Detecting latency spikes in DNS server implementation(s)

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https://www.isc.org

Talk structure

- Motivation: BIND bug report
- Testing
  - existing tools
  - dnsperf improvements
- Visualization
- Recommendations

BIND bug report

"After upgrading our **secondary** servers with BIND from version 9.11 to 9.16, our monitoring **sometimes** detects **latency spikes**. They **disappear eventually**."

BIND bug report

Testing latency: tools 1/2

- dnsperf 2.10
  - min/avg/max
  - at the end of test run
- resperf 2.10
  - only avg
  - per interval

Testing latency

- When Bill Gates walks into a bar, on average everyone inside becomes a billionaire.
- Histogram!

Testing latency: tools 2/2

- flamethrower 0.10.2
  - min/avg/max, per second
- shotgun 20210714
  - histogram each second, 1 ms granularity – yay!
  - histogram visualization – yay!
  - **suitable only for resolver testing** – boo-boo
    - (requires PCAP with correct query timing)

dnsperf 2.11 – new features

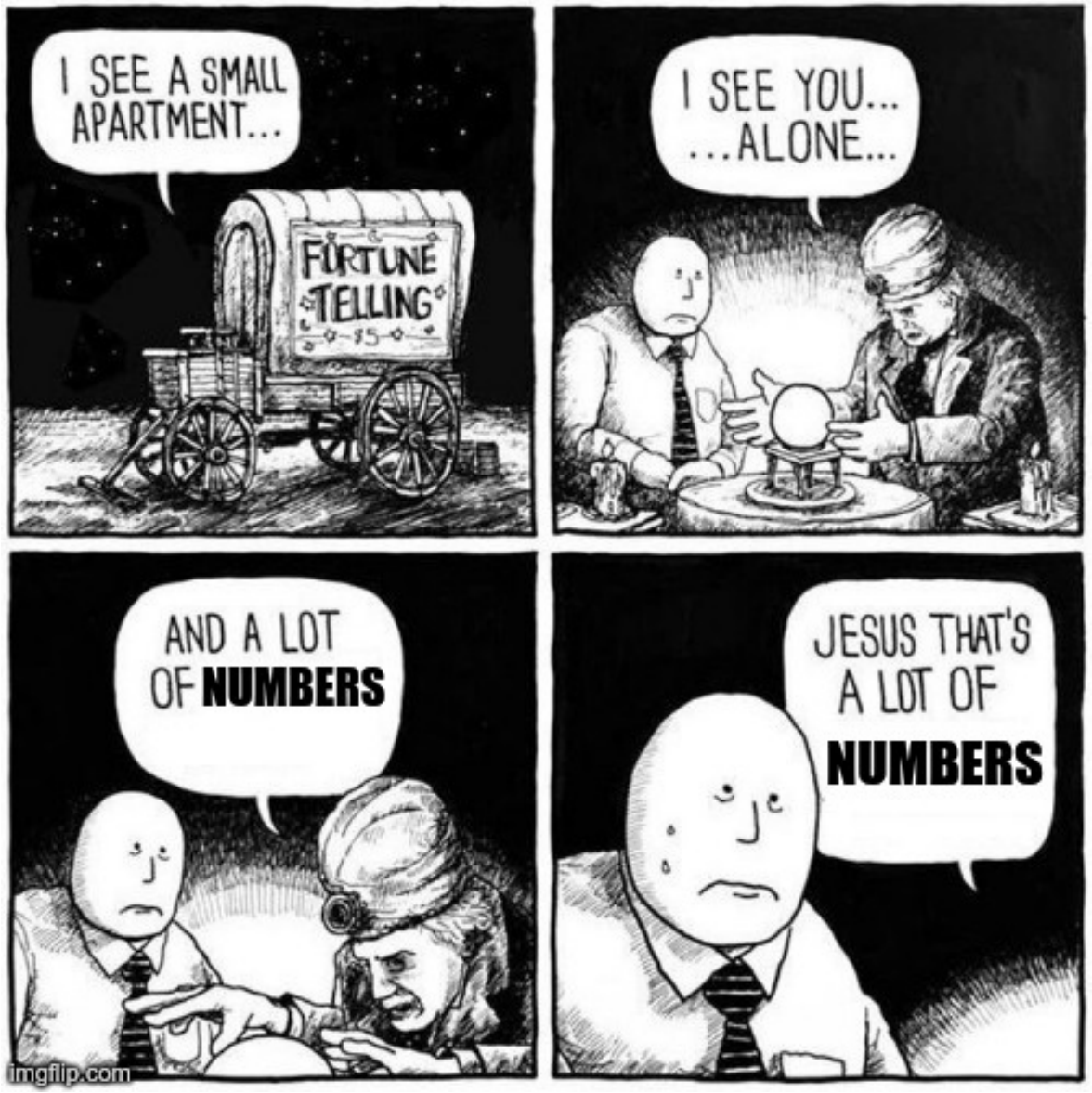
- Latency histogram, per second!
- dnsperf
  - -S 1 # print stats every second
  - -O suppress=timeout
  - **-O verbose-interval-stats**
  - **-O latency-histogram**

dnsperf 2.11 – new features

```
Interval Statistics: …
Latency bucket (s):    answer count
0.000320 - 0.000327:   30
0.032768 - 0.033791:   1
0.417792 - 0.425983:   1
```

- logarithmic with ~ 3 % accuracy
  - clever optimizations, courtesy of Tony Finch

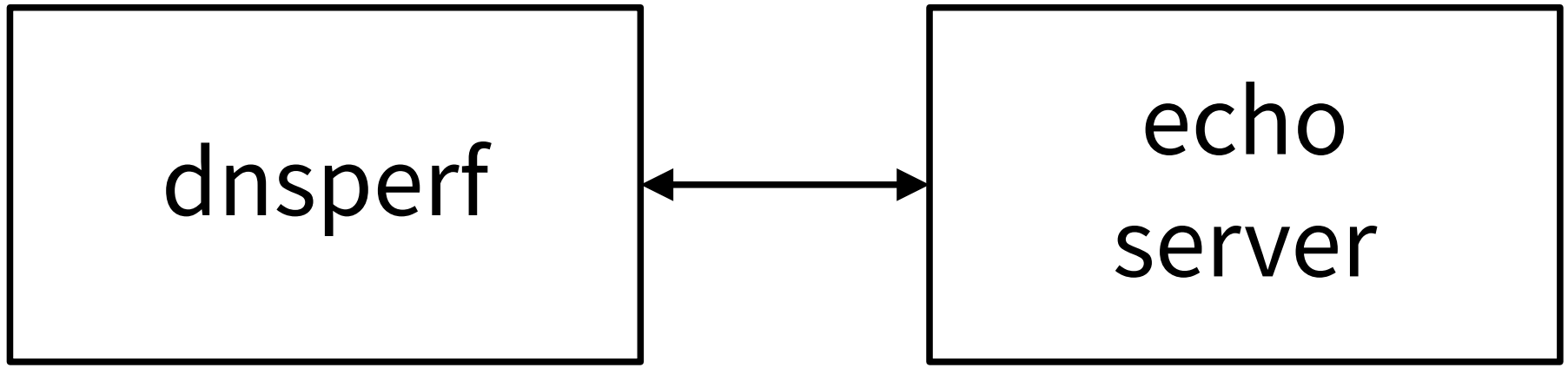
Interpretation



Visualization

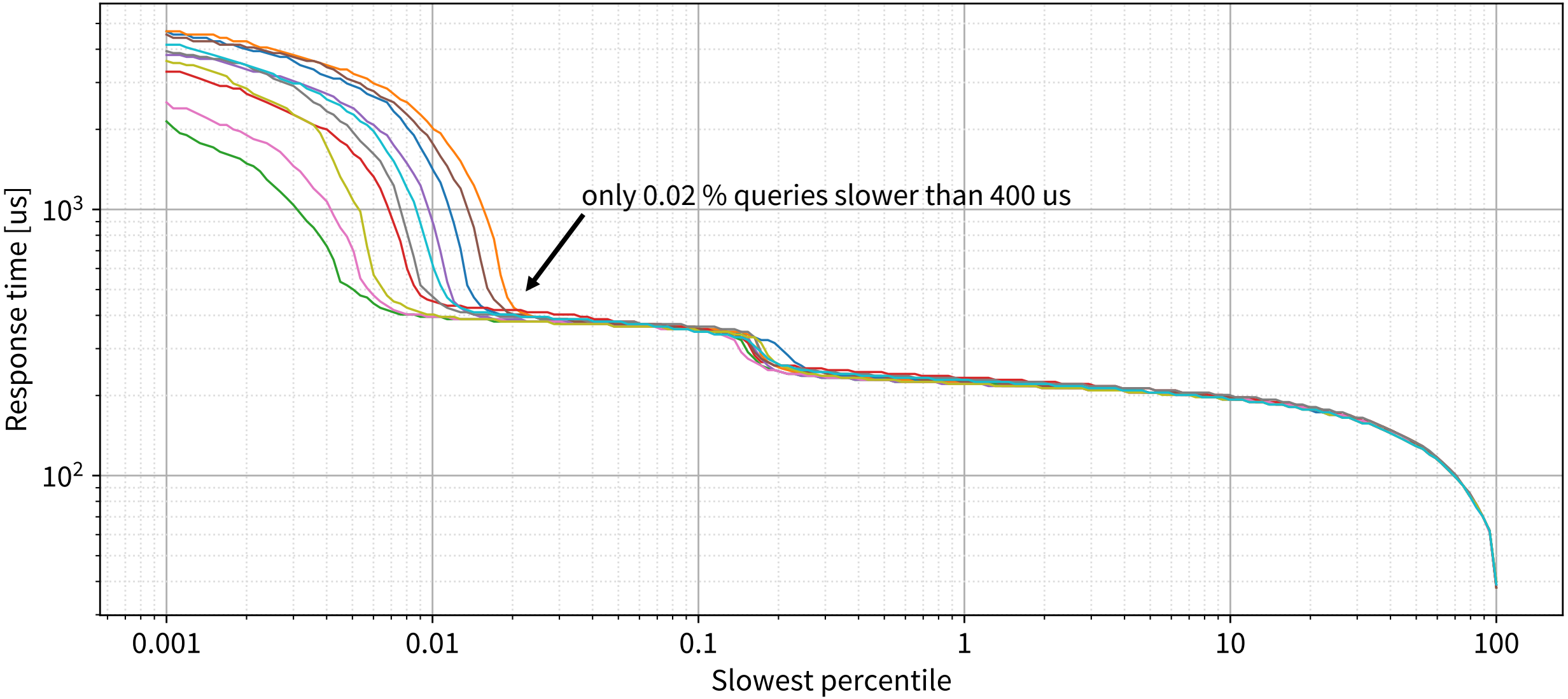
- Reuse visualization from DNS Shotgun
  - Different output formats …
    - … a little hack needed …
- JSON output for dnsperf
  - https://github.com/pspacek/dnsperf/tree/json_output
- dnsperf JSON input for DNS Shotgun
  - https://gitlab.nic.cz/knot/shotgun/-/tree/oarc40

Test setup #1

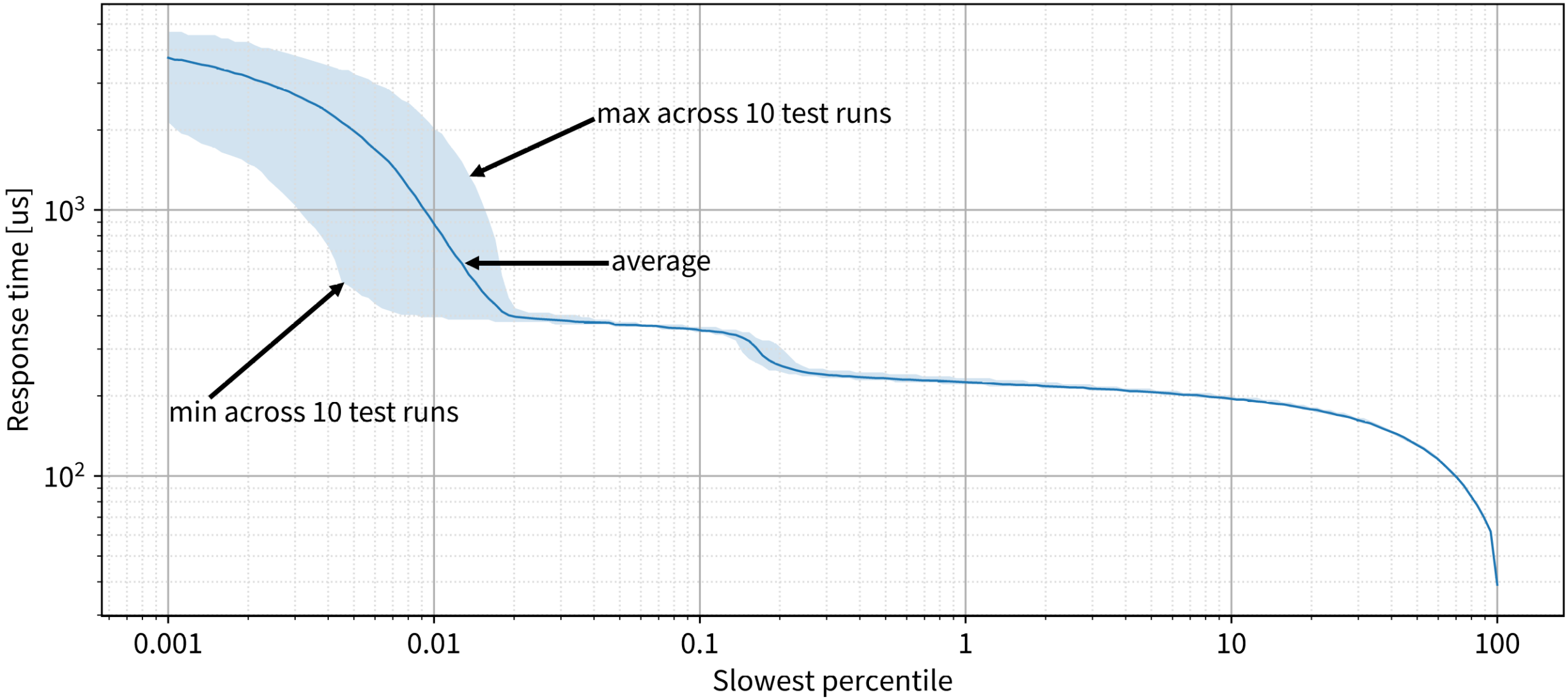


- VMs in AWS ?!? 👀
- Baseline < 400 us for 99.98% queries!
  - Long tail up to 4 ms for the rest

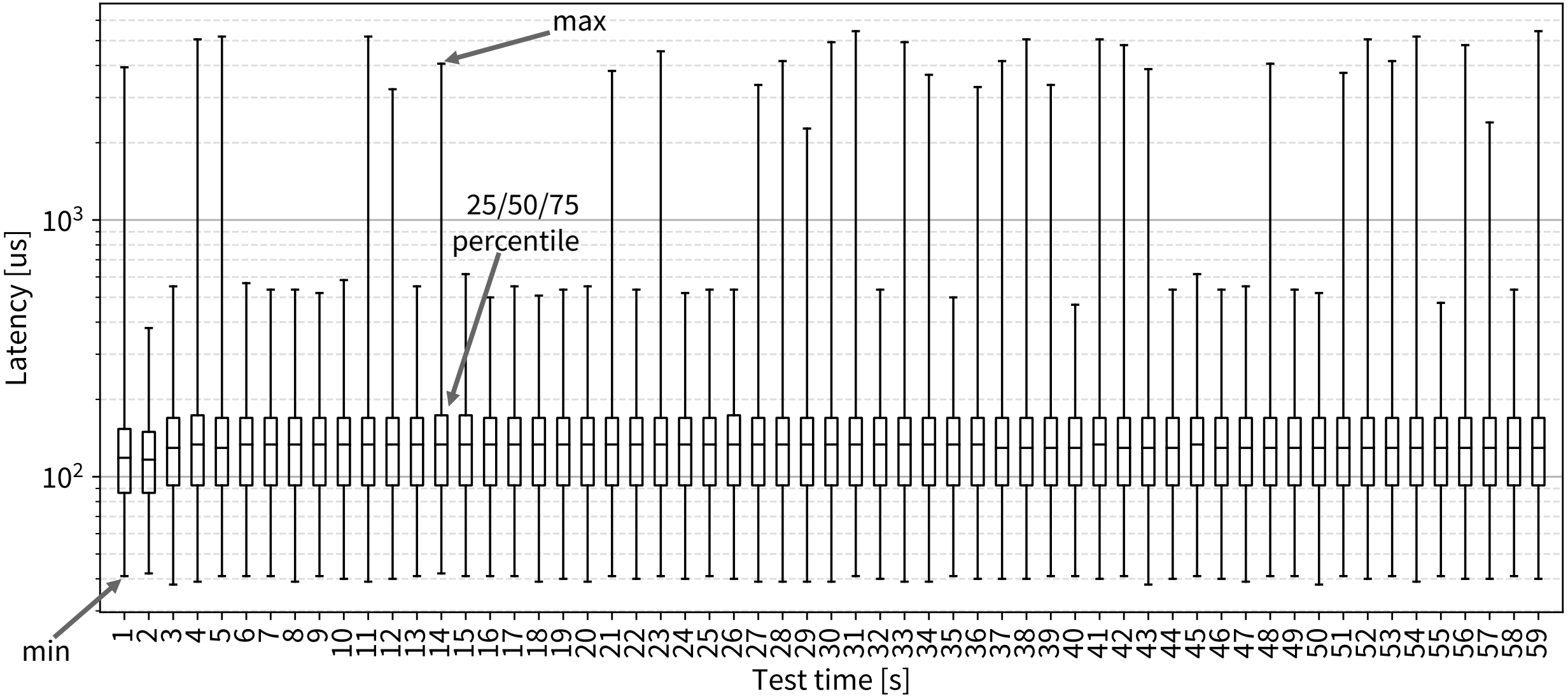
Echo server: latency histogram



Echo server: latency histogram



Echo: min/25/50/75/max boxplot

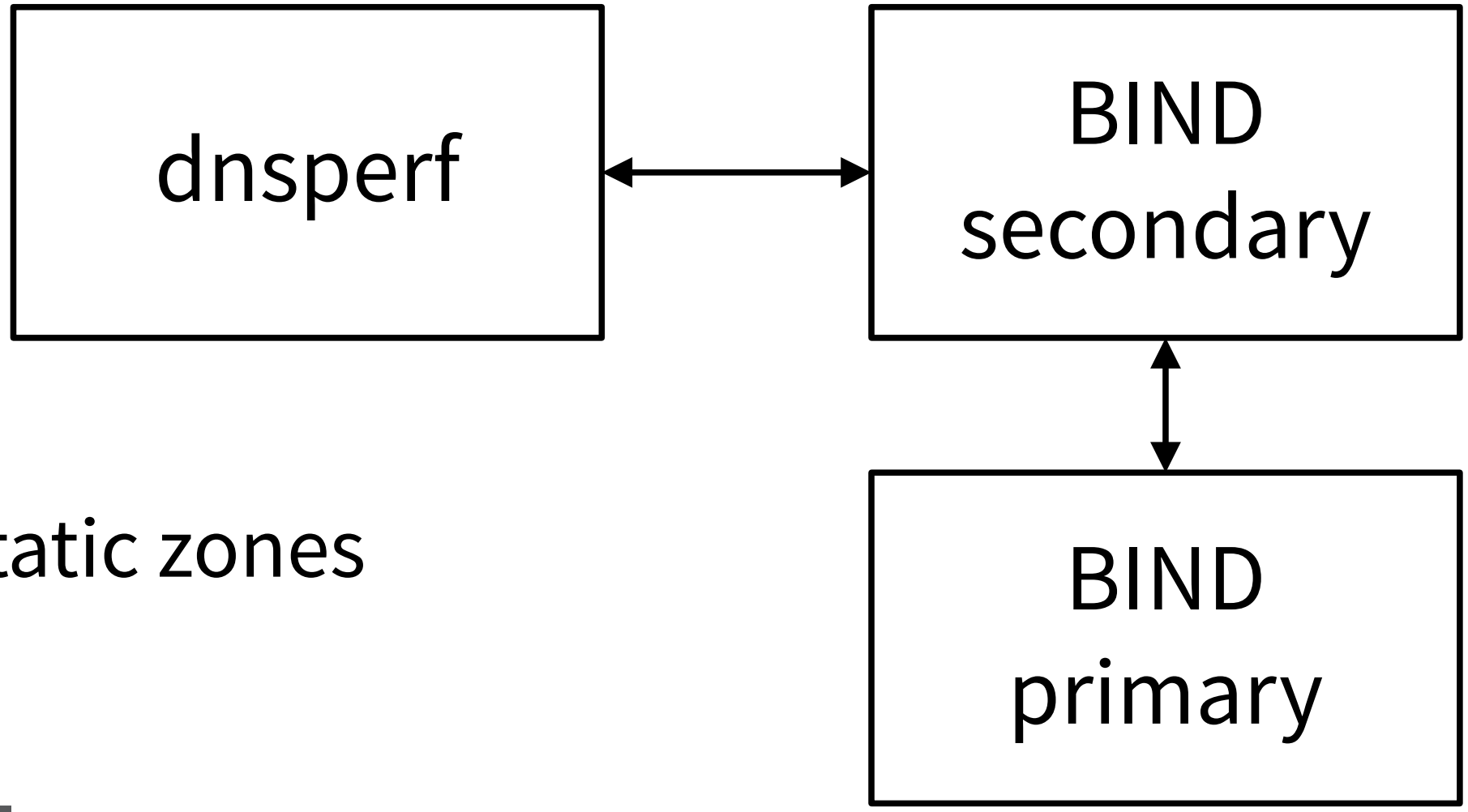


Echo server

Test setup #2

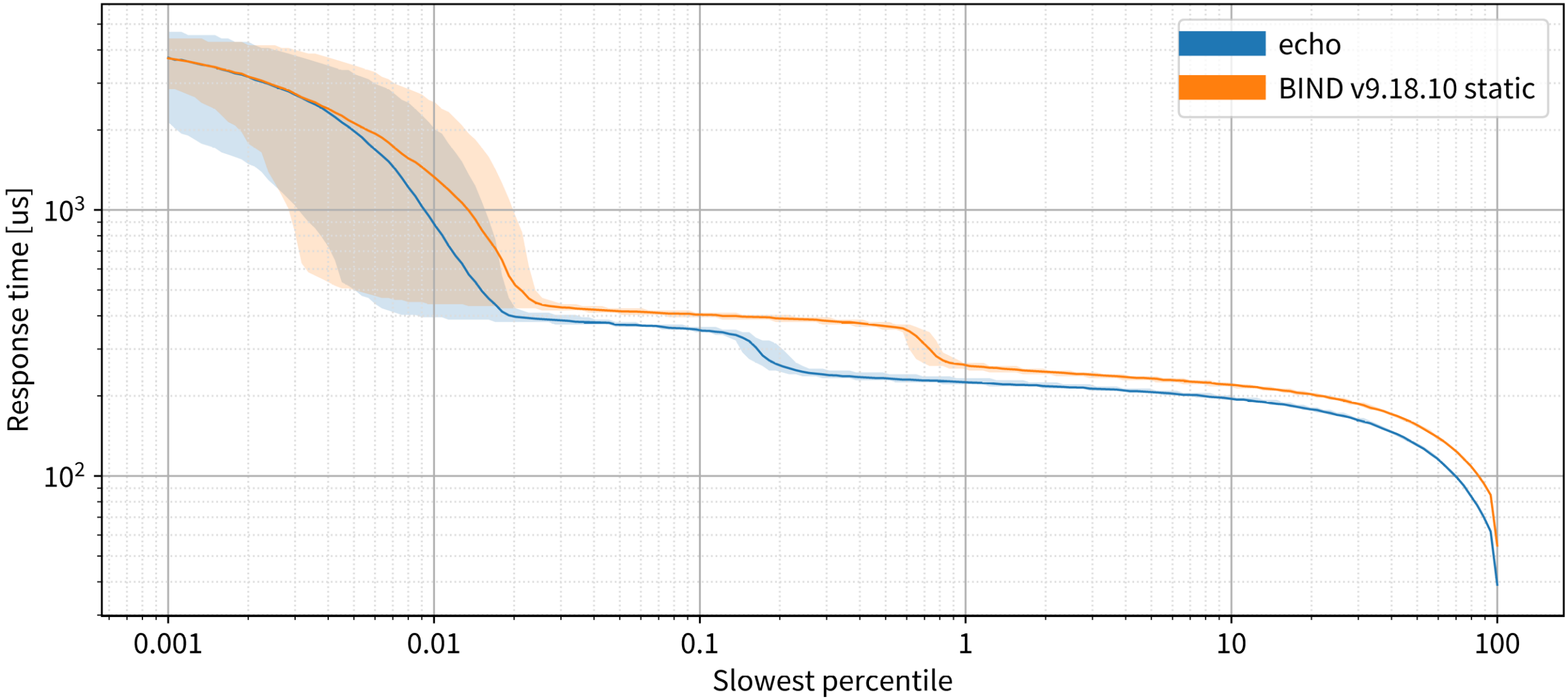
- Primary: 100 k zones + catalog zone
- Secondary: consumes the catalog
- dnsperf -> secondary
  - CPU load < 20 %
  - -Q 100000 -S1 -c 256 -q 65535 -t 1 -l 60 -O json -O latency-histogram -O verbose-interval-stats -O suppress=timeout,unexpected

Test setup #2

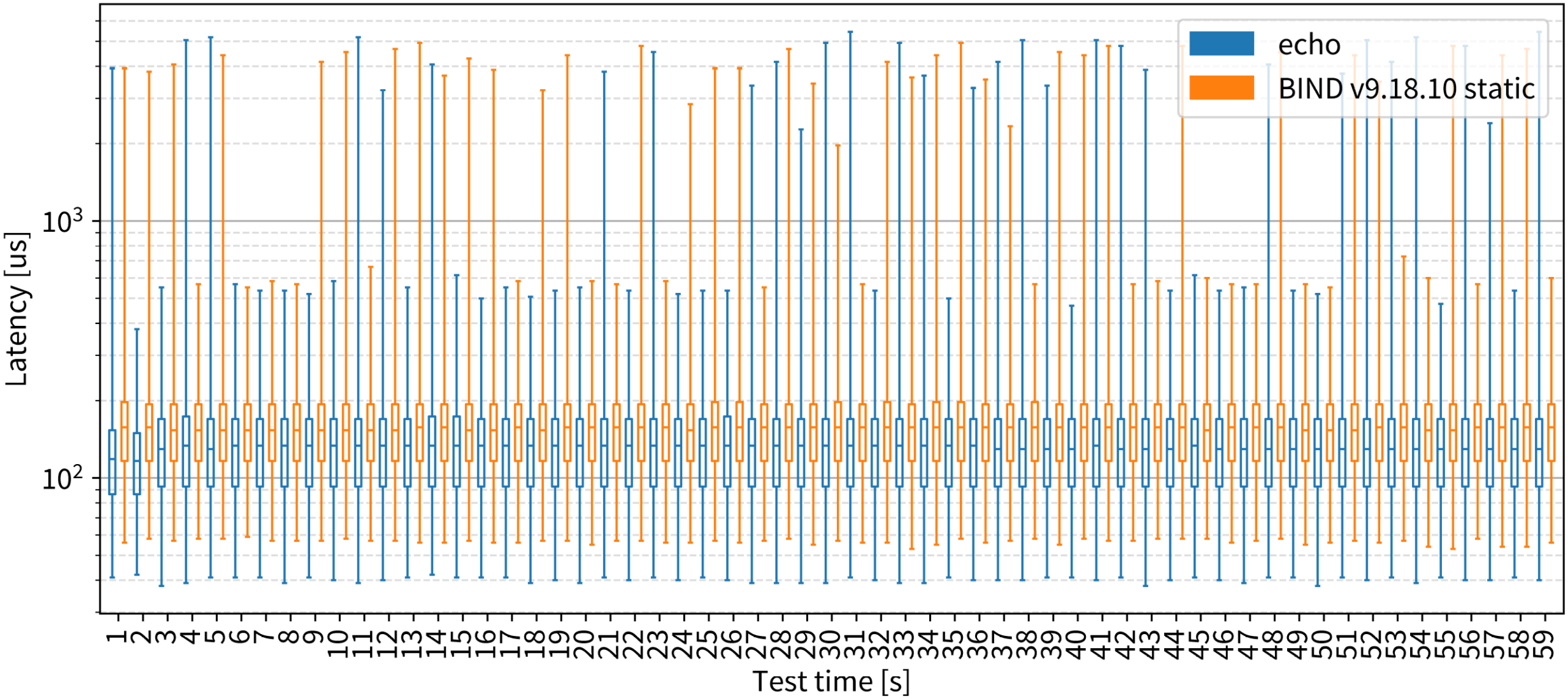


- static zones

Static BIND: latency histogram

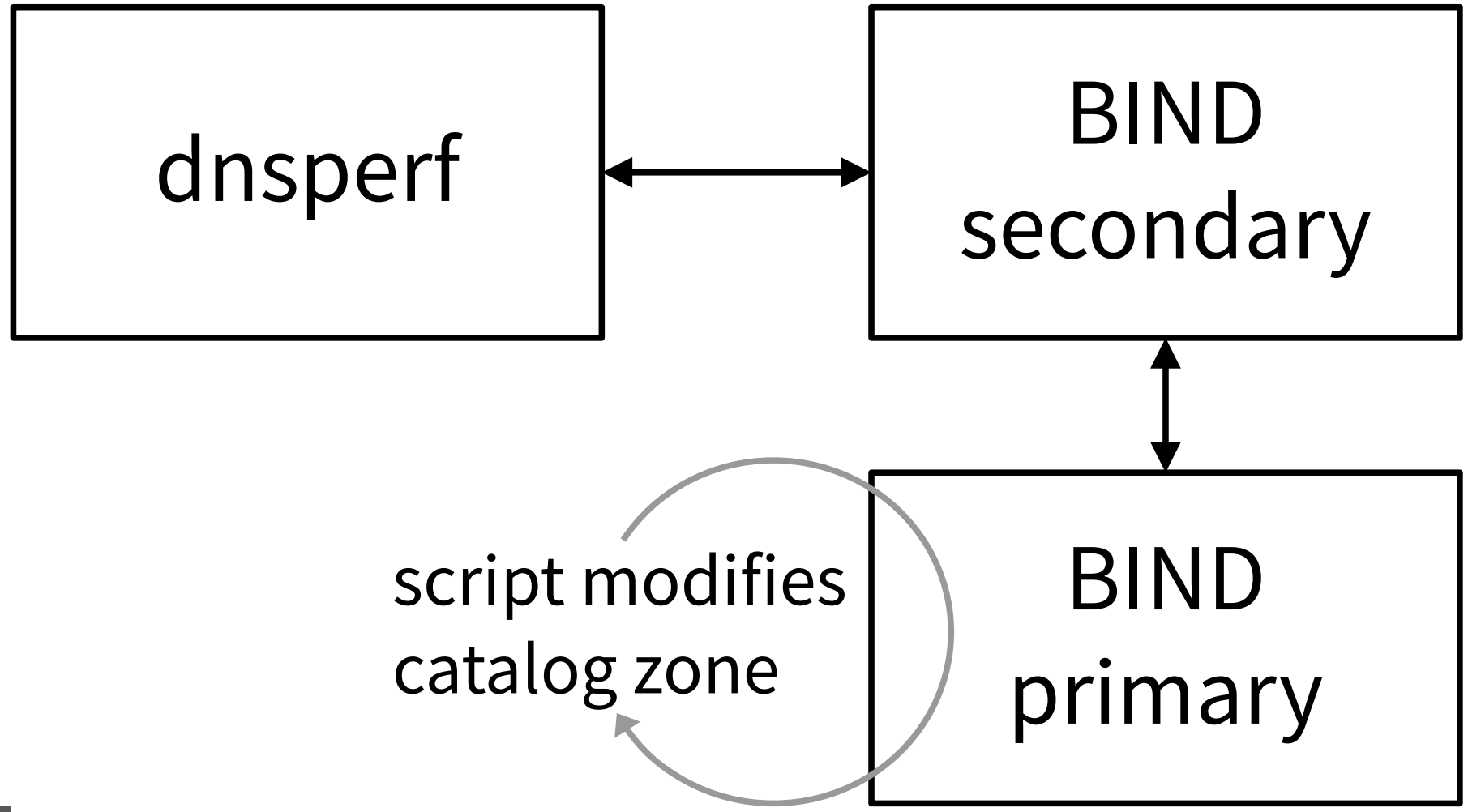


Static BIND: latency boxplot

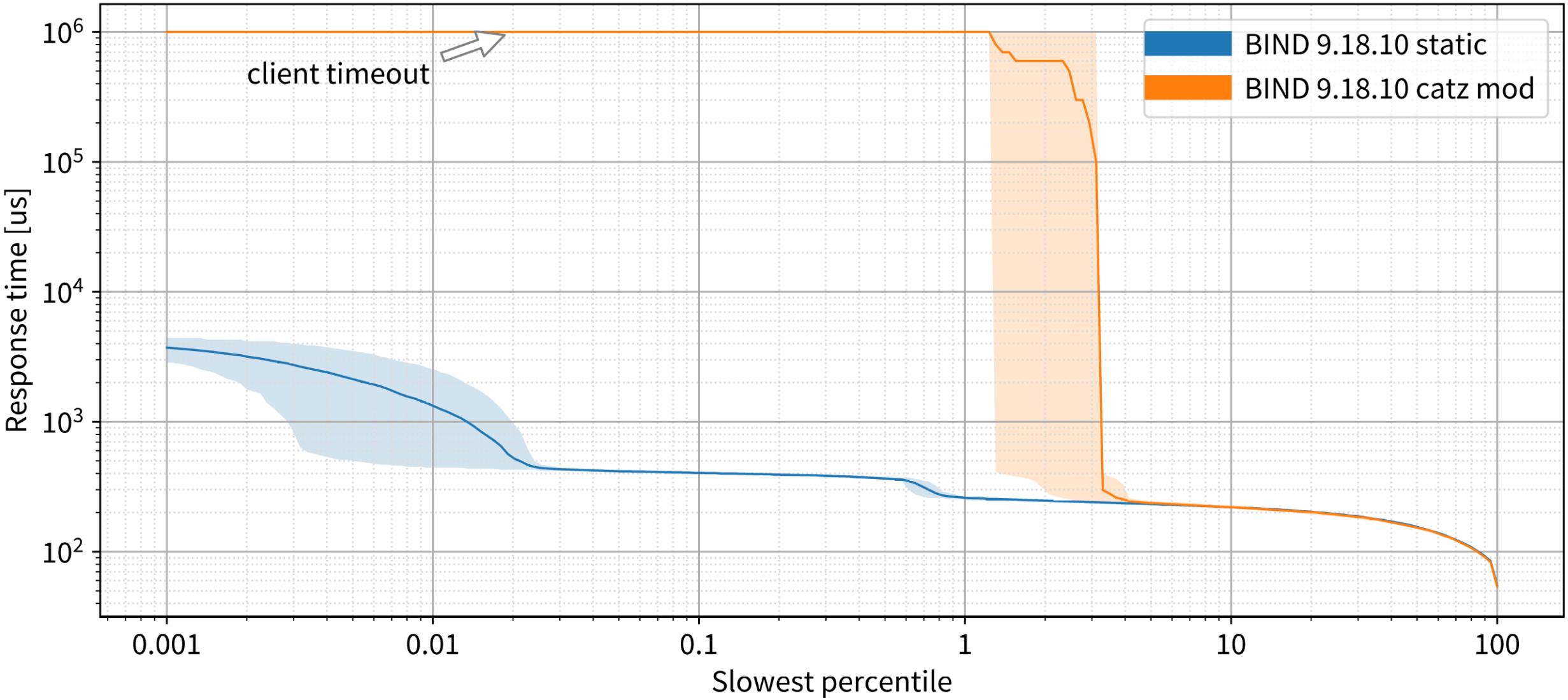


Static BIND

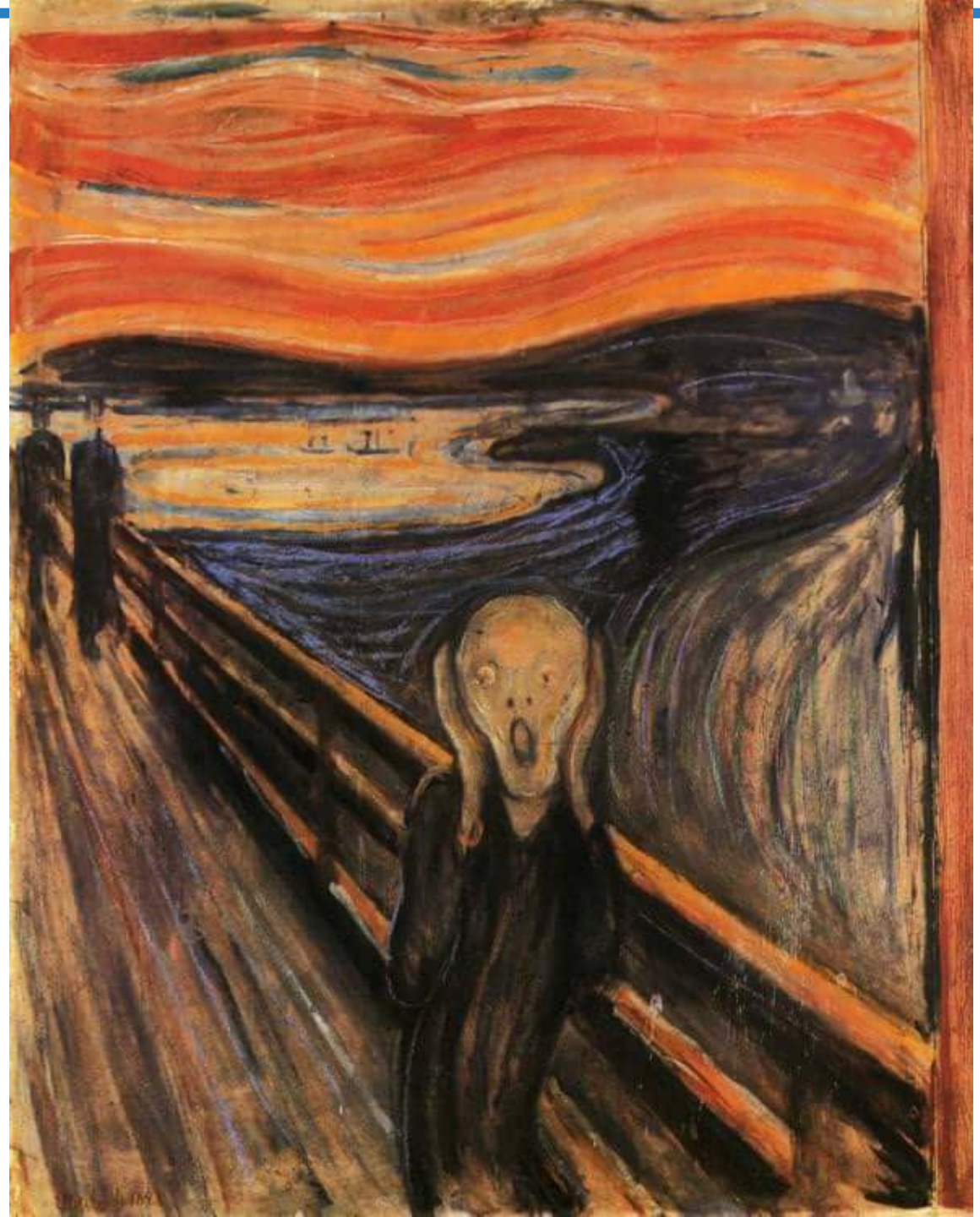
Test setup #3


dnsperf
BIND
secondary
script modifies
catalog zone
BIND
primary

BIND 9.18.10 catalog modification



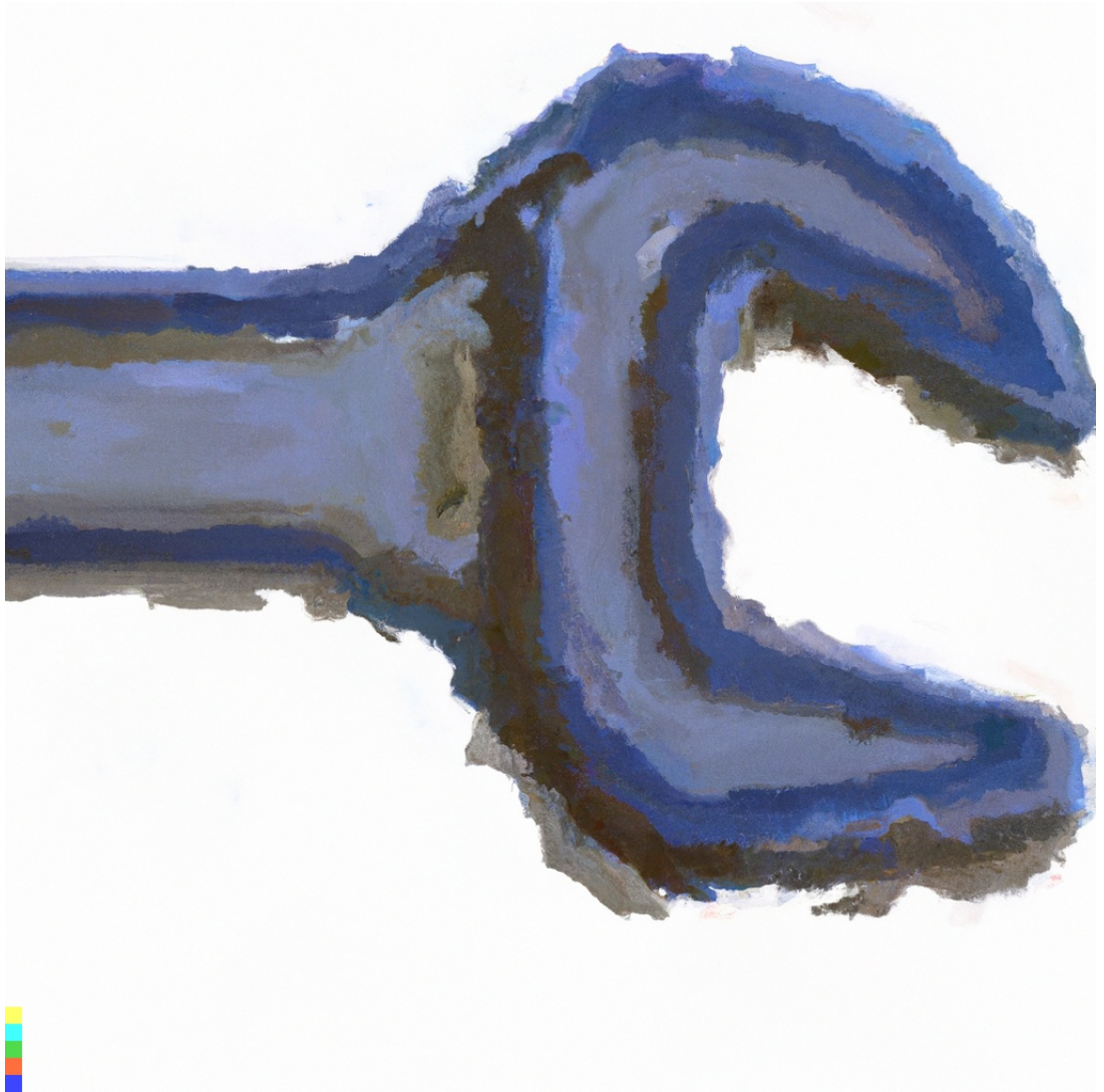
BIND 9.18.10 catalog modification



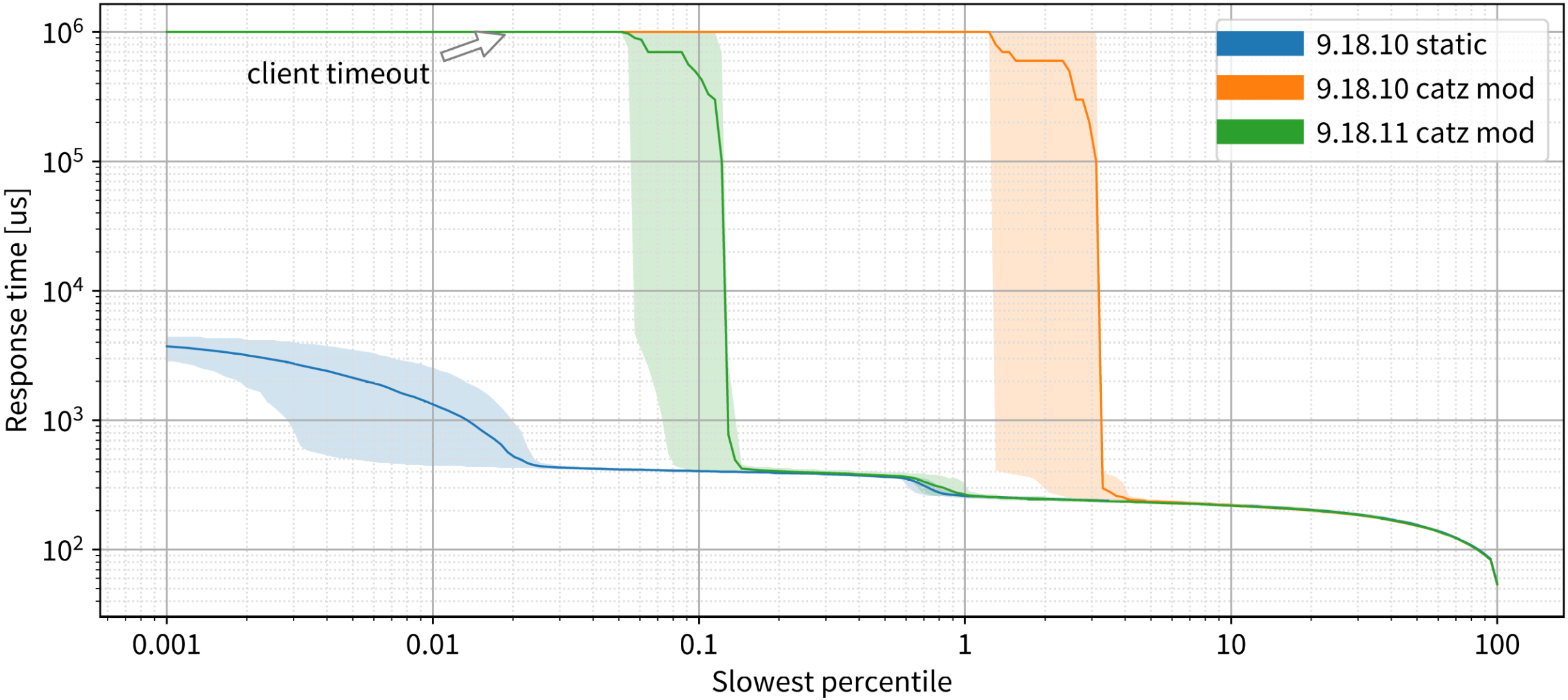
BIND problem confirmed

- Catalog zone processing
  - Hash table too small
  - Degradation to linear list
    - 100k zones in catalog => 6000 items in list
- Hash table sizing fixed
  - 9.16.37
  - 9.18.11

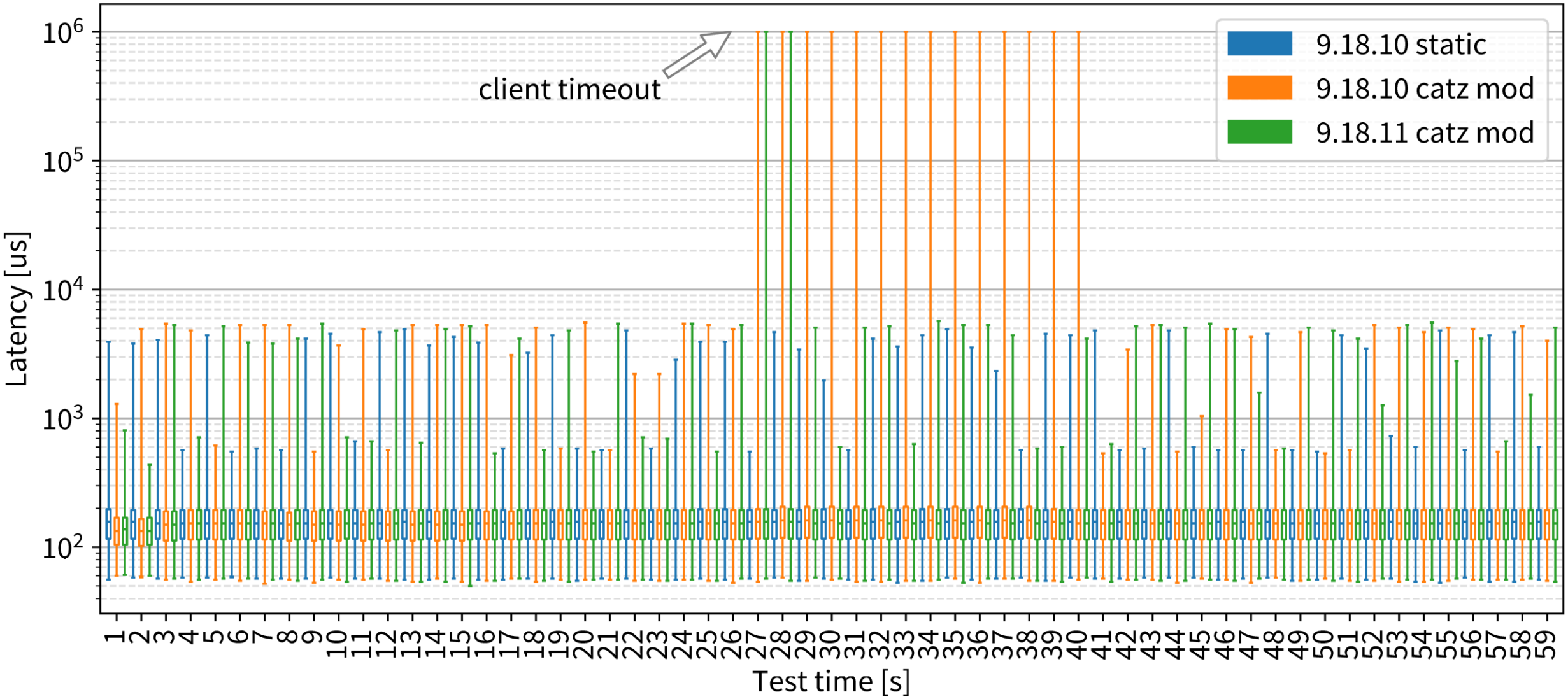
BIND problem confirmed



BIND 9.18.11 catalog modification



BIND 9.18.11 catalog modification



Another problem identified

- Blind packets-to-thread assignment
  - in kernel, SO_REUSEPORT …
  - vs "long"-running operations
- A fix is in the works

Takeaway #1: outliers matter

- Averages lie
- Check raw data first
- Percentiles beyond 95 % **still matter**
  - with 100 k QPS … 1 % = 1000 QPS …

Takeaway #2: timeouts

- Timeouts detected retrospectively
- For timeout = 5 seconds
  - Loss occurred in <now - 5, now> interval
- Correct(ish) attribution required

Recommendations

- Outliers matter
- Attribute timeouts properly
- Upgrade, upgrade, **upgrade** ...
  - BIND 9.16.37, 9.18.11 or newer

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Thank you!

- Main website: https://www.isc.org
- Software downloads: https://www.isc.org/download or https://downloads.isc.org
- Presentations: https://www.isc.org/presentations
- Main GitLab: https://gitlab.isc.org