Benchmarking Elasticsearch with Rally

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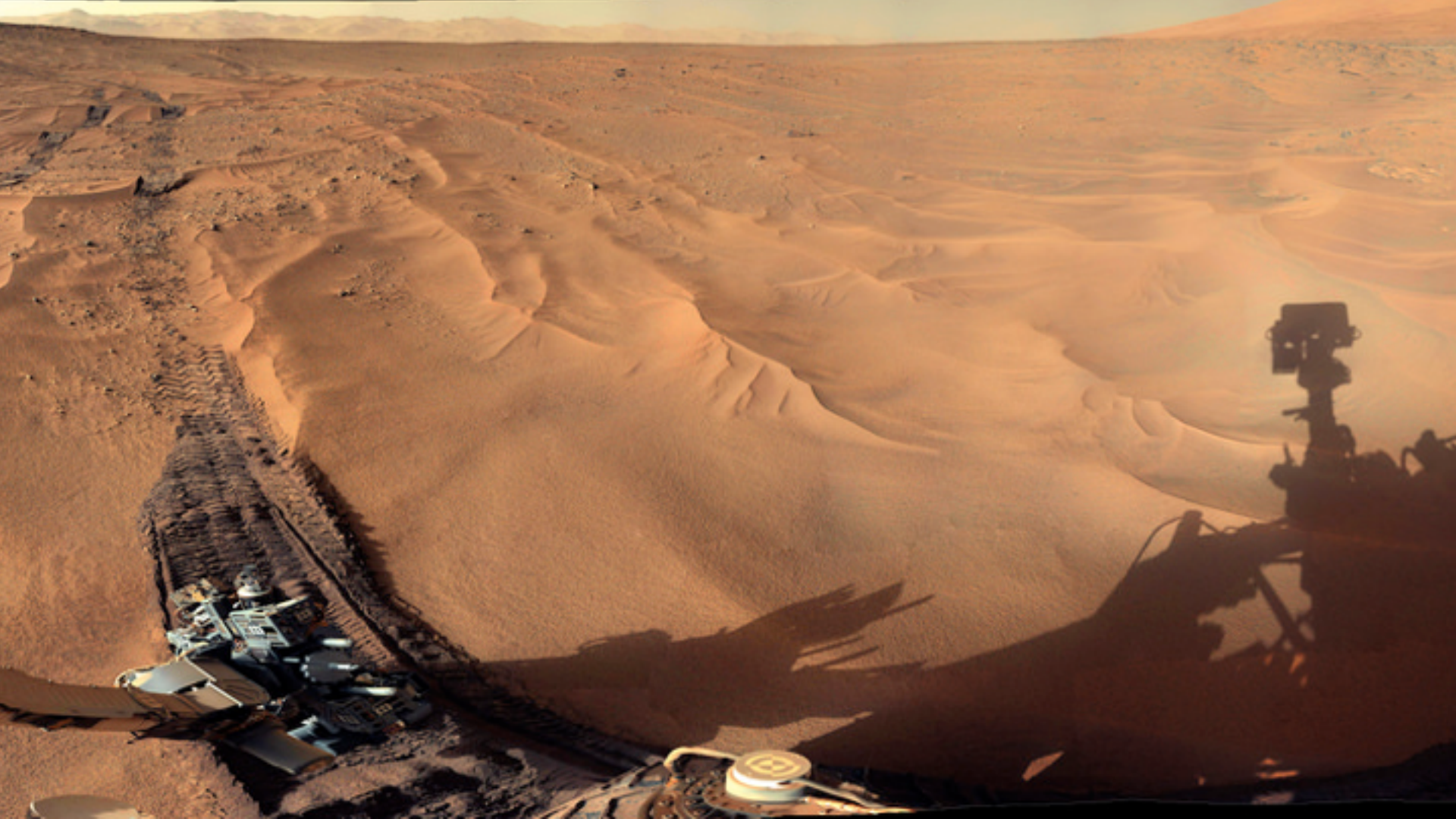
Outline

1. The Need for Benchmarking in the Elasticsearch Project
2. 7 Deadly Benchmarking Sins
3. Demo

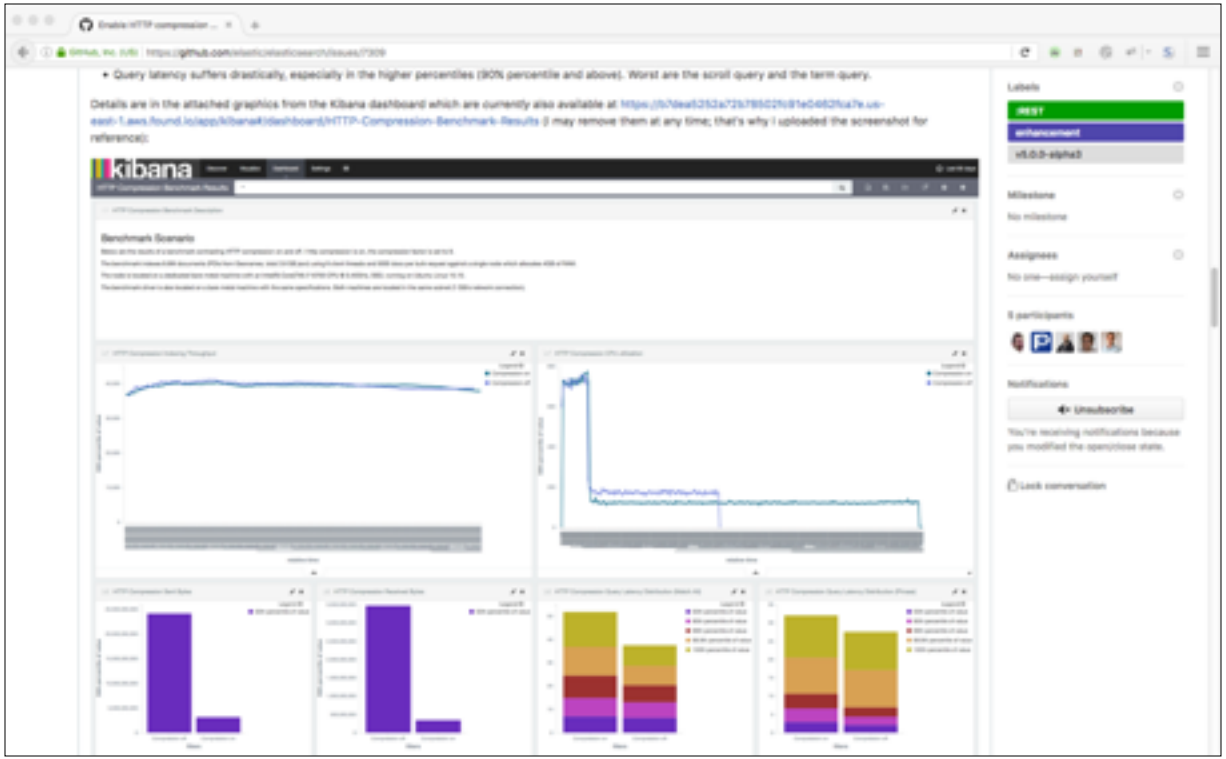
“Elasticsearch is just a search engine, isn't it?”



How do you evaluate performance for all these use-cases?

What we do: Measure, Measure, Measure

During Development

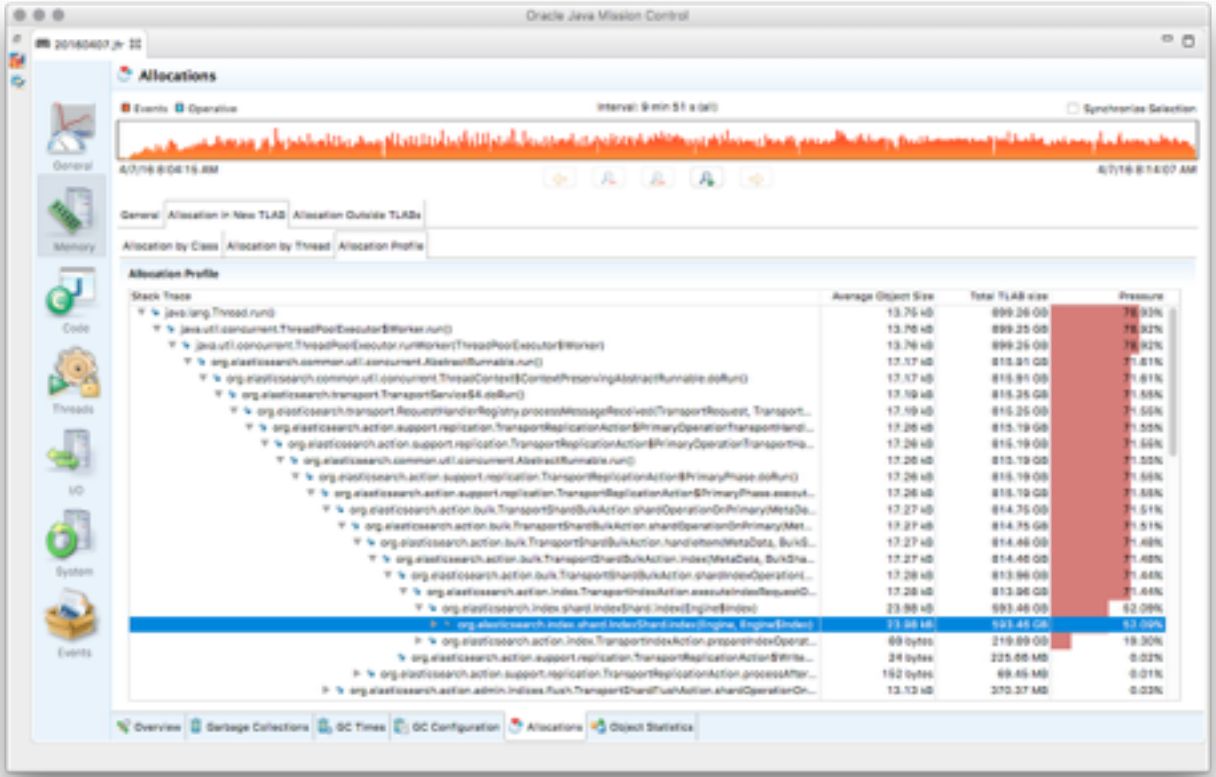


Source: https://github.com/elastic/elasticsearch/issues/7309

elastic

What we do: Measure, Measure, Measure

During Development



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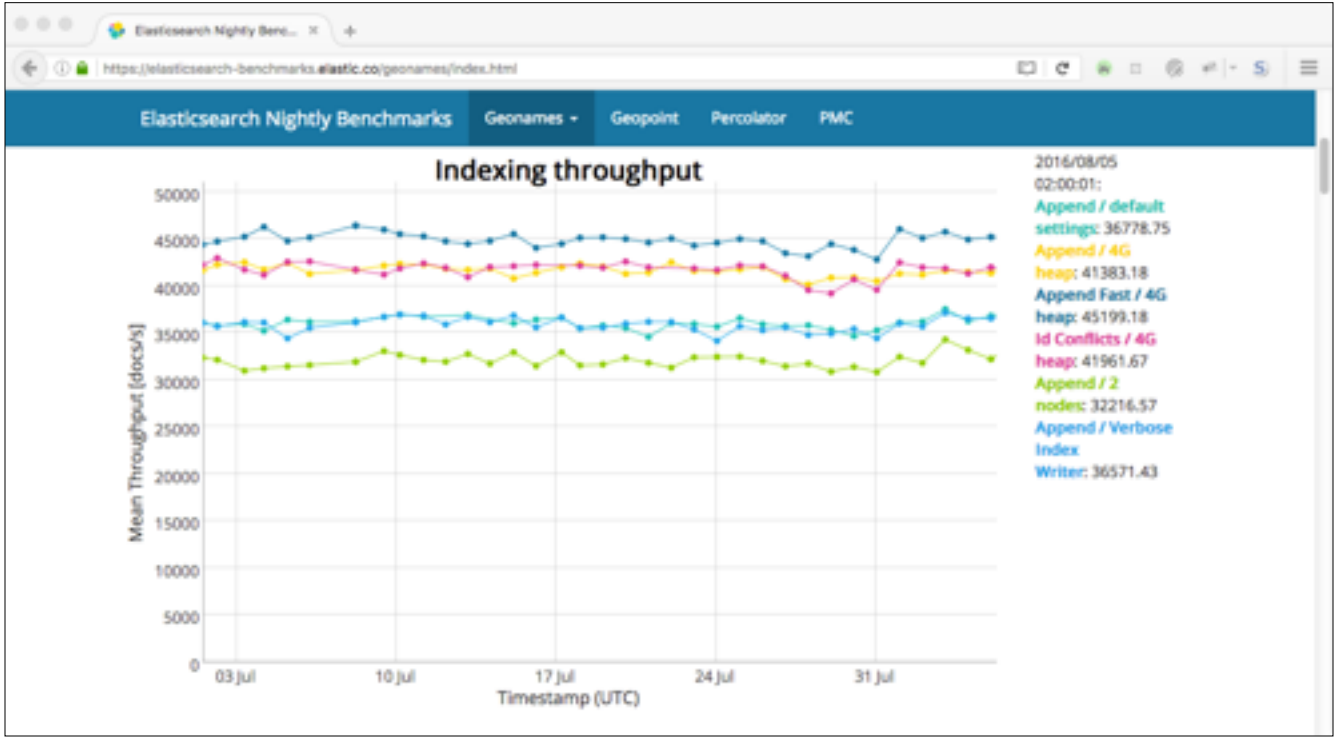
What we do: Measure, Measure, Measure

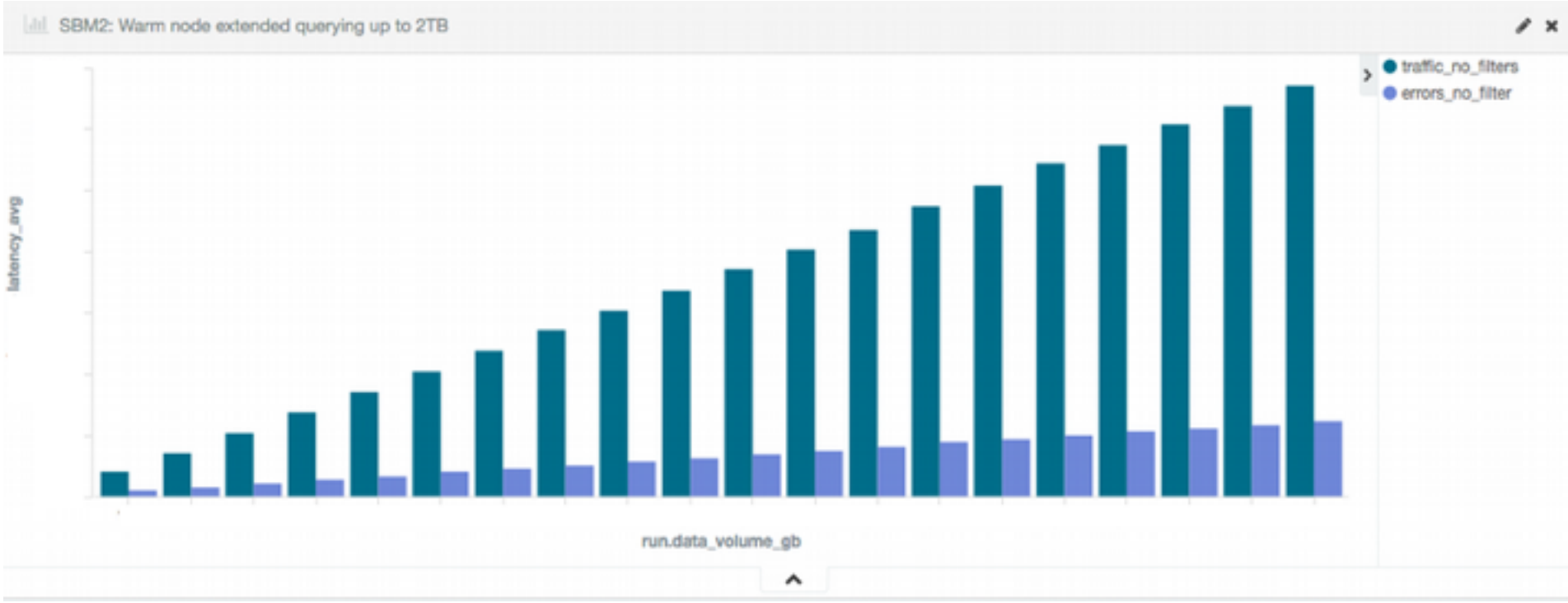
Nightly benchmarks



 Source: https://elasticsearch-benchmarks.elastic.co/geonames/

What we do: Measure, Measure, Measure

Sizing benchmarks for specific scenarios*



*) numbers on axis intentionally stripped to avoid interpretation out of context

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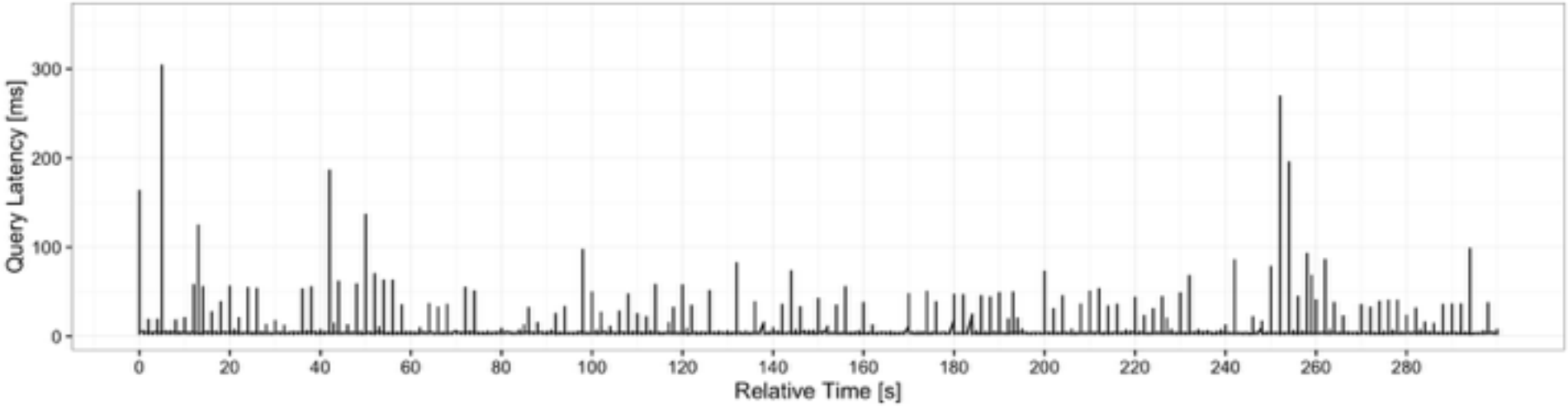
What we do: Measure, Measure, Measure

Performance measurement / tuning at customer site



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7 Deadly Benchmark Sins

Sin #1: Not paying attention to system setup

Hardware

- Bare-metal
- SSDs
- Server-class CPU
- Single socket, multi socket?
- Enough memory head-room for FS cache

Sin #1: Not paying attention to system setup

Operating System

- Linux, Windows
- Check network configuration
- File system, LVM, etc.
- No Swap
- I/O scheduler: cfq, noop, deadline
- CPU governor: powersave, performance

Sin #1: Not paying attention to system setup

Benchmark Setup

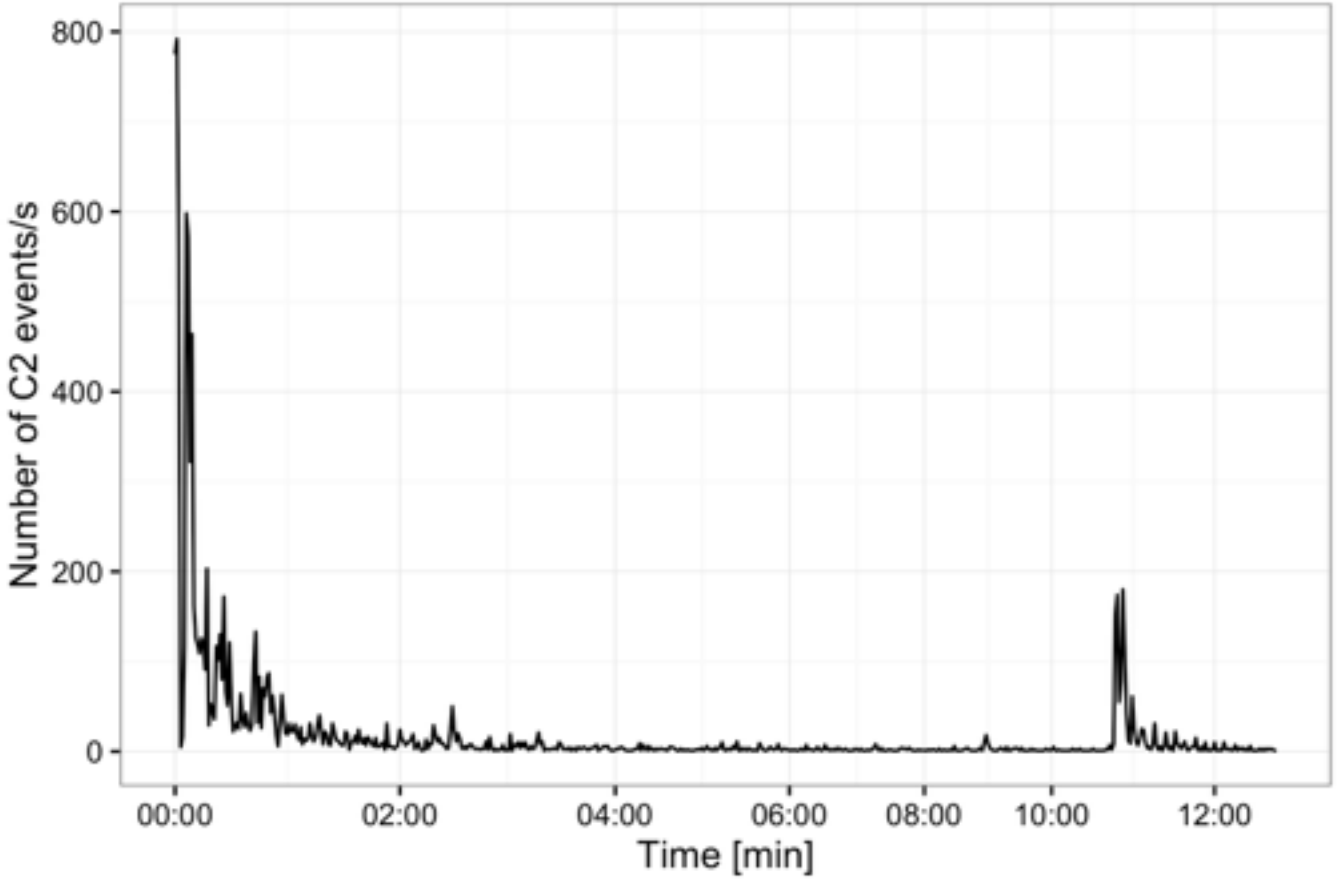
- Beware of unwanted caching effects (FS cache, …)
- Benchmark driver and ES on separate machines
- One node per machine (or adjust JVM parameters (GC threads))
- Low-latency, high-throughput network between benchmark driver and ES
- No other traffic on this network

Sin #2: No warmup

Awake before your first coffee? Elasticsearch isn’t either.

- JIT compiler needs to run first
- Creation of long-living data structures
- FS cache for Lucene segments (memory-mapped IO)
- Benchmark driver needs to reach stable state too

Warmup Behaviour: C2 Compilation Events/s



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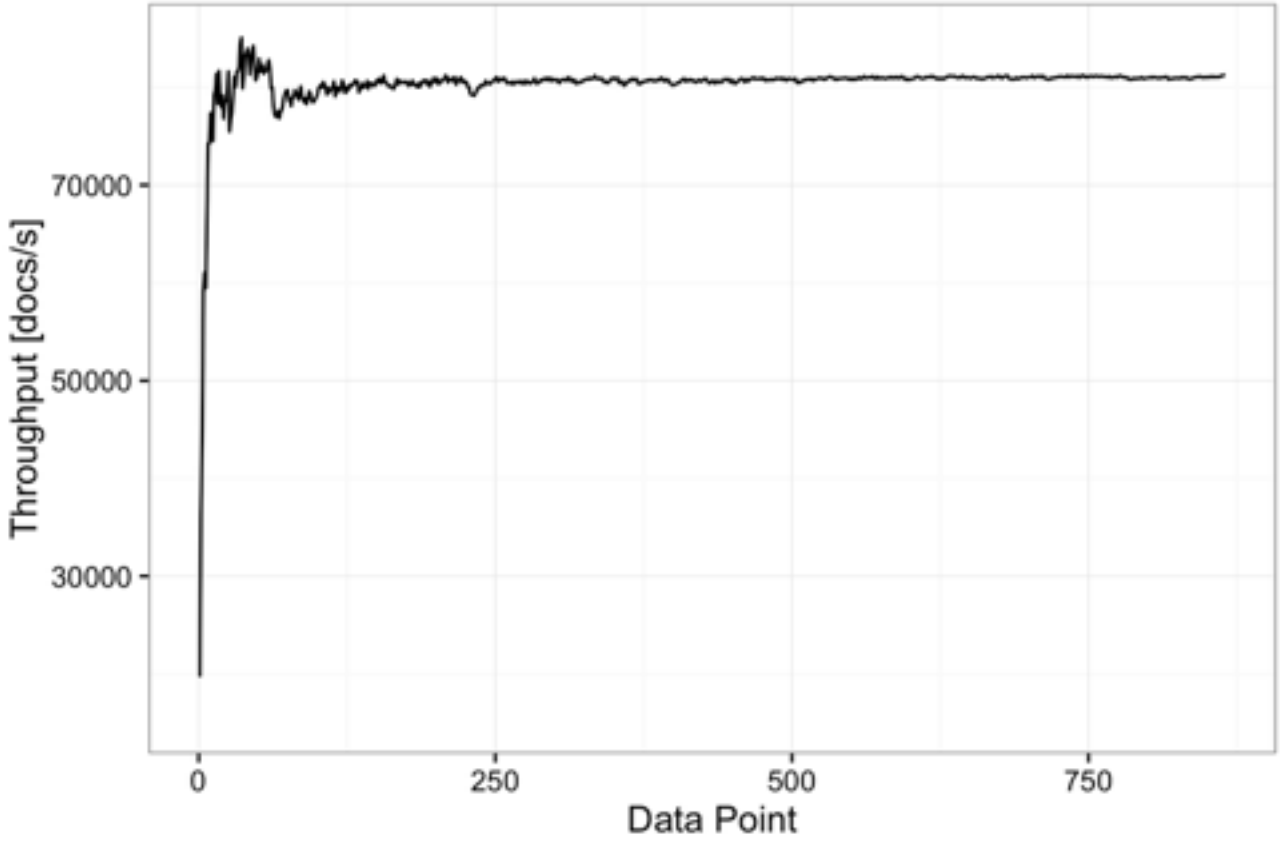
Warmup Behaviour: Benchmark Driver Throughput



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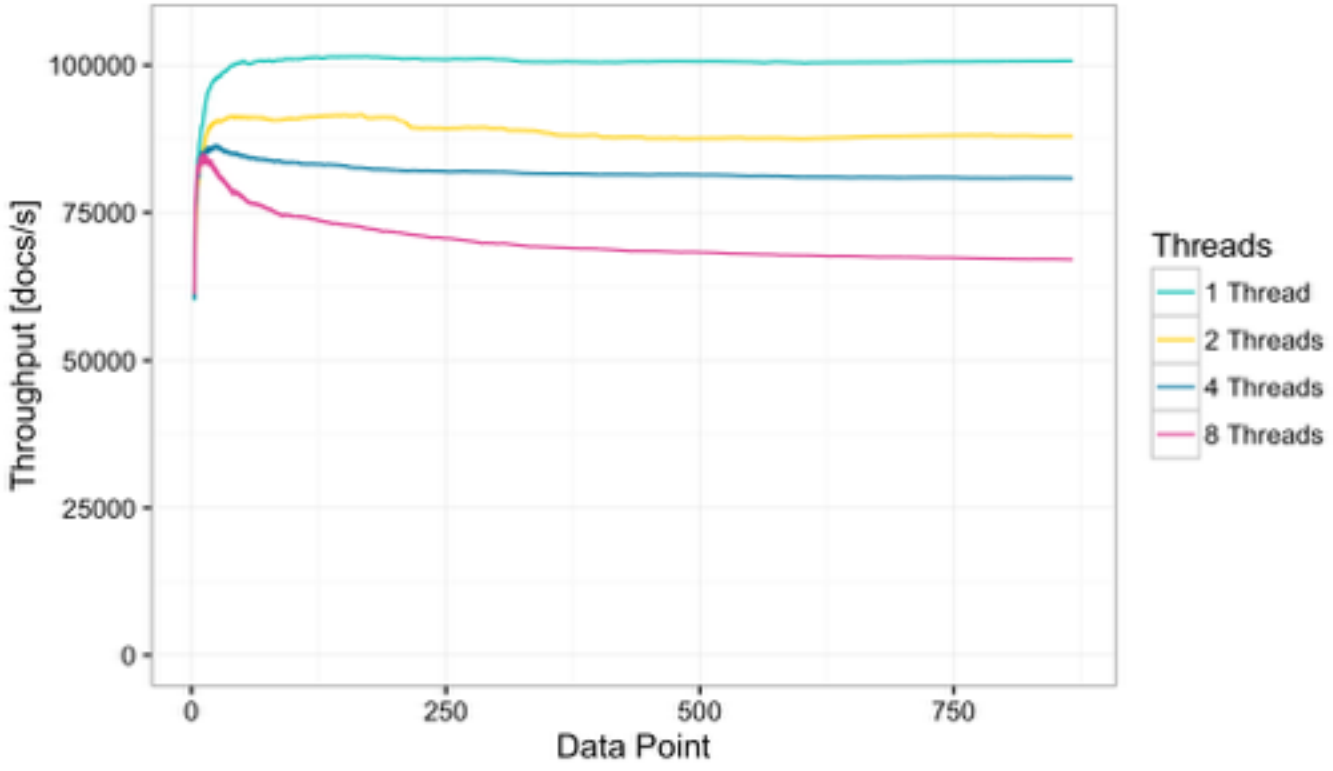
Sin #3: No bottleneck analysis

Are you really benchmarking what you think you're benchmarking?

- Benchmark driver
- System setup: analysis of system background noise (jhiccup)
- Network

First Driver Stress Tests

Contention all over the place



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Sin #4: The divine benchmarking script

"After all, it produces numbers with 6 decimal places!"

- Not paying attention how metrics are gathered
  - `System.currentTimeMillis()` vs. `System.nanoTime()`
- Not checking measurement overhead
- No return code checks: the fast 404
- Blind trust in tools: No cross-verification

Cross-Validation of Metrics

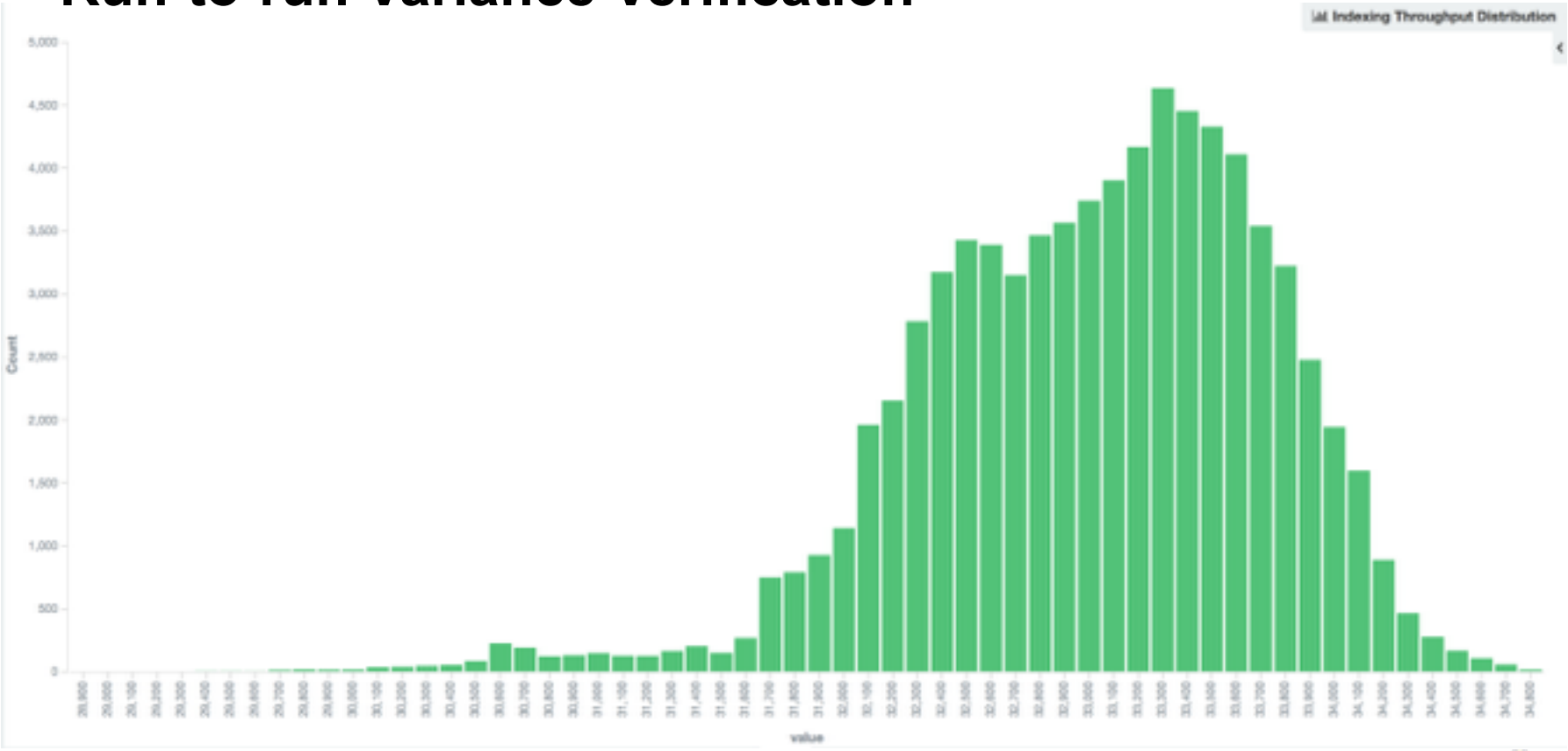
Metric	Rally	Flight Recorder	GC log
Young Gen GC	79,416 ms	**89,003 ms(?)**	80,853 ms
Old Gen GC	23,964 ms	**156,630 ms(?)**	23,989 ms

Sin #5: Denying Statistics

Run-to-run variance

- How is run-to-run variance distributed?
- Multiple trial runs and t-test

Run-to-run Variance Verification



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Sin #5: Denying Statistics

Latency Measurement

- The meaningless mean: Half of the responses are worse than the mean
- Cannot calculate 99.99th percentile from 10 samples
- Don’t average percentiles
- Latency distribution is multi-modal

Sin #6: Vague Metrics

- Latency
- Service Time
- Throughput
- Waiting Time
- Response Time
- Utilisation
- …

Service Time

Sin #6: Vague metrics

Service Time

```
while (!isDone()) {
    Request req = createRequest();
    long start = System.nanoTime();
    // block until the request has finished
    send(req);
    long end = System.nanoTime();
    long serviceTime = end - start;
}
```

Waiting Time

Response Time / Latency

+

Sin #6: Vague metrics

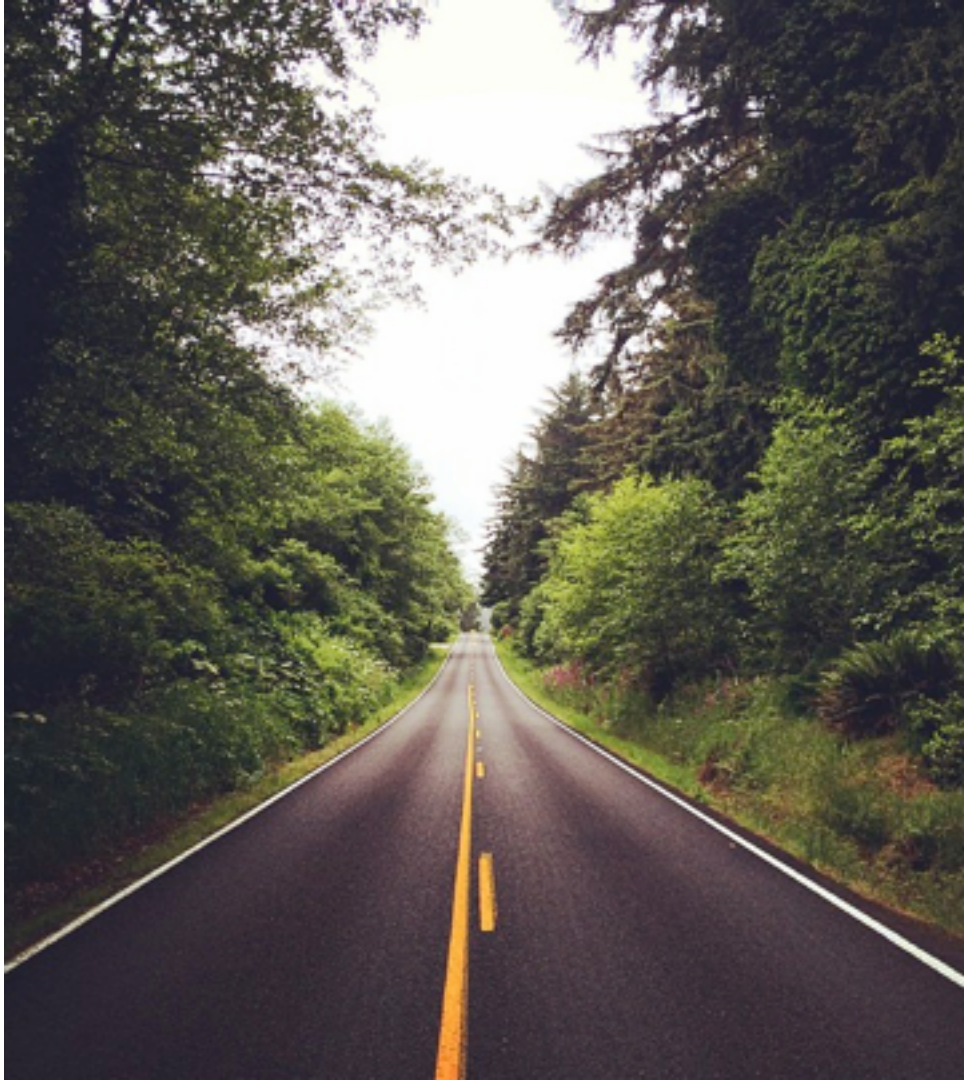
Latency

```
// generator thread
while (!isDoneGenerating()) {
    Request req = createRequest();
    long start = System.nanoTime();
    queue.put(req, start);
}

// request issuing thread
while (!isDoneSending()) {
    request, start = queue.take();
    send(request);
    long end = System.nanoTime();
    long latency = end - start;
}
```

Utilisation

0% utilisation: no waiting time



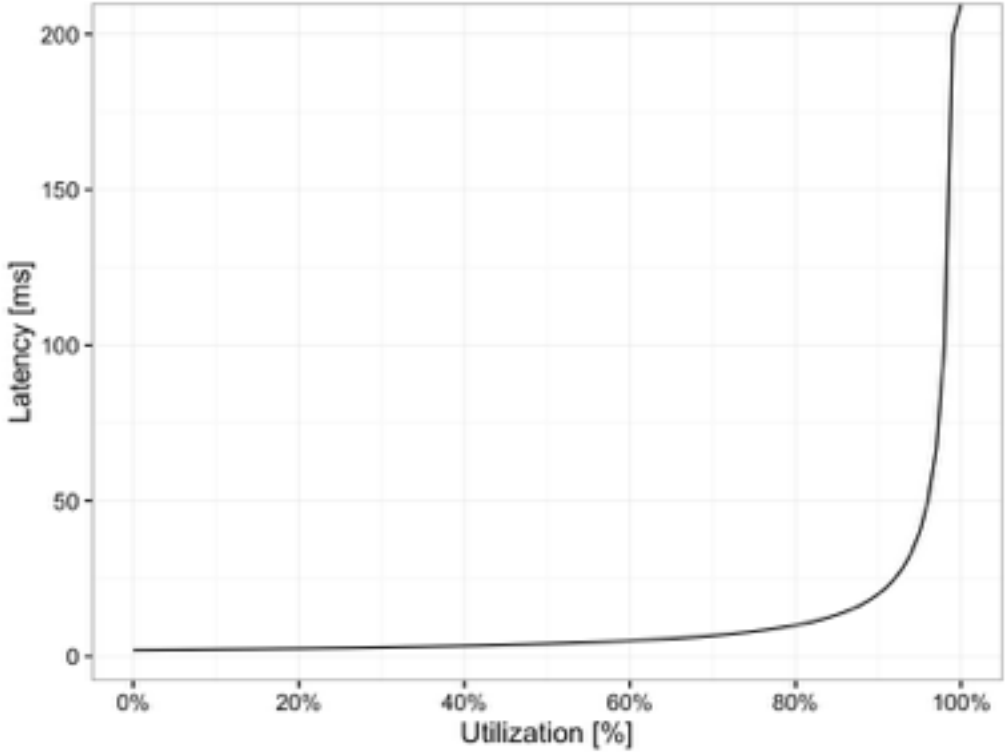
Utilisation

100% utilisation: high waiting time

Throughput and Utilisation

Sin #6: Vague metrics

Latency … at which throughput?



 Created based on http://robharrop.github.io/maths/performance/2016/02/20/service-latency-and-utilisation.html

Sin #6: Vague metrics

Latency at a defined throughput

```
// generator thread
while (!isDoneGenerating()) {
    Request req = createRequest();
    long start = System.nanoTime();
    queue.put(req, start);
    Thread.sleep(waitTime(targetThroughput));
}

// request issuing thread
while (!isDoneSending()) {
    request, start = queue.take();
    send(request);
    long end = System.nanoTime();
    long latency = end - start;
}
```

Sin #7: Treat Performance as One-Dimensional

Vary inputs

- Bulk size
- Query parameters
- Document structure

Sin #7: Treat Performance as One-Dimensional

Vary execution order

- Run queries in different order: Avoid caching effects
- Interfere operations: How does indexing behave with concurrent queries?

Sin #7: Treat Performance as One-Dimensional

And more

- Hardware
- OS
- JDK
- …

How we measure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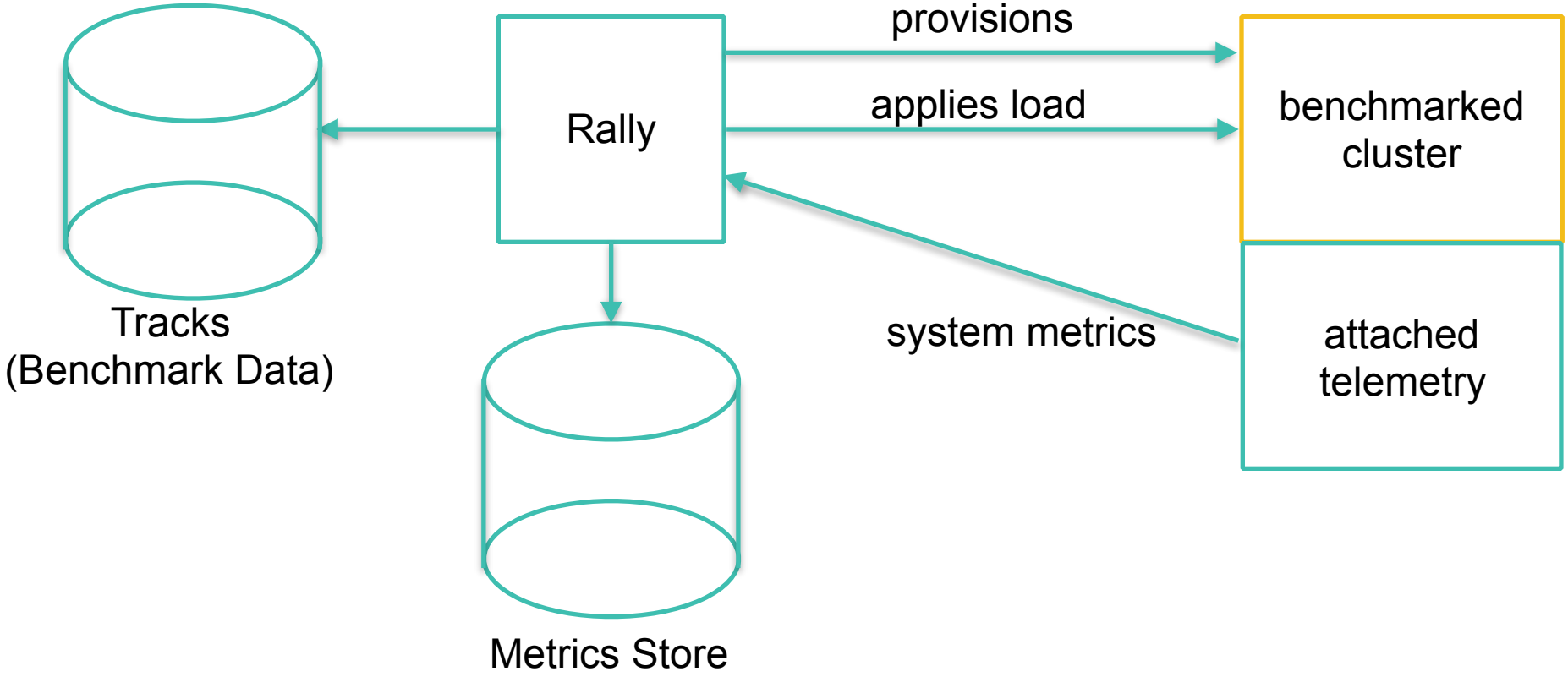
JB 93B

Rally

You know … for benchmarking Elasticsearch

https://github.com/elastic/rally

10.000 feet view of Rally



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Demo

Summary


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Performance is easy, all you need to know is everything

Sergey Kuksenko, Oracle Performance Engineer

Questions?

Slides

https://bit.ly/rally-javazone-16

Further Resources: Talks and Articles

- What is coordinated omission? https://groups.google.com/forum/#!msg/mechanical-sympathy/icNZJejUHfE/BfDekfBEs_sJ
- Example: “Fixing Coordinated Omission in Cassandra Stress”: https://psy-lob-saw.blogspot.de/2016/07/fixing-co-in-cstress.html
- Relating Service Utilisation to Latency: http://robharrop.github.io/maths/performance/2016/02/20/service-latency-and-utilisation.html
- “How not to measure latency”: http://www.youtube.com/watch?v=lJ8ydIuPFeU
- “Benchmarking Blunders and Things That Go Bump in the Night”: http://arxiv.org/pdf/cs/0404043v1.pdf

Further Resources: Tools & Methodology

- USE method: http://www.brendangregg.com/usemethod.html
- Java Flight Recorder: http://docs.oracle.com/javacomponents/jmc-5-5/jfr-runtime-guide/index.html
- JITWatch: https://github.com/AdoptOpenJDK/jitwatch
- Rally: https://github.com/elastic/rally

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