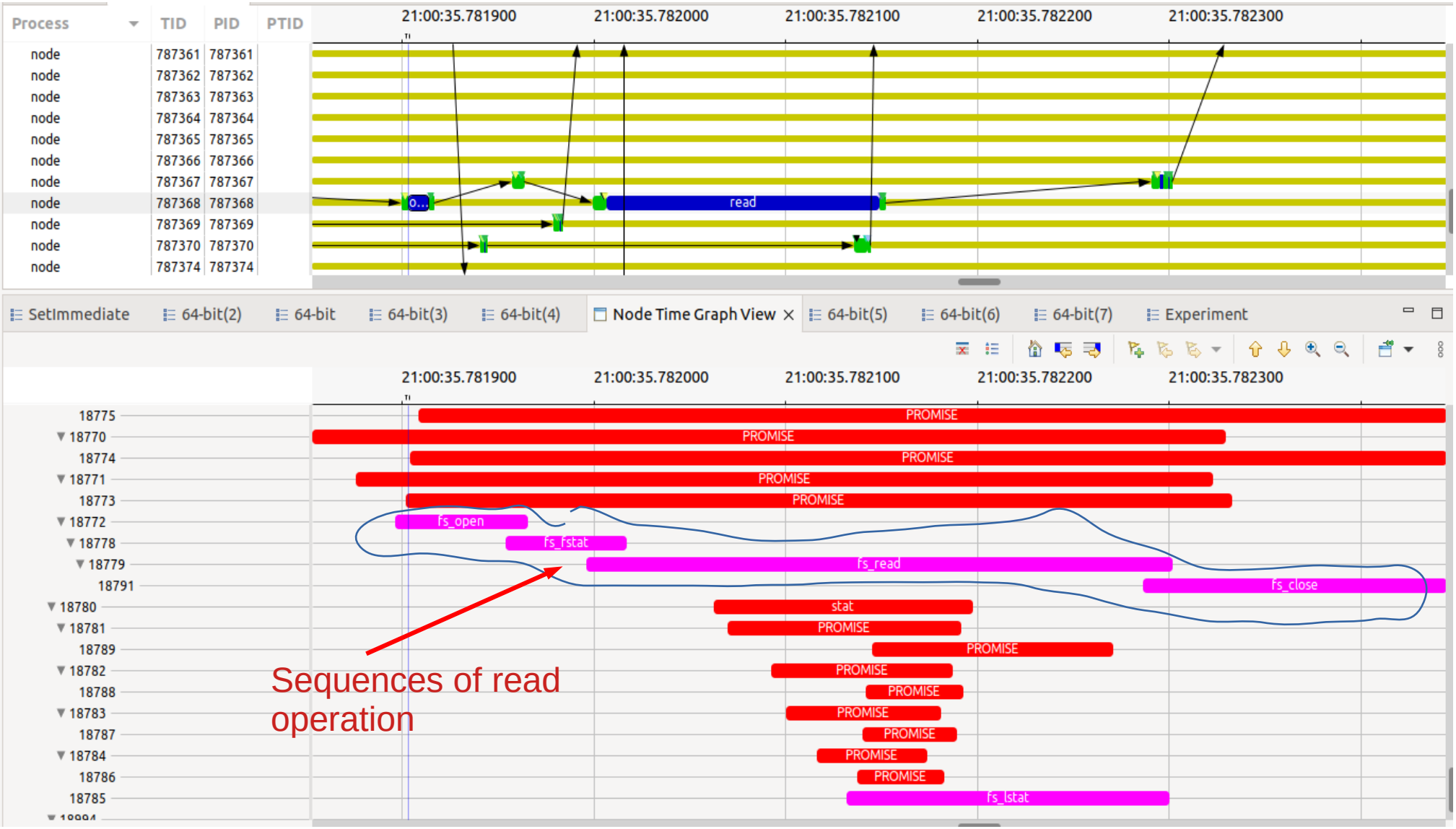
Use case 3

Resulting flow



Use case 3

Resulting flow



Use case 3

Results interpretation

Use case 3

Results interpretation

State System Explorer | Node Time Graph View

20:20:08.180000 | 20:20:08.180500 | 20:20:08.181000 | 20:20:08.181500

fs_write
fs_close
PROMISE
fs_open
fs_unlink

Trace	91
Date	2022-05-12
Start Time	20:20:08.179950359
Stop Time	20:20:08.181058121
Duration	0.001107762s (1,1 ms)

it(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5) | 64-bit(6) | 64-bit(7) | 64-bit(8) | Experiment | 64-bit(13)

hannel	CPU	Event type	Contents
srch>	<srch>	<srch>	<srch>
hannel0_3	3	uv_provider:uv_send_event	id=87, channel=85, method=PROMISE.29685, backend_fd=13, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_send_event	id=6.21200713404852, channel=85, method=js_open_main, backend_fd=12, context.packet_seq_num=0, contex
hannel0_3	3	uv_provider:uv_send_event	id=88, channel=85, method=PROMISE.29685, backend_fd=13, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_send_event	id=6.480561237982693, channel=6.21200713404852, method=js_open_create, backend_fd=14, context.packet_
hannel0_3	3	uv_provider:uv_send_event	id=89, channel=85, method=FSREQCALLBACK.29685, backend_fd=19, context.packet_seq_num=0, context.cpu_
hannel0_3	3	uv_provider:uv_fs_open_event	fd=29685, path=0xffffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_async_file_event	id=1649709016, backend_fd=29685, oper=fs_open, context.packet_seq_num=0, context.cpu_id=3, context._pro
hannel0_3	3	uv_provider:uv_work_submit_event	add_loop=0xffffffffbe1eed08, add_work=0xffffffffbe1eecf8, add_w=0xffffffffbe1eed00, add_done=0xffffffffb

s | Promise Queue XY View | Timers Latency XY View | Tick Frequency XY View | Thread Pool Monitor | Progress | Critical Flow View

Use case 3

Results interpretation

State System Explorer | Node Time Graph View

20:20:08.180000 | 20:20:08.180500 | 20:20:08.181000 | 20:20:08.181500

fs_write
fs_close
PROMISE
fs_open
fs_unlink

Trace	91
Date	2022-05-12
Start Time	20:20:08.179950359
Stop Time	20:20:08.181058121
Duration	0.001107762s (1,1 ms)

Race condition

it(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5) | 64-bit(6) | 64-bit(7) | 64-bit(8) | Experiment | 64-bit(13)

hannel	CPU	Event type	Contents
srch>	<srch>	<srch>	<srch>
hannel0_3	3	uv_provider:uv_send_event	id=87, channel=85, method=PROMISE.29685, backend_fd=13, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_send_event	id=6.21200713404852, channel=85, method=js_open_main, backend_fd=12, context.packet_seq_num=0, contex
hannel0_3	3	uv_provider:uv_send_event	id=88, channel=85, method=PROMISE.29685, backend_fd=13, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_send_event	id=6.480561237982693, channel=6.21200713404852, method=js_open_create, backend_fd=14, context.packet_
hannel0_3	3	uv_provider:uv_send_event	id=89, channel=85, method=FSREQCALLBACK.29685, backend_fd=19, context.packet_seq_num=0, context.cpu_
hannel0_3	3	uv_provider:uv_fs_open_event	fd=29685, path=0xffffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_async_file_event	id=1649709016, backend_fd=29685, oper=fs_open, context.packet_seq_num=0, context.cpu_id=3, context._pro
hannel0_3	3	uv_provider:uv_work_submit_event	add_loop=0xffffffffbe1eed08, add_work=0xffffffffbe1eecf8, add_w=0xffffffffbe1eed00, add_done=0xffffffffb

s | Promise Queue XY View | Timers Latency XY View | Tick Frequency XY View | Thread Pool Monitor | Progress | Critical Flow View

Use case 3

Results interpretation

State System Explorer | Node Time Graph View

20:20:08.180000 | 20:20:08.180500 | 20:20:08.181000 | 20:20:08.181500

fs_write
fs_close
PROMISE
fs_open
fs_unlink

Trace	91
Date	2022-05-12
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Duration	0.001107762s (1,1 ms)

Race condition

64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5) | 64-bit(6) | 64-bit(7) | 64-bit(8) | Experiment | 64-bit(13)

Channel	CPU	Event type	Contents
<srch>	<srch>	<srch>	<srch>
hannel0_3	3	uv_provider:uv_send_event	id=87, channel=85, method=PROMISE.29685, backend_fd=13, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_send_event	id=6.21200713404852, channel=85, method=js_open_main, backend_fd=12, context.packet_seq_num=0, contex
hannel0_3	3	uv_provider:uv_send_event	id=88, channel=85, method=PROMISE.29685, backend_fd=13, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_send_event	id=6.480561237982693, channel=6.21200713404852, method=js_open_create, backend_fd=14, context.packet_
hannel0_3	3	uv_provider:uv_send_event	id=89, channel=85, method=FSREQCALLBACK.29685, backend_fd=19, context.packet_seq_num=0, context.cpu_
hannel0_3	3	uv_provider:uv_fs_open_event	fd=29685, path=0xffffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, co
hannel0_3	3	uv_provider:uv_async_file_event	id=1649709016, backend_fd=29685, oper=fs_open, context.packet_seq_num=0, context.cpu_id=3, context._pro
hannel0_3	3	uv_provider:uv_work_submit_event	add_loop=0xffffffffbe1eed08, add_work=0xffffffffbe1eecf8, add_w=0xffffffffbe1eed00, add_done=0xffffffffb

Promise Queue XY View | Timers Latency XY View | Tick Frequency XY View | Thread Pool Monitor | Progress | Critical Flow View

Use case 3

Results interpretation

State System Explorer | Node Time Graph View

20:20:08.180000 | 20:20:08.180500 | 20:20:08.181000 | 20:20:08.181500

fs_write
fs_close
PROMISE
fs_open
fs_unlink

Trace	91
Date	2022-05-12
Start Time	20:20:08.179950359
Stop Time	20:20:08.181058121
Duration	0.001107762s (1,1 ms)

Race condition

Opening a file in reading mode while the file was already deleted

64-bit(2) | 64-bit | 64-bit(3) | 64-bit(4) | 64-bit(5) | 64-bit(6) | 64-bit(7) | 64-bit(8) | Experiment | 64-bit(13)

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hannel0_3	3	uv_provider:uv_work_submit_event	add_loop=0xffffffffbe1eed08, add_work=0xffffffffbe1eecf8, add_w=0xffffffffbe1eed00, add_done=0xffffffffb

Promise Queue XY View | Timers Latency XY View | Tick Frequency XY View | Thread Pool Monitor | Progress | Critical Flow View

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- Can be used to instrument functions in the way distributed tracers work

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Thank you