# Performance testing done right

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# Hazelcast

**HAZELCAST IMDG** is an operational, in-memory, distributed computing platform that manages data using

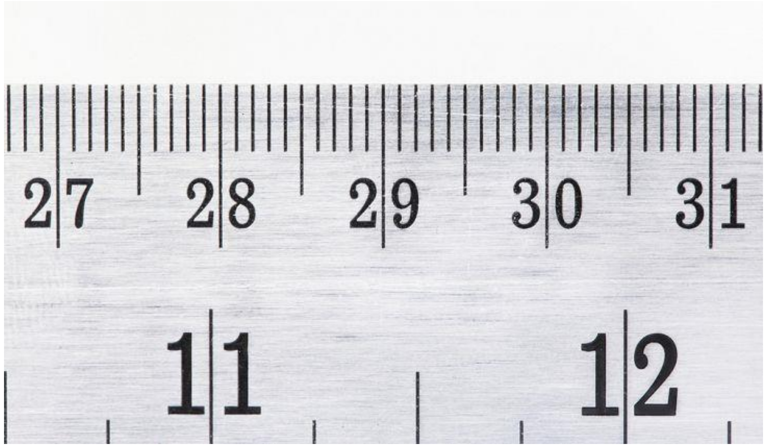
in-memory storage, and performs parallel execution for breakthrough application speed and scale.

**HAZELCAST JET** is the ultra fast, application embeddable, 3rd generation stream processing engine for low latency batch and stream processing.

# Quick terminology

# Metrics

- **Throughput** - number of operations per time unit (ops/sec)
- **Latency, response time** - time from the making the request to getting the response (us, ms, s, ...)



# Test types

- **Performance** - results are **numbers**
    - Throughput tests - the more operations done, the better
    - Latency tests - lower latency at *fixed number of operations*
- **Stability** - result is a **yes/no** answer
    - Load/soak tests - system has to remain stable under given (extreme) conditions

# Problems

**Description**

**Example**

**Solution**

Problem #1: Description

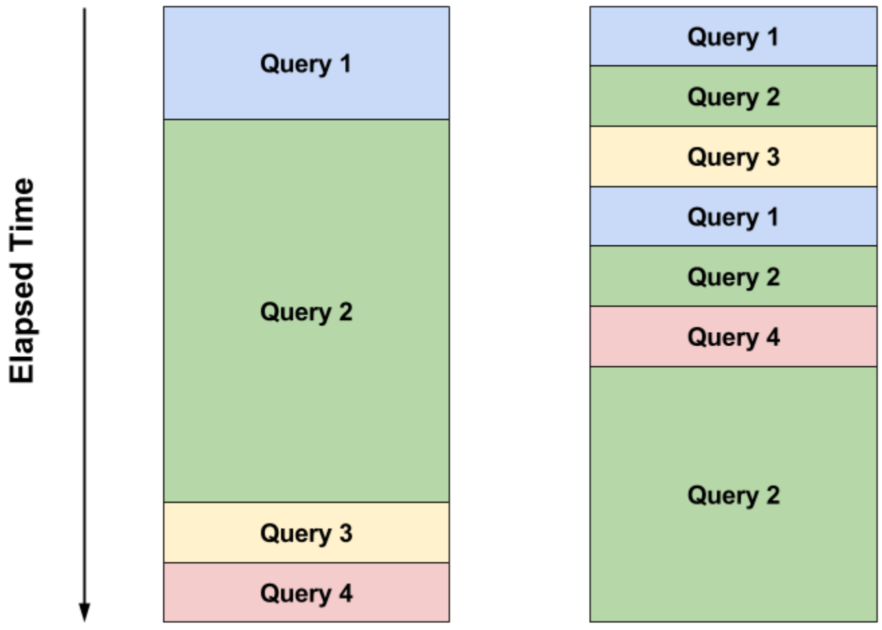
# Not distinguishing between latency and throughput tests

- These metrics are **often** related
  - The bigger the throughput, the lower the latency and vice versa
- Still, they are two different properties of the system
- Plus the relation does **not always** hold!

## Problem #1: Example (1/2)

# Not distinguishing between latency and throughput test

### Better latency, same (or worse) throughput



## Problem #1: Example (2/2)

# Not distinguishing between latency and throughput test

**Better throughput, same (or worse) latency**

- Adding number of response threads to web server

## Problem #1: Solution

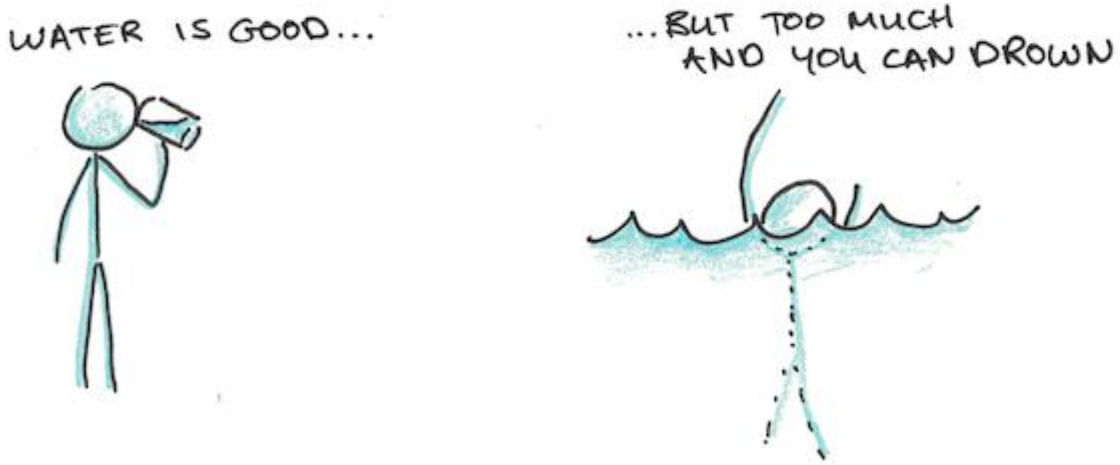
# Not distinguishing between latency and throughput test

- Always differ between latency and throughput tests
  - Latency test - fix the throughput
- Make sure to understand what we want to test for a given scenario

### Problem #2: Description

# Inadequate load on the system

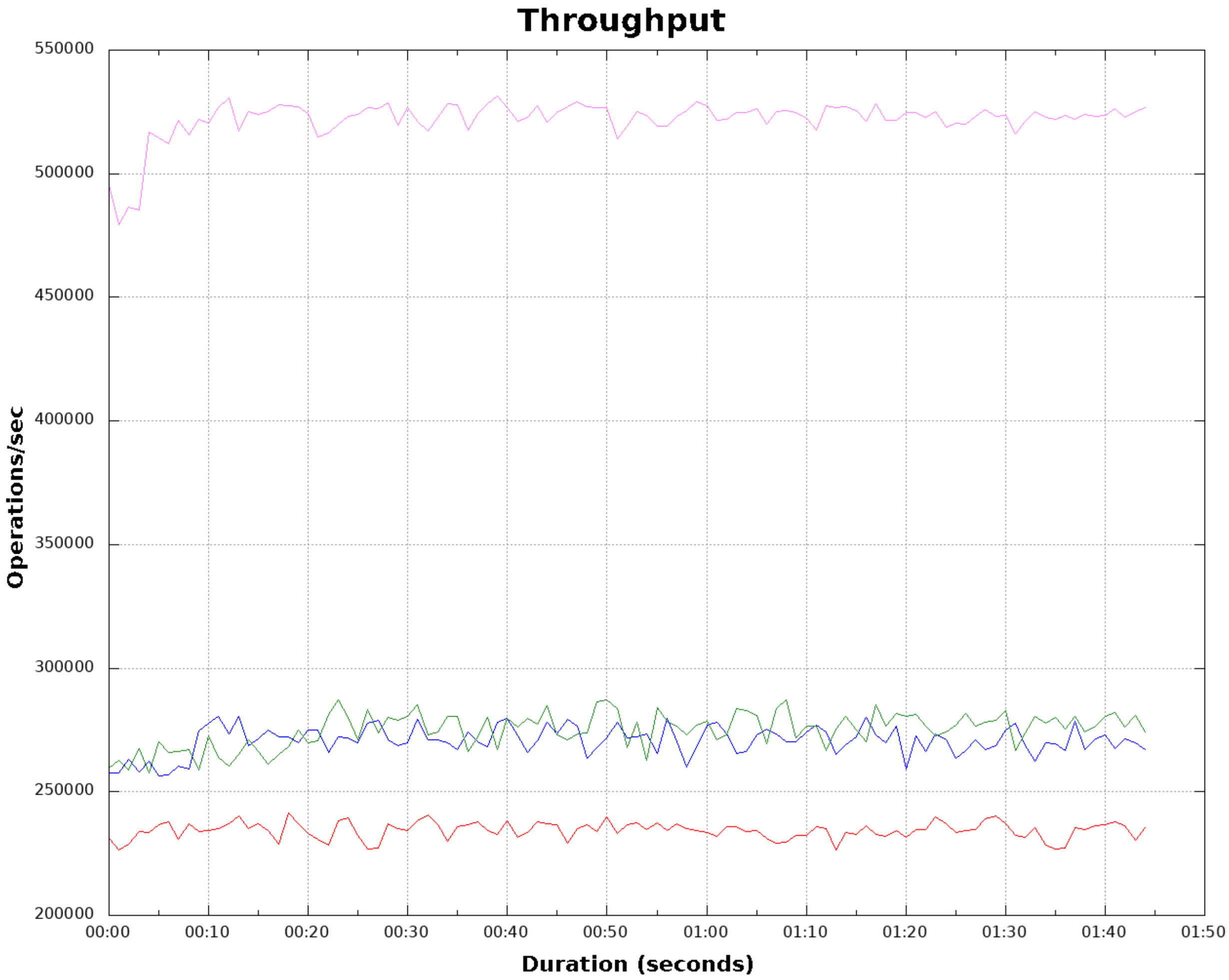
- Stressing the system over the limit is a stability test, not suitable for comparing the numbers
- Not stressing the system enough might cause suboptimal performance causing actually testing of something else unintentionally



## Problem #2: Example (1/3)

# Inadequate load on the system

## Too much load



8 clients on 1 machine

16 clients on 1 machines

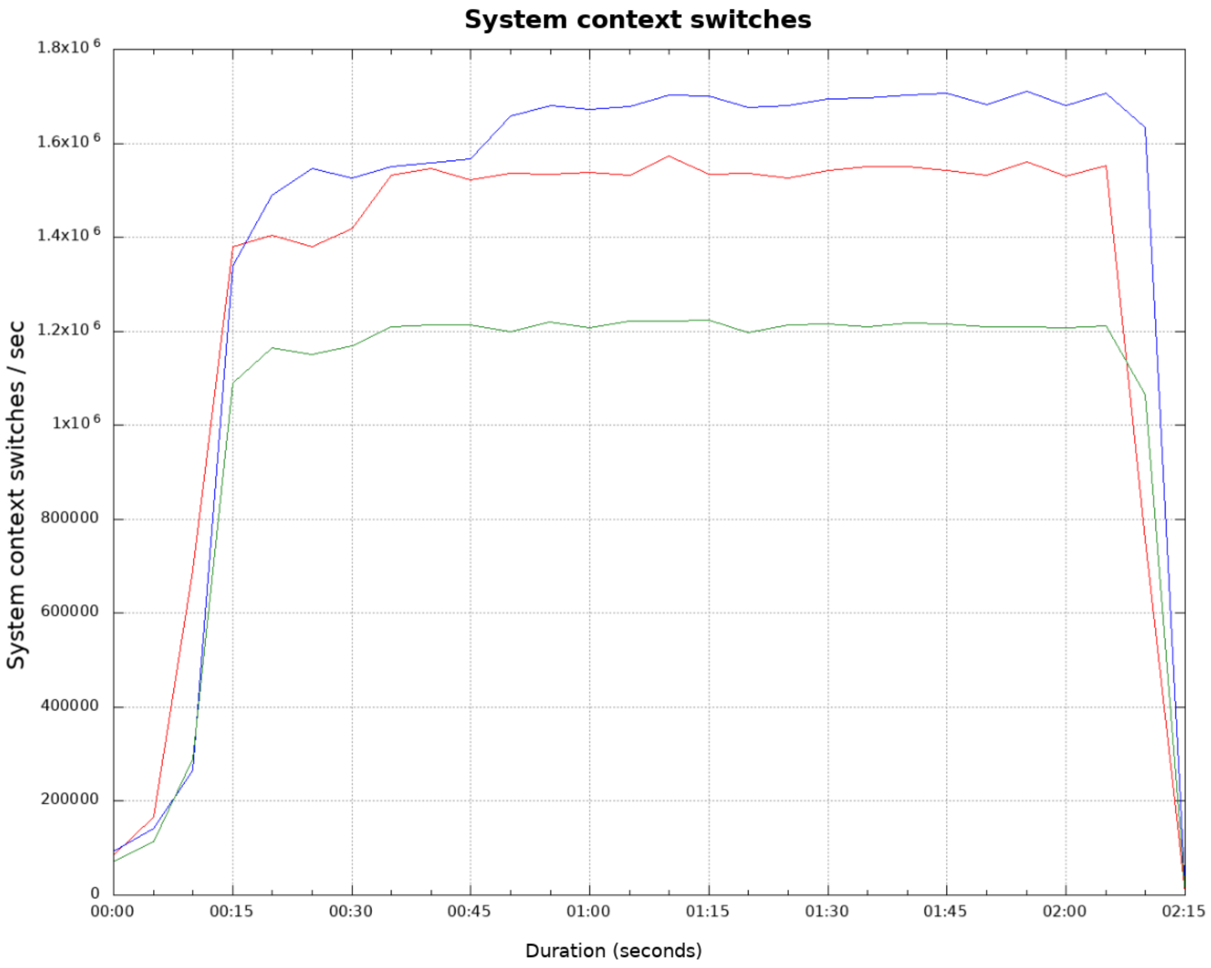
24 clients on 1 machines

24 clients on 2 machines

## Problem #2: Example (2/3)

# Inadequate load on the system

### Too much load - extensive context switching



16 clients on 1 machine

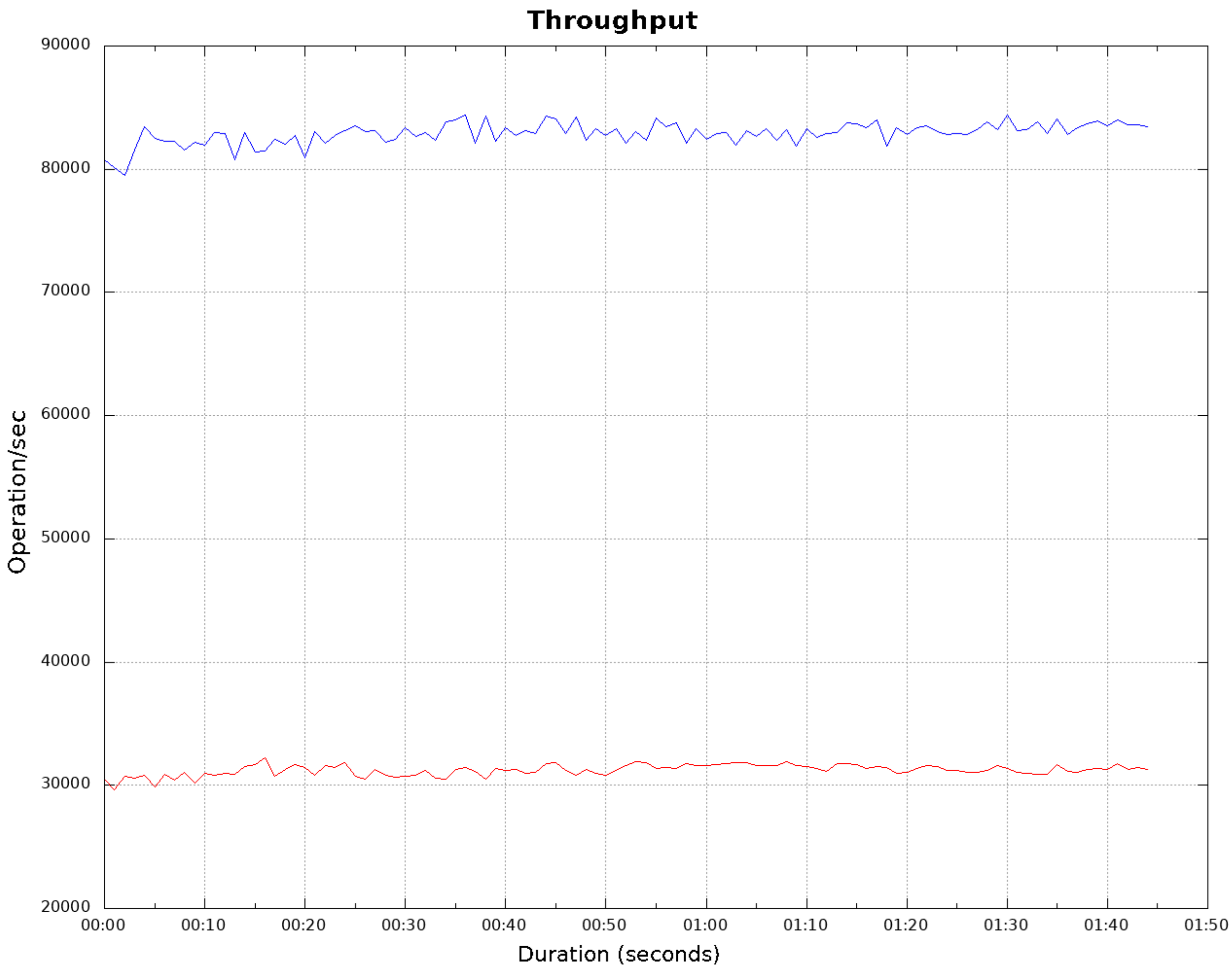
24 clients on 1 machines

24 clients on 2 machines

### Problem #2: Example (3/3)

# Inadequate load on the system

## Not enough load



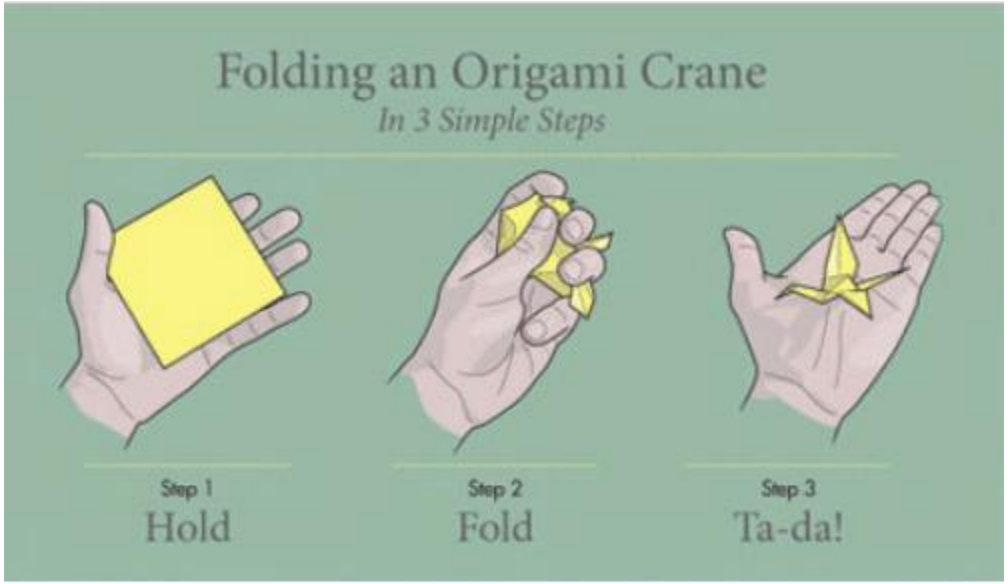
1 thread per 4 clients

4 threads per 1 client

## Problem #2: Solution

# Inadequate load on the system

- Get to know the behavior of your system
- Start with simple scenarios, then add complexity, observe the behavior and understand **why** is something happening



How to origami

## Problem #3: Description

# Throwing away latency results information

- Showing only:
    - Average
    - Minimum, maximum
    - Selected percentiles (p90, p95, p99, ...)
    - Full latency distributions

## Problem #3: Example (1/4)

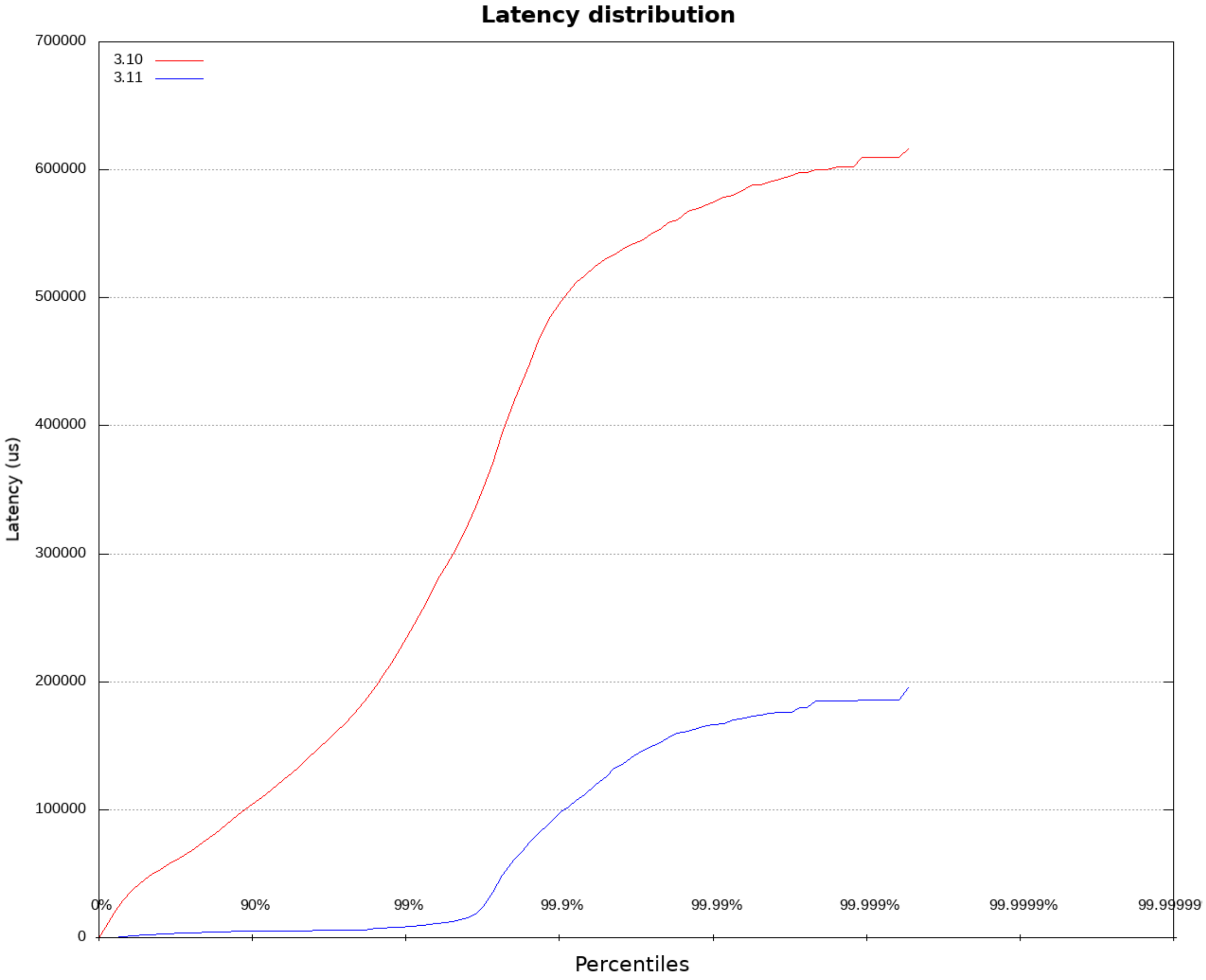
# Throwing away latency results information

| Dataset (e.g. latency of operations in ms) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **A** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 52 | 100 |
| **B** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 30 | 50 |

| | A | B |
|---|---|---|
| **average** | 16 | 12 |
| **minimum** | 1 | 5 |
| **maximum** | 100 | 50 |
| **p20** | 1 | 5 |
| **p50** | 1 | 5 |
| **p80** | 1 | 5 |
| **p90** | 52 | 30 |

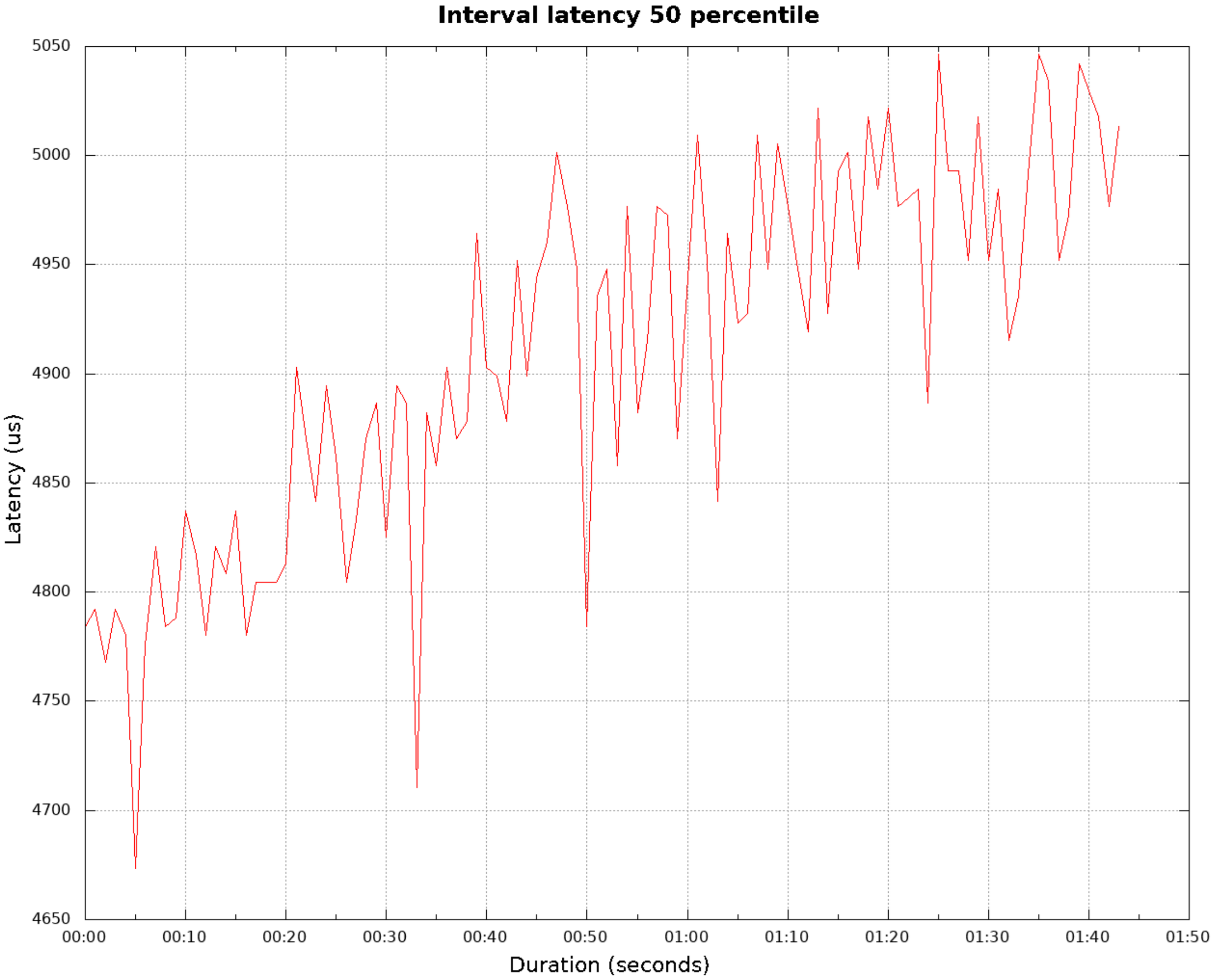
## Problem #3: Example (2/4)

# Throwing away latency results information



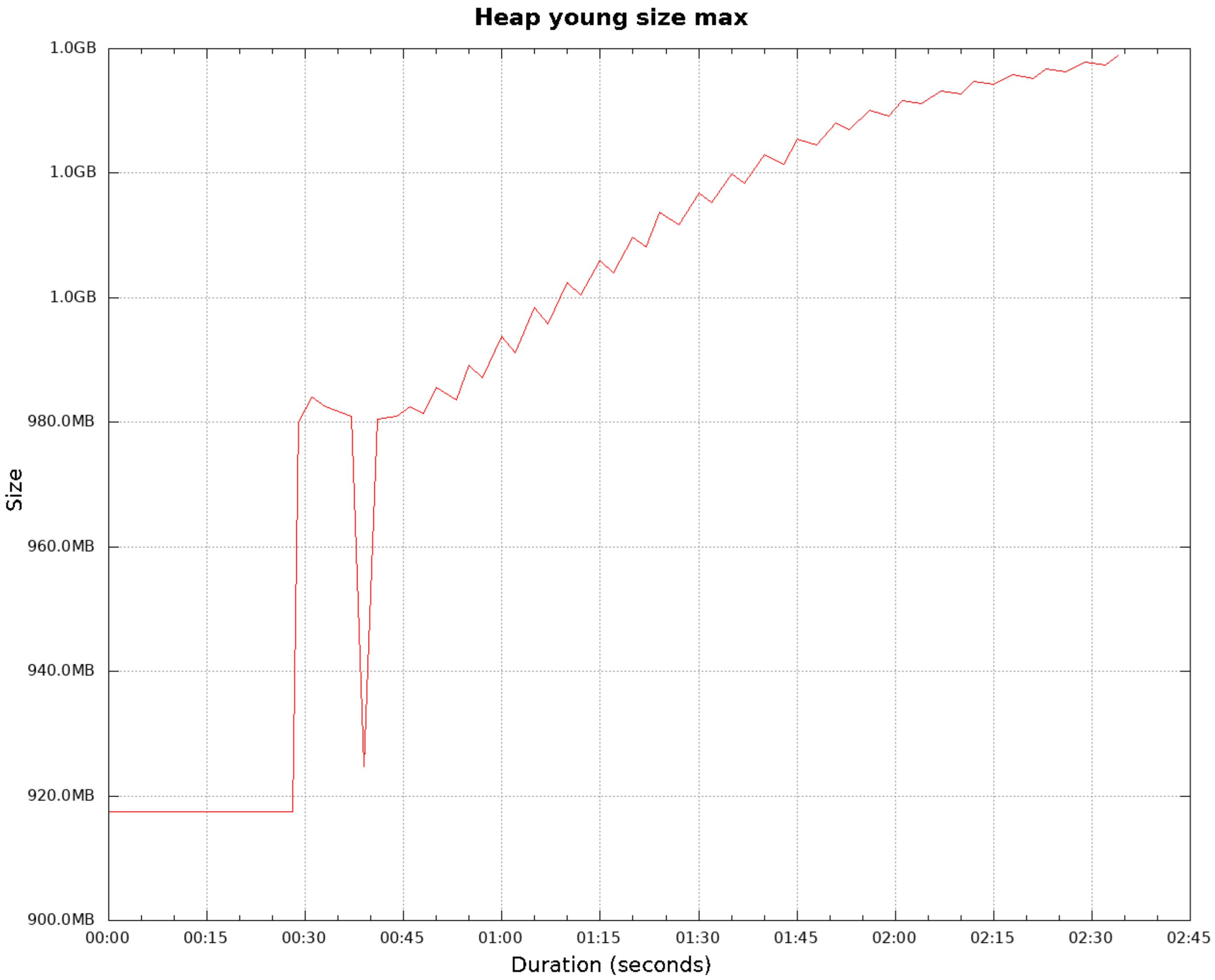
## Problem #3: Example (3/4)

# Throwing away latency results information



## Problem #3: Example (4/4)

# Throwing away latency results information



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## Problem #3: Solution

# Throwing away latency results information

- In general, generate as many charts as possible
  - latency, throughput, system stats, memory stats, GC info, networking etc.
- Look at all of them, everything is related
- Great tool: HdrHistogram

## Problem #4: Description

# Unexpected operations ratio

- Operation types: reads and writes
- Customer scenario "We have 80:20 read:write ratio"
- Accidentally ending up with a different ratio without noticing

## Problem #4: Example

# Unexpected operations ratio

**Test setup** - 80 read clients and 20 write clients

latency(read) = 1 ms | latency(write) = 2 ms

## Problem #4: Example

# Unexpected operations ratio

**Test setup** - 80 read clients and 20 write clients

latency(read) = 1 ms | latency(write) = 2 ms

Read client: 1 s / 1 ms = 1000 ops / sec

Write client: 1 s / 2 ms = 500 ops / sec

## Problem #4: Example

# Unexpected operations ratio

**Test setup** - 80 read clients and 20 write clients

latency(read) = 1 ms | latency(write) = 2 ms

Read client: 1 s / 1 ms = 1000 ops / sec

Write client: 1 s / 2 ms = 500 ops / sec

1000 reads/s * 60 s * 5 min * 80 clients = 24 000 000 reads

500 writes/s * 60 s * 5 min * 20 clients = 3 000 000 writes

**Resulting ratio ~= 88:11**

## Problem #4: Solution

# Unexpected operations ratio

- Find more info about the test scenario
- Executing different operations based on probability

### Problem #5: Description

# Performance regression

- Code change causing performance degradation
- Worst thing to happen
- Customer is unhappy

Word on the street is that our customer service is getting worse.
No, it's just getting harder. Customers are smarter. They know more, expect more and compare us to other great companies who raise the bar.
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## Problem #5: Solution

# Performance regression

- Automation, automation, automation
- Storing and organizing the results
- Check it the results on a regular basis

# Useful resources

- **How NOT to measure latency**, Gil Tene
  - https://www.youtube.com/watch?v=lJ8ydIuPFeU
- **Optimizing Java**, Benjamin J. Evans, James Gough
- **Systems Performance**, Brendan Gregg

And ...

- My Twitter! **@jholusa**

QUIZ
TIME!

# Quiz

- Test setup
  - 2 servers, 2 clients
  - Client is doing writes with values of sizes 1 KB, 10 KB and 100 KB
- Results

| **Value size** | **Throughput (ops / sec)** |
|---:|---:|
| 1 KB | 101 558 |
| 10 KB | 11 214 |
| 100 KB | 1 105 |

- Anything fishy going on?