

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

Progress Report Meeting

Hervé KABAMBA

PhD Candidate

Supervisor: Michel Dagenais

May 16, 2022

Polytechnique Montréal

Département de Génie Informatique et Génie Logiciel





POLY TECHNIQUE MONTREAL – Hervé Kabamba

Agenda

1. Introduction

2. Architecture



POLY TECHNIQUE MONTREAL – Hervé Kabamba

Agenda

- 1. Introduction
- 2. Architecture
- 3. Use Cases



Agenda

- 1. Introduction
- 2. Architecture
- 3. Use Cases
- 4. Bibliography







Yes. Performance Analysis is done differently



Yes. Performance Analysis is done differently

We consider all layers interacting in the system as part of the Perf. Analysis



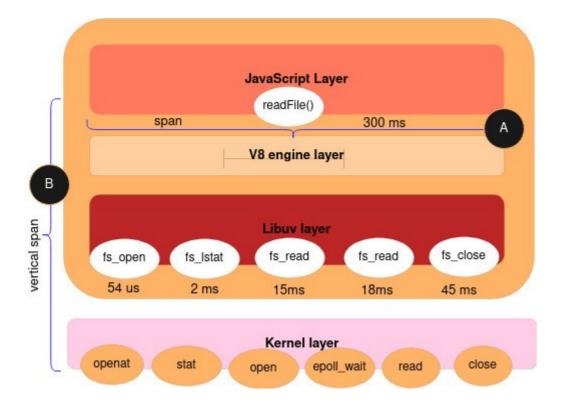
- Yes. Performance Analysis is done differently
- We consider all layers interacting in the system as part of the Perf. Analysis
- Reduced Instrumentation overhead by using LTTng in the JavaScript land

- Yes. Performance Analysis is done differently
- We consider all layers interacting in the system as part of the Perf. Analysis
- Reduced Instrumentation overhead by using LTTng in the JavaScript land
- Focus on High Level of Granularity in the Perf. Analysis

- Yes. Performance Analysis is done differently
- We consider all layers interacting in the system as part of the Perf. Analysis
- Reduced Instrumentation overhead by using LTTng in the JavaScript land
- 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



Why is NodeCompass different?

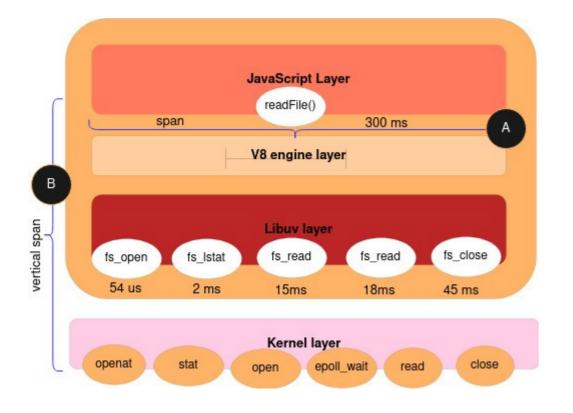


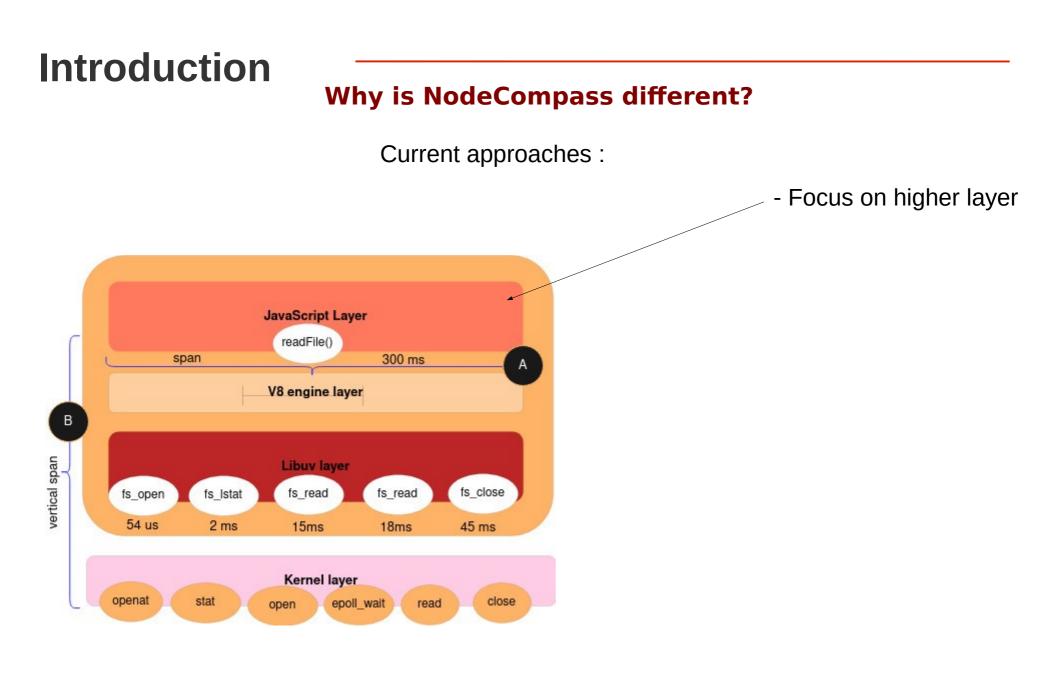


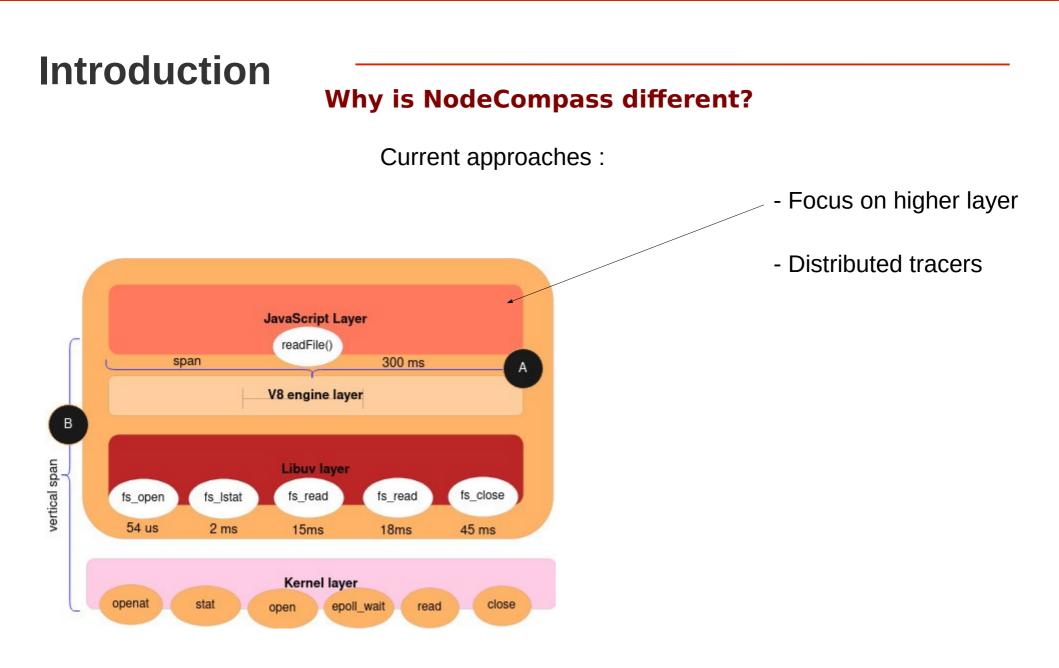
Why is NodeCompass different?

Current approaches :

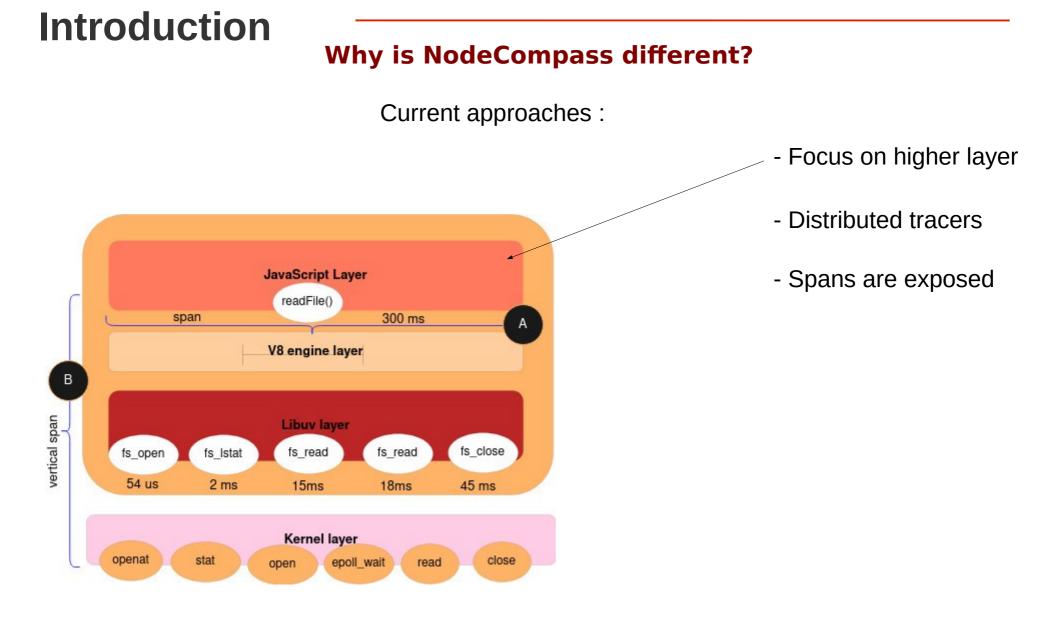
- Focus on higher layer





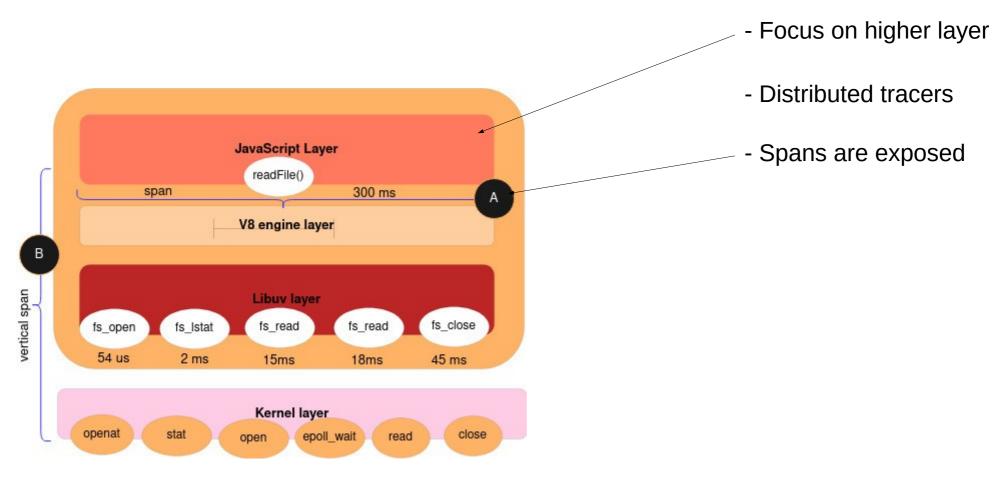


POLYTECHNIQUE MONTREAL – Hervé Kabamba



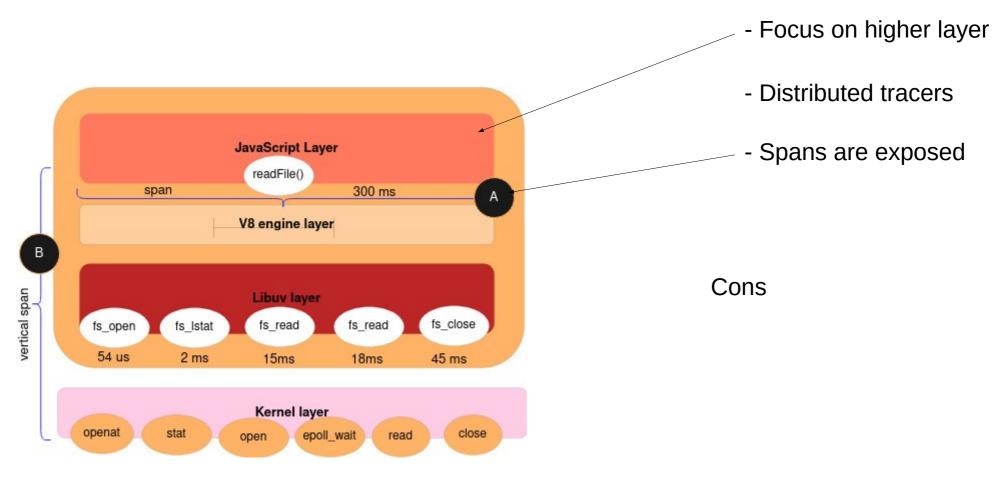


Why is NodeCompass different?

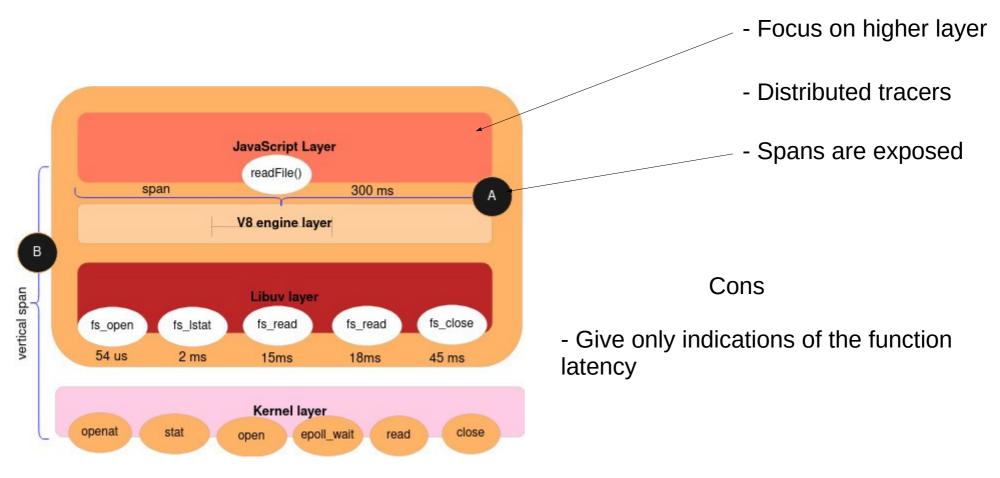




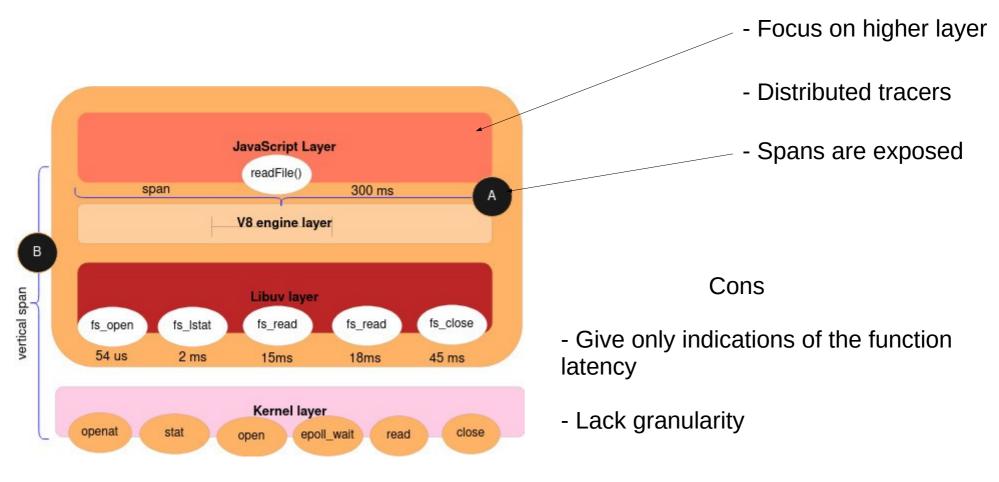
Why is NodeCompass different?



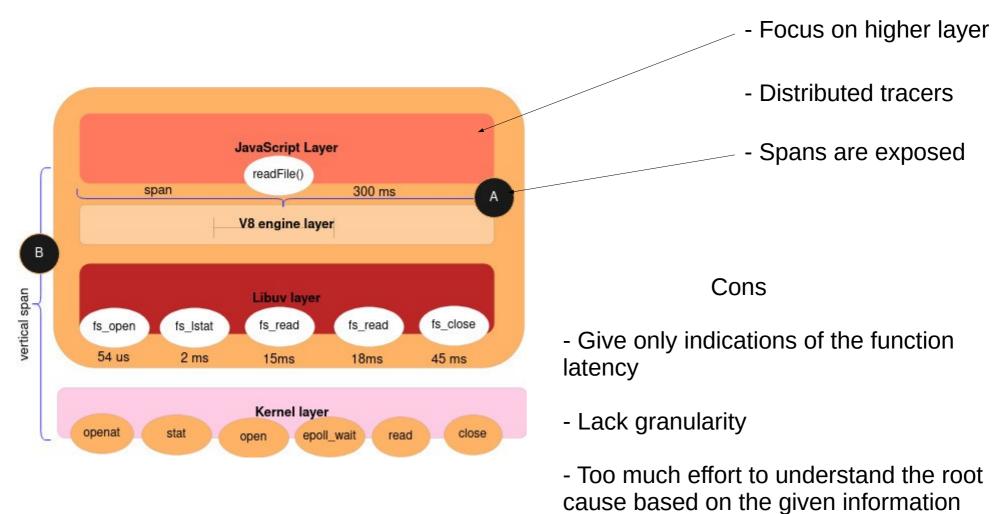
Why is NodeCompass different?

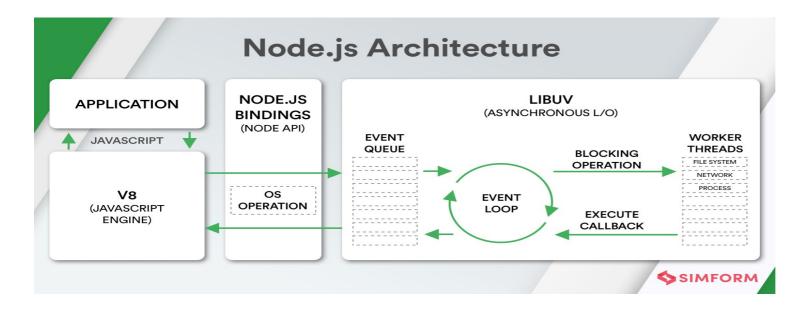


Why is NodeCompass different?



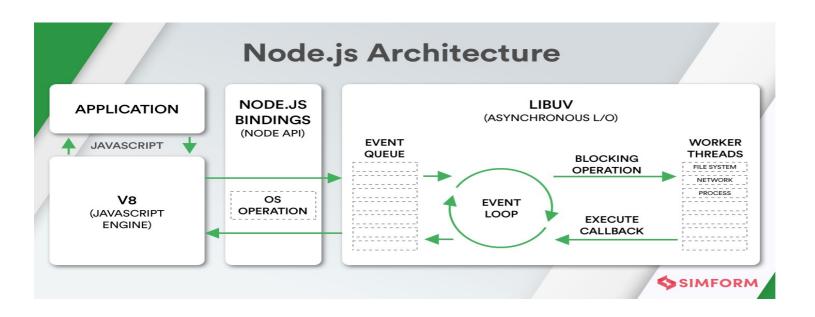
Why is NodeCompass different?

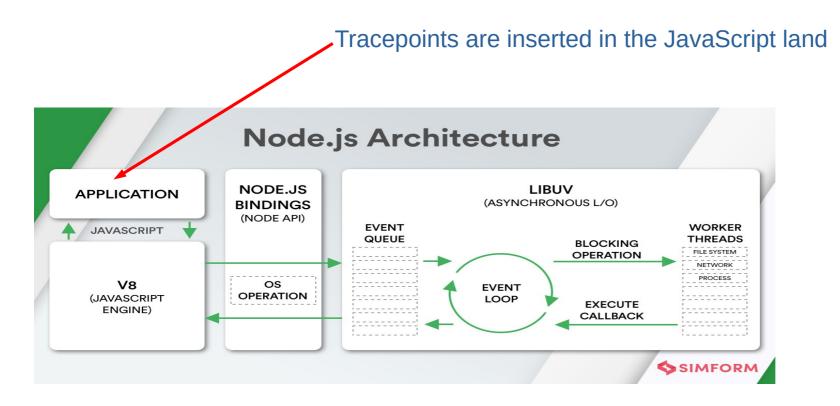




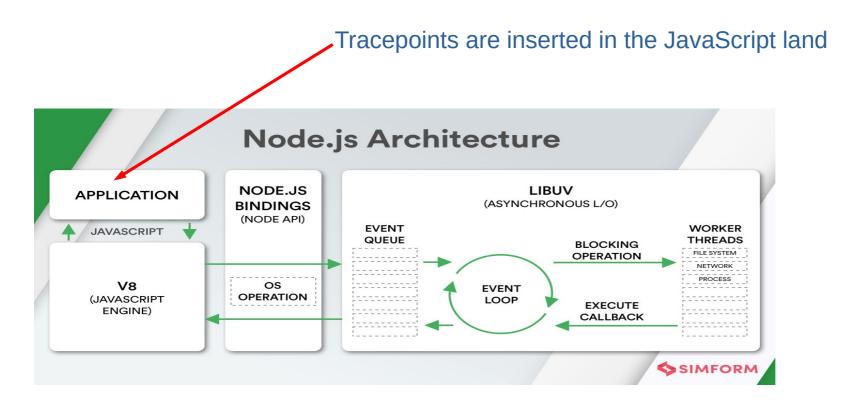
NodeCompass approach for Perf. Analysis

Tracepoints are inserted in the JavaScript land

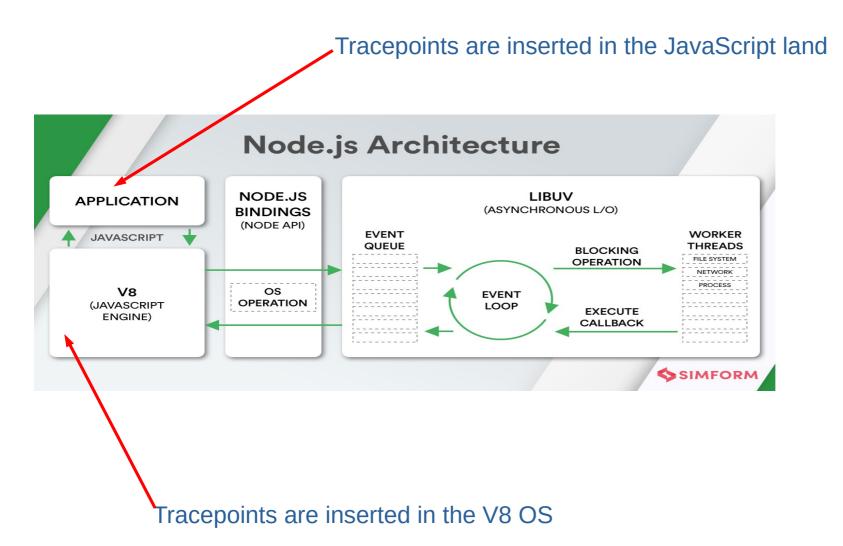


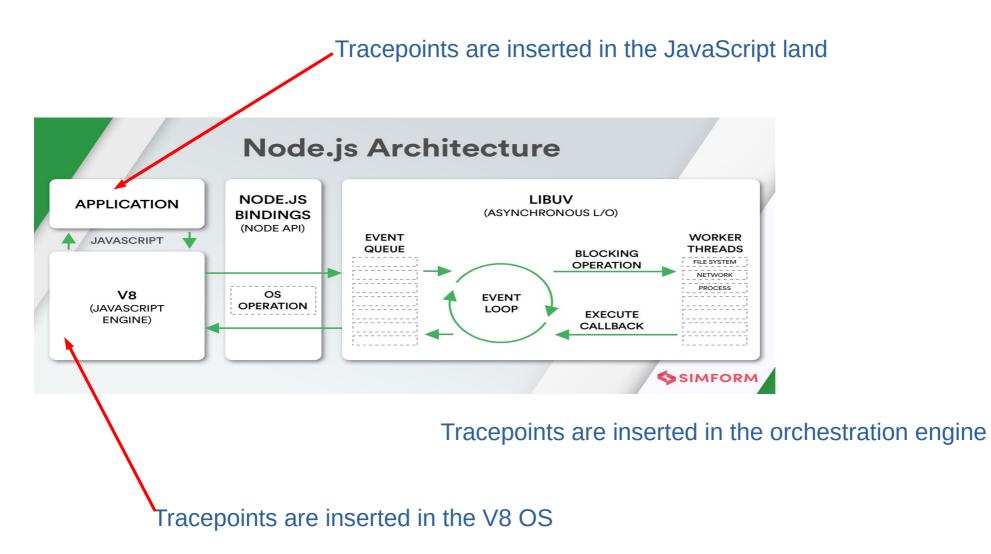


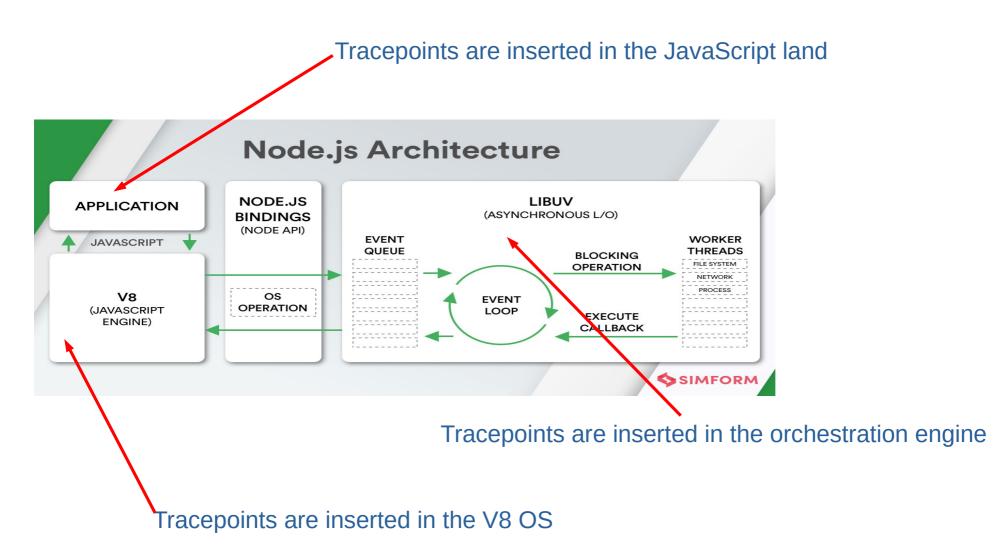
NodeCompass approach for Perf. Analysis



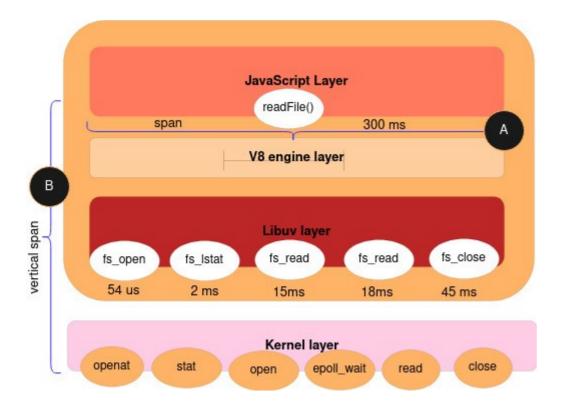
Tracepoints are inserted in the V8 OS





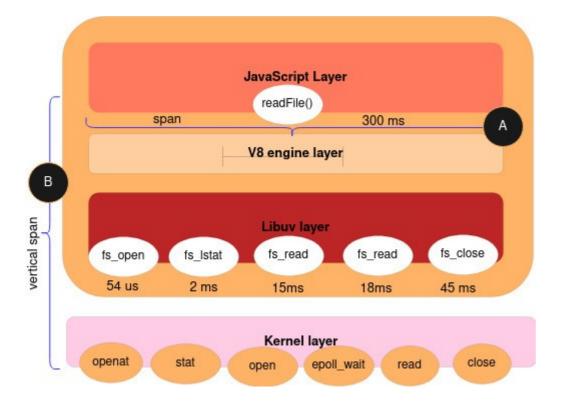






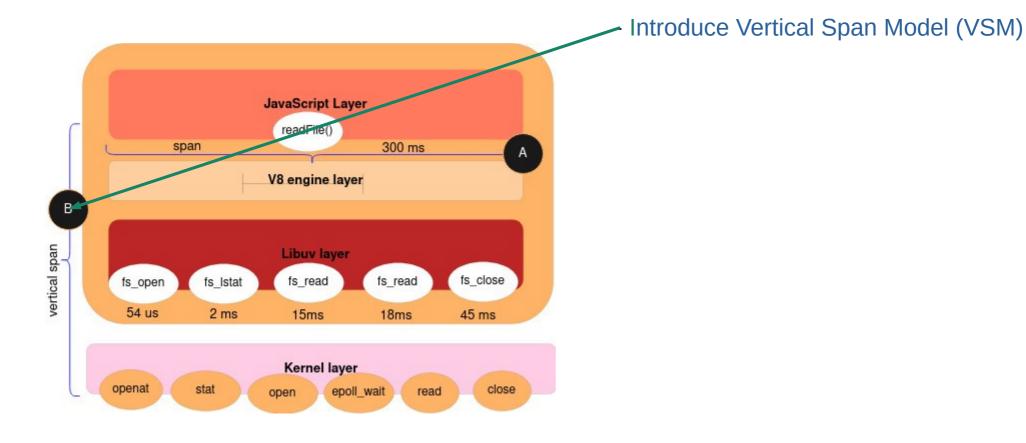


New paradigm:

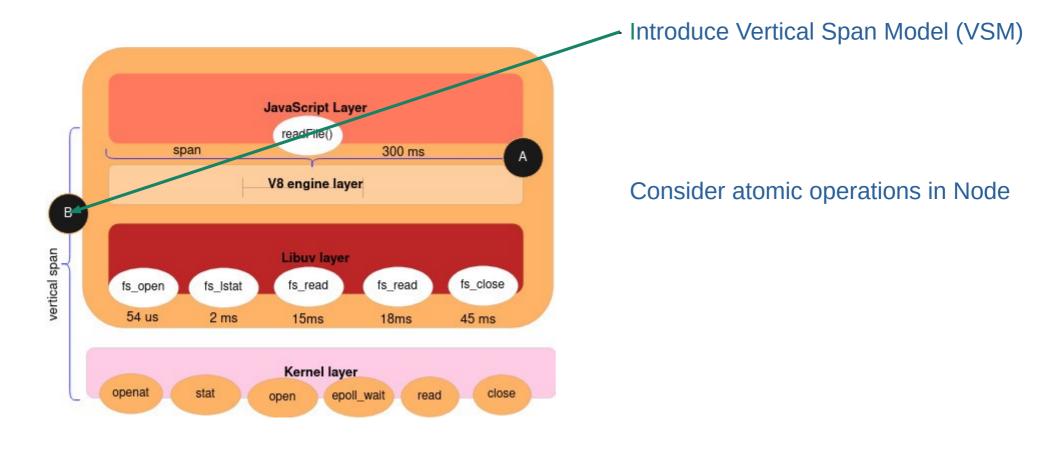


- Introduce Vertical Span Model (VSM)

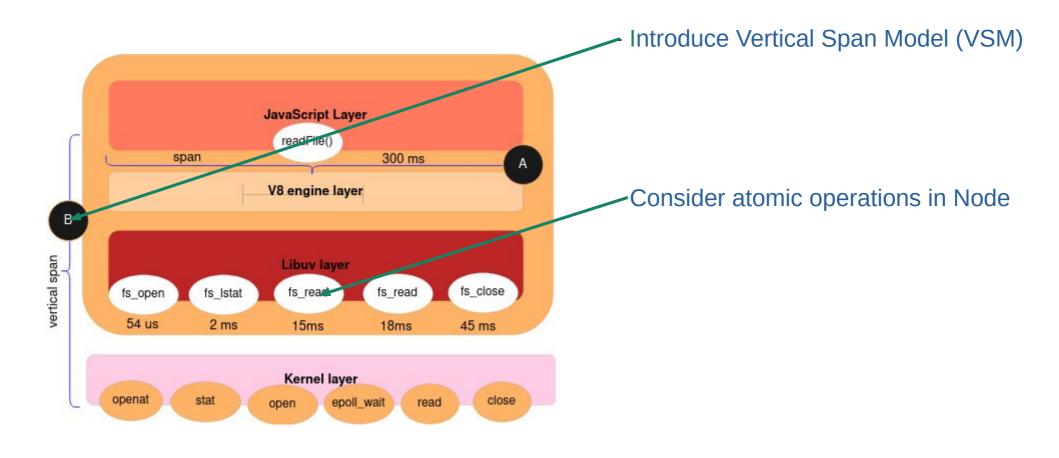




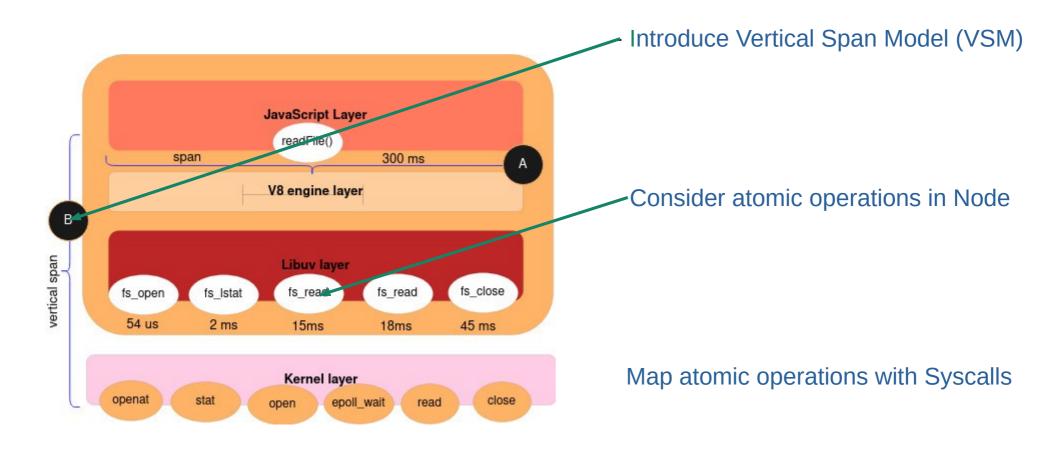




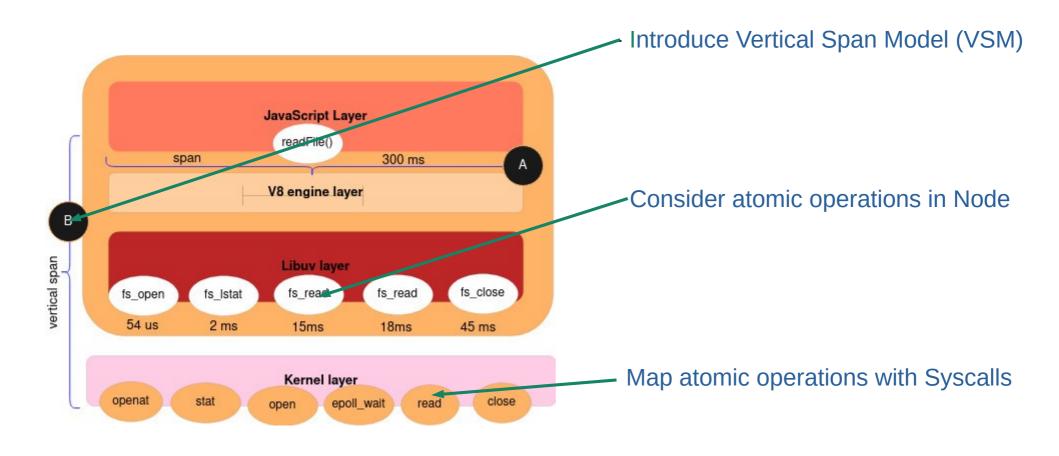












The Vertical Span Model: The new paradigm



The Vertical Span Model: The new paradigm

Represent a request with all its underlying atomic operations



The Vertical Span Model: The new paradigm

Represent a request with all its underlying atomic operations

Expose the application flow and the request underlying paths

The Vertical Span Model: The new paradigm

Represent a request with all its underlying atomic operations

Expose the application flow and the request underlying paths

Expose sequence of events in each layer with its latency

The Vertical Span Model: The new paradigm

Represent a request with all its underlying atomic operations

Expose the application flow and the request underlying paths

Expose sequence of events in each layer with its latency

Performance analysis with high granularity degree

The Vertical Span Model: The new paradigm

Represent a request with all its underlying atomic operations

Expose the application flow and the request underlying paths

Expose sequence of events in each layer with its latency

Performance analysis with high granularity degree

Pinpoint performance bottlenecks, system bugs, Root cause

The Vertical Span Model: The new paradigm

Represent a request with all its underlying atomic operations

Expose the application flow and the request underlying paths

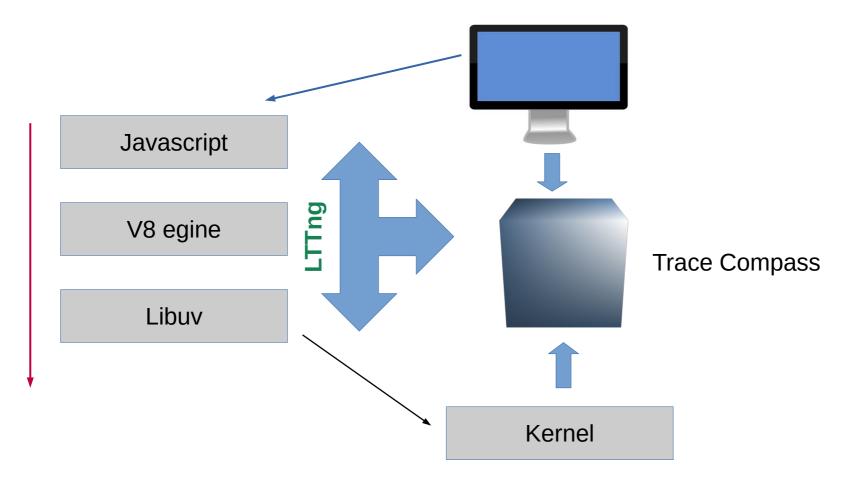
Expose sequence of events in each layer with its latency

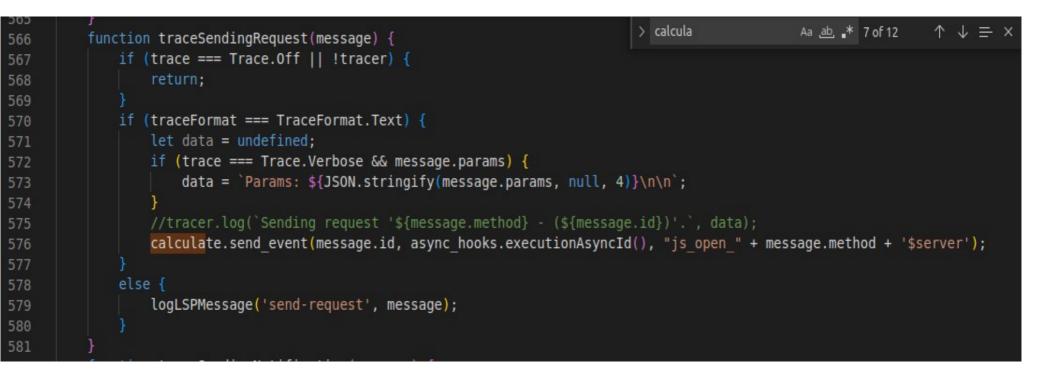
Performance analysis with high granularity degree

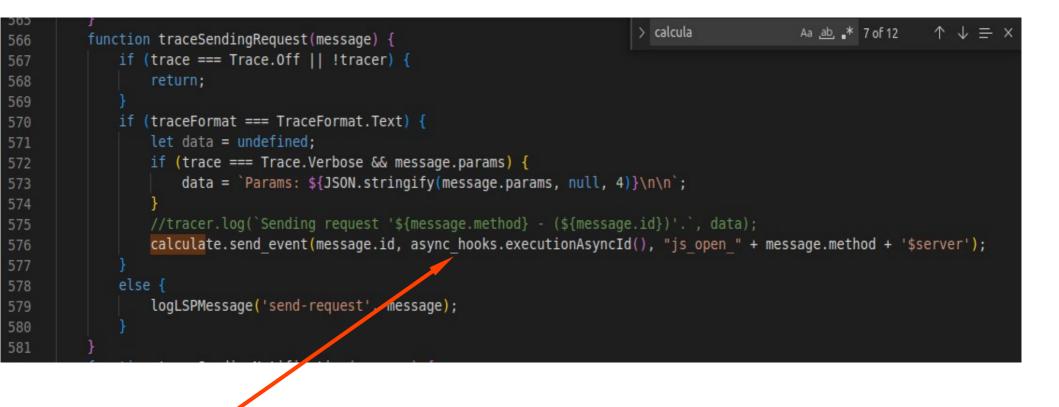
Pinpoint performance bottlenecks, system bugs, Root cause

Expose race Conditions in Node.js

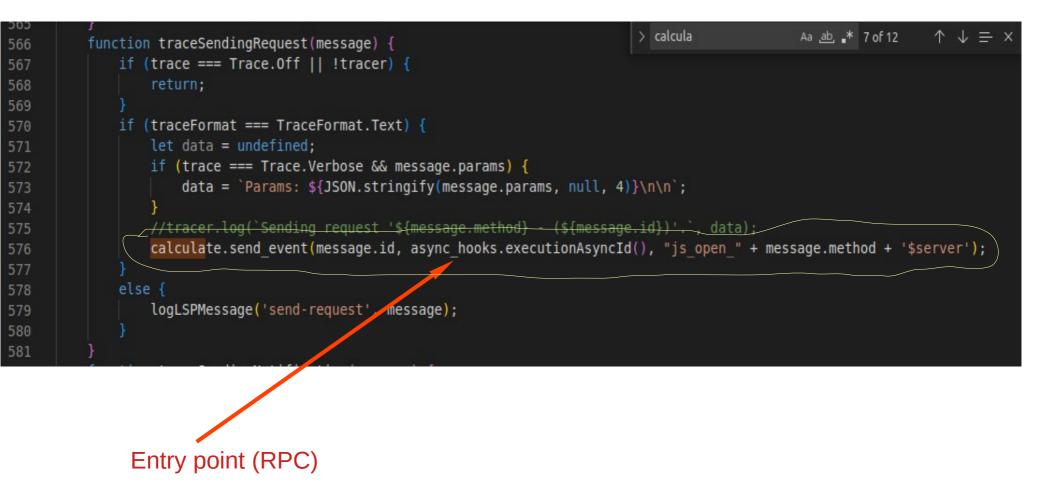
System Architecture

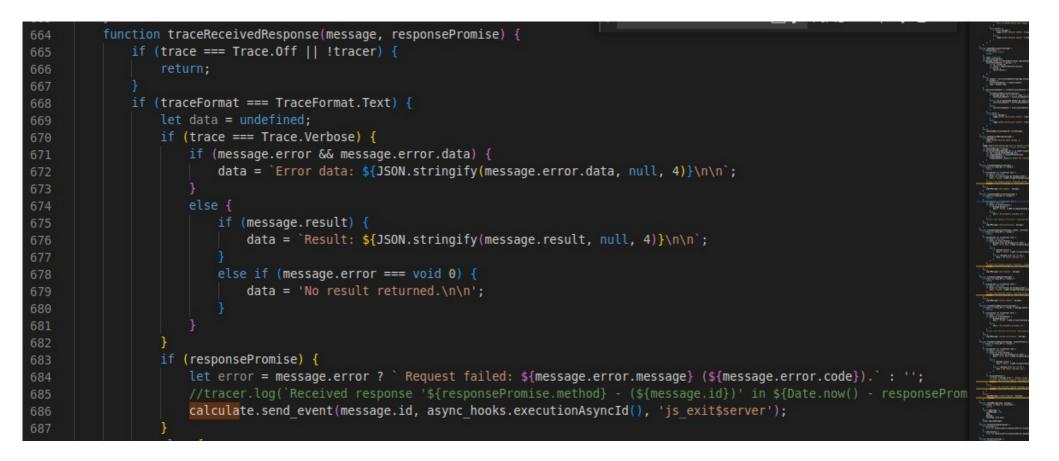




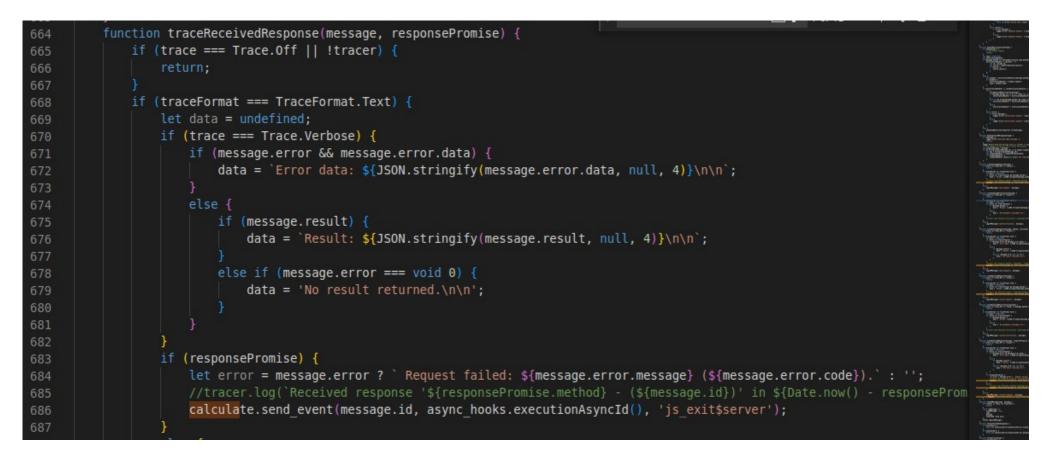






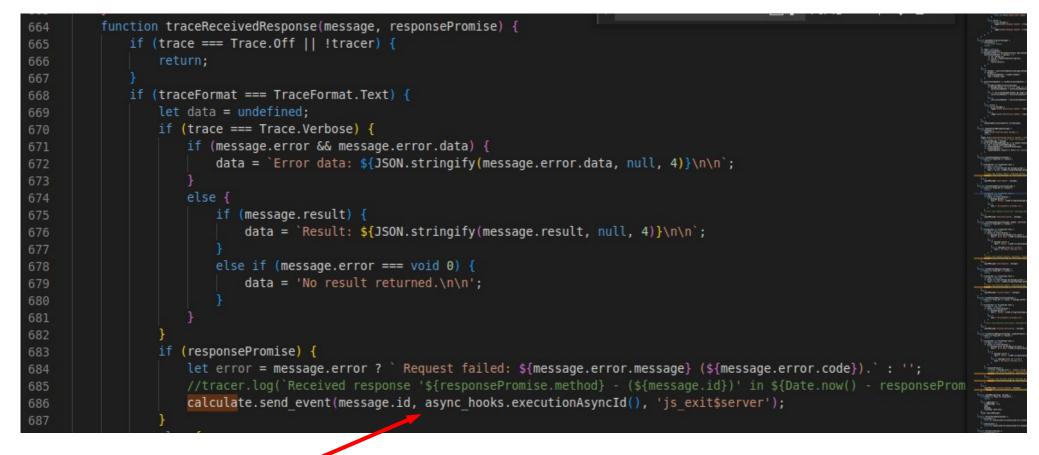


User-Level Instrumentation Example



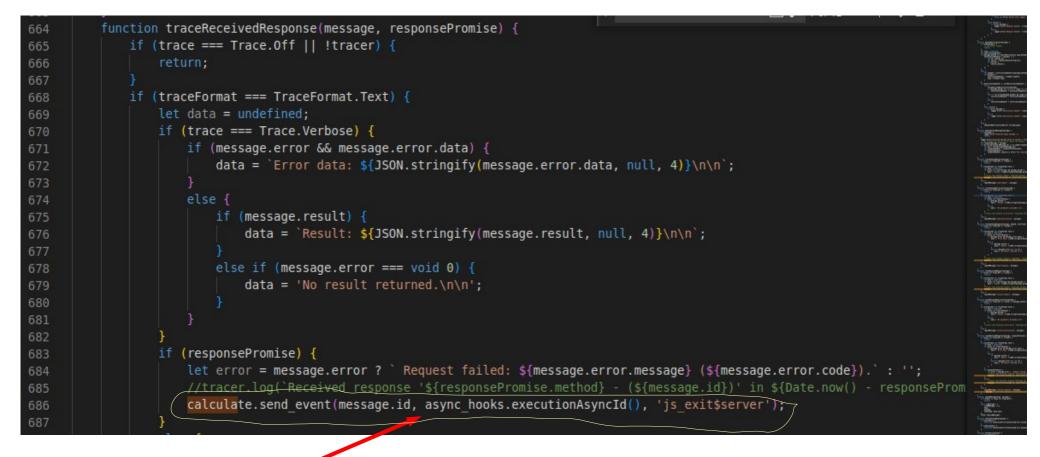
Exit Point (RPC)

User-Level Instrumentation Example





User-Level Instrumentation Example





Pinpointing process.NexTick Performance Issues

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Queue must be exhausted before the Event-loop continues to next phases

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Queue must be exhausted before the Event-loop continues to next phases

Must be used with caution since it can slow or block the Event-loop

Nextick Performance degradation scenario

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Queue must be exhausted before the Event-loop continues to next phases

Must be used with caution since it can slow or block the Event-loop

Nextick Performance degradation scenario

An express server contacted on the rout /nexttick

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Queue must be exhausted before the Event-loop continues to next phases

Must be used with caution since it can slow or block the Event-loop

Nextick Performance degradation scenario

An express server contacted on the rout /nexttick A client **A** contacting continuously the server at the route /nexttick

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Queue must be exhausted before the Event-loop continues to next phases

Must be used with caution since it can slow or block the Event-loop

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

Pinpointing process.NexTick Performance Issues

Postpone function execution to the Event-loop next tick

Queue must be exhausted before the Event-loop continues to next phases

Must be used with caution since it can slow or block the Event-loop

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





| 🕼 Resources 📑 Contr | rol Flow 🔲 Stat | istics 🔚 State | System Explore | er × | | | | | 🗄 🤜 🤜 🚺 | 466- | ∂ ♣ € € | 2, 🖆 🕶 🖇 | - 0 |
|--------------------------|-------------------|----------------|----------------|--------------|---|---------------|--------------|--------------|--------------|--------------|----------------|--------------|------------|
| State System / Att | 16:39:52.420 | 16:39:52.425 | 16:39:52.430 | 16:39:52.435 | 16:39:52.440 | 16:39:52.445 | 16:39:52.450 | 16:39:52.455 | 16:39:52.460 | 16:39:52.465 | 16:39:52.470 | 16:39:52.475 | |
| 14046895426 ► Metrics | I/O Polling Phase | | | _ | | | | | | I/O Pollin | g Phase | Check)/O | Polling P |
| ≣ SetImmediate | ≣ 64-bit(2) 📲 | i 64-bit 🛛 📔 6 | 64-bit(3) 📰 | 64-bit(4) | Node Time G | raph View 🗙 🗄 | 64-bit(5) | ≡ 64-bit(6) | ≖ ≔ 🕆 🕻 | | | ₽ ® @ [t | |
| | 16:39:52.420 | 16:39:52.425 | 16:39:52.430 | 16:39:52.435 | 16:39:52.440 | 16:39:52.445 | 16:39:52.450 | 16:39:52.455 | 16:39:52.460 | 16:39:52.465 | 16:39:52.470 | | → 8 |
| ¥ 29 ¥ 30 ¥ 3 ¥ | | | | | нарана и казана и ка | | | | | | | | |



| 🔚 Resources 📑 Contr | ol Flow 🔲 Stat | istics 🔚 State | System Explore | er × | | | | | 🗄 🤜 🤜 🚺 | ₽ ₿ ₿ ▼ | ∂ € € € | 2 📑 🕶 🖇 | - 0 |
|---------------------|-------------------|----------------|----------------|--------------|--------------|--------------|--------------|--------------|--------------|----------------|----------------|--------------|--|
| State System / Att | 16:39:52.420 | 16:39:52.425 | 16:39:52.430 | 16:39:52.435 | 16:39:52.440 | 16:39:52.445 | 16:39:52.450 | 16:39:52.455 | 16:39:52.460 | 16:39:52.465 | 16:39:52.470 | 16:39:52.475 | |
| 14046895426 | I/O Polling Phase | | | _ | | | | | | I/O Pollir | ig Phase | Check)/O F | Polling P |
| E SetImmediate | 64-bit(2) | 64-bit 🔚 6 | 64-bit(3) 🛛 🔚 | 64-bit(4) | Node Time Gr | aph View 🗙 🔢 | 64-bit(5) | ≡ 64-bit(6) | | | | | - 8 |
| | | | | | | | | | ≖ !≡ 🏠 🛡 | 5 🔜 🎼 R | 5 🕏 🔹 🗘 | 4 Q Q | in the second se |
| | 16:39:52.420 | 16:39:52.425 | 16:39:52.430 | 16:39:52.435 | 16:39:52.440 | 16:39:52.445 | 16:39:52.450 | 16:39:52.455 | 16:39:52.460 | 16:39:52.465 | 16:39:52.470 | 16:39:52.475 | |
| ▼ 29 - ▼ 30 | | | | | | | | | | | | | |
| ▼ 3 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

Let zoom on the view

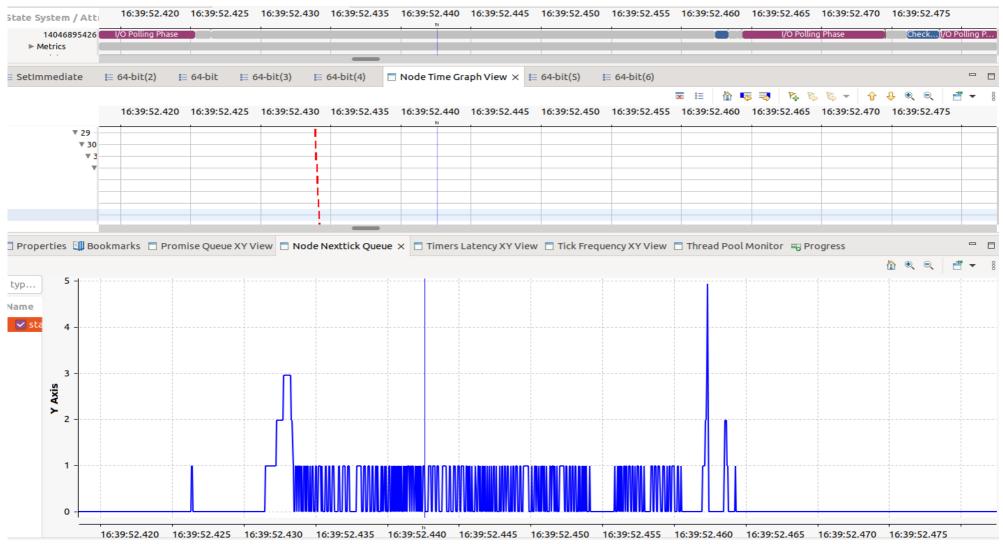


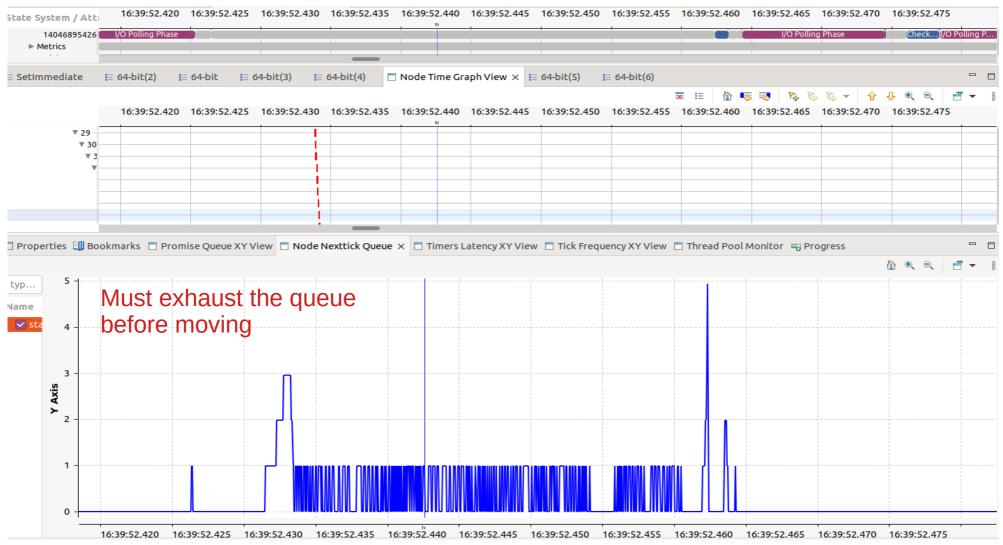
| 🔚 Resources 📑 Contr | ol Flow 🔲 Stat | istics 🔚 State | System Explore | er × | | | | x i≡ | 🗄 🤜 🗟 | ₽ ₿ ₿ ▼ | ∂ ₽ € € | 2 🕺 🖌 8 | - 0 |
|------------------------|-------------------|----------------|----------------|--------------|--------------|--------------|--------------|--------------|--------------|----------------|----------------|--------------|------------|
| State System / Att | 16:39:52.420 | 16:39:52.425 | 16:39:52.430 | 16:39:52.435 | 16:39:52.440 | 16:39:52.445 | 16:39:52.450 | 16:39:52.455 | 16:39:52.460 | 16:39:52.465 | 16:39:52.470 | 16:39:52.475 | |
| 14046895426 Metrics | I/O Polling Phase | | | | | | | | | I/O Pollin | g Phase | Check)/OF | Polling P |
| E SetImmediate | 64-bit(2) | ≣ 64-bit 🛛 🔝 6 | i4-bit(3) 📰 | 64-bit(4) | Node Time Gr | aph View 🗙 📔 | 64-bit(5) | 🗏 64-bit(6) | | | | | - 0 |
| | | | | | | | | | 🗙 🗄 🔺 🖬 | 5 🚽 🛱 🕅 | · 🗞 🔹 🔓 | 4 Q Q E | * 8 |
| | 16:39:52.420 | 16:39:52.425 | 16:39:52.430 | 16:39:52.435 | 16:39:52.440 | 16:39:52.445 | 16:39:52.450 | 16:39:52.455 | 16:39:52.460 | 16:39:52.465 | 16:39:52.470 | 16:39:52.475 | |
| ¥ 29 - ¥ 30 | | | | | | | | | | | | | |
| ▼ 3 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| _ | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

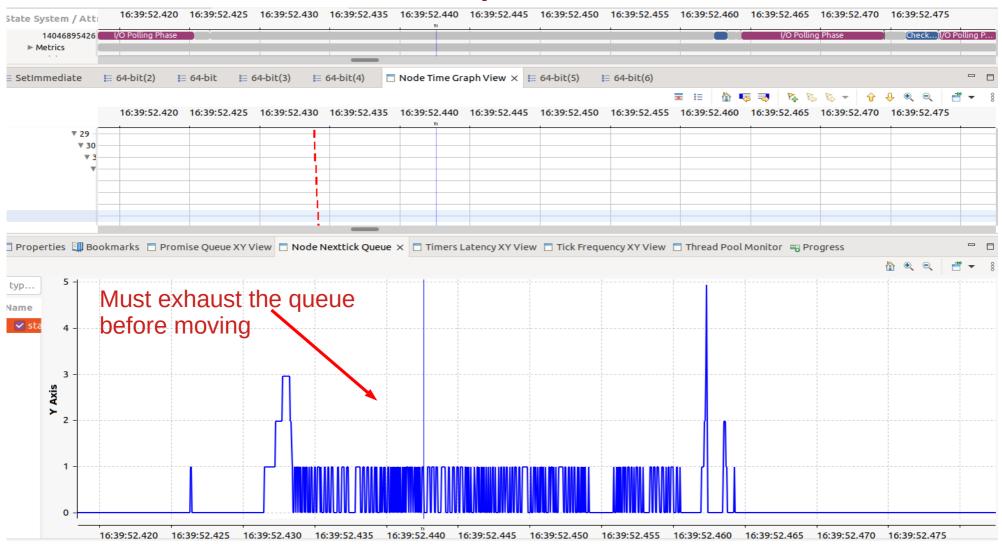
Let zoom on the view

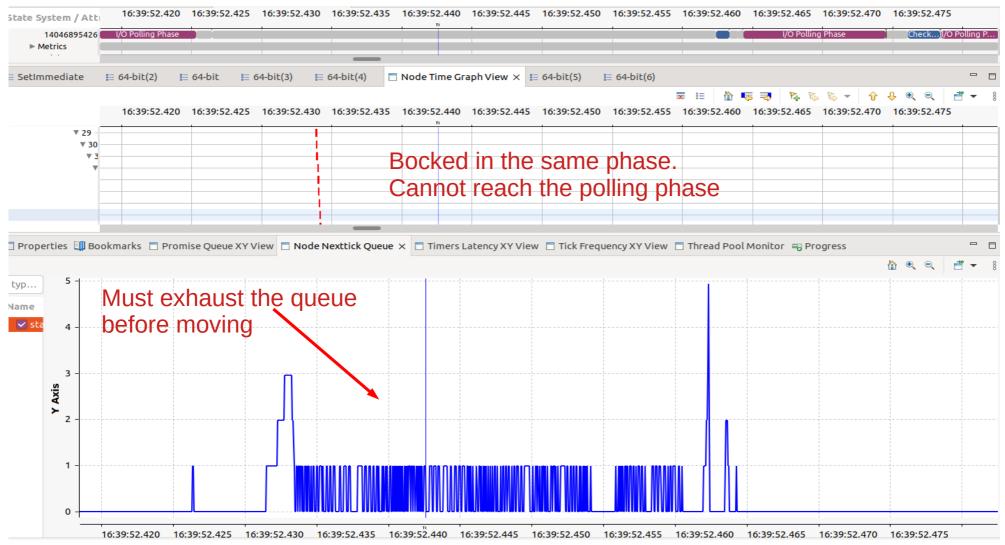
| 16:39:52.434000 | 16:39:52.434100 | 16:39:52.434200 | 16:39:52.434300 | 16:39:52.434400 | 16:39:52.434500 | 16:39:52.434600 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | 1 | | | | 1 | |
| PROMISE | | | | | | |
| NextTick | | | | | | |
| PROMIS | | | | | | |
| | NextTick | | | | | |
| | PROMISE | | | | | |
| | Next | | | | | |
| | | PROMISE NextTi | | | | |
| | | Nexth | PROMISE | | | |
| | | | NextTick | | | |
| | | | | PROMISE | | |
| | | | | NextTick | | |
| | | | | PROMISE | | |
| | | | | | | |

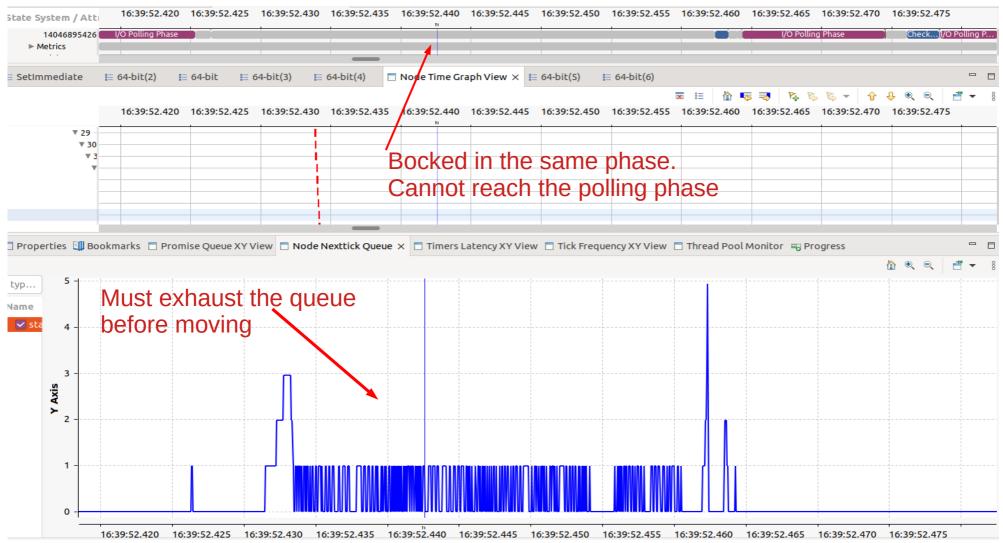
Results Interpretation

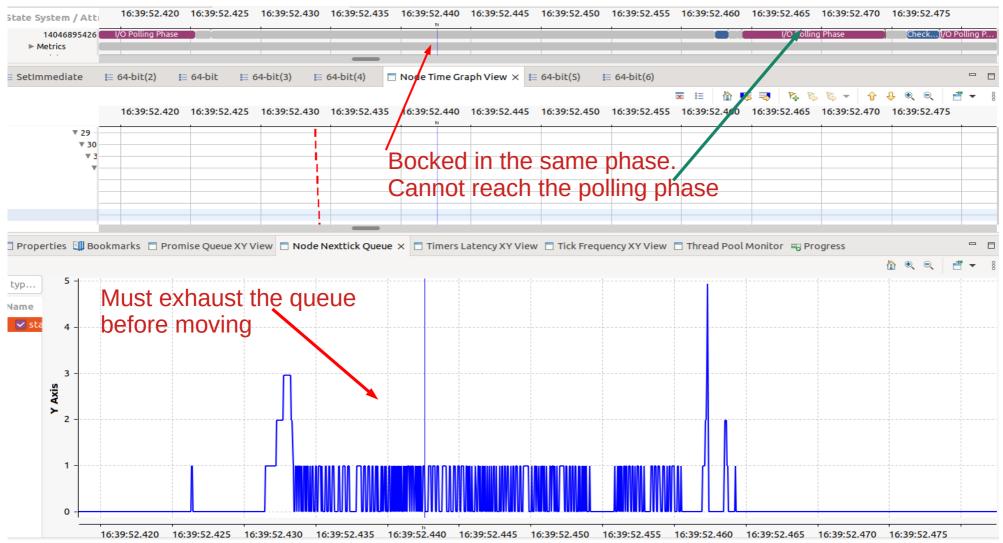














Asynchronous resources destruction bug



Asynchronous resources destruction bug

Each asynchronous resource has a lifetime



Each asynchronous resource has a lifetime

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



- 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



- 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



- 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



- 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



Resulting Flow

Resulting Flow

| E Res | ources 🖶 Control Flow 🔲 Statistics 듣 | State System Explorer $	imes$ | | 🔽 🗄 🟠 | एइ 💐 😤 १६ १६ 🕶 🗘 🗘 ९, ९, २, 📲 र 🖇 😑 🗖 |
|---------------|--------------------------------------|-------------------------------|----------------------------|-------------------------------------|--|
| State | Syst 16:47:40.695 | 16:47:40.696 | 16:47:40.69 | 97 16:47:40.698 | 16:47:40.699 |
| | 14 | | | Checking Phase | |
| | Met | | | | |
| - | aad | | | 1 | |
| I≣ Setl | mmediate 🔚 64-bit(2) 🔚 64-bit | ≣ 64-bit(3) 🛛 🗄 64-bit(4) | ≣ 64-bit(5) × | | |
| CPU | Event type | Contents | | | |
| <srch></srch> | <srch></srch> | id=9544 | | | |
| 3 | uv_provider:uv_send_event | id=7923, channel=undefined, m | ethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10 |), context.cpu_id=3, contextprocname=node, contextpthread_ |
| 3 | uv_provider:uv_send_event | id=7906, channel=undefined, m | ethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10 |), context.cpu_id=3, contextprocname=node, contextpthread_ |
| 3 | uv_provider:uv_send_event | id=7905, channel=undefined, m | ethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10 |), context.cpu_id=3, contextprocname=node, contextpthread_ |
| 3 | uv_provider:uv_send_event | id=7912, channel=undefined, m | ethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10 |), context.cpu_id=3, contextprocname=node, contextpthread_ |
| - | | 1.1.7040 shared undefined as | alle dates actor bash | ad Ed 42 as about a shake and all | and and and id a sector to sector and a sector to the strend |

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

Resulting Flow

| 🗄 Reso | ources 🖶 Control Flow 🔲 Statistics | E State System Explorer × | | 📼 🗄 👘 🎼 | 🤜 隋 🗞 👻 🕆 😯 🔍 이 🛃 🖛 🔋 🗖 🗖 |
|---------------|------------------------------------|-------------------------------|-----------------------------|--|---|
| State | Syst 16:47:40.695 | 16:47:40.696 | 16:47:40.6 | 97 16:47:40.698 | 16:47:40.699 |
| | 14 | | | Checking Phase | |
| | Met | | | | |
| - | and . | _ | | | |
| E Setl | mmediate 🔚 64-bit(2) 🔚 64-bit | ≣ 64-bit(3) ≣ 64-bit(4) | i≣ 64-bit(5) × | | |
| CPU | Event type | Contents | | | |
| <srch></srch> | <srch></srch> | id=9544 | | | |
| 3 | uv_provider:uv_send_event | id=7923, channel=undefined, n | nethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10, con | ntext.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider:uv_send_event | id=7906, channel=undefined, n | nethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10, coi | ntext.cpu_id=3, contextprocname=node, contextpthread_ |
| 3 | uv_provider:uv_send_event | id=7905, channel=undefined, n | nethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10, con | ntext.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider:uv_send_event | id=7912, channel=undefined, n | nethod=destroy_16102, backe | nd_fd=13, context.packet_seq_num=10, con | ntext.cpu_id=3, contextprocname=node, contextpthread |
| 2 | | id zono - to - a - defined - | abbad daabaan 40400 baalia | and fail and another allock and another and an | -kank and 1d to an about an and an about athread |

🗈 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 👘 🗖

| | | | | | ⋭ <i>⋭⋭</i> ● |
|----|--------------|--------------|-----------------------------|------------|--------------------|
| | 16:47:40.695 | 16:47:40.696 | 16:47:40.697 | | 16:47:40.699 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | - I <mark>S</mark> |
| | | PROMIS | E | | |
| | | PROMIS | SE | | • |
| | | Trac | e 9545 | | |
| | | Date | | | |
| PR | | | t Time 16:47:40.694818529 | | |
| | fs_read | | D Time 16:47:40.699026325 | | |
| | | | | | |
| | | Dura | ation 0.004207796s (4,2 ms) | | |
| | | | | | |
| | | | | Atomic rea | ad operation |
| | | | | | |
| _ | | | | | |

Resulting Flow

| ta Res | ources 🖶 Co | ontrol Flow 🔲 S | tatistics | State System Ex | plorer × | | | 📼 🏭 🏠 👼 🗟 | ┋ 陸 ╚ ▾ 😚 Ө € 즉 📑 ▾ 🕴 🗖 Ε |
|---------------|---------------|-----------------|-----------|-----------------|------------------|-----------------|----------------------|----------------------------------|--|
| State | Syst | 16:47:4 | 0.695 | | 16:47:40.696 | | 16:47:40.697 | 16:47:40.698 | 16:47:40.699 |
| | 14 | | | | | | | Checking Phase | |
| | Met | | | | | | | | |
| - | | | | | _ | | | | |
| E Setl | mmediate | ≣ 64-bit(2) | 🗄 64-bit | ≣ 64-bit(3) | 🗎 64-bit(4) | ≣ 64-bit(5) × | | | |
| CPU | Event type | | | Contents | | | | | |
| <srch></srch> | <srch></srch> | | | id=9544 | | | | | |
| 3 | uv_provider | uv_send_event: | | id=7923, chan | nel=undefined, m | ethod=destroy_1 | 16102, backend_fd=13 | , context.packet_seq_num=10, con | text.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | :uv_send_event | | id=7906, chan | nel=undefined, m | ethod=destroy_1 | 16102, backend_fd=13 | , context.packet_seq_num=10, con | text.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | :uv_send_event | | id=7905, chan | nel=undefined, m | ethod=destroy_1 | 16102, backend_fd=13 | , context.packet_seq_num=10, con | text.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | uv_send_event: | | id=7912, chan | nel=undefined, m | ethod=destroy_1 | 16102, backend_fd=13 | , context.packet_seq_num=10, con | text.cpu_id=3, contextprocname=node, contextpthread |
| 2 | | | | :d 7040 -b | | | cana be dead and | | hank and id. I contain according and a containt attacked |

🗇 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 | | ≩ 陸 ♥ ▼ 🔐 🤤 ♥ ♥ ♥ ♥ ♥ 📑 ▼ 🗄 |
|----|--------------|------------------------|--|------------|-----------------------------|
| | | | | | |
| | | | | | |
| | | | | | |
| | | PROMISI PROMIS | | | |
| PR | | Trace Date Start | | | |
| | fs_read | Stop | Time 16:47:40.699026325 tion 0.004207796s (4,2 ms) | | |
| | | | | Atomic rea | d operation |
| | | | | | |



Results interpretation

| ta Res | ources 📑 Control F | low 🔲 Statistics | ∃ State System E> | oplorer × | | | 📼 💷 🯠 🏹 | 🎼 🗞 🏷 🖌 😯 🍕 🖉 🖛 | 8 |
|---------------|--------------------|-------------------|-------------------|------------------|------------------|-----------------------|---------------------------------------|--------------------------------------|-------------|
| 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 | | | | | | | | |
| - | and. | | | _ | | | 1 | | |
| 🗏 Setl | mmediate 🛛 📔 64 | bit(2) 🛛 🔚 64-bit | ≣ 64-bit(3) | ≣ 64-bit(4) | ≣ 64-bit(5) × | | | | - 0 |
| CPU | Event type | | Contents | | | | | | |
| <srch></srch> | <srch></srch> | | id=9544 | | | | | | |
| 3 | uv_provider:uv_sen | d_event | id=7923, chan | nel=undefined, n | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context.o | :pu_id=3, contextprocname=node, cont | extpthread_ |
| | uv_provider:uv_sen | d_event | id=7906, chan | nel=undefined, n | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context.or | :pu_id=3, contextprocname=node, cont | extpthread_ |
| 3 | uv_provider:uv_sen | d_event | id=7905, chan | nel=undefined, n | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context.or | :pu_id=3, contextprocname=node, cont | extpthread_ |
| 3 | uv_provider:uv_sen | d_event | id=7912, chan | nel=undefined, n | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context.or | :pu_id=3, contextprocname=node, cont | extpthread_ |
| - | | d | :d 7040 -b | | | CADD Feelend Ed. 40 | anakanka aluska ana ana 40 anakanka | | |

🗈 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 👘 🗖

| | 16.47.40 605 | 16:47:40.696 | 16:47:40.697 | | □ □ |
|----|--------------|--------------|--------------------------------|--------------|---|
| | 16:47:40.695 | 10:47:40.090 | 10:47:40.097 | 16:47:40.698 | 16:47:40.699 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | [S |
| | | | PROMISE | | |
| | | | PROMISE | | |
| | | | Trace 9545 | | |
| | | | | | |
| PR | | | Date 2022-05-04 | | |
| | | s_read | Start Time 16:47:40.694818529 | | |
| | | | Stop Time 16:47:40.699026325 | | |
| | | | Duration 0.004207796s (4,2 ms) | | |
| - | | | 2313131 0.0042011503 (4,2113) | | |
| - | | | | | |
| | | | | | |
| | | | | | |
| _ | | | | | |

Results interpretation

| E Res | ources 📑 Co | ontrol Flow 🔲 S | statistics | ∃ State System Ex | plorer × | | | 📼 🗄 🖄 🐺 🤜 | <u> <u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u> |
|---------------|---------------|-----------------|------------|-------------------|------------------|-----------------|----------------------|-------------------------------------|---|
| State | Syst | 16:47:4 | 0.695 | | 16:47:40.696 | | 16:47:40.697 | 16:47:40.698 | 16:47:40.699 |
| | 14 | | | | | | | Checking Phase | |
| | Met | | | | | | | | |
| - | and. | | | | _ | | | | |
| E Setl | mmediate | ≣ 64-bit(2) | 듣 64-bit | ≣ 64-bit(3) | 🗎 64-bit(4) | ≣ 64-bit(5) × | | | - E |
| CPU | Event type | | | Contents | | | | | |
| <srch></srch> | <srch></srch> | | | id=9544 | | | | | |
| 3 | uv_provider | uv_send_event: | | id=7923, chan | nel=undefined, n | nethod=destroy_ | 16102, backend_fd=13 | , context.packet_seq_num=10, contex | xt.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | :uv_send_event | | id=7906, chan | nel=undefined, n | nethod=destroy_ | 16102, backend_fd=13 | , context.packet_seq_num=10, conte | xt.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | uv_send_event: | | id=7905, chan | nel=undefined, n | nethod=destroy_ | 16102, backend_fd=13 | , context.packet_seq_num=10, contex | xt.cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | uv_send_event | | id=7912, chan | nel=undefined, n | nethod=destroy_ | 16102, backend_fd=13 | , context.packet_seq_num=10, conte | xt.cpu_id=3, contextprocname=node, contextpthread |
| - | | | | :d 7040 -b | | | cana be dead and | | and an an internet and a second se |

🗇 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 | | 돛 陸 등 ♥ ☆ ♣ € € ₫ 16:47:40.699 |
|------------|--------------|------------------|-----------------------------|----------|---------------------------------------|
| | | | | ті ті | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | [<mark>5</mark> |
| | | PROMIS PROMIS | | | |
| | | Trac | | | |
| | | Date | | | |
| PR | fs_read | | t Time 16:47:40.694818529 | | |
| _ , | | | Time 16:47:40.699026325 | | |
| - I | | Dura | ation 0.004207796s (4,2 ms) | | |
| | | | | Abnormal | hohovior |
| | | | | Abnormal | Dellaviul |
| - | | | | | |

Results interpretation

| 🗄 Res | ources 📑 Co | ontrol Flow 🔲 S | tatistics | State System Ex | plorer × | | | 📼 💷 🟠 👼 🤜 | k k k → 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 |
|--------|---------------|-----------------|-----------|-----------------|------------------|------------------|-------------------------|------------------------------------|--|
| State | Syst | 16:47:4 | 0.695 | | 16:47:40.696 | | 16:47:40.697 | 16:47:40.698 | 16:47:40.699 |
| | 14 | | | | | | - | Checking Phase | |
| | Met | | | | | | | | |
| - | and. | | | | | | | | |
| ∃ Setl | mmediate | ≣ 64-bit(2) | ≣ 64-bit | i≣ 64-bit(3) | 🗄 64-bit(4) | i≣ 64-bit(5) × | | | |
| CPU | Event type | | | Contents | | | | | |
| srch> | <srch></srch> | | | id=9544 | | | | | |
| 3 | uv_provider | :uv_send_event | | id=7923, chan | nel=undefined, m | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context | cpu_id=3, contextprocname=node, contextpthread |
| 3 | uv_provider | :uv_send_event | | id=7906, chan | nel=undefined, m | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context | cpu_id=3, contextprocname=node, contextpthrea |
| 3 | uv_provider | :uv_send_event | | id=7905, chan | nel=undefined, m | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context | cpu_id=3, contextprocname=node, contextpthrea |
| 3 | uv_provider | uv_send_event: | | id=7912, chan | nel=undefined, m | nethod=destroy_1 | 16102, backend_fd=13, | context.packet_seq_num=10, context | cpu_id=3, contextprocname=node, contextpthrea |
| - | | | | :1 7040 | | | canon keelinged fiel an | anakaukanalushana awa 10 anakauk | and the second and an and a second address. |

🗇 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 👘 🗖

| | | | | | 록 🛼 ଓ ▾ 🔓 🔍 ର୍ 🗄 |
|----|--------------|--------------|--------------------------------|--------------|-------------------|
| | 16:47:40.695 | 16:47:40.696 | 16:47:40.697 | 16:47:40.698 | 16:47:40.699 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | PROMISE | | |
| | | | PROMISE | | |
| | | | Trace 9545 | | |
| | | | Date 2022-05-04 | | |
| PR | fs_re | | Start Time 16:47:40.694818529 | | |
| | | | Stop Time 16:47:40.699026325 | | |
| | | | Duration 0.004207796s (4,2 ms) | | |
| | | | | | |
| | | | | Ahnorn | nal behavior |
| | | | | ADITUT | |
| - | | | | | |
| - | | | | | |

Results interpretation

| 16:47:40 | .695 | | | | |
|-------------------|---|--|--|--|--|
| | | 16:47:40.696 | 16:47:40.697 | 16:47:40.698 | 16:47:40.699 |
| | | | | Checking Phase | |
| | | | | | |
| | | | | , | |
| e 📔 64-bit(2) | i 64-bit i 64-bit(3) | ≣ 64-bit(4) ≣ 64-b | pit(5) × | | - |
| уре | Contents | | | | |
| | id=9544 | | | | |
| der:uv_send_event | id=7923, cha | nnel=undefined, method=c | destroy_16102, backend_fd=13, conte | xt.packet_seq_num=10, context.cp | u_id=3, contextprocname=node, contextpthread |
| | | | | | |
| | | | | | |
| der:uv_send_event | id=7912, cha | nnel=undefined, method=o | destroy_16102, backend_fd=13, conte | xt.packet_seq_num=10, context.cp | u_id=3, contextprocname=node, contextpthread |
| | • | | completion | n a b a b a b b b c | |
| | | | | | |
| PR) | fs_read | | Trace 9545 Date 2022-05-04 Start Time 16:47:40.694818529 Stop Time 16:47:40.699026329 | 5 | |
| | | | | Abnori | mal behavior |
| | ider:uv_send_event ider:uv_send_event ider:uv_send_event ider:uv_send_event Bookmarks No 16:47:40 Garba | contents id=9544 id=7923, char id=7906, char id=7905, char id=7905, char id=7905, char id=7912, char id | te = 64-bit(2) = 64-bit = 64-bit(3) = 64-bit(4) = 64-bit type Contents id=9544 ider:uv_send_event id=7923, channel=undefined, method=c ider:uv_send_event id=7906, channel=undefined, method=c ider:uv_send_event id=7905, channel=undefined, method=c id=7912, channel=undefined, method=c id=7912 | te E 64-bit(2) E 64-bit E 64-bit(3) E 64-bit(4) E 64-bit(5) × type Contents id=9544 id=7923, channel=undefined, method=destroy_16102, backend_fd=13, conte ider:uv_send_event id=7905, channel=undefined, method=destroy_16102, backend_fd=13, conte ider:uv_send_event id=7912, channel=undefined, method=destroy_16102, backend_fd=13, conte id=7912, channel=undefined, method=destroy_16102, backend_fd=14, conte id=7914, channel=undefined, method=destroy_16102, backend_fd=14, conte id=791 | te E 64-bit(2) E 64-bit E 64-bit(3) E 64-bit(4) E 64-bit(5) × sype Contents Id=5544 Id=7923, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cp Id=7905, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cp Id=7912, channel=undefined, method=destroy_16102, backend_fd=13, context.packet_seq_num=10, context.cp Id=7 |

Results interpretation

| | Control Flow | | er × 7:40.696 | 16:47:40.697 | | ≰ 陸 ັ ▼ û ↓ ⊕ ℚ ℚ ii ▼ β □ 16:47:40.699 |
|---------------------|----------------------|------------------------|--------------------------------|---|--|--|
| State Syst | | | | | ng Phase | |
| ► Met | | | | | | |
| SetImmediate | ≣ 64-bit(2) 📰 64-bit | | 64-bit(4) ≣ 64-bit(5) × | (| | - |
| PU Event typ | e | Contents | | | | |
| srch> <srch></srch> | | id=9544 | | | | |
| uv_provide | er:uv_send_event | id=7923, channel=u | undefined, method=destroy | _16102, backend_fd=13, context.pa | cket_seq_num=10, context.cp | ou_id=3, contextprocname=node, contextpthre |
| | er:uv_send_event | | | — | | ou_id=3, contextprocname=node, contextpthre |
| | er:uv_send_event | | | | | ou_id=3, contextprocname=node, contextpthre |
| uv_provide | er:uv_send_event | id=7912, channel=u | undefined, method=destroy | _16102, backend_fd=13, context.pa | cket_seq_num=10, context.cp | ou_id=3, contextprocname=node, contextpthre |
| _ | 16:47:40.695 | 16:4 | 7:40.696 | 16:47:40.697 | 16:47:40.698 | 16:47:40.699 |
| | Garbage is | destroyi | / | s linearly and | 16:47:40.698 | 16:47:40.699 |
| | Garbage is | destroyi | ng resources peration com | s linearly and pletion | 16:47:40.698 | 16:47:40.699 |
| | Garbage is | destroyi | ng resources Deration com | s linearly and pletion | л П I | |
| | Garbage is | destroyii atomic op | ng resources Deration com | S linearly and pletion MISE race 9545 ate 2022-05-04 tart Time 16:47:40.694818529 top Time 16:47:40.699026325 | л П I | 16:47:40.699 |





Atomic operation may access the same resource



Atomic operation may access the same resource Two or more processes may access a shared resource



- 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



- 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



- 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



- 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

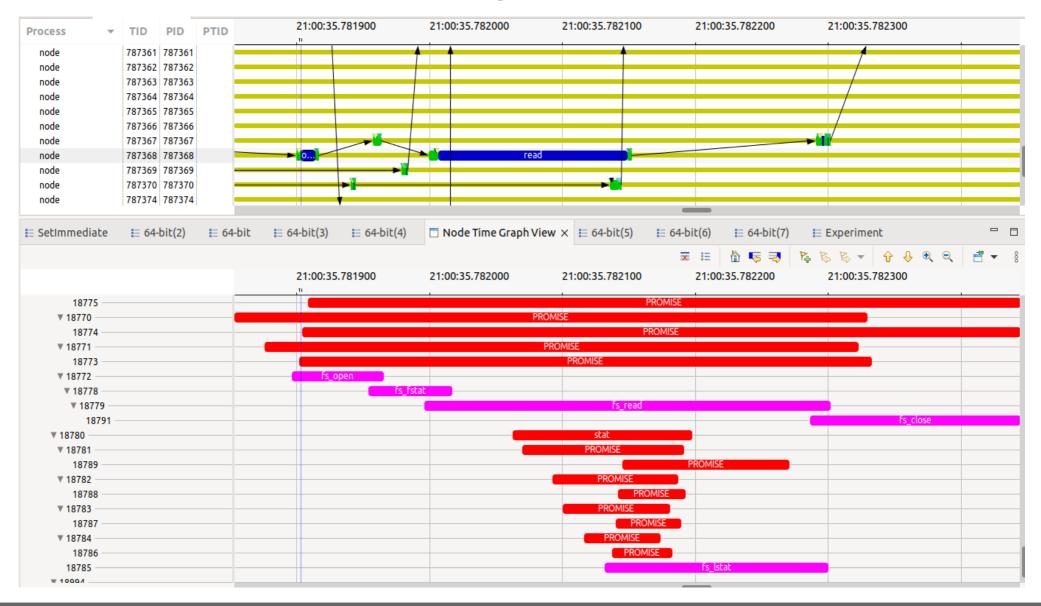
Test scenario

- 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

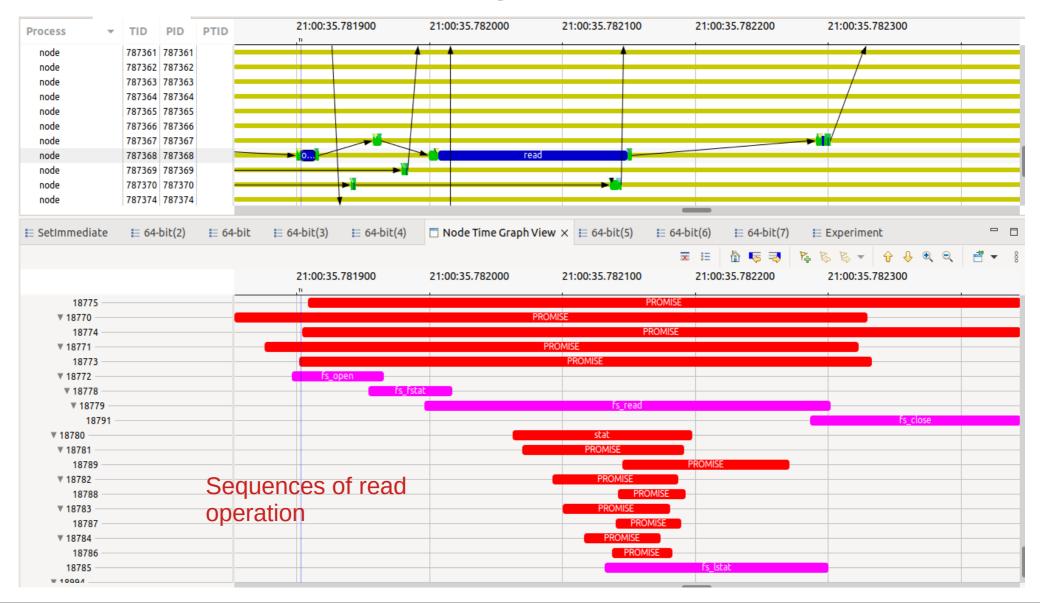


Resulting flow

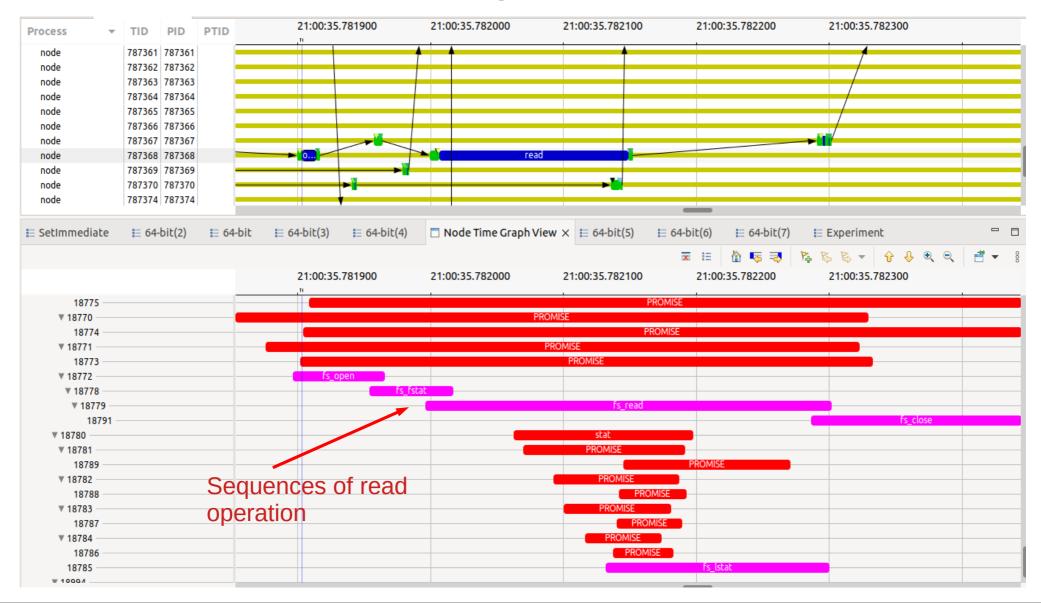
Resulting flow



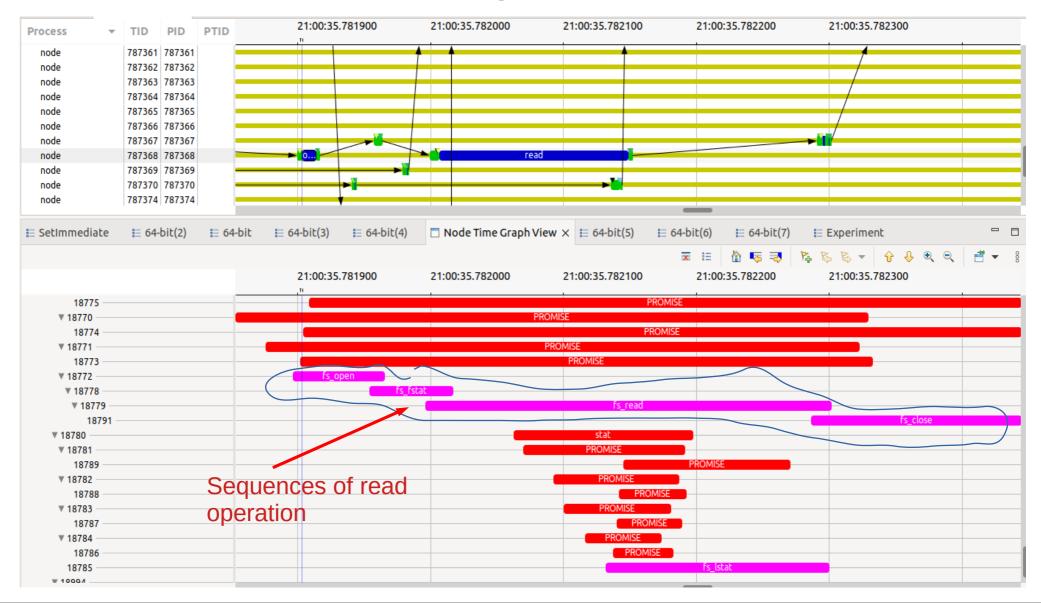
Resulting flow



Resulting flow



Resulting flow





| 🗄 State System Explorer 📋 Node Time Graph View 🗙 | | 🕱 🗄 💧 😽 💐 | R & B - 0. | 0- • • • = = | 000 |
|---|-----------------|---|------------|-----------------|-----|
| 20:20:08.180000 | 20:20:08.180500 | 20:20:08.1810 | 00 | 20:20:08.181500 | |
| | | fs_w | rite | | |
| | | 91 2022-05-12 20:20:08.179950359 20:20:08.181058121 0.001107762s (1,1 ms) | | | |
| Image: Section of the sectio | | | | | _ |

| oit(2) | 🗏 64-bit | ≣ 64-bit(3) ≣ 64-bit(4) ≣ 64 | 4-bit(5) $\equiv 64$ -bit(6) $\equiv 64$ -bit(7) $\equiv 64$ -bit(8) $\equiv Experiment$ $\equiv 64$ -bit(13) \times 3 |
|-----------|---------------|---------------------------------------|--|
| hannel | CPU | Event type | Contents |
| srch> | <srch></srch> | <srch></srch> | <srch></srch> |
| hannel0_3 | 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 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 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 3 | uv_provider:uv_send_event | id=6.480561237982693, channel=6.21200713404852, method=js_open_create, backend_fd=14, context.packet_ |
| hannel0_3 | 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 | 33 | uv_provider:uv_fs_open_event | fd=29685, path=0xfffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, context.packet_seq_num=0, context |
| hannel0_3 | 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, contextpro |
| hannel0 3 | 3 3 | uv provider:uv work submit event | add loop=0xffffffbe1eed08, add work=0xffffffbe1eecf8, add w=0xfffffffbe1eed00, add done=0xfffffffb |
| s 🗖 Pro | mise Que | eue XY View × 🗖 Timers Latency XY Vie | ew 📄 Tick Frequency XY View 📄 Thread Pool Monitor 🖷 Progress 🗳 Critical Flow View 👘 |

| 🗄 State System Explorer 🛛 Node T | Time Graph View $	imes$ | | | × i≘ | 🖄 🤜 🤜 | P. & & - | 0 4 Q | ् 📑 👻 | 000 |
|----------------------------------|-------------------------|----------------|-----------|----------|--|----------|-------|------------|-----|
| 20:20:0 | 08.180000 | 20:20:08.18050 | 0 | | 20:20:08.1810 | 000 | 20:20 | :08.181500 | |
| | | | | | fs_v | vrite | | | |
| PROMISE | | | | | | | | | |
| | fs_o | pen | | | | | | | |
| | | fs_unlink | Stop Time | 20:20:08 | 12 9.179950359 9.181058121 7762s (1,1 ms) | | | | |
| Race condition | | | | | | | | | |
| | | | | | | | | | _ |

| oit(2) | ≣ 64-bit | ≣ 64-bit(3) ≣ 64-bit(4) ≣ 64 | $l-bit(5) \equiv 64-bit(6) \equiv 64-bit(7) \equiv 64-bit(8) \equiv Experiment \equiv 64-bit(13) \times 3^{3}$ |
|-----------|---------------|---------------------------------------|---|
| hannel | CPU | Event type | Contents |
| srch> | <srch></srch> | <srch></srch> | <srch></srch> |
| hannel0_3 | 33 | 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 | 33 | 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 | 33 | 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 3 | uv_provider:uv_send_event | id=6.480561237982693, channel=6.21200713404852, method=js_open_create, backend_fd=14, context.packet_ |
| hannel0_3 | 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 | 33 | uv_provider:uv_fs_open_event | fd=29685, path=0xfffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, context.packet_seq_num=0, context.packet_seq_num=0, context.packet_seq_num=0, context.packet_seq_num=0, context.packet_seq_num=0, context.packet_seq_num=0, context.packet |
| hannel0_3 | 33 | uv_provider:uv_async_file_event | id=1649709016, backend_fd=29685, oper=fs_open, context.packet_seq_num=0, context.cpu_id=3, contextpro |
| hannel0 3 | 3 3 | uv provider:uv work submit event | add loop=0xfffffffbe1eed08, add work=0xfffffffbe1eecf8, add w=0xfffffffbe1eed00, add done=0xfffffffb |
| s 🗖 Pro | mise Que | eue XY View × 🗖 Timers Latency XY Vie | w 🗖 Tick Frequency XY View 🗖 Thread Pool Monitor 🖷 Progress 🔄 Critical Flow View 🦳 |

| 🗄 State System Explorer 📋 Node Time Graph View 🗙 | | ≍ :≘ | 🖞 🦻 🖘 🕅 | 66- | ି (} € € € | 者 🔹 🖇 🗖 |
|--|-----------------|-------------|---|----------|------------------------|---------|
| 20:20:08.180000 | 20:20:08.180500 | | 20:20:08.181000 | | 20:20:08. | 181500 |
| | | | <mark>fs_write</mark> | fs_close | | |
| | fs_open | | | | | |
| | | 20:20:08 | -12 8.179950359 8.181058121 7762s (1,1 ms) | | | |
| Race condition | | | | | | |
| | | | | | | _ |

| oit(2) | 🗏 64-bit | : ≣ 64-bit(3) ≣ 64-bit(4) ≣ 6 | 4-bit(5) $\equiv 64$ -bit(6) $\equiv 64$ -bit(7) $\equiv 64$ -bit(8) $\equiv Experiment$ $\equiv 64$ -bit(13) \times 3 |
|-----------|---------------|---------------------------------------|--|
| hannel | CPU | Event type | Contents |
| srch> | <srch></srch> | <srch></srch> | <srch></srch> |
| hannel0_3 | 33 | 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 | 33 | 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 | 33 | 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 | 33 | uv_provider:uv_send_event | id=6.480561237982693, channel=6.21200713404852, method=js_open_create, backend_fd=14, context.packet_ |
| hannel0_3 | 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 | 33 | uv_provider:uv_fs_open_event | fd=29685, path=0xfffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, context.packet_seq_num=0, con |
| hannel0_3 | 33 | uv_provider:uv_async_file_event | id=1649709016, backend_fd=29685, oper=fs_open, context.packet_seq_num=0, context.cpu_id=3, contextpro |
| hannel0 3 | 3 3 | uv provider:uv work submit event | add loop=0xfffffffbe1eed08, add work=0xfffffffbe1eecf8, add w=0xfffffffbe1eed00, add done=0xffffffffb |
| s 🗖 Pro | mise Qu | eue XY View × 🗖 Timers Latency XY Vie | ew 🗇 Tick Frequency XY View 🗇 Thread Pool Monitor 🖷 Progress 📴 Critical Flow View 🧧 |

| State System Explorer Node Time Graph Vie 20:20:08.180000 | 20:20:08.180500 | | | ⊕ ⊕ ≡ ≡ € 20:20:08.181500 |
|--|---|---|-----------|---|
| PROMISE | | fs_v | vrite | |
| | | 91 2022-05-12 20:20:08.179950359 20:20:08.181058121 0.001107762s (1,1 ms) | | |
| Race condition | Opening a file in rea file was already del | | vhile the | |

| oit(2) | 🗄 64-bit | ≣ 64-bit(3) ≣ 64-bit(4) ≣ 64 | 4-bit(5) 1 64-bit(6) 1 64-bit(7) 1 64-bit(8) 1 Experiment 1 64-bit(13) × 3 □ |
|----------|---------------|---------------------------------------|--|
| hannel | CPU | Event type | Contents |
| srch> | <srch></srch> | <srch></srch> | <srch></srch> |
| hannel0_ | 33 | 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_ | 33 | uv_provider:uv_send_event | id=6.21200713404852, channel=85, method=js_open_main, backend_fd=12, context.packet_seq_num=0, contex |
| hannel0_ | 33 | 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_ | 33 | 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_ | 33 | uv_provider:uv_fs_open_event | fd=29685, path=0xfffffffbe1eed68, backend_fd=2032454154, context.packet_seq_num=0, context.cpu_id=3, context.packet_seq_num=0, con |
| hannel0_ | 33 | uv_provider:uv_async_file_event | id=1649709016, backend_fd=29685, oper=fs_open, context.packet_seq_num=0, context.cpu_id=3, contextpro |
| hannel0 | 33 | uv provider:uv work submit event | add loop=0xfffffffbe1eed08, add work=0xfffffffbe1eecf8, add w=0xfffffffbe1eed00, add done=0xfffffffb |
| s 🗖 Pro | mise Que | eue XY View × 🗖 Timers Latency XY Vie | ew 🗖 Tick Frequency XY View 🗖 Thread Pool Monitor 🖷 Progress 📴 Critical Flow View 🧧 |

- NodeCompass a powerful tool for Node.js applications performance analysis

- NodeCompass a powerful tool for Node.js applications performance analysis
- Brings a high level of granularity in the Performance Analysis

- NodeCompass a powerful tool for Node.js applications performance analysis
- Brings a high level of granularity in the Performance Analysis
- Helps in understanding the application flow

- NodeCompass a powerful tool for Node.js applications performance analysis
- Brings a high level of granularity in the Performance Analysis
- Helps in understanding the application flow
- Allows pinpointing bottlenecks, bugs, errors, race conditions

- NodeCompass a powerful tool for Node.js applications performance analysis
- Brings a high level of granularity in the Performance Analysis
- Helps in understanding the application flow
- Allows pinpointing bottlenecks, bugs, errors, race conditions
- Can be used to instrument functions in the way distributed tracers work

Bibliography

[1] I. Beschastnikh, P. Wang, Y. Brun, M. D. Ernst, Debugging distributed systems, ACM-Queue (2015).

[2] J. Hoglund, An analysis of a distributed tracing systems effect on performance. jaeger and opentracing api, UMEA University (2020).

[3] S. Tilkov, S. Vinoski, Node.js: Using javascript to build high-performance network programs, IEEE INTERNET COMPUTING (2010).

[4] Cloud desktop ide platform.

URL https://kubernetes.io/fr/

[5] Visual studio code.

URL https://code.visualstudio.com/

[6] Y. Geng, S. Liu, Z. Yin, A. Naik, B. Prabhakar, M. Rosenblum, A. Vahdat, Exploiting a natural network effect for scalable, fine-grained clock synchronization, 2018.

```
2007, pp. 171-180.
```

Thank you