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Latency SLOs Done Right

By Fred Moyer

SCaLE17x

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Latency

Is it important?

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Latency

For any of your services, how many requests were served within **500 ms** over the last month?

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Latency

For any of your services, how many requests were served within **250ms** over the last month?

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How would you answer that question for your services?

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Latency

How accurate would your answer be?

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I’m Fred and I like SLOs

- Developer Evangelist @Circonus
- Engineer who talks to people
- Writing code and breaking prod for 20 years
- @phredmoyer on Twitter
- Likes C, Go, Perl, PostgreSQL

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Talk Agenda

- SLO Refresher
- A Common Mistake
- Computing SLOs with log data
- Computing SLOs by counting requests
- Computing SLOs with histograms

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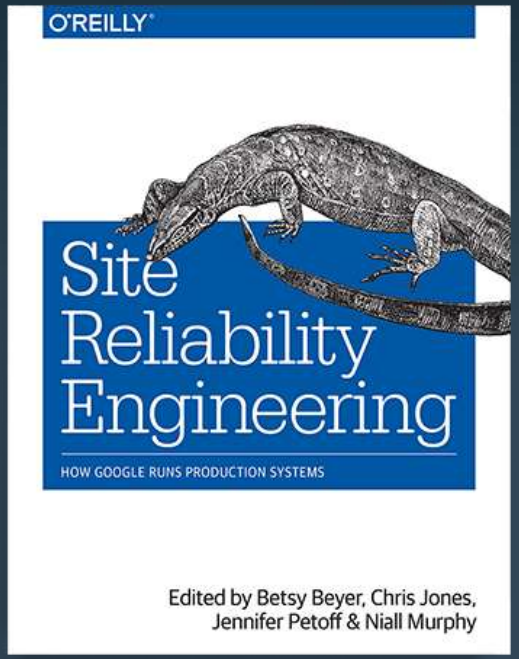
Service Level Objectives

SLI - Service Level Indicator

SLO - Service Level Objectives

SLA - Service Level Agreement



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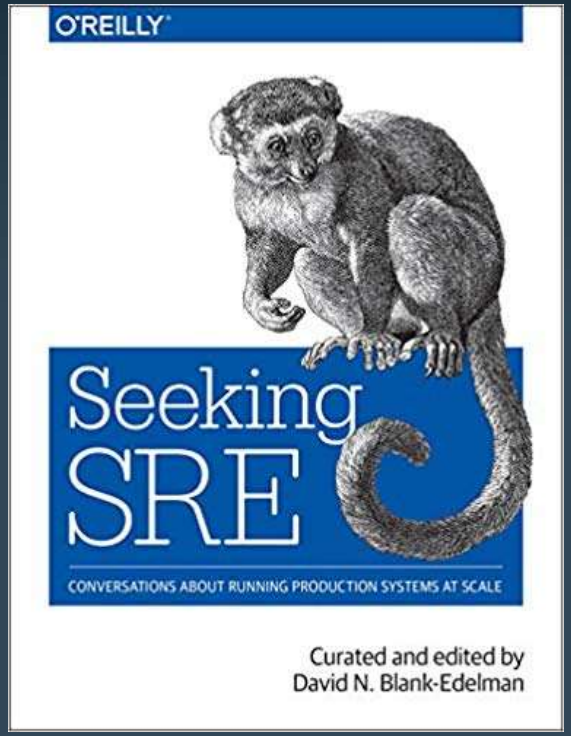
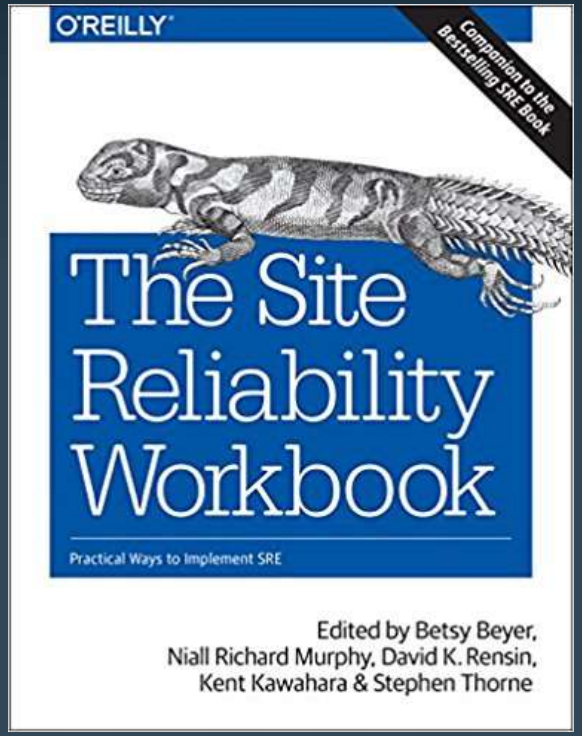
Service Level Objectives





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“SLIs drive SLOs which inform SLAs”

SLI - Service Level Indicator, a measure of the service that can be quantified

“99th percentile latency of homepage requests over the past 5 minutes < 300ms”

Excerpted from “SLIs, SLOs, SLAs, oh my!” @sethvargo @lizthegrey

https://youtu.be/tEylFyxbDLE

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“SLIs drive SLOs which inform SLAs”

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SLO - Service Level Objective, a target for Service Level Indicators

“99th percentile homepage SLI will succeed 99.9% over trailing year”

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“SLIs drive SLOs which inform SLAs”

SLA - Service Level Agreement, a legal agreement

“99th percentile homepage SLI will succeed 99% over trailing year”

Excerpted from “SLIs, SLOs, SLAs, oh my!” @sethvargo @lizthegrey

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A Common Mistake

Averaging Percentiles

$$p95(W1 \cup W2) \neq (p95(W1) + p95(W2))/2$$

Works fine when node workload is symmetric

Hides problems when workloads are asymmetric

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A Common Mistake

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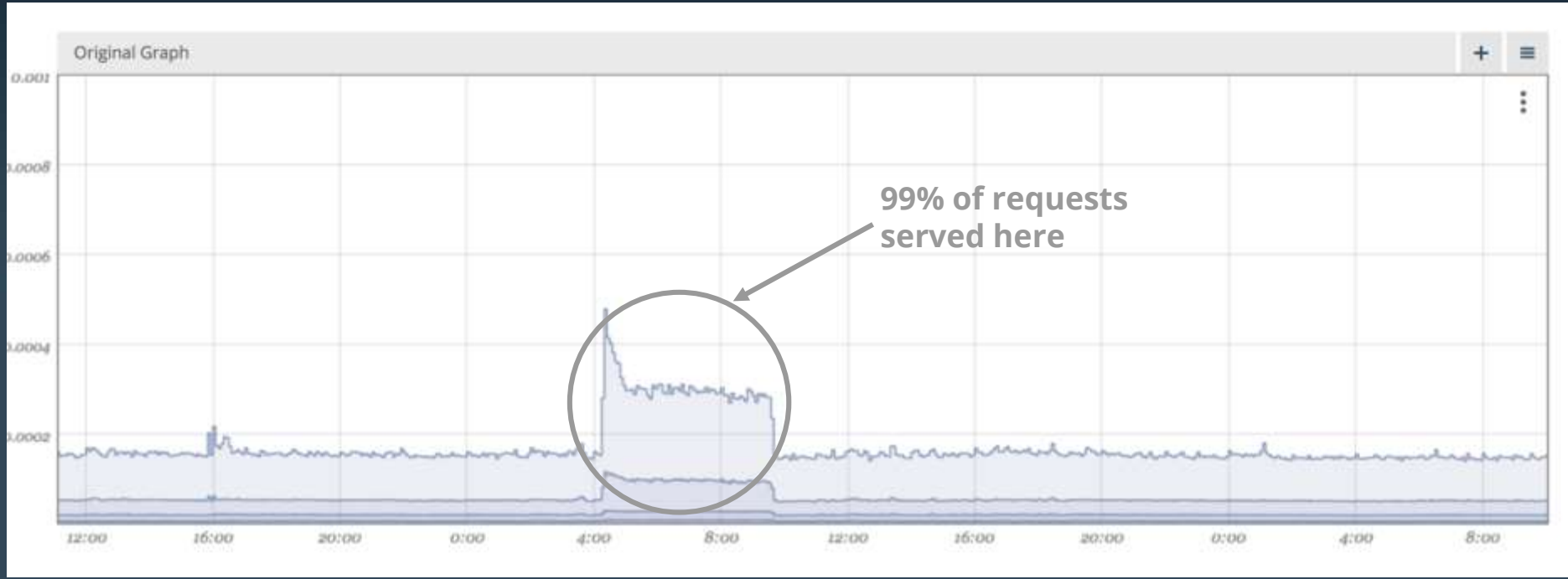
A Common Mistake



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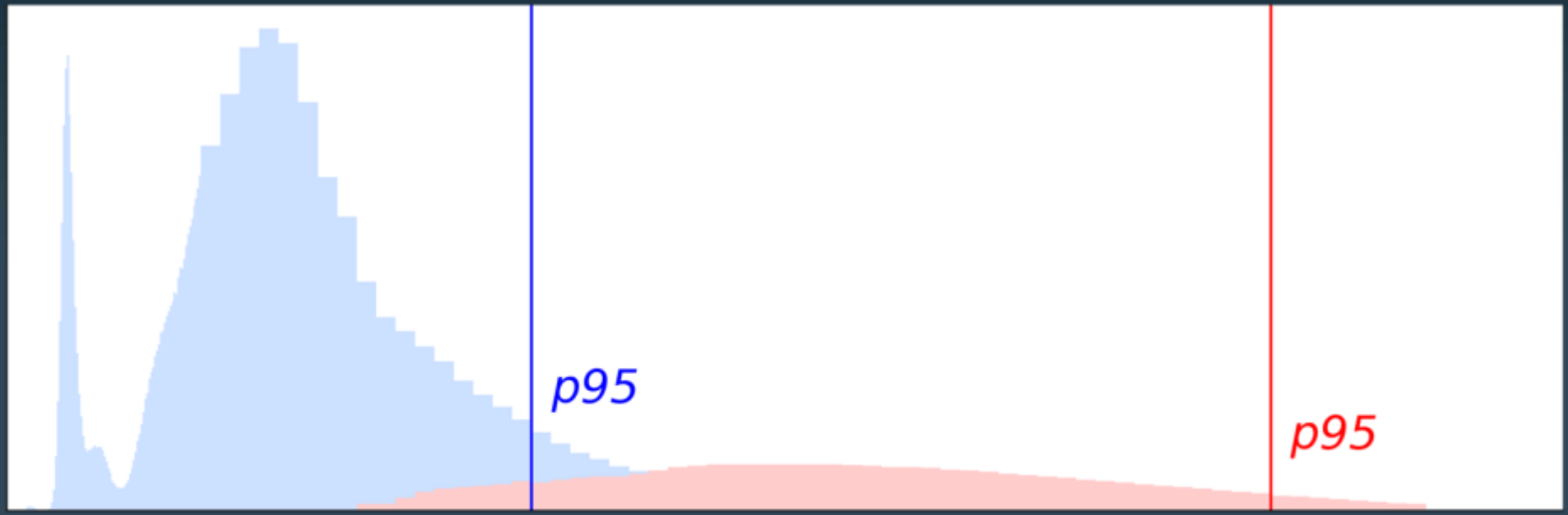
A Common Mistake



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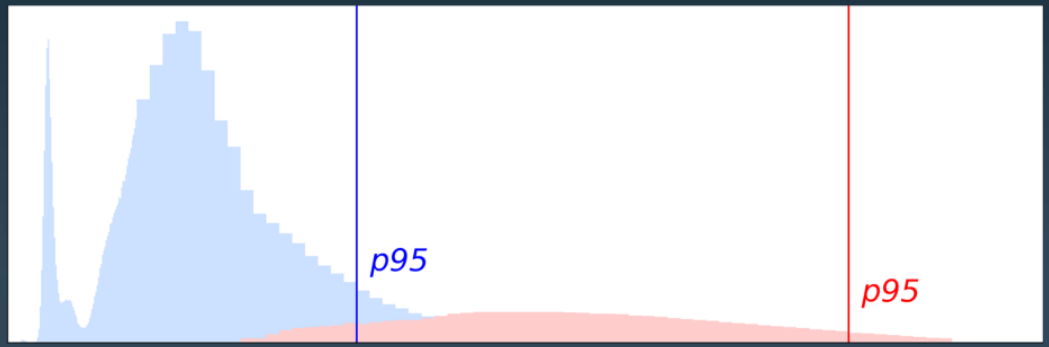
A Common Mistake

p95(W1) = 220ms
p95(W2) = 650ms

p95(W1 ∪ W2) = 230ms



(p95(W1)+p95(W2))/2 = 430ms

~200% difference

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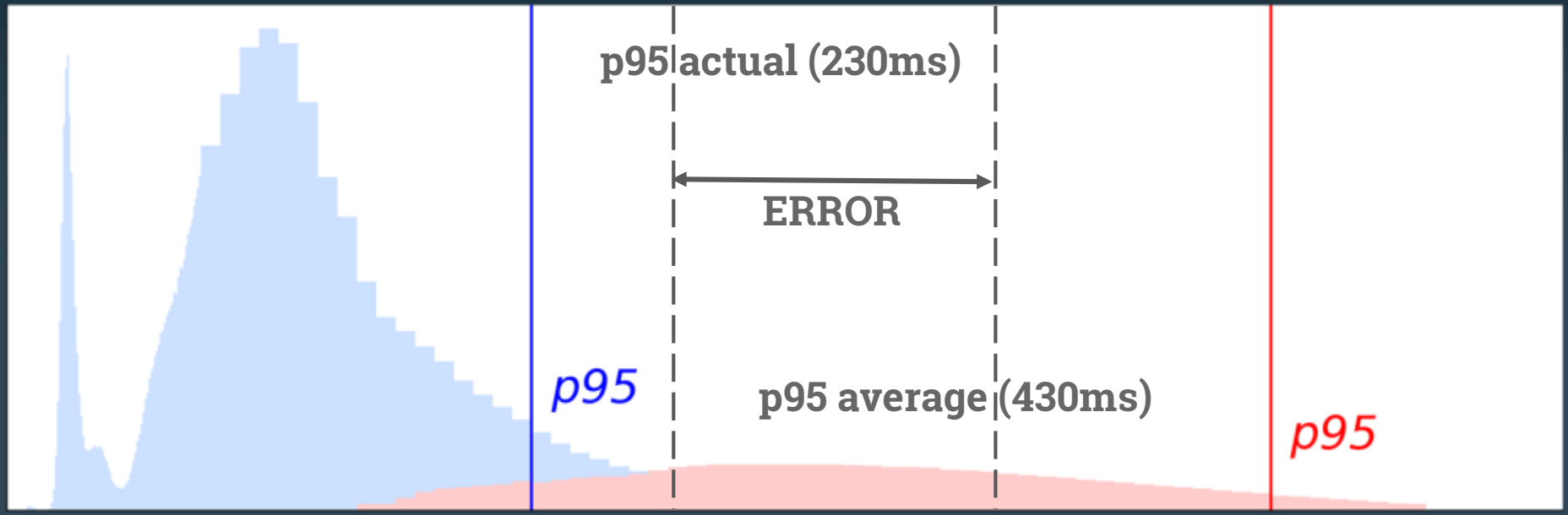
A Common Mistake



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A Common Mistake

Log parser => Metrics (mtail)

What metrics are you storing?

Averages? p50, p90, p95, p99, p99.9, p99.9?

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Computing SLOs with log data

"%{%d/%b/%Y %T}t.**%{msec_frac}t** %{%z}t"

~100 bytes per log line

~1GB for 10M requests

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Computing SLOs with log data

Logs => HDFS

Logs => ElasticSearch/Splunk

ssh -- `grep ... | awk ... > 550 ... | wc -l`
Then query all the log files

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Computing SLOs with log data

Calculating p95 SLI

1. Extract samples for time window
2. Sort the samples by value
3. Find the sample 5% count from largest
4. That's your p95

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Computing SLOs with log data

Calculating p95 SLO

“95th percentile SLI will succeed 99.9% trailing year”

1. Divide 1 year samples into 1,000 slices
2. For each slice, calculate SLI
3. Was p95 SLI met for 999 slices? Met SLO if so

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Computing SLOs with log data

Pros:

1. Easy to configure logs to capture latency
2. Easy to roll your own processing code, some open source options out there
3. Accurate results

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Computing SLOs with log data

Cons:

1. Expensive (see log analysis solution pricing)
2. Sampling possible but skews accuracy
3. Slow
4. Difficult to scale

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Computing SLOs by counting requests

1. Count # of requests that violate SLI threshold
2. Count total number of requests
3. % success = 100 - (#failed_reqs/#total_reqs)*100

Similar to Prometheus cumulative ‘le’ histogram

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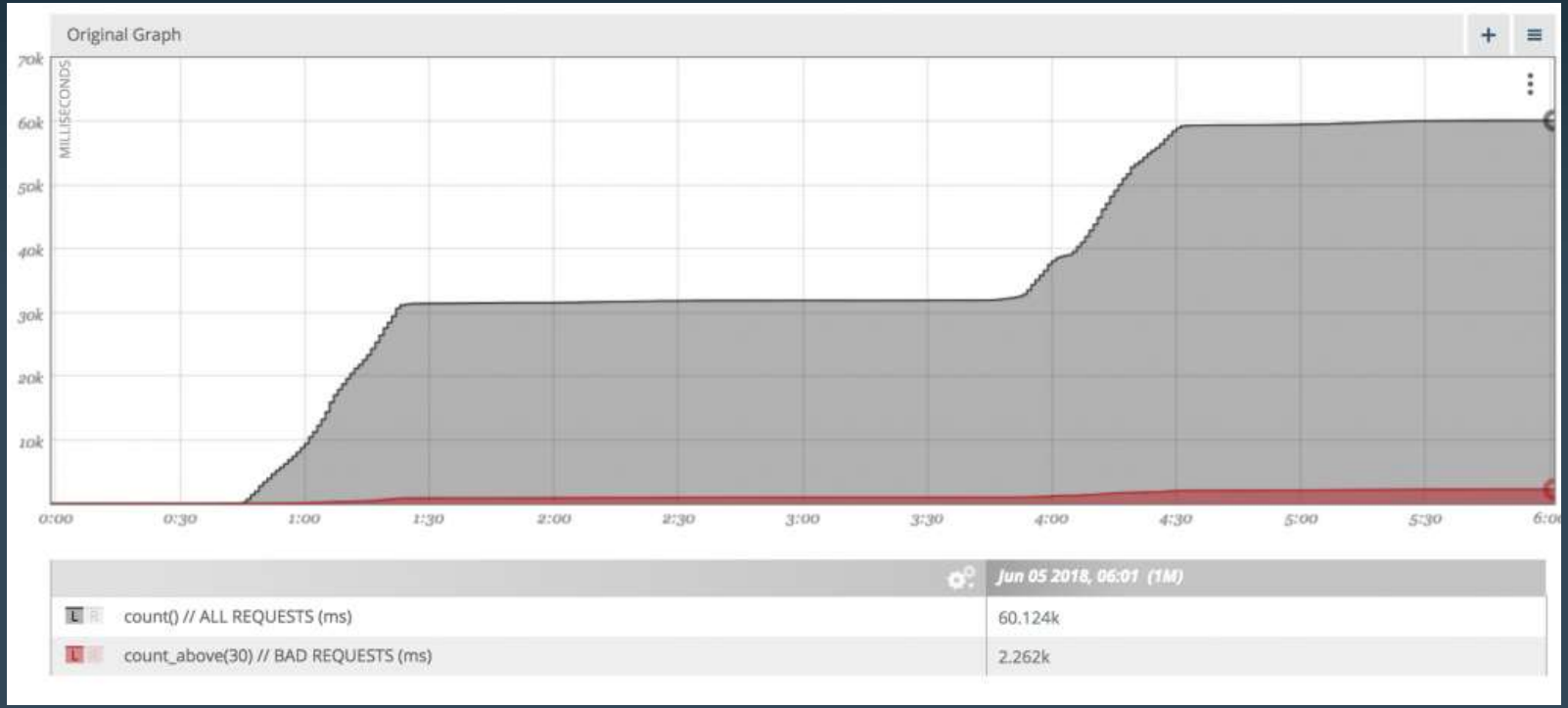
Computing SLOs by counting requests



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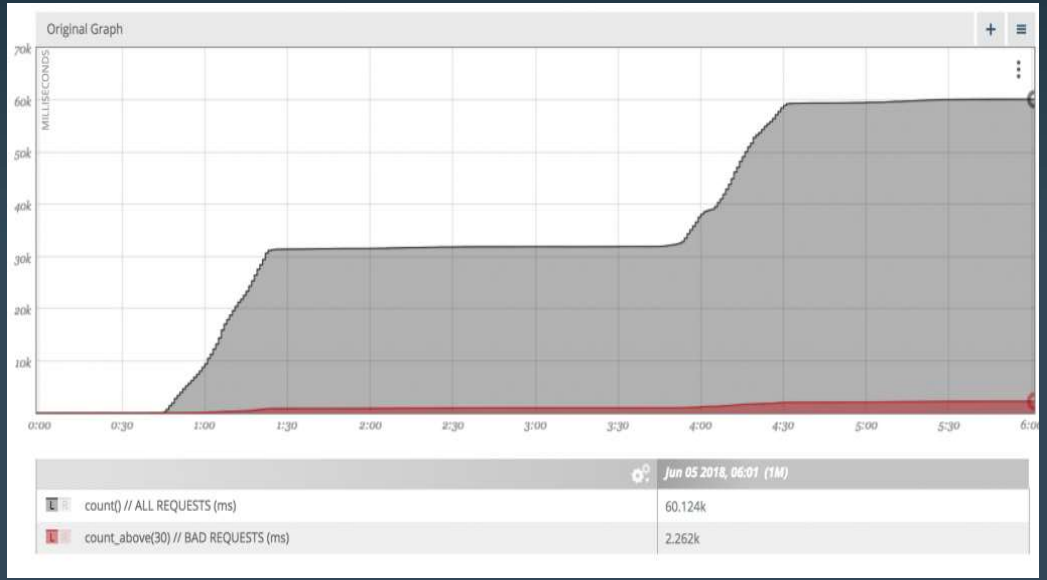
Computing SLOs by counting requests

SLO = 90% of reqs < 30ms

bad requests = 2,262
total requests = 60,124

100-(2262/60124)*100=96.2%

SLO was met



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Computing SLOs by counting requests

Pros:

1. Simple to implement
2. Performant
3. Scalable
4. Accurate

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Computing SLOs by counting requests

Cons:

1. Fixed SLO threshold - must reconfigure
2. Look back impossible for other thresholds

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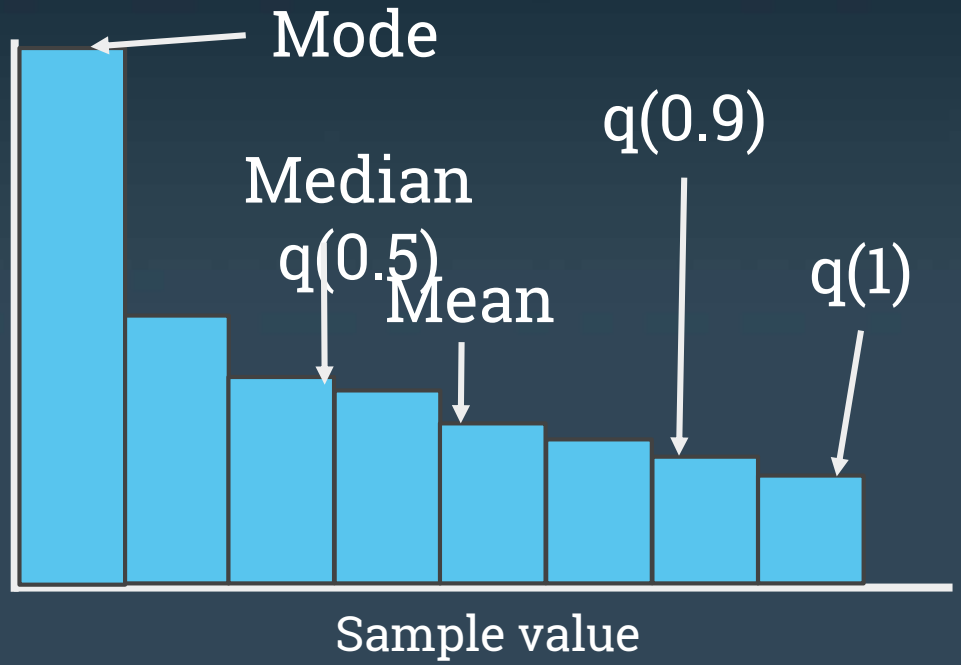
Computing SLOs with histograms

AKA distributions

Sample counts
in bins/buckets

Gil Tene's hdrhistogram.org



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Computing SLOs by counting requests

Some histogram types:

1. Linear
2. Approximate
3. Fixed bin
4. Cumulative
5. Log Linear

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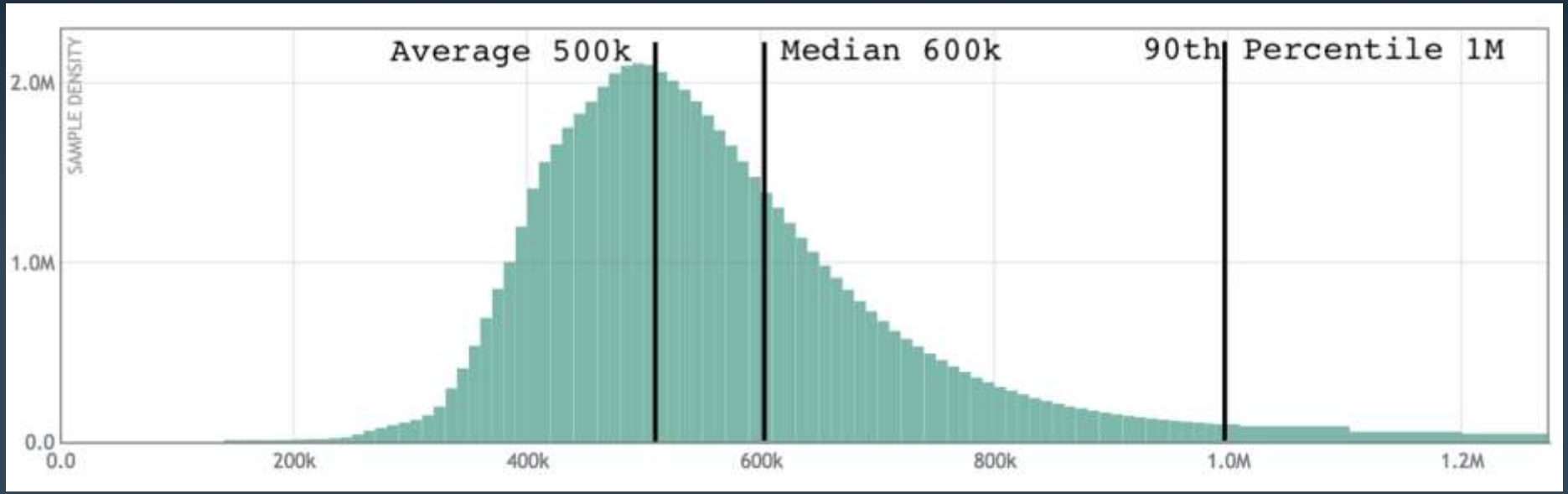
Log Linear Histogram



github.com/circonus-labs/libcircllhist
github.com/circonus-labs/circonusllhist

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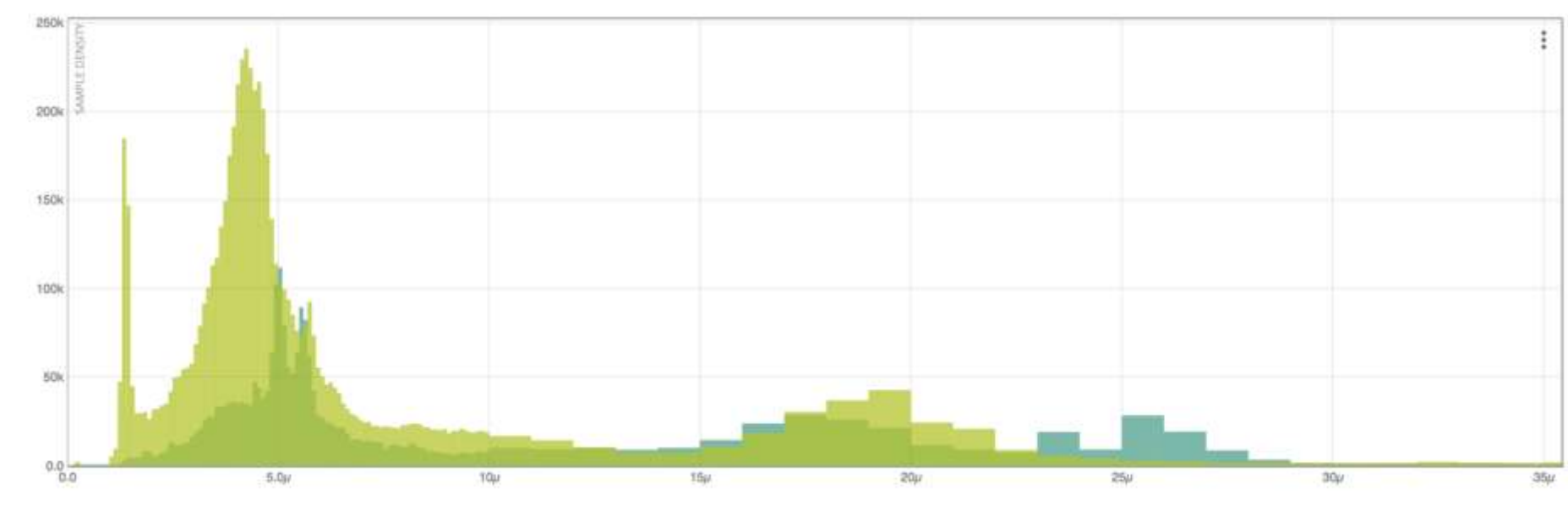
Log Linear Histogram



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Mergeability

$$h(A \cup B) = h(A) \cup h(B)$$

A & B must have identical bin boundaries

Can be aggregated both in space and time

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Computing SLOs with histograms

How many requests are faster than 330ms?

1. Walk the bins lowest to highest until you reach 330ms
2. Sum the counts in those bins
3. Done

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Liz Fong-Jones (方禮真)
@lizthegrey
Following
This is brilliant. However worth noting is that you still do have to make sure values you pick are in a histogram bin line. Make sure you know what your binning algorithm is.
Fred Moyer @phredmoyer
Slides from my lightning talk "Latency SLOs done right" at #newopsdays, hosted at @splunk slideshare.net/redhotpenguin/...
6:26 PM - 11 Oct 2018
2 Retweets 9 Likes
1
2
9

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So ... where are the bin boundaries?

For the libcircllhist implementation we have bins at:

... 320, 330, 340, ...

.... And: 10,11,12,13...

.... And: 0.0000010, 0.0000011, 0.0000012,

For every decimal floating point number, with 2 significant digits, we have a bin (within 10^{+/-128}).

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Computing SLOs with histograms

Pros:

1. Space Efficient (HH: ~ 300bytes / histogram in practice, 10x more efficient than logs)
2. Full Flexibility:
   - Thresholds can be chosen as needed and analyzed
   - Statistical methods applicable, IQR, count_below, q(1), etc.
3. Mergability (HH: Aggregate data across nodes)
4. Performance (ns insertions, µs percentile calculations)
5. Bounded error (half the bin size)
6. Several open source libraries available

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Computing SLOs with histograms

Cons:

1. Math is more complex than other methods
2. Some loss of accuracy (<<5%) in worst cases

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Log Linear histograms with Python

github.com/circonus-labs/libcircllhist

```
(autoconf && ./configure && make && make install)
```

github.com/circonus-labs/libcircllhist/tree/master/src/python

```
(pip install circllhist)
```

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Log Linear histograms with Python

```
h = Circllhist()   # make a new histogram
h.insert(123)      # insert value 123
h.insert(456)      # insert value 456
h.insert(789)      # insert value 789
print(h.count())           # prints 3
print(h.sum())             # prints 1,368
print(h.quantile(0.5))  # prints 456
```

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Log Linear histograms with Python

```
from matplotlib import pyplot as plt
from circllhist import Circllhist
H = Circllhist()
... # add latency data to H via insert()
H.plot()
plt.axvline(x=H.quantile(0.95), color=red)
```

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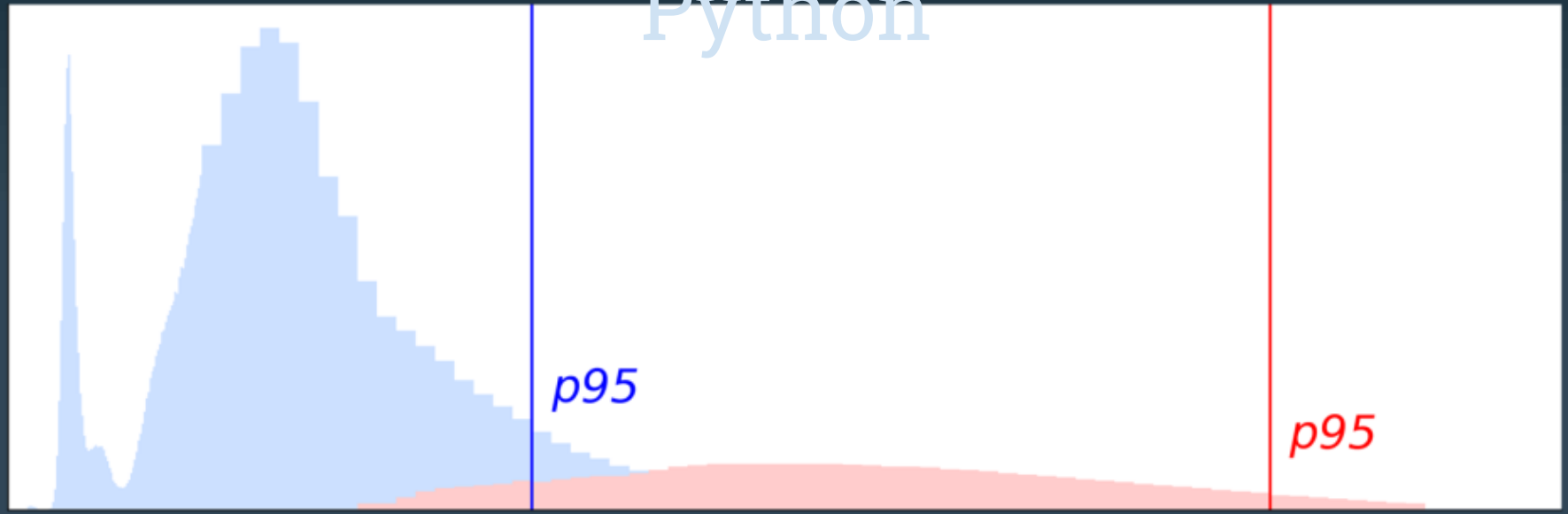
Log Linear histograms with Python



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Conclusions

1. Averaging Percentiles is tempting, but misleading
2. Use counters or histograms to calculate SLOs correctly
3. Histograms give the most flexibility in choosing latency thresholds, but only a couple libraries implement them (libcircllhist, hdrhistogram)
4. Full support for (sparsely encoded-, HDR-) histograms in TSDBs still lacking (except IRONdb).

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Thank you!

Tweet me: @phredmoyer

AMA about histograms on: slack.s.circonus.com

More talks about histograms:

slideshare.net/redhotpenguin

https://github.com/HeinrichHartmann/DS4OPS

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DEMO