How NOT to Measure Latency

Gil Tene, CTO & co-Founder, Azul Systems
@giltene

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The "Oh S@%#!" talk

Gil Tene, CTO & co-Founder, Azul Systems
@giltene

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About me: Gil Tene

- co-founder, CTO @Azul Systems
- Have been working on "think different" GC approaches since 2002
- A Long history building Virtual & Physical Machines, Operating Systems, Enterprise apps, etc...
- I also depress people by pulling the wool up from over their eyes...

* working on real-world trash compaction issues, circa 2004

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Latency Behavior

- Latency: The time it took one operation to happen
- Each operation occurrence has its own latency
- What we care about is how latency behaves
- Behavior is a lot more than "the common case was X"

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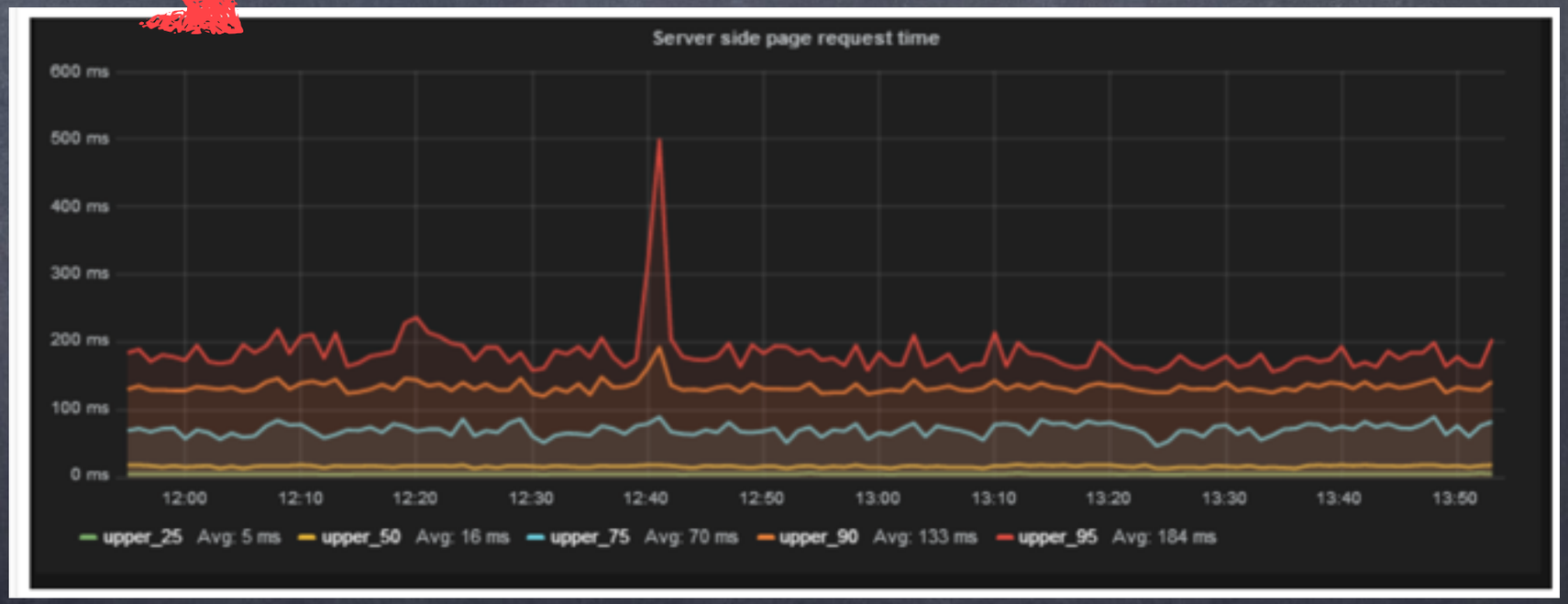
We like to look at pretty charts…

95%'lie



The "We only want to show good things" chart

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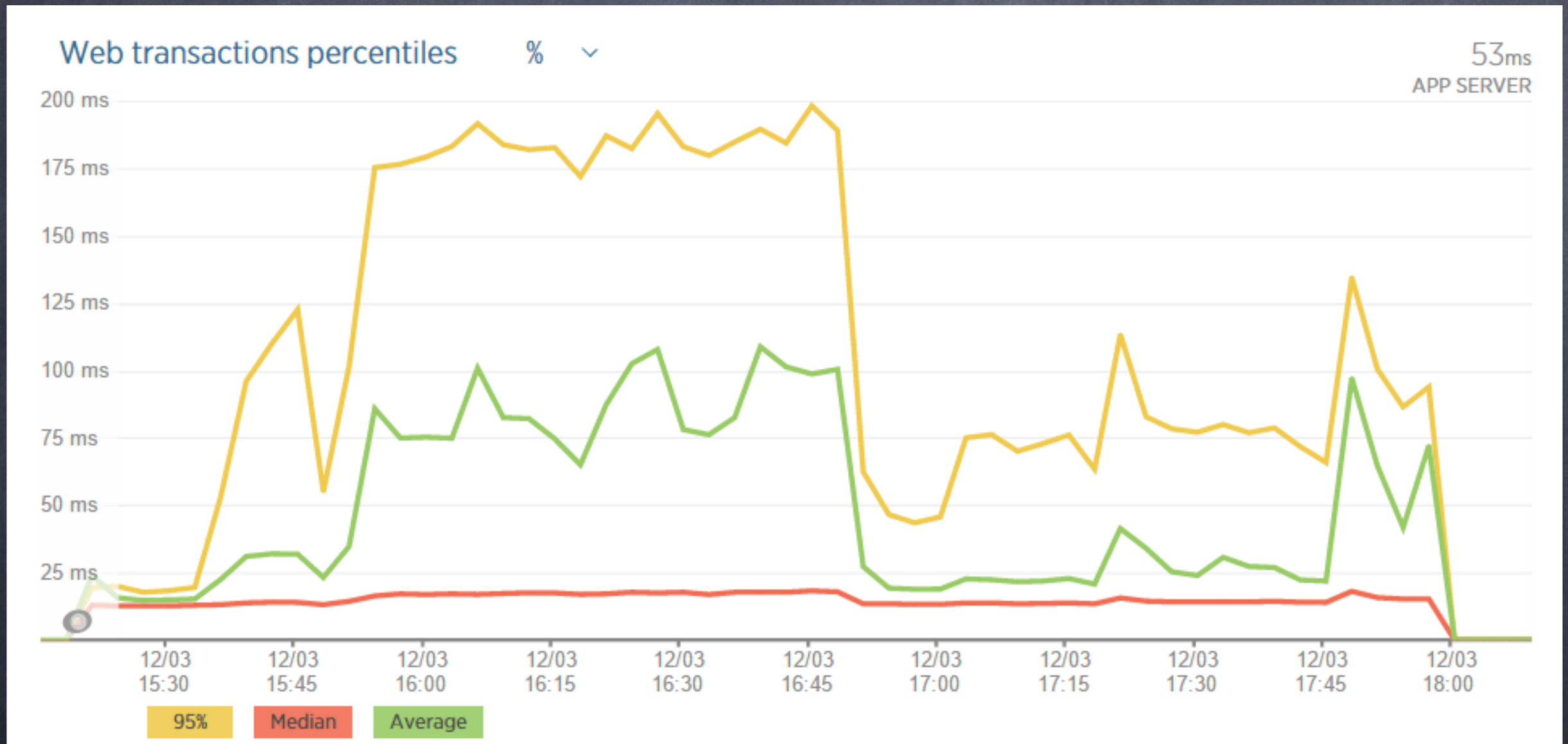
A real world, real time example



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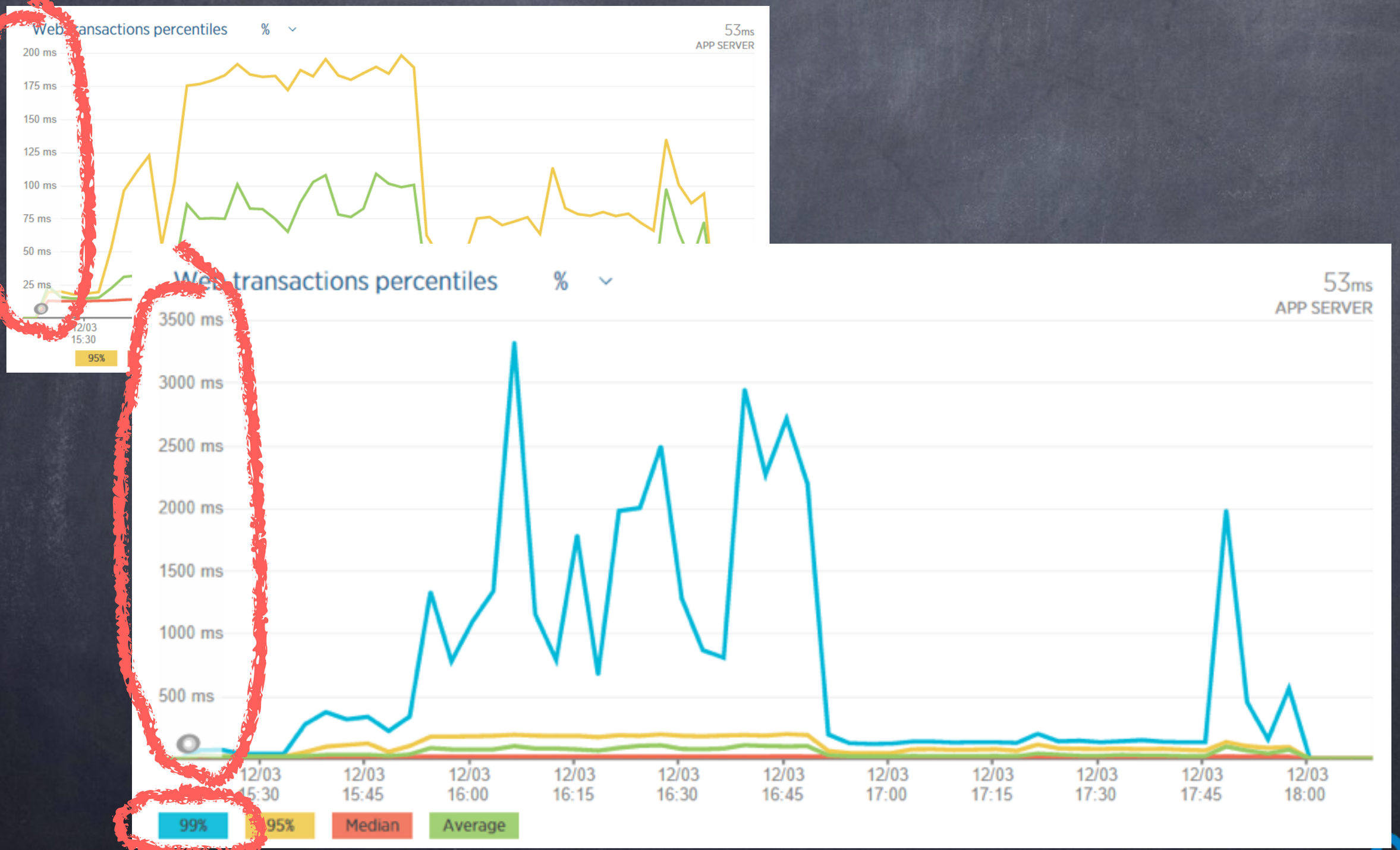
A real world, real time example



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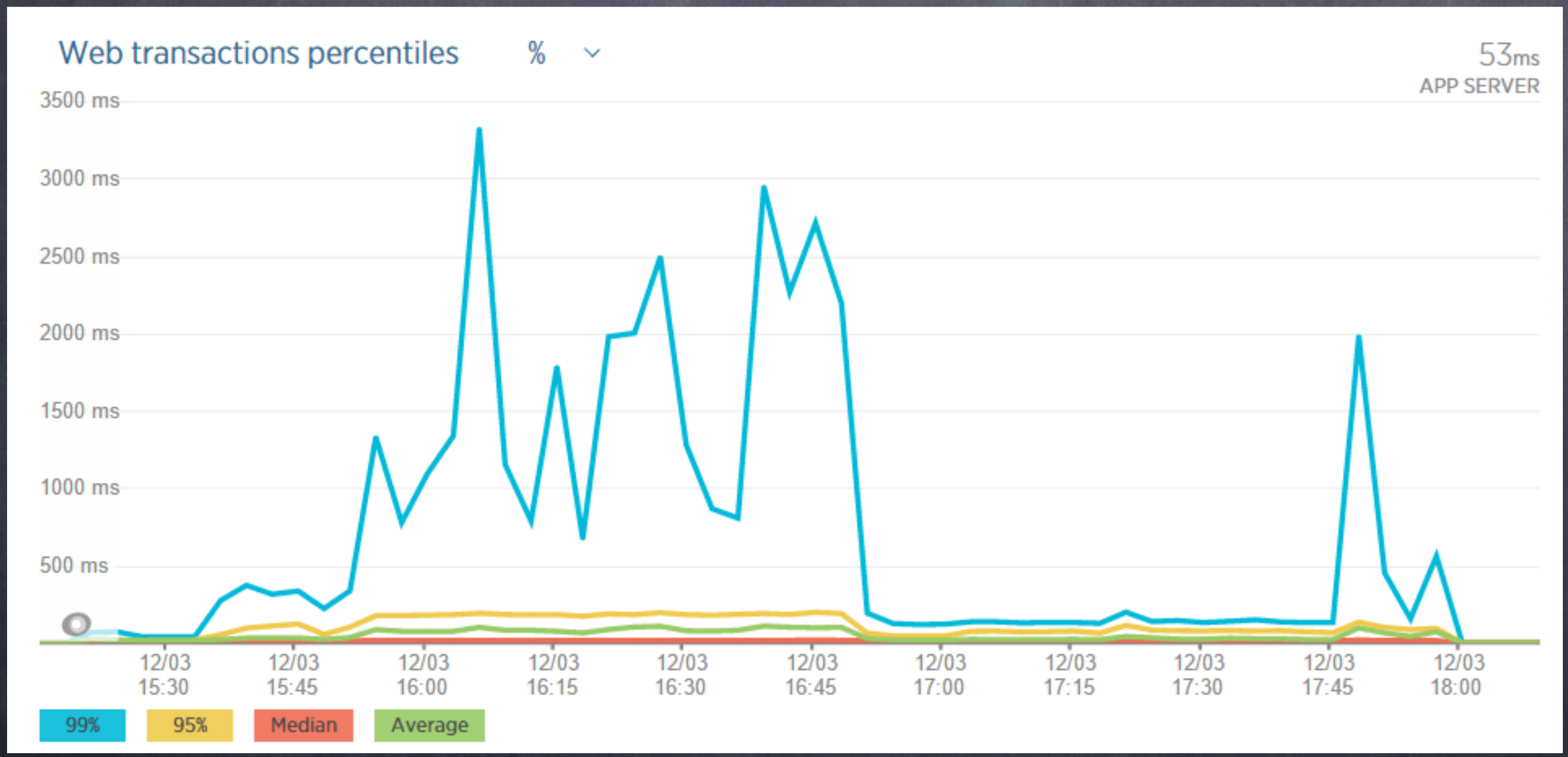
A real world, real time example



So this is a better picture. Right?

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I like to rant about latency…

About Me

Gil Tene

CTO and co-founder of Azul Systems.

View my complete profile

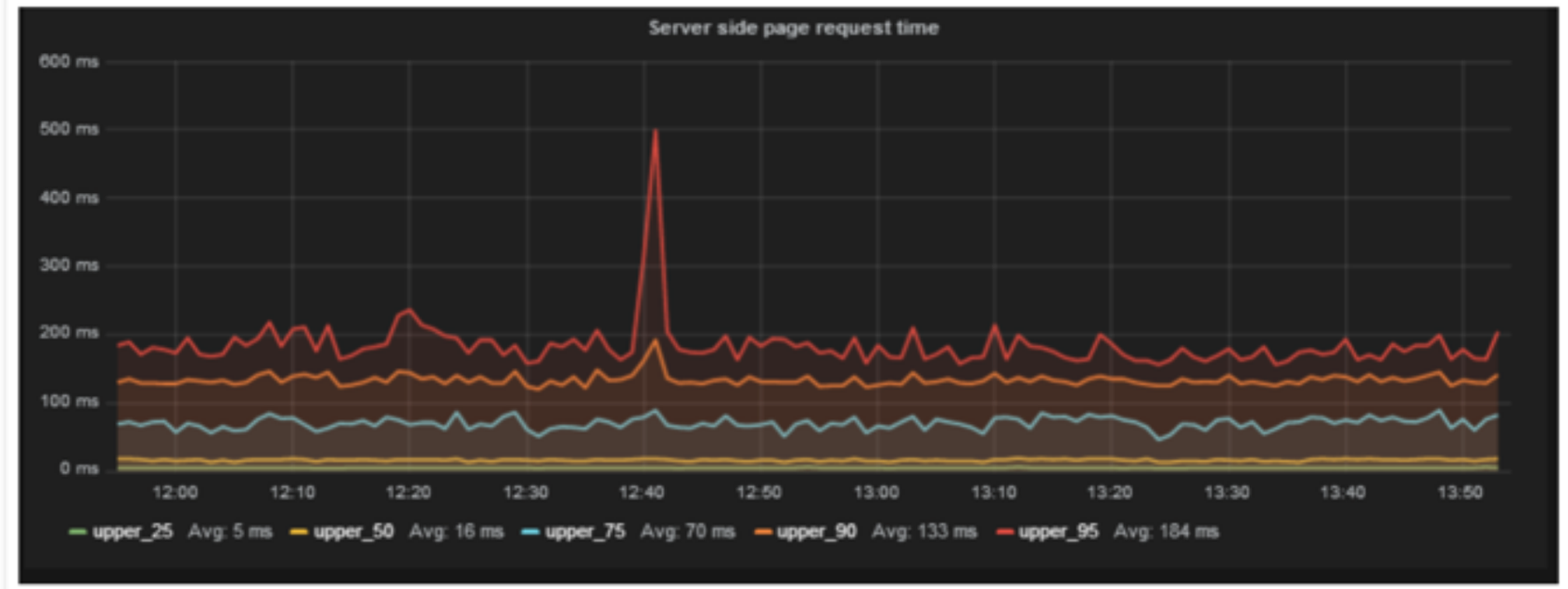
Blog Archive

- 2014 (8)
  - June (8)
    - #LatencyTipOfTheDay: Median Server Response Time: ...
    - #LatencyTipOfTheDay: MOST page loads will experien...
    - #LatencyTipOfTheDay: Q: What's wrong with this pic...
    - #LatencyTipOfTheDay: If you are not measuring and/...
    - #LatencyTipOfTheDay : Measure what you need to mon...
    - #LatencyTipOfTheDay: Average (def): a random numbe...

Saturday, June 21, 2014

#LatencyTipOfTheDay: Q: What's wrong with this picture? A: Everything!

Question: What's wrong with this picture:



Answer: Everything!

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#LatencyTipOfTheDay:

If you are not measuring and/or plotting Max, what are you hiding (from)?

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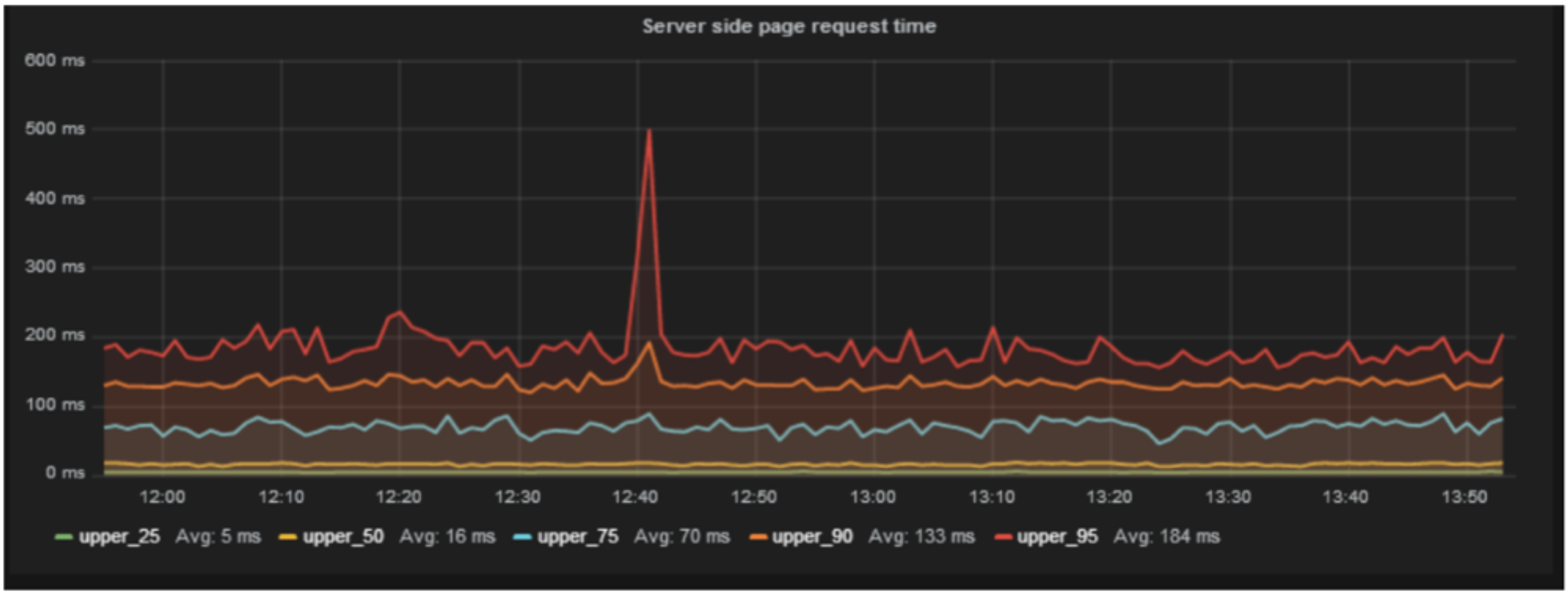

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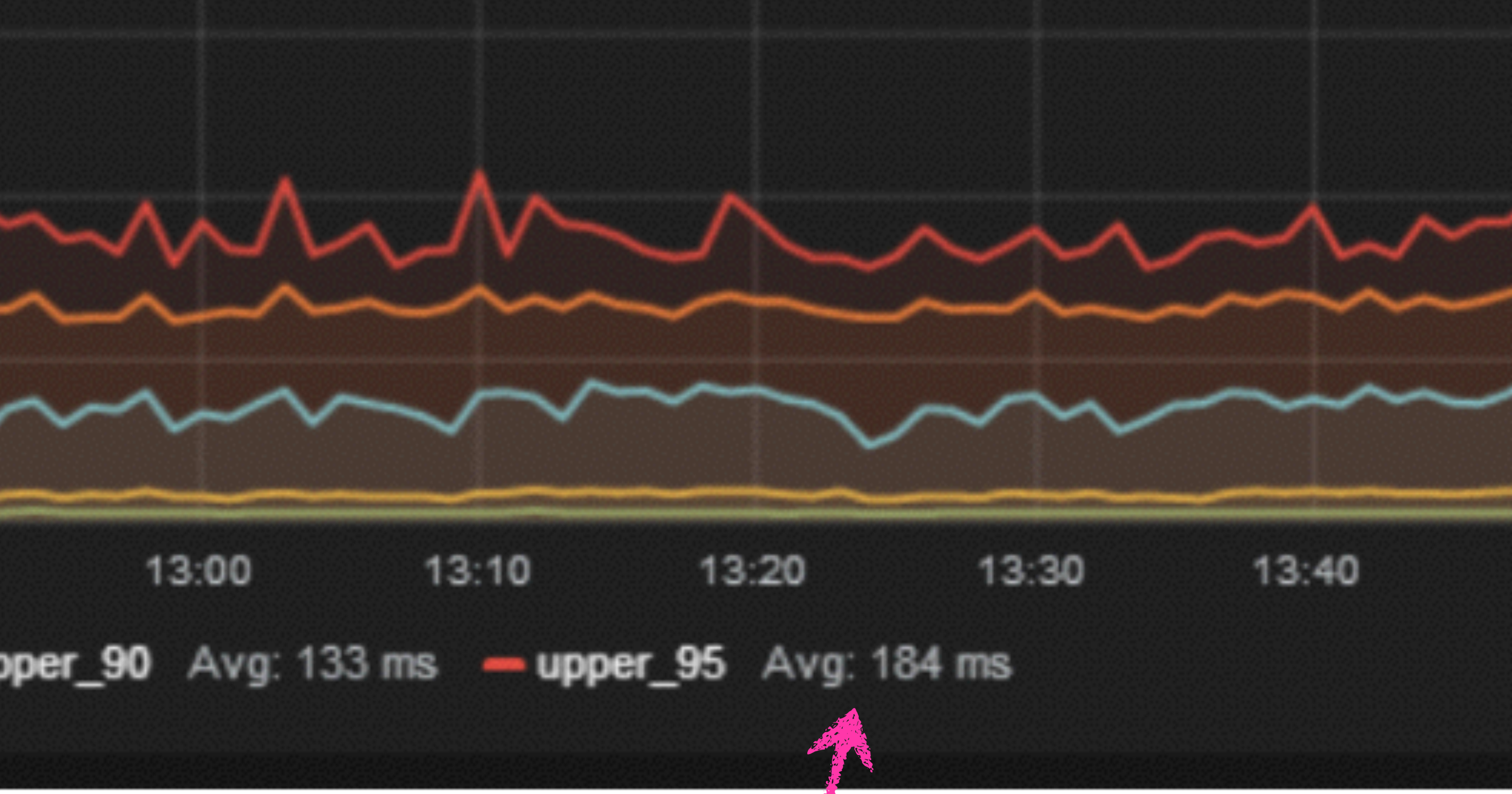

What (TF) does the Average of the 95%'lie mean?

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What (TF) does the Average of the 95%'lie mean?

- Lets do the same with 100%'ile; Suppose we a set of 100%'ile values for each minute:

[1, 0, 3, 1, 601, 4, 2, 8, 0, 3, 3, 1, 1, 0, 2]

"The average 100%'ile over the past 15 minutes was 42"

- Same nonsense applies to any other %'lie

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#LatencyTipOfTheDay:

You can't average percentiles.

Period.

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Percentiles Matter

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Is the 99%'lie "rare"?

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99%'lie: a good indicator, right?

What are the chances of a single web page view experiencing >99%'lie latency of:

- A single search engine node?

- A single Key/Value store node?

- A single Database node?

- A single CDN request?

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Site	# of requests
amazon.com	190
kohls.com	204
jcrew.com	112
saksfifthavenue.com	109
--	--
nytimes.com	173
cnn.com	279
--	--
twitter.com	87
pinterest.com	84
facebook.com	178
--	--
google.com (yes, that simple noise-free page)	31
google.com search for "http requests per page"	76

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Site	# of requests	page loads that would experience the 99%'lie [(1 - (.99 ^ N)) * 100%]
amazon.com	190	85.2%
kohls.com	204	87.1%
jcrew.com	112	67.6%
saksfifthavenue.com	109	66.5%
--	--	--
nytimes.com	173	82.4%
cnn.com	279	93.9%
--	--	--
twitter.com	87	58.3%
pinterest.com	84	57.0%
facebook.com	178	83.3%
--	--	--
google.com (yes, that simple noise-free page)	31	26.7%
google.com search for "http requests per page"	76	53.4%

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#LatencyTipOfTheDay:

MOST page loads will experience the 99%'lie server response

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Which HTTP response time metric is more "representative" of user experience?

The 95%'lie or the 99.9%'lie

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Gauging user experience

Example: If a typical user session involves 5 page loads, averaging 40 resources per page.

- How many of our users will NOT experience something worse than the 95%'lie of http requests?

Answer: ~0.003%

- How may of our users will experience at least one response that is longer than the 99.9%'lie?

Answer: ~18%

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Gauging user experience

Example: If a typical user session involves 5 page loads, averaging 40 resources per page.

- What http response percentile will be experienced by the 95%'ile of users?

Answer: ~99.97%

- What http response percentile will be experienced by the 99%'ile of users

Answer: ~99.995%

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#LatencyTipOfTheDay:

Median Server Response Time:
The number that 99.9999999999%
of page views can be worse than

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Why don’t we have response time or latency stats with multiple 9s in them???

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Why don’t we have response time or latency stats with multiple 9s in them???

You can’t average percentiles…

And you also can’t get an hour’s 99.999%’lie out of lots of 10 second interval 99%’lie reports…

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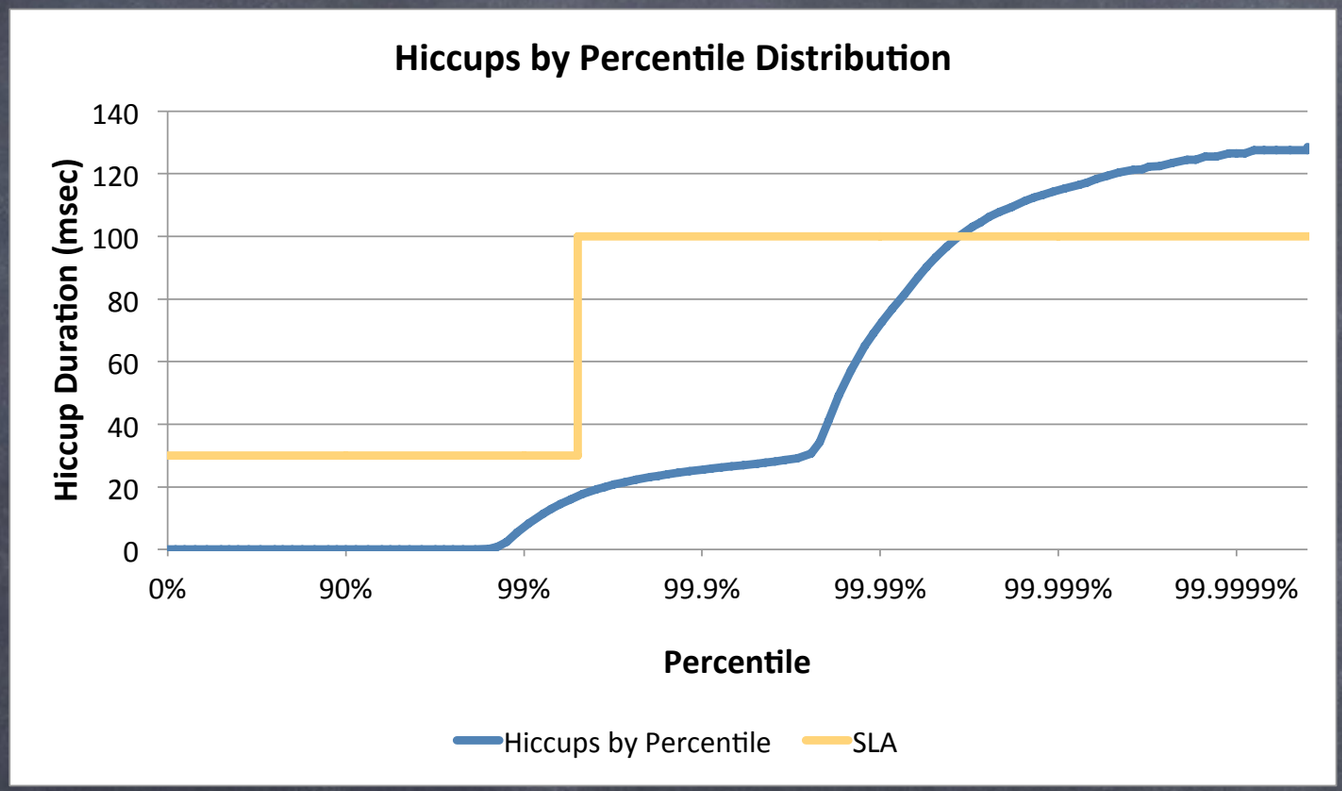
Why don’t we have response time or latency stats with multiple 9s in them???

Check out HdrHistogram



You can’t average percentiles…

It lets you have nice things….

And you also can’t get an hour’s 99.999%’lie out of lots of 10 second interval 99%’lie reports…

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The coordinated omission problem

An accidental conspiracy...

The *lie* in the 99%'lies

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The coordinated omission problem

- Common Example A (load testing):
  - each "client" issues requests at a certain rate
  - measure/log response time for each request

- So what's wrong with that?
  - works **only** if ALL responses fit within interval
  - implicit "automatic back off" coordination

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Common Example B: Coordinated Omission in Monitoring Code

```
/**
 * Performs the actual reading of a row out of the StorageService, fetching
 * a specific set of column names from a given column family.
 */
public static List<Row> read(List<ReadCommand> commands, ConsistencyLevel consistency_level)
        throws UnavailableException, IsBootstrappingException, ReadTimeoutException
{
    if (StorageService.instance.isBootstrapMode())
        throw new IsBootstrappingException();
    long startTime = System.nanoTime();
    List<Row> rows;
    try
    {
        rows = fetchRows(commands, consistency_level);
    }
    finally
    {
        readMetrics.addNano(System.nanoTime() - startTime);
    }
    return rows;
}
```

- Long operations only get measured once
- delays outside of timing window do not get measured at all

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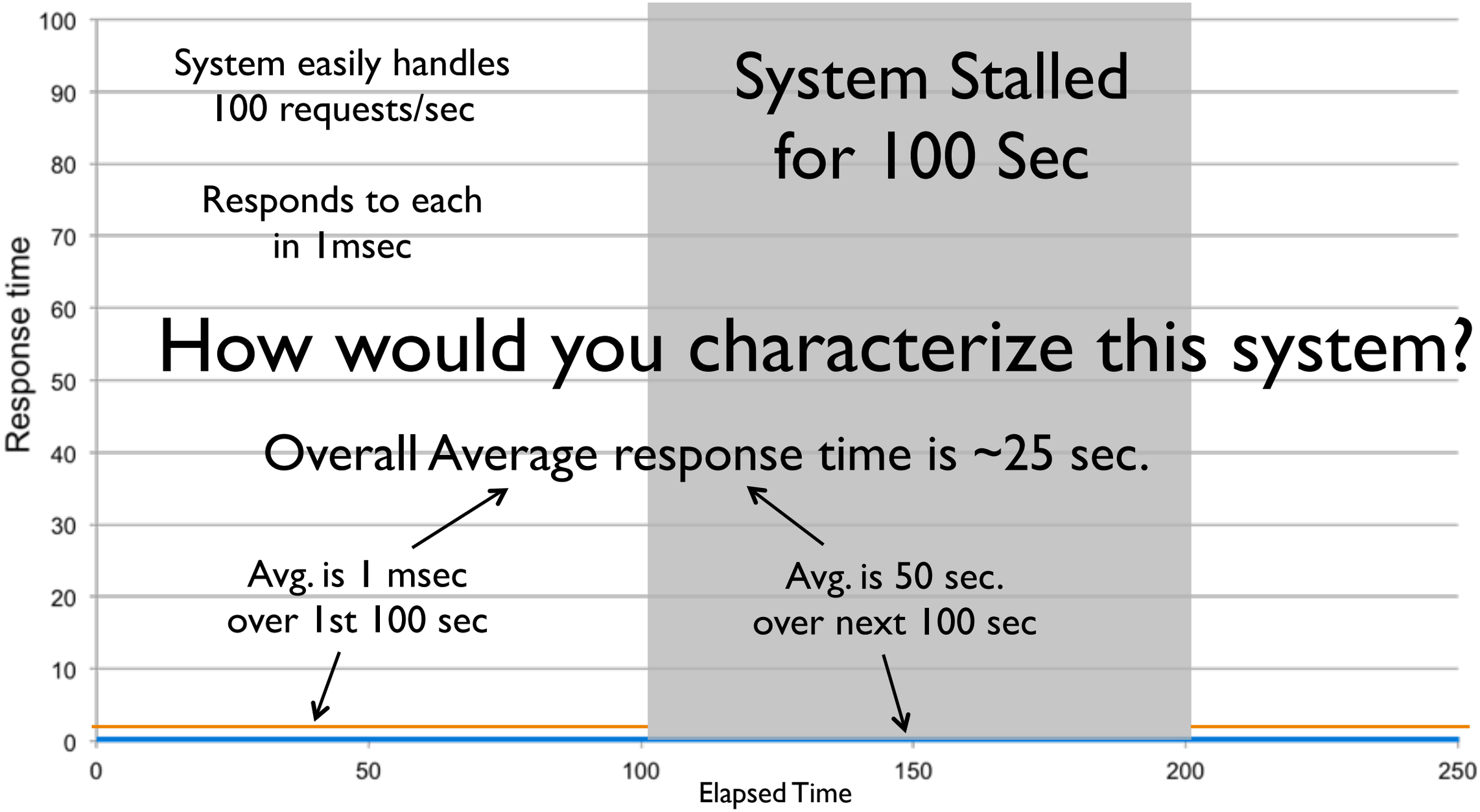
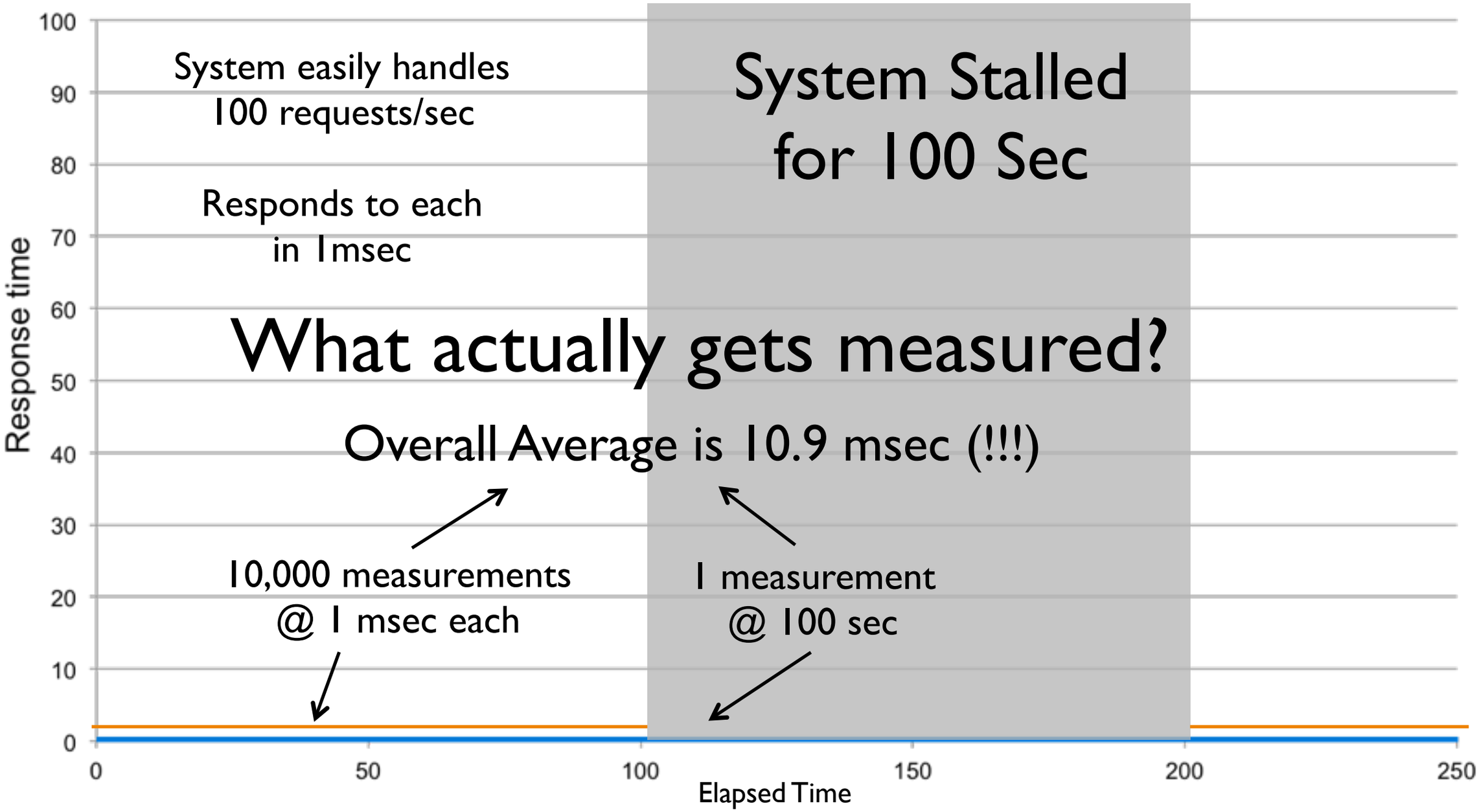
How bad can this get?



~50%‘ile is 1 msec ~75%‘ile is 50 sec 99.99%‘ile is ~100sec

Measurement in practice



50%'ile is 1 msec

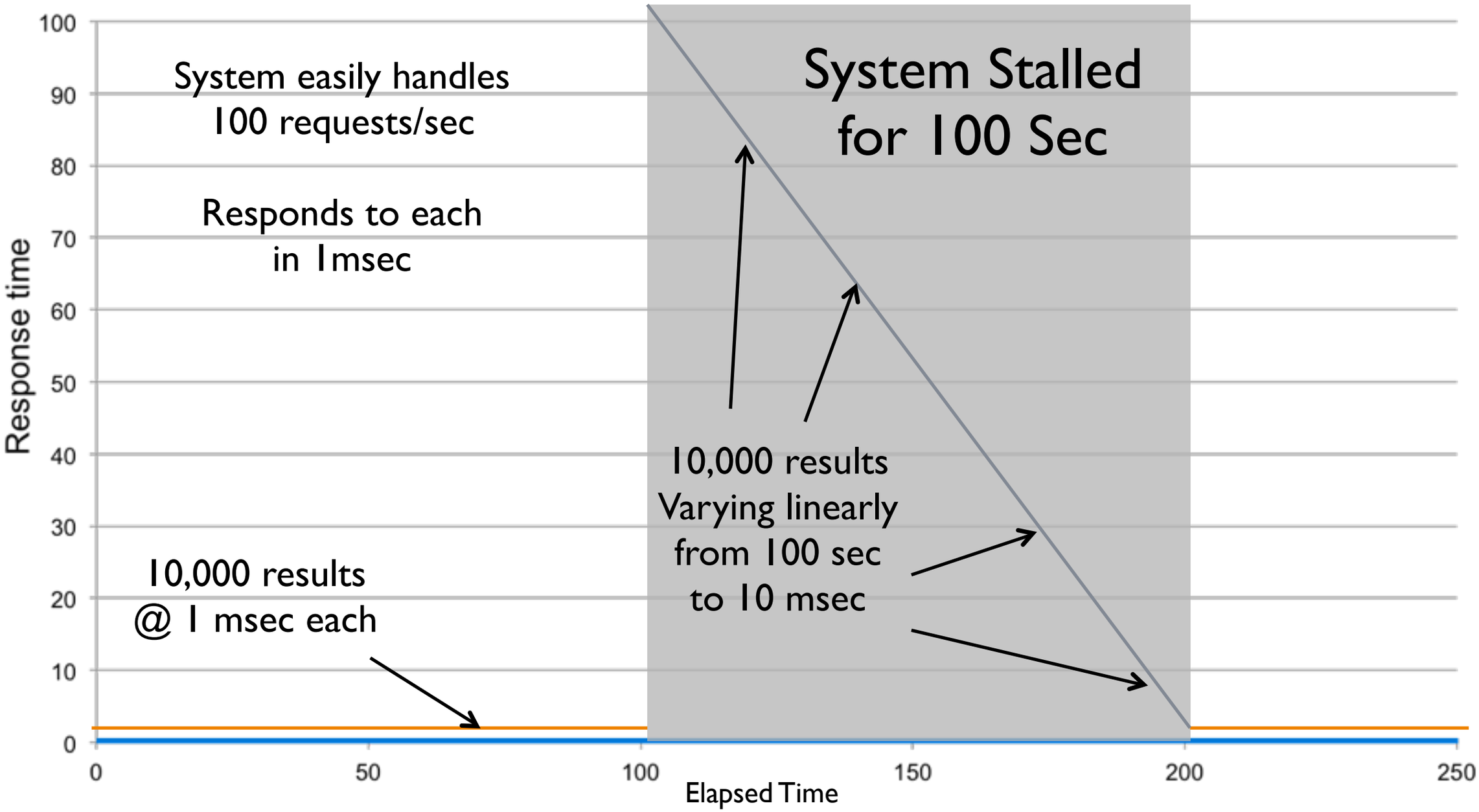
75%'lie is 1 msec

(should be ~50sec)

99.99%'lie is 1 msec

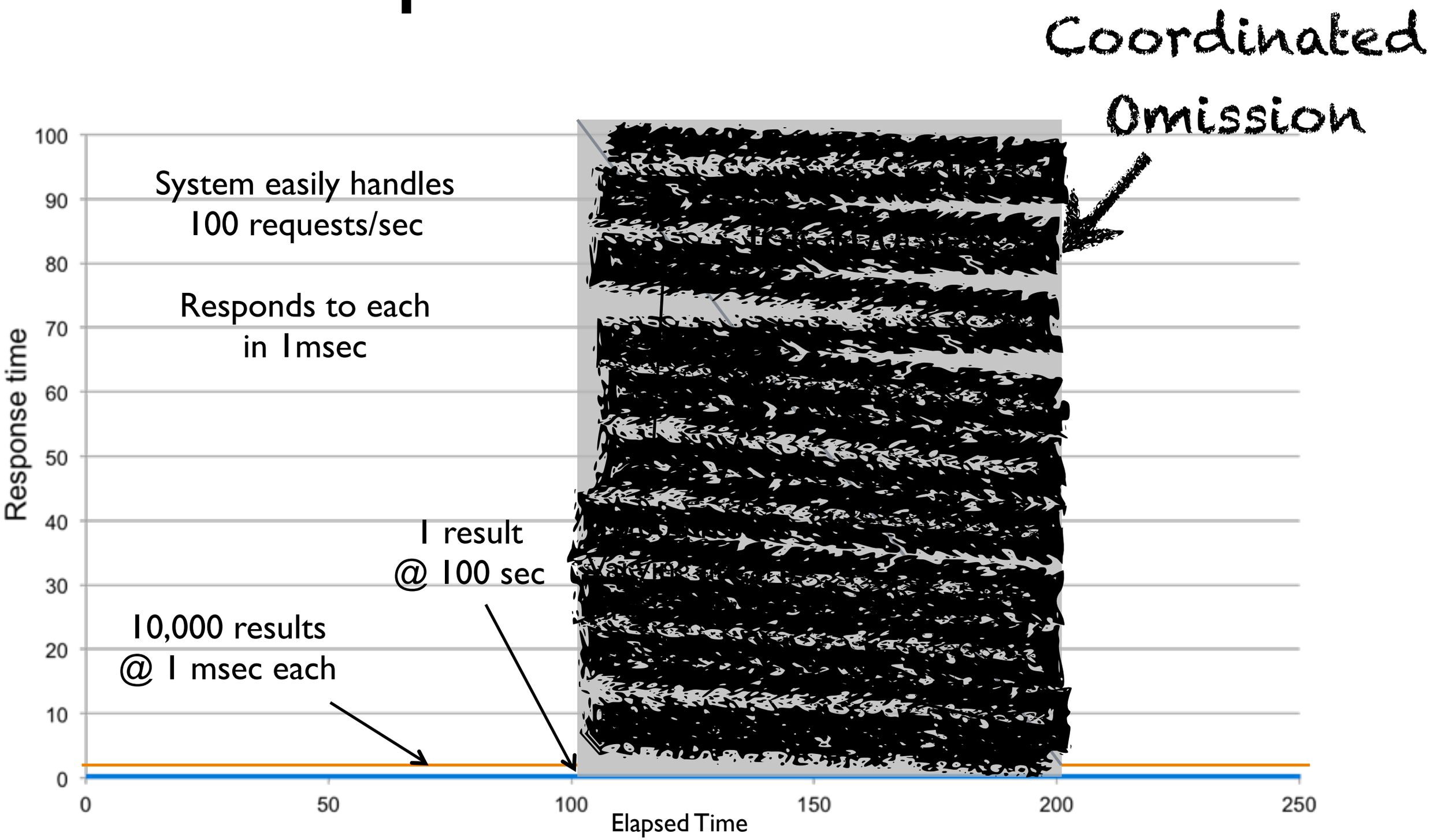
(should be ~100 sec)

Proper measurement



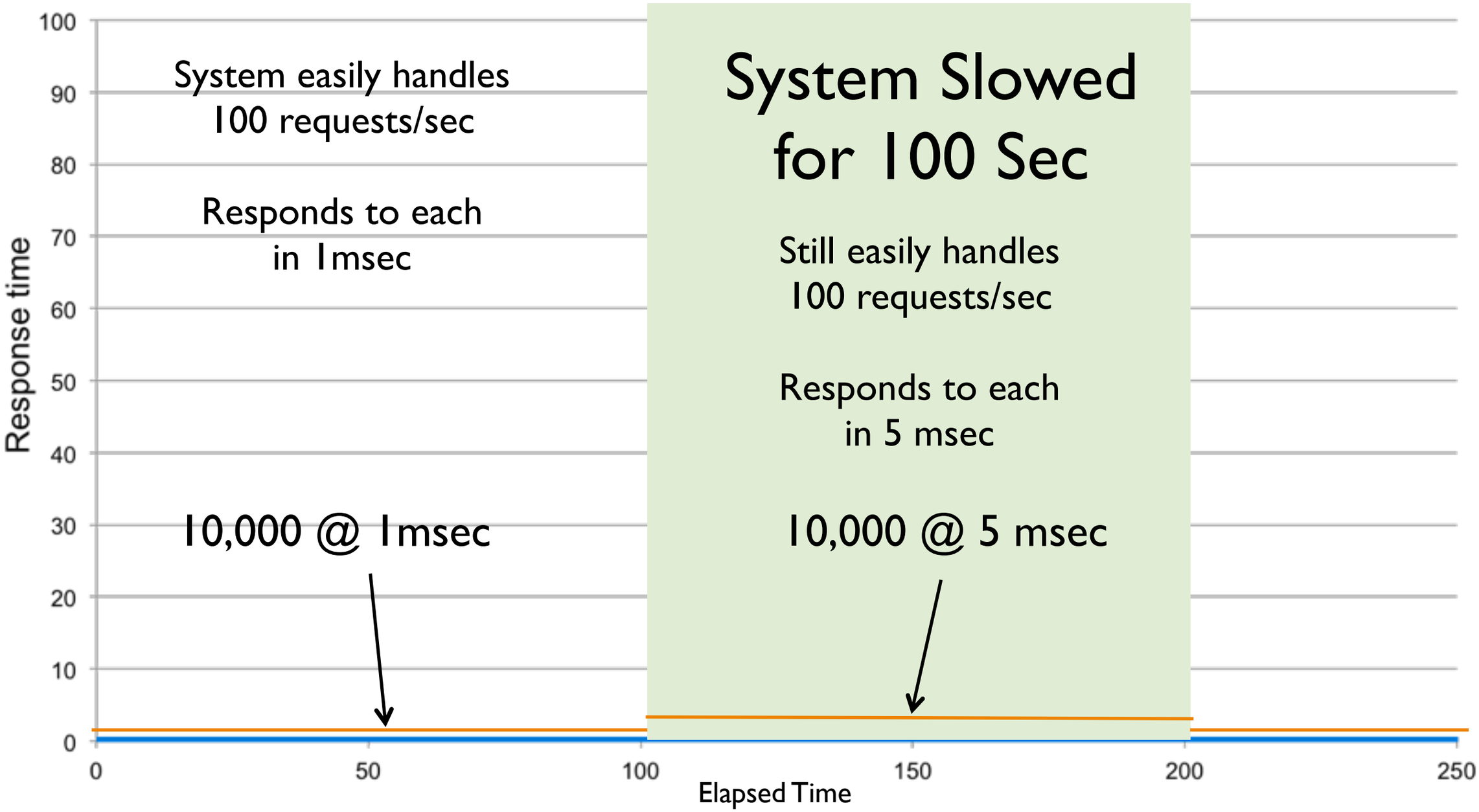
~50%‘ile is 1 msec ~75%‘ile is 50 sec 99.99%‘ile is ~100sec

Proper measurement



~50%‘ile is 1 msec ~75%‘ile is ~~50 sec~~ 1 msec 99.99%‘ile is ~~100 sec~~ 1 msec

"Better" can look "Worse"

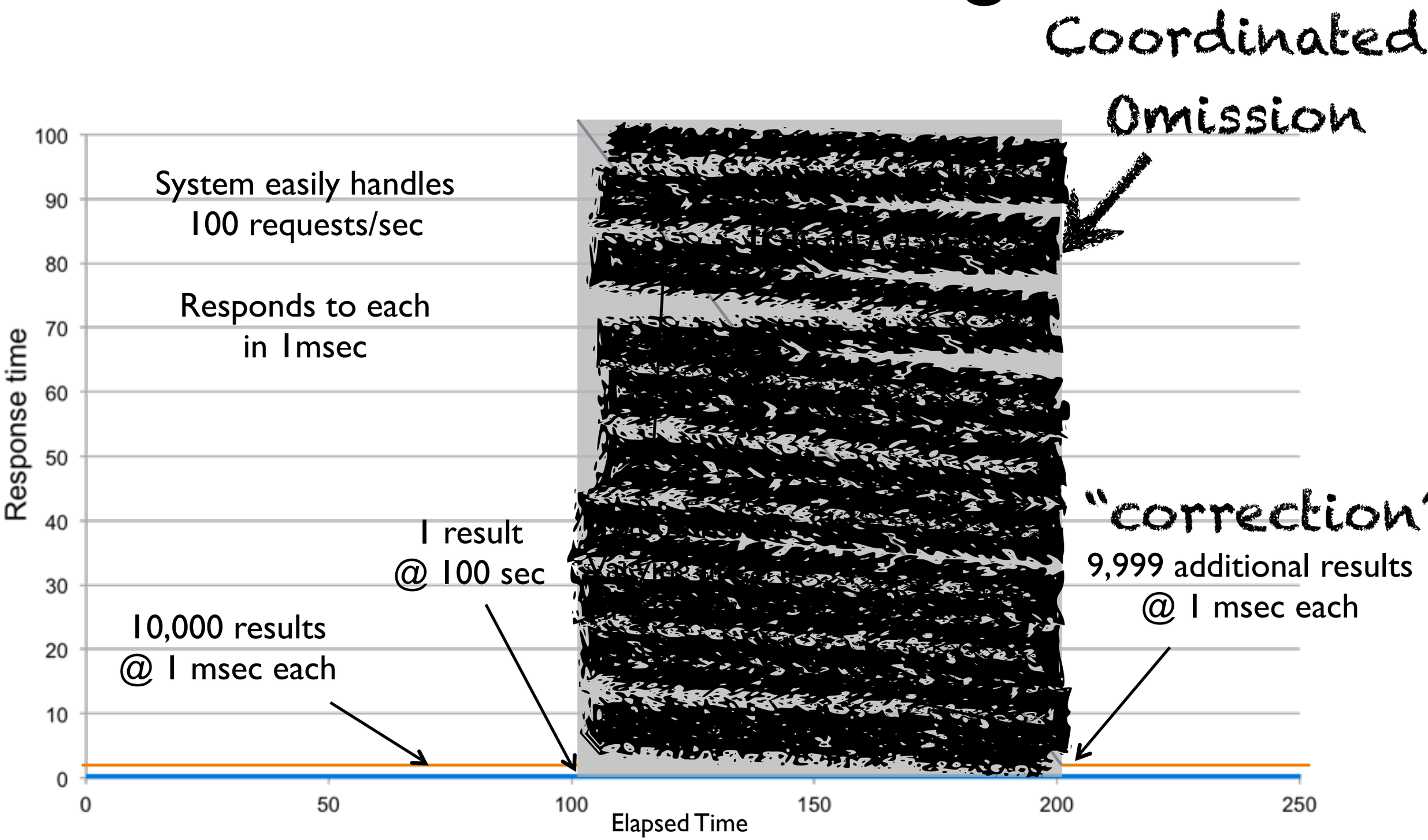


50%'ile is 1 msec

75%'lie is 2.5msec
(stalled shows 1 msec)

99.99%'lie is ~5msec
(stalled shows 1 msec)

"Correction": "Cheating Twice"



~50%'ile is 1 msec

~75%'ile is ~~50 sec~~ 1 msec

99.994%'ile is ~~100 sec~~ 1 msec

Response Time vs. Service Time

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Service Time vs. Response Time

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Coordinated Omission

Usually

makes something that you ***think*** is a

Response Time metric

only represent

the ***Service Time*** component

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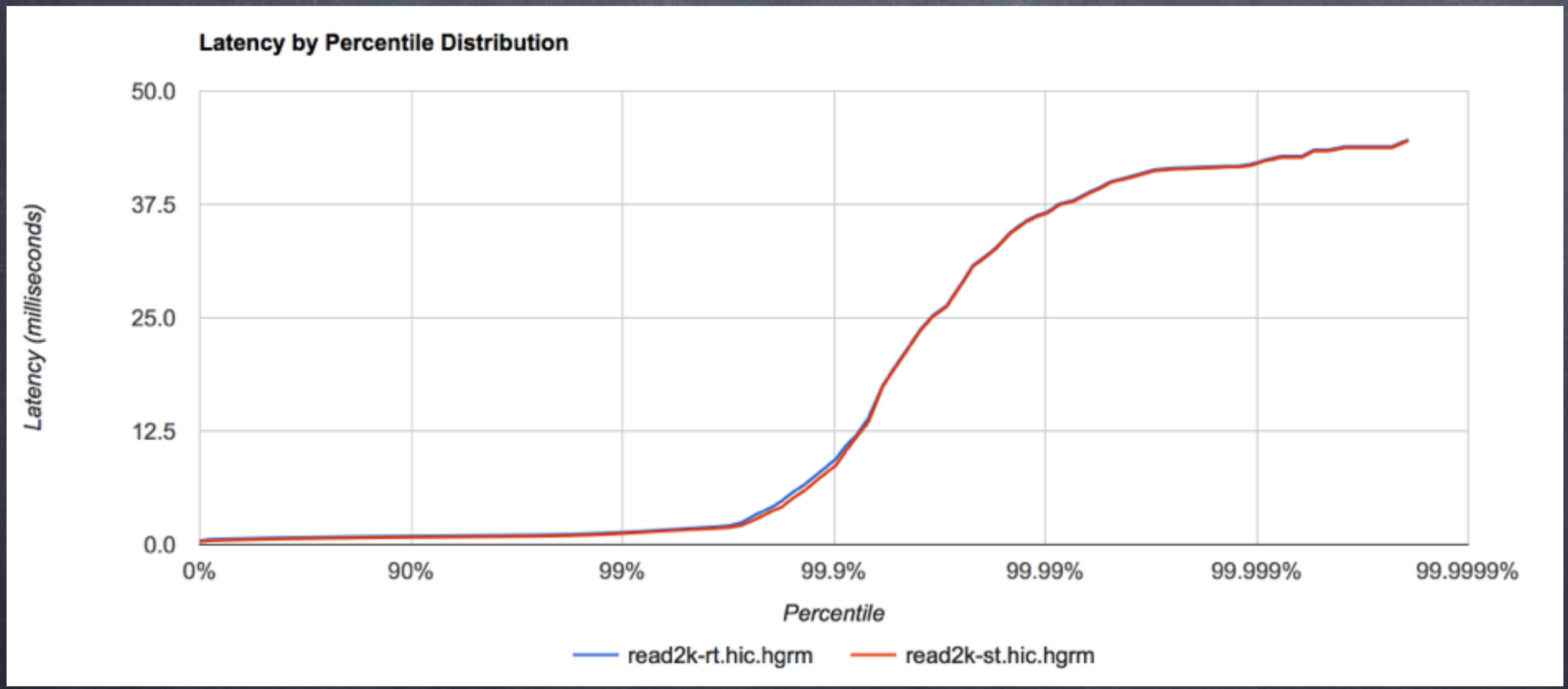
Response Time vs. Service Time @2K/sec



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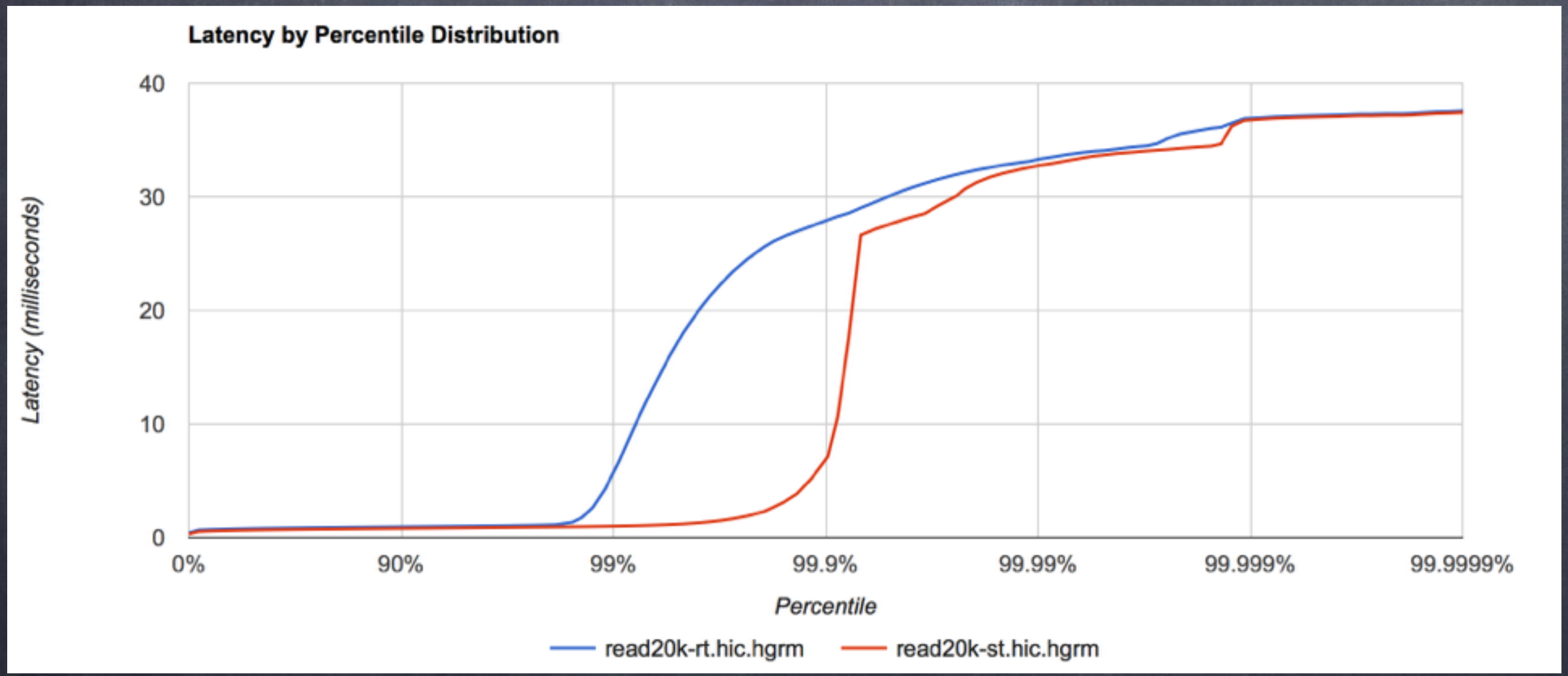
Response Time vs. Service Time @20K/sec



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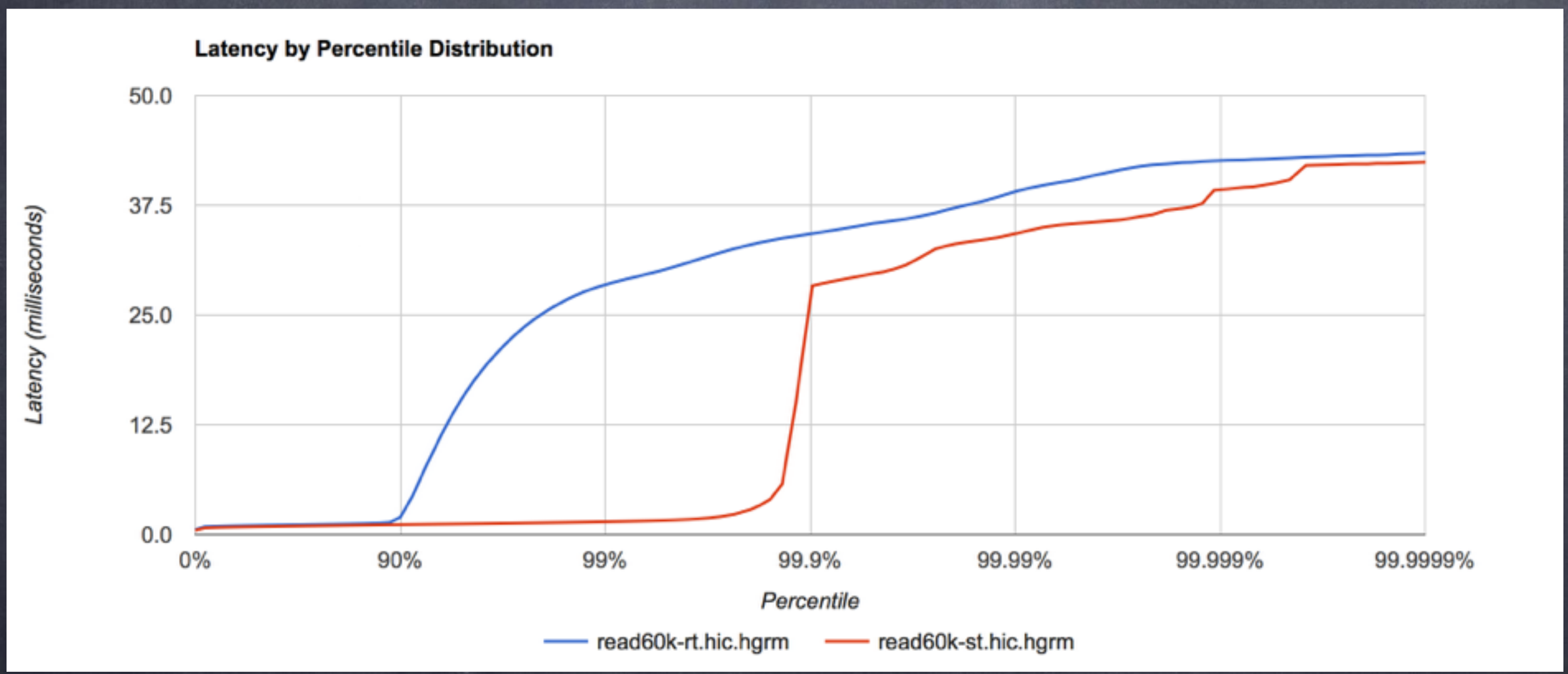
Response Time vs. Service Time @60K/sec



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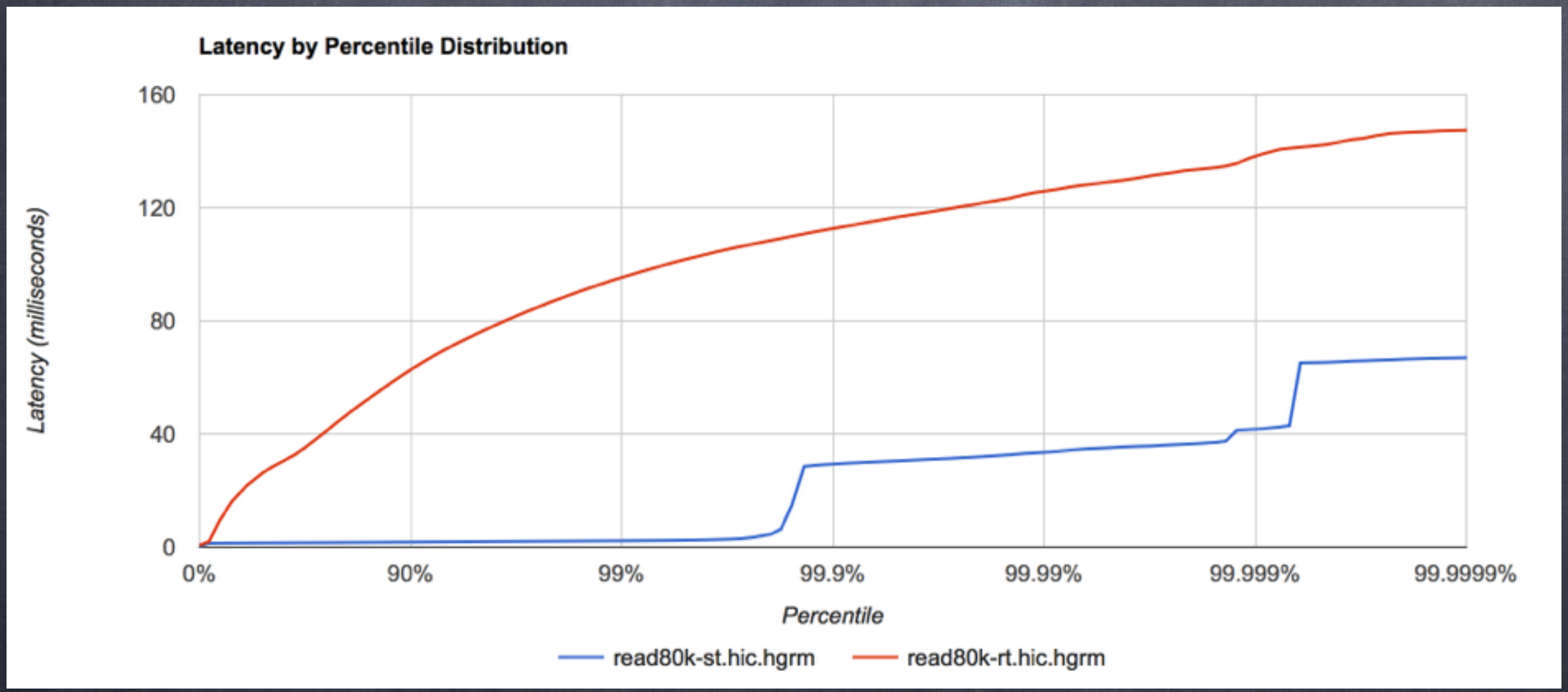
Response Time vs. Service Time @80K/sec



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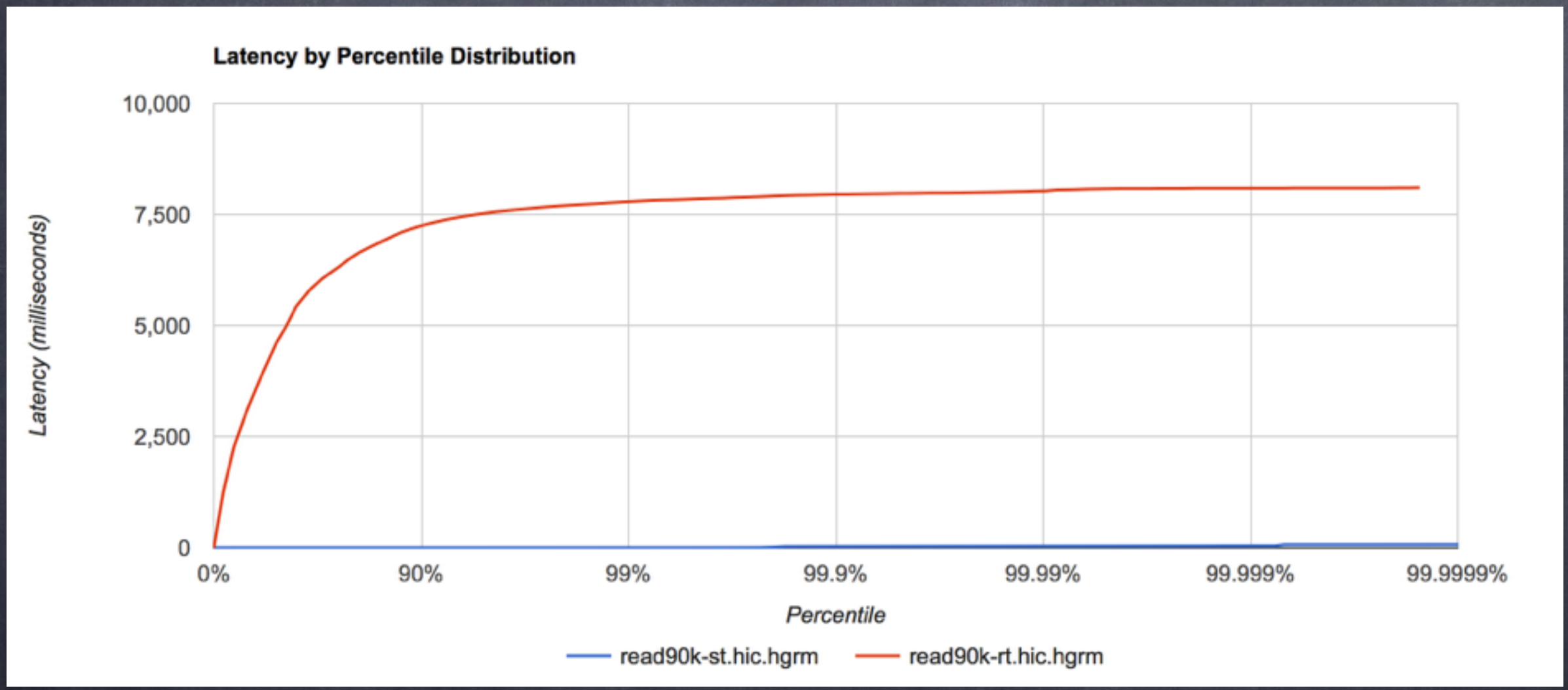
Response Time vs. Service Time @90K/sec



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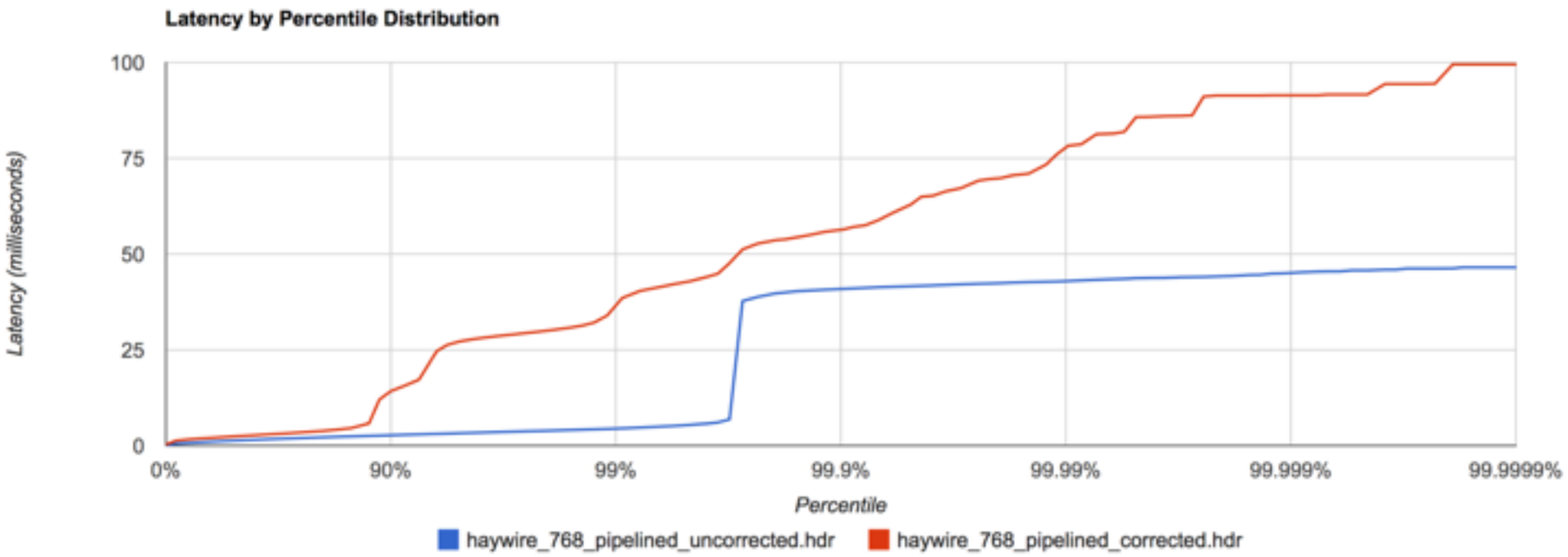
How "real" people react

Kelly Sommers @kellabyte 2d

LOL at how badly we all benchmark. Blue is how most of us are benchmarking, Red is the actual truth i.imgur.com/HYoWEu6.png



Leandro Pereira @lafp

@kellabyte Blue, you believe in whatever you want to believe. Red, you wake up in Wonderland and see how deep the rabbit hole goes.

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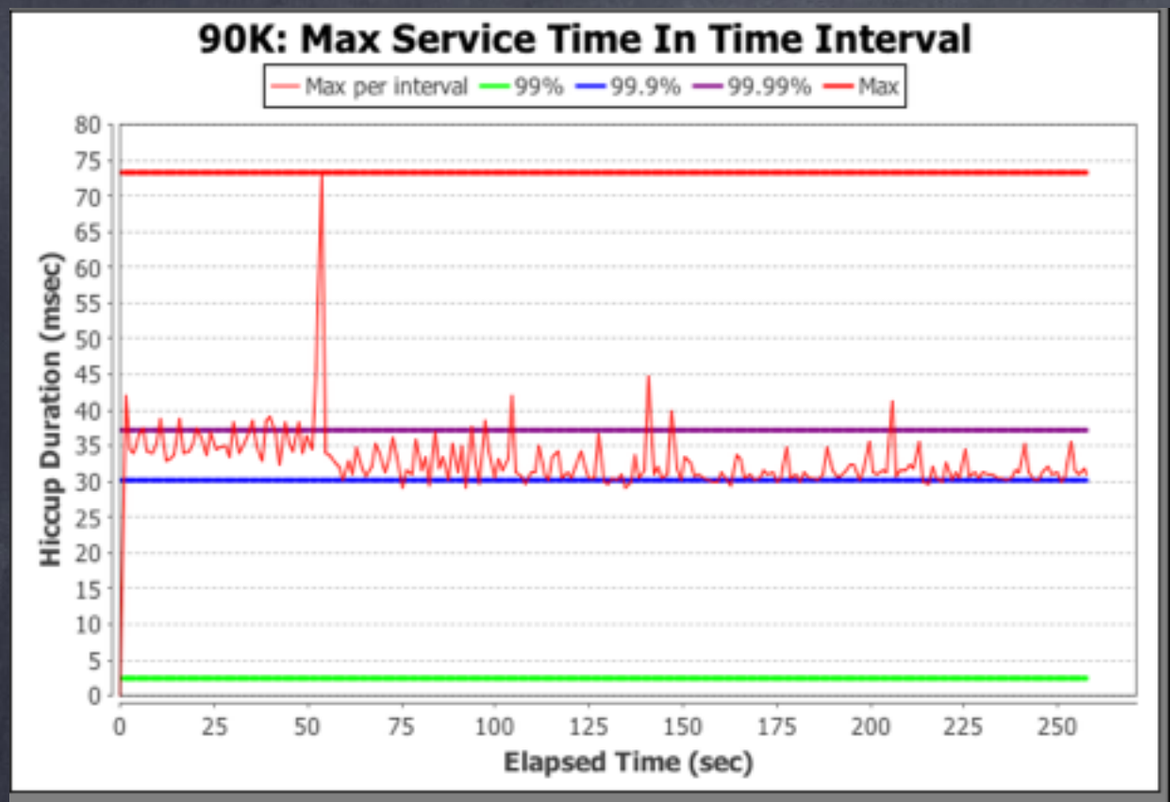
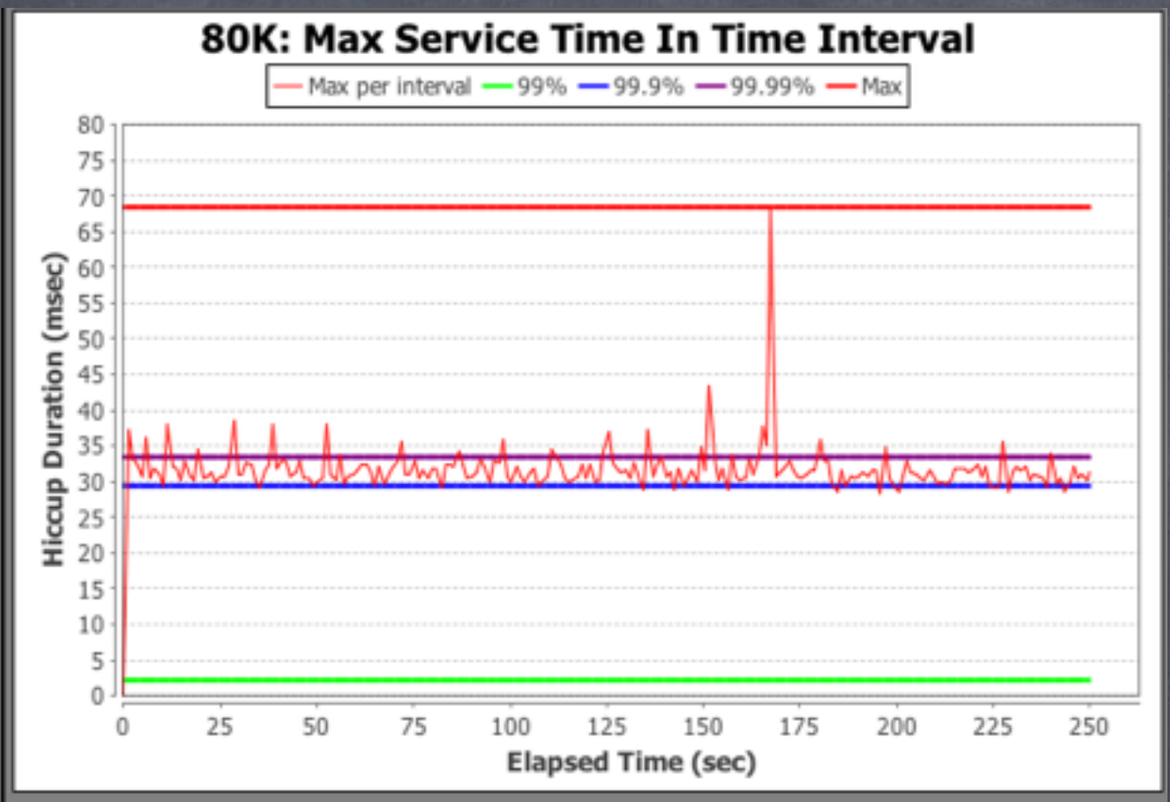
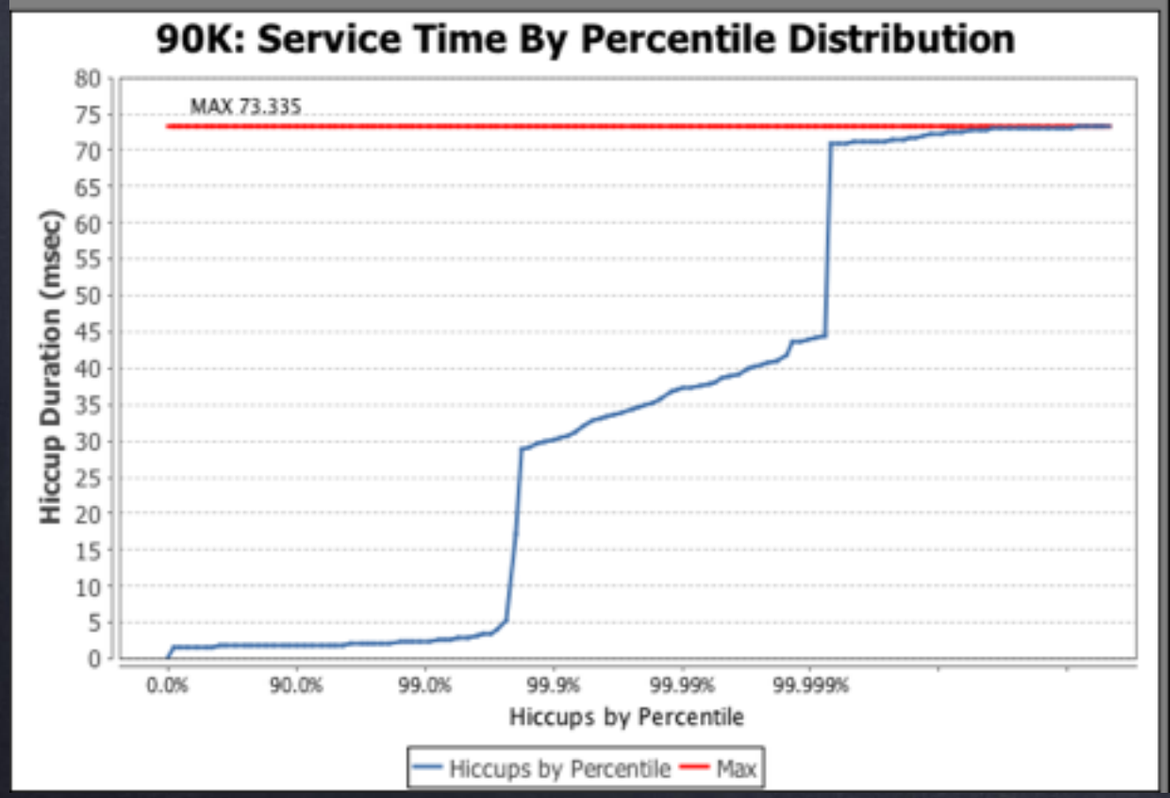
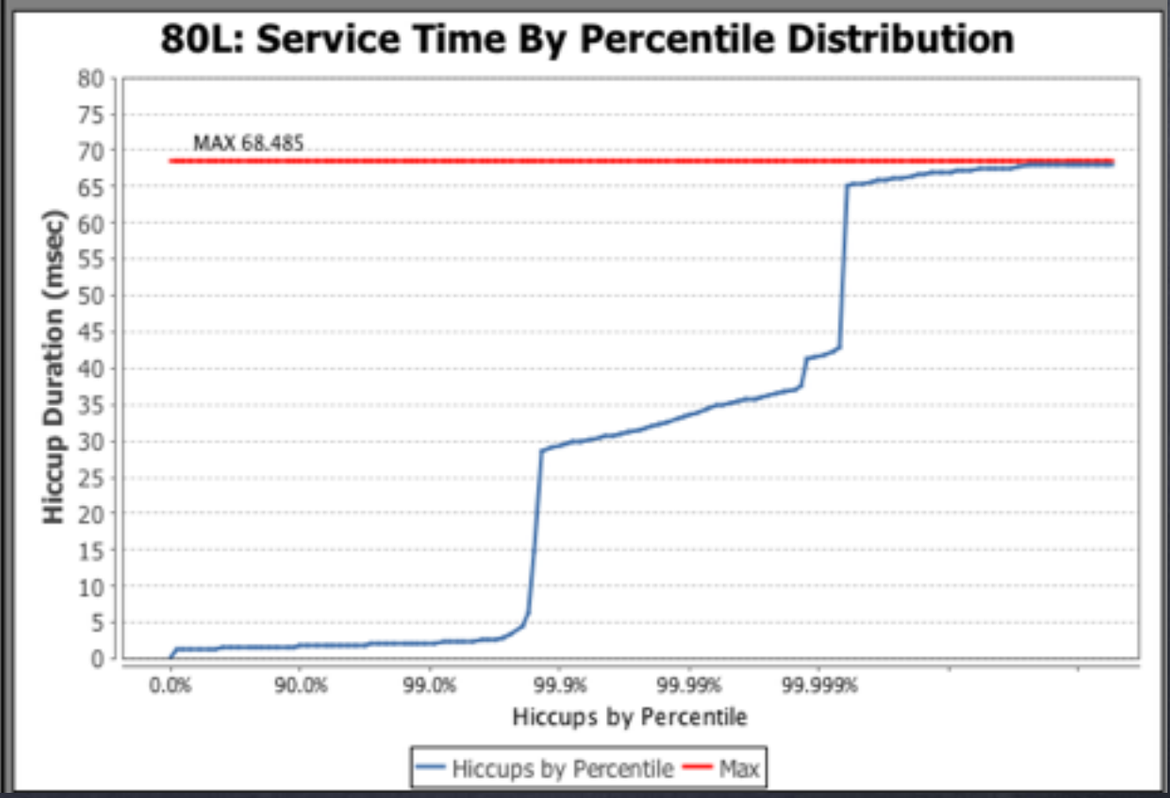
Service Time, 90K/s vs 80K/s









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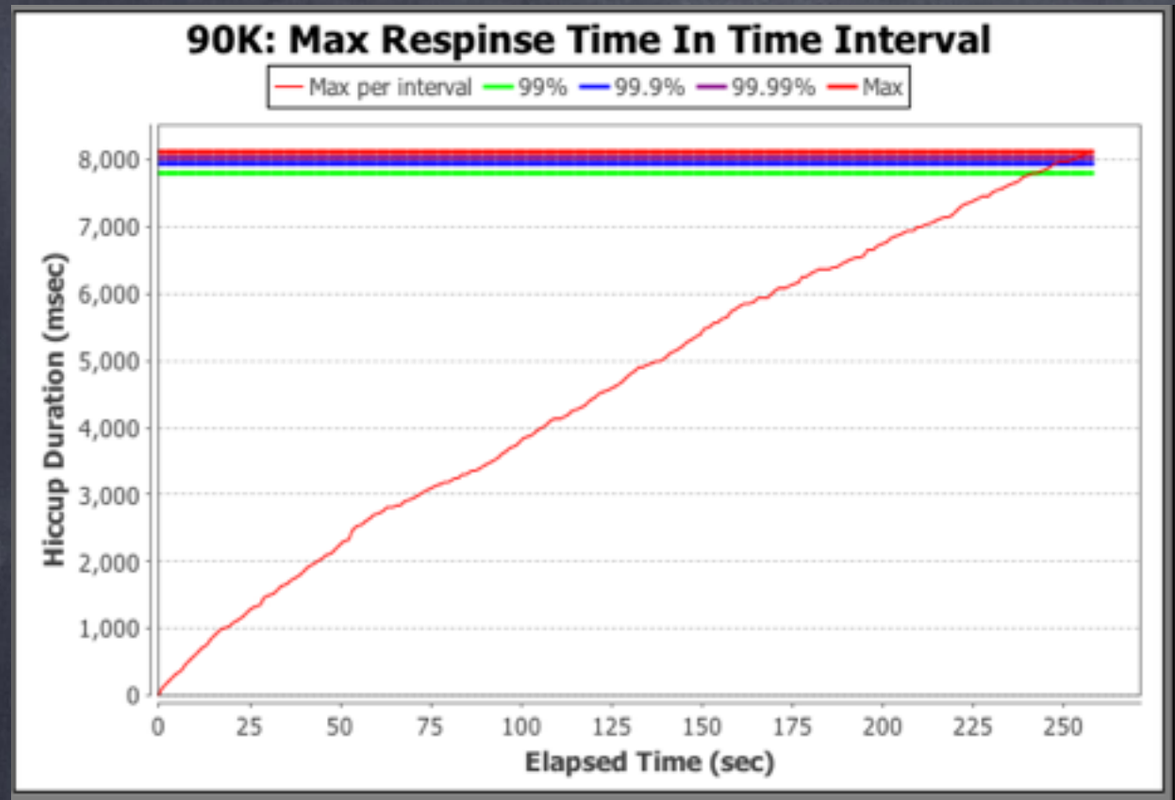
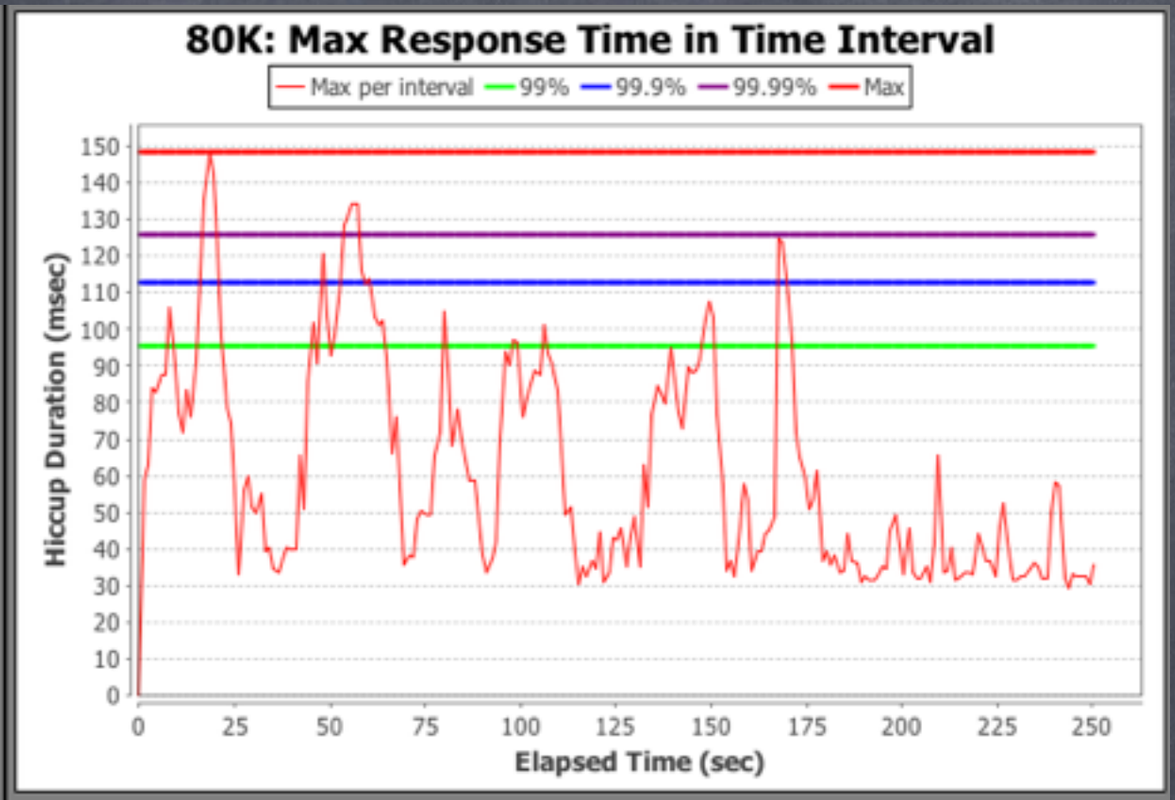
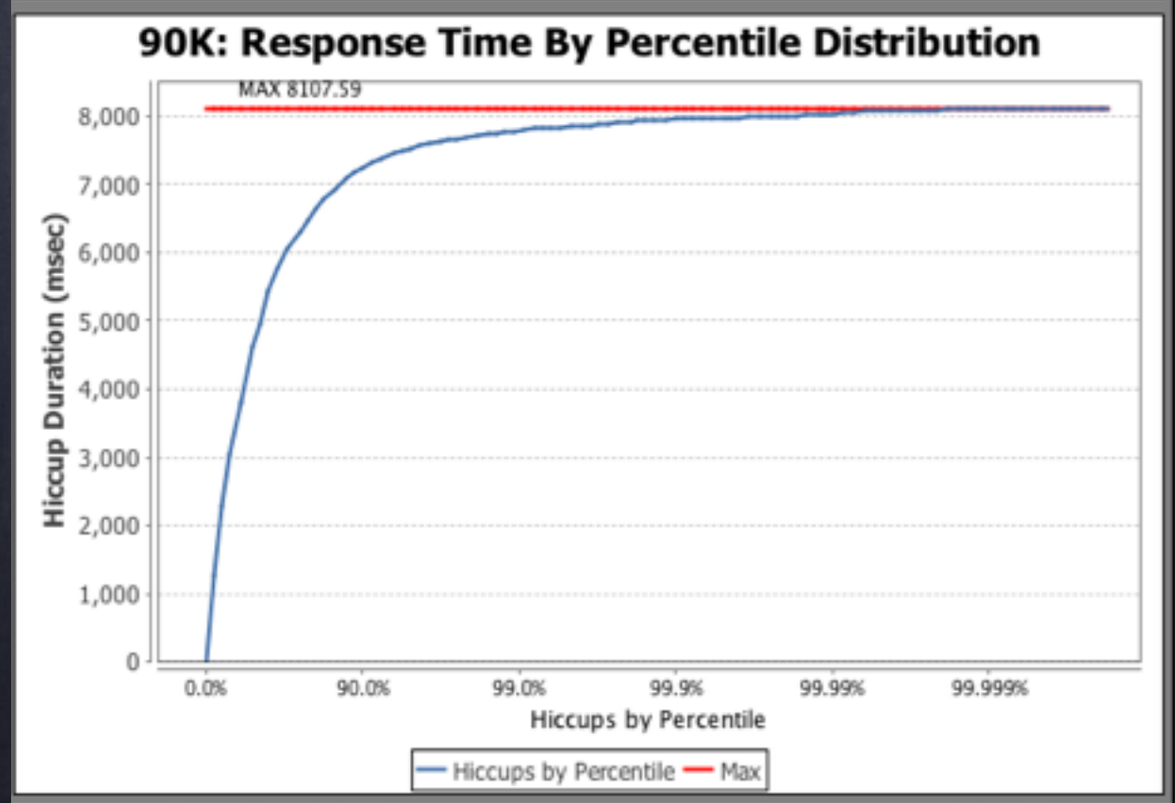
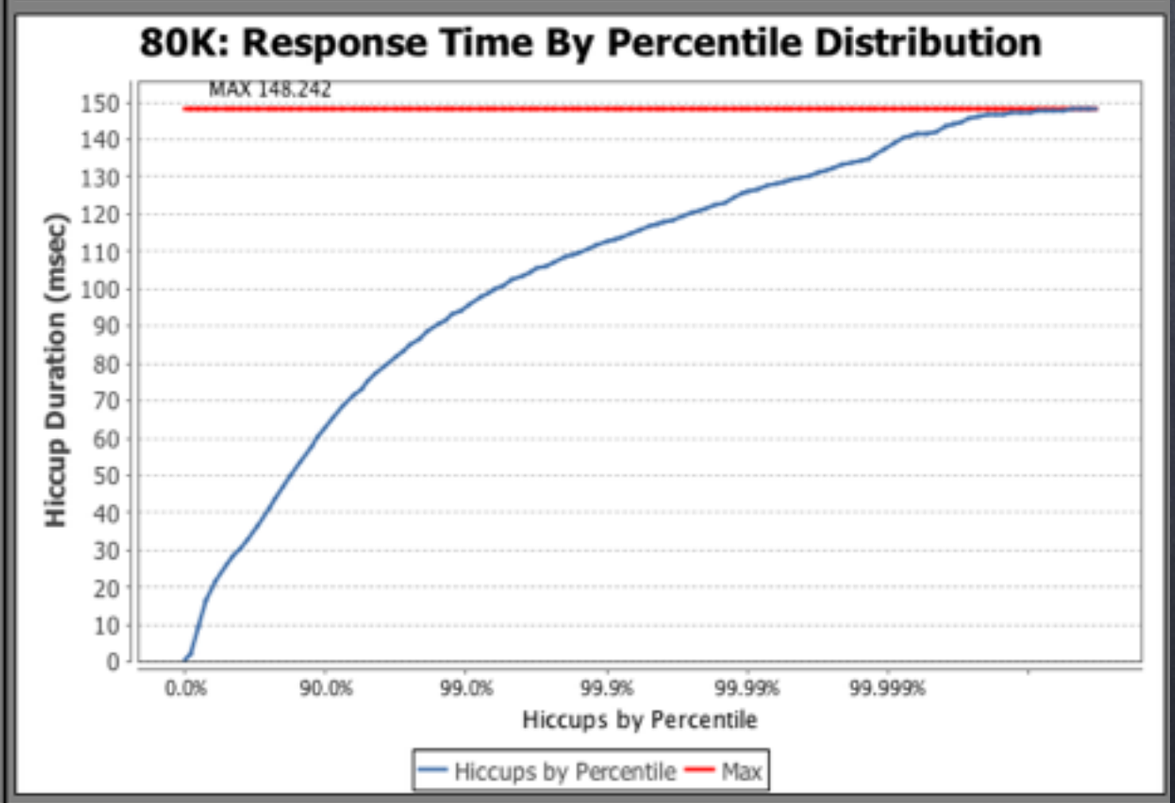
Response Time, 90K/s vs 80K/s









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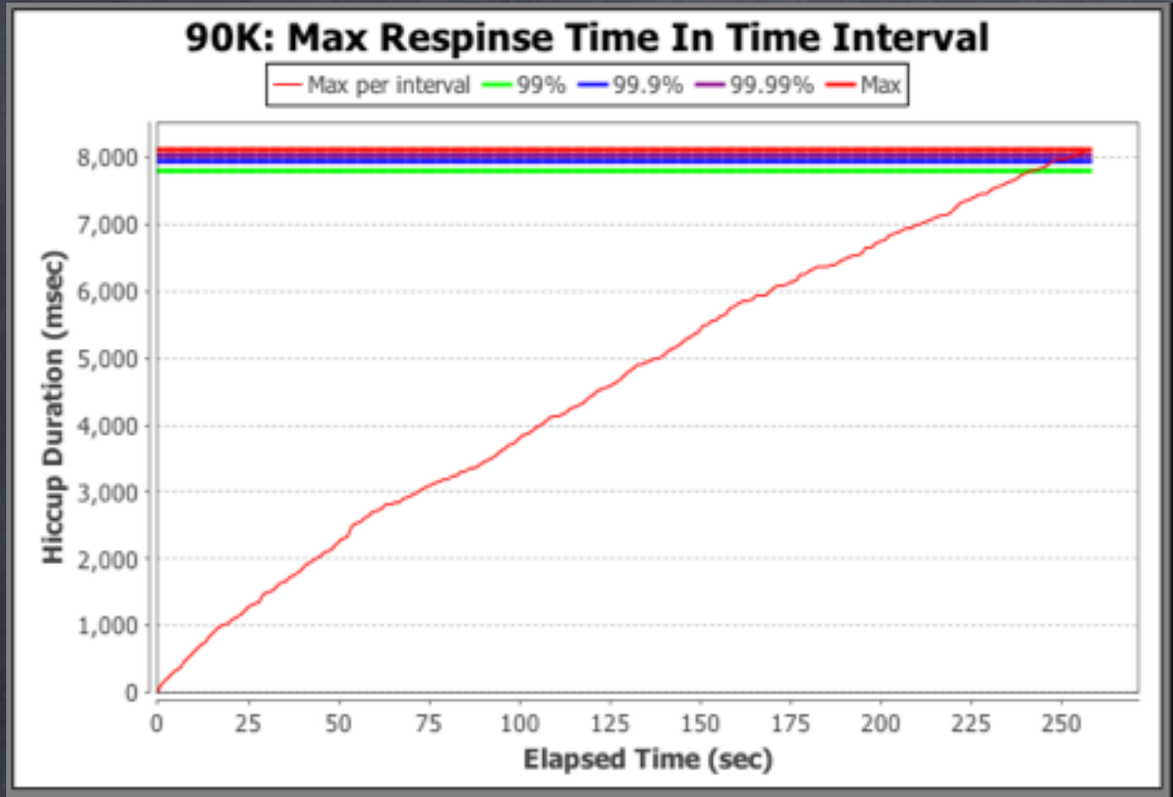
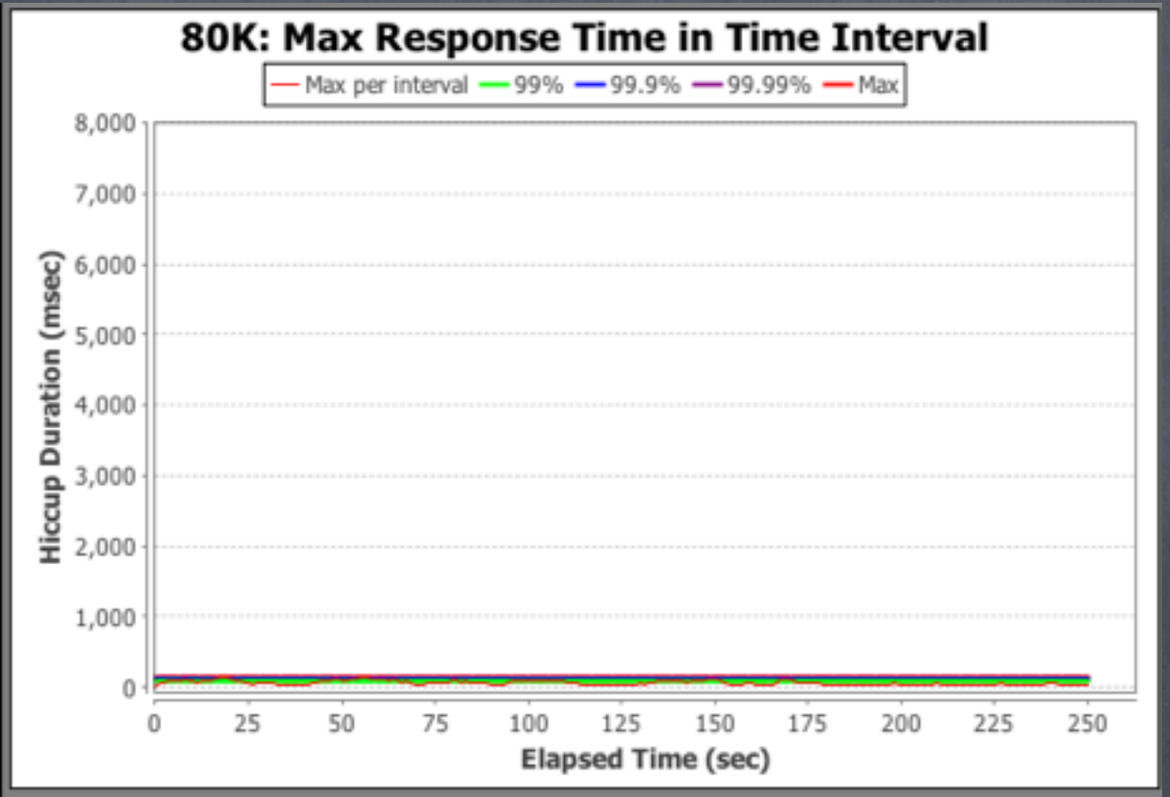
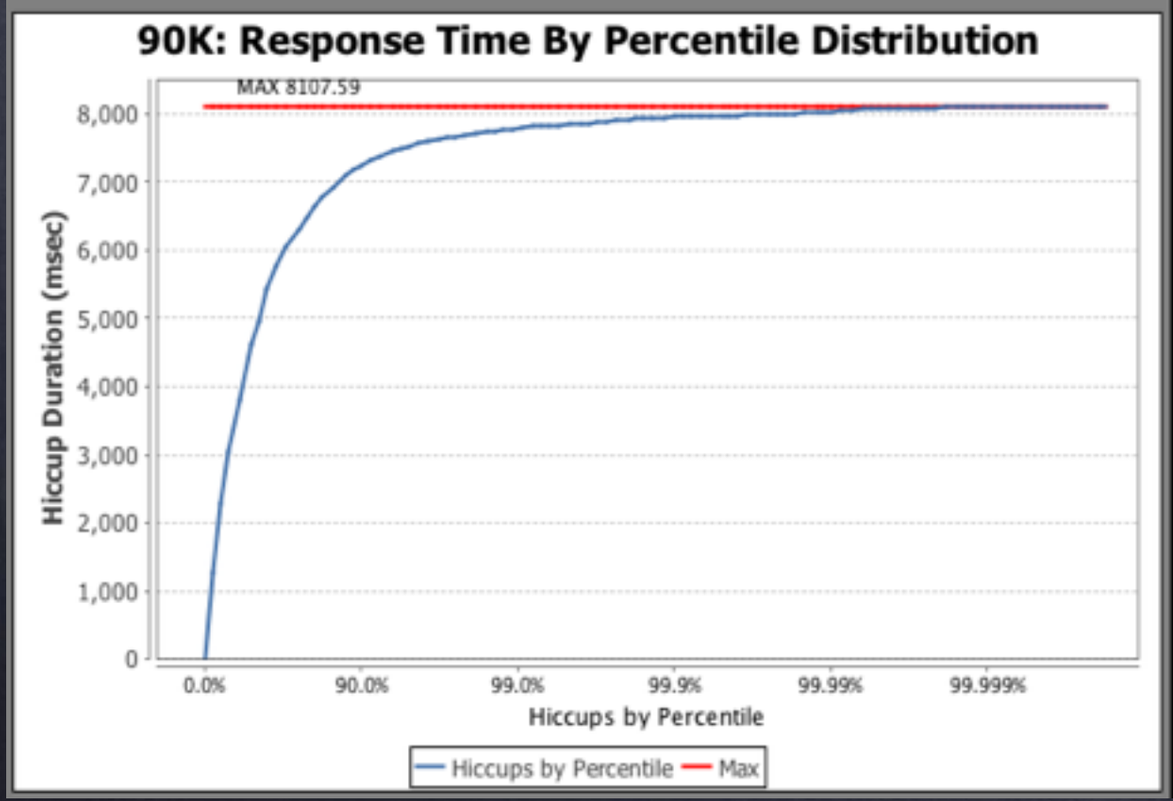
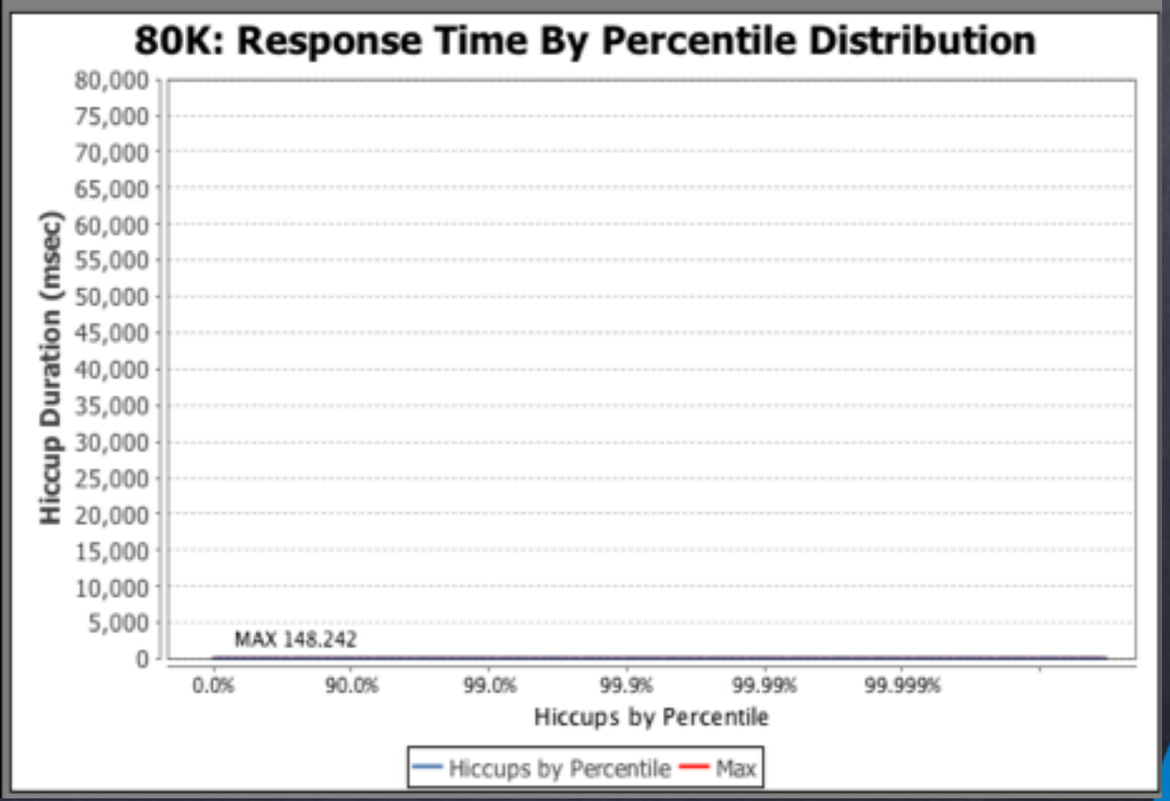
Response Time, 90K/s vs 80K/s (to scale)









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Latency doesn’t live in a vacuum

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Sustainable Throughput:
The throughput achieved while safely maintaining service levels

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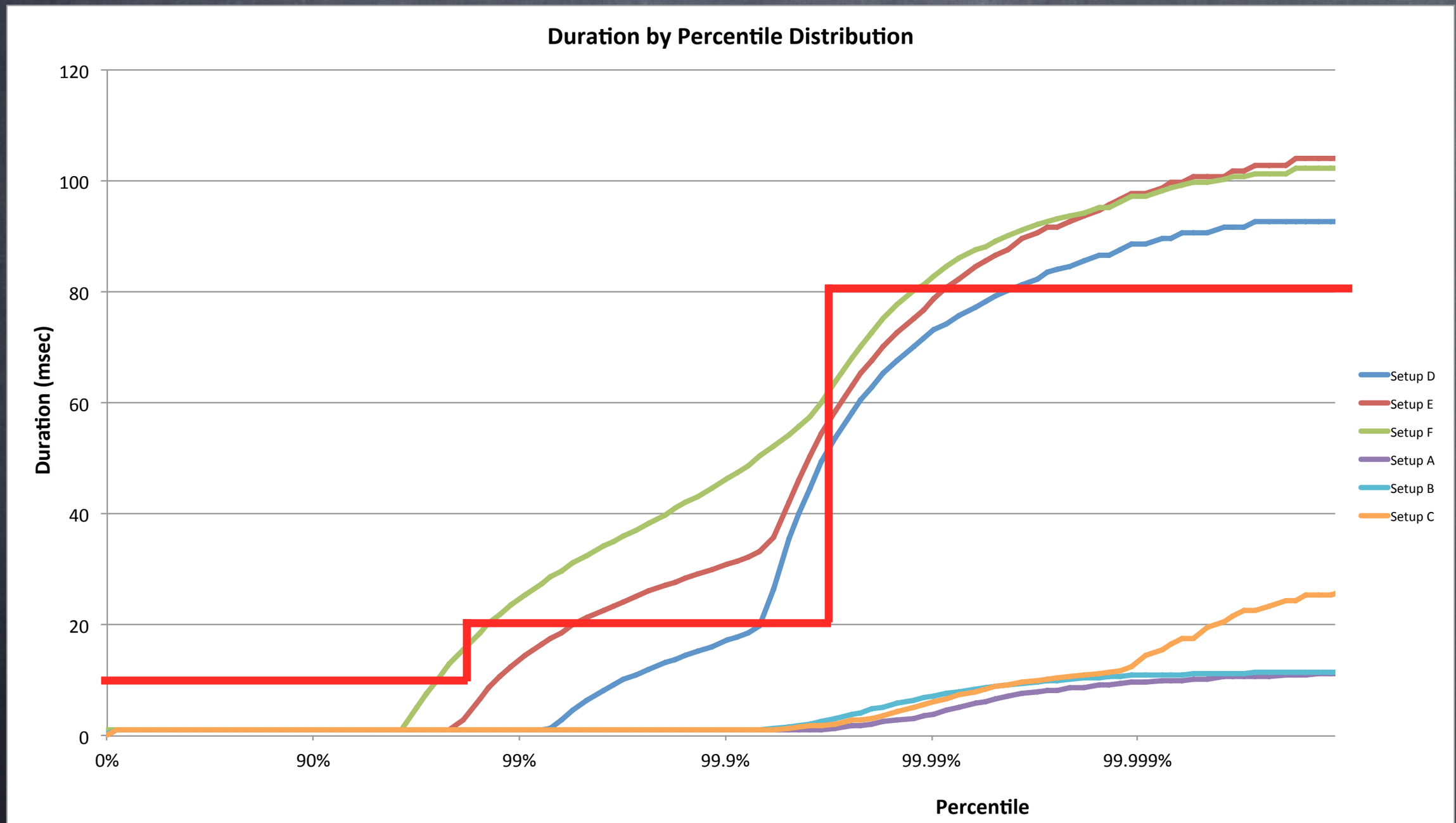
Comparing behavior under different throughputs and/or configurations



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Comparing response time or latency behaviors

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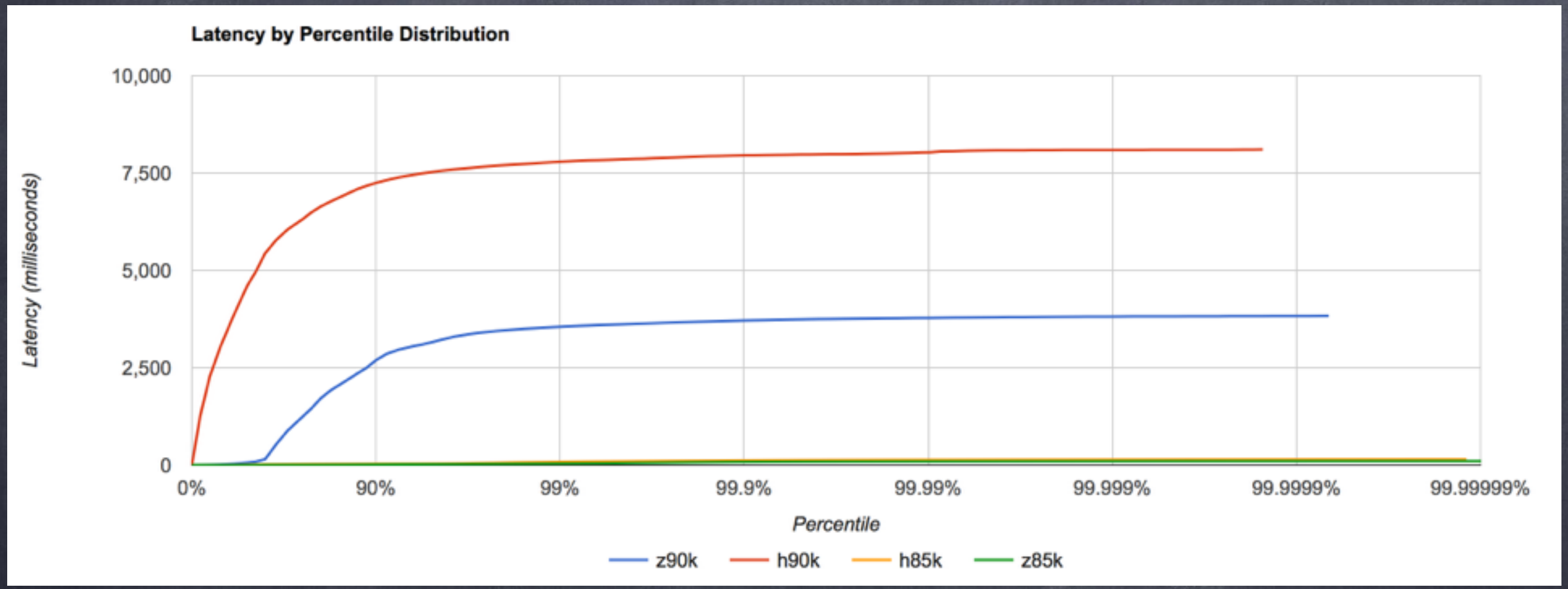
System A @90K/s & 85K/s vs. System B @90K/s & 85K/s



Wrong Place to Look: They both "suck" at >85K/sec

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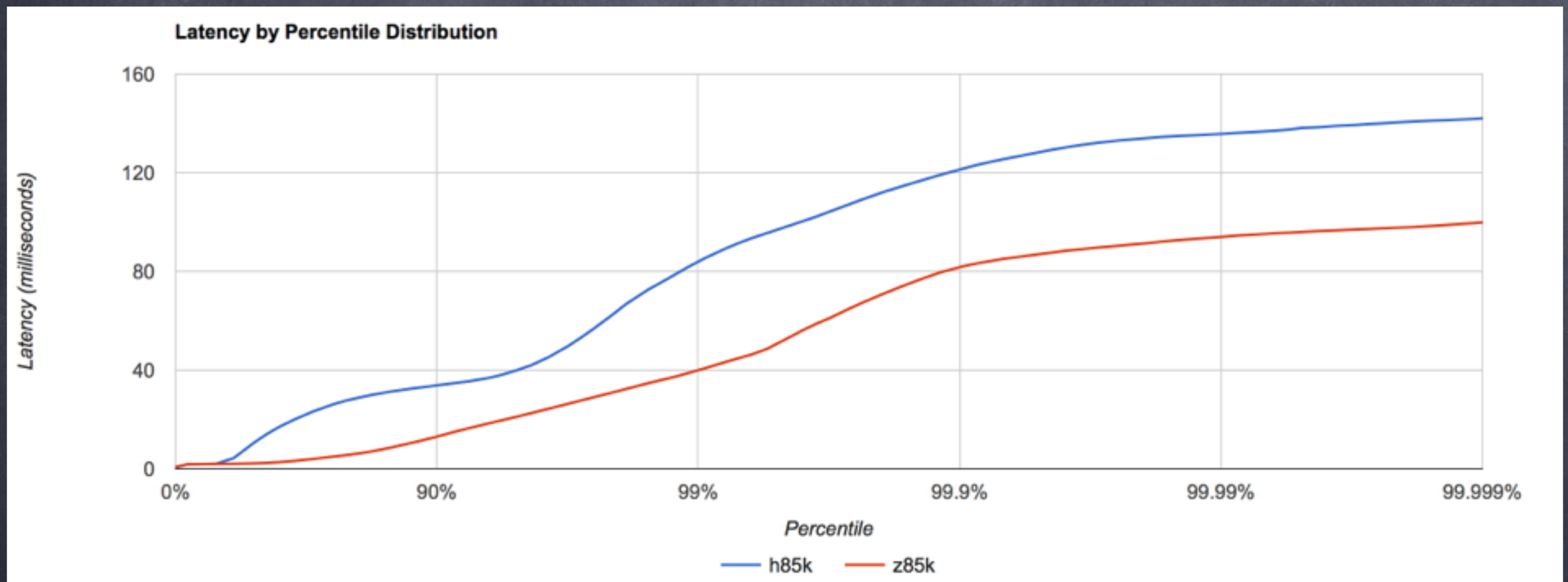
System A 85K/s vs. System B 85K/s



Looks good, but still
the wrong place to look

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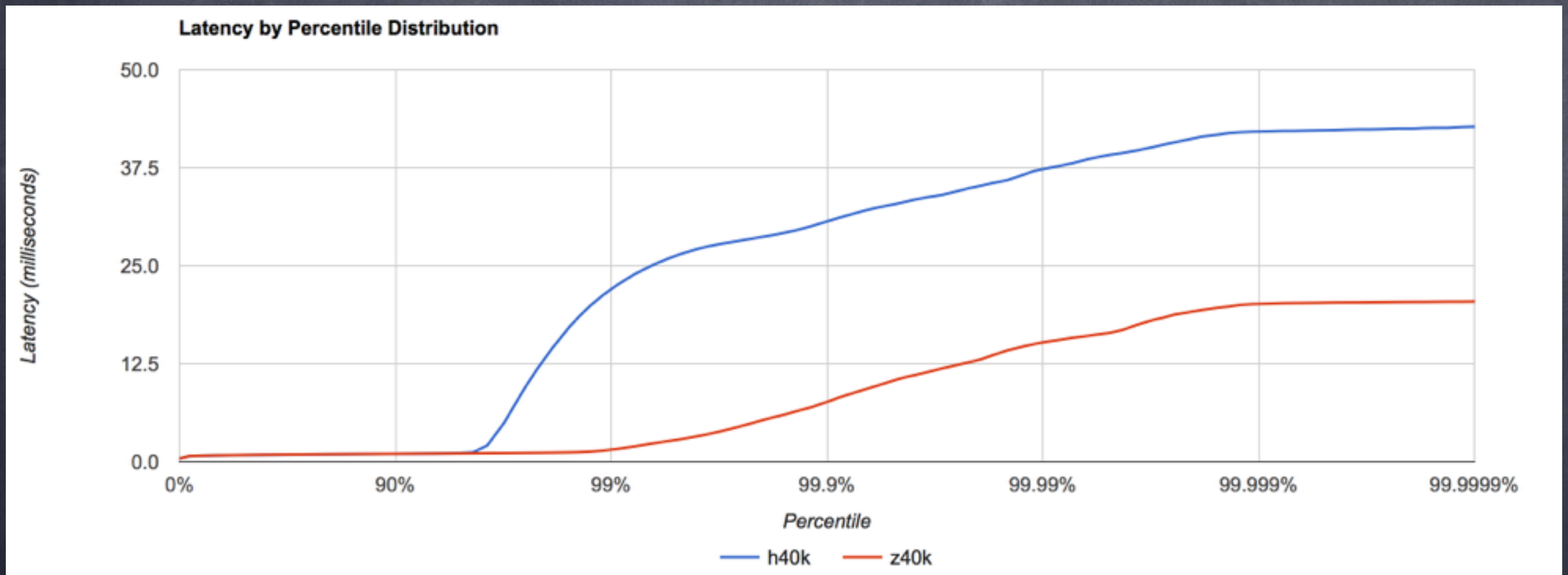
System A @40K/s vs. System B @40K/s



More interesting…
What can we do with this?

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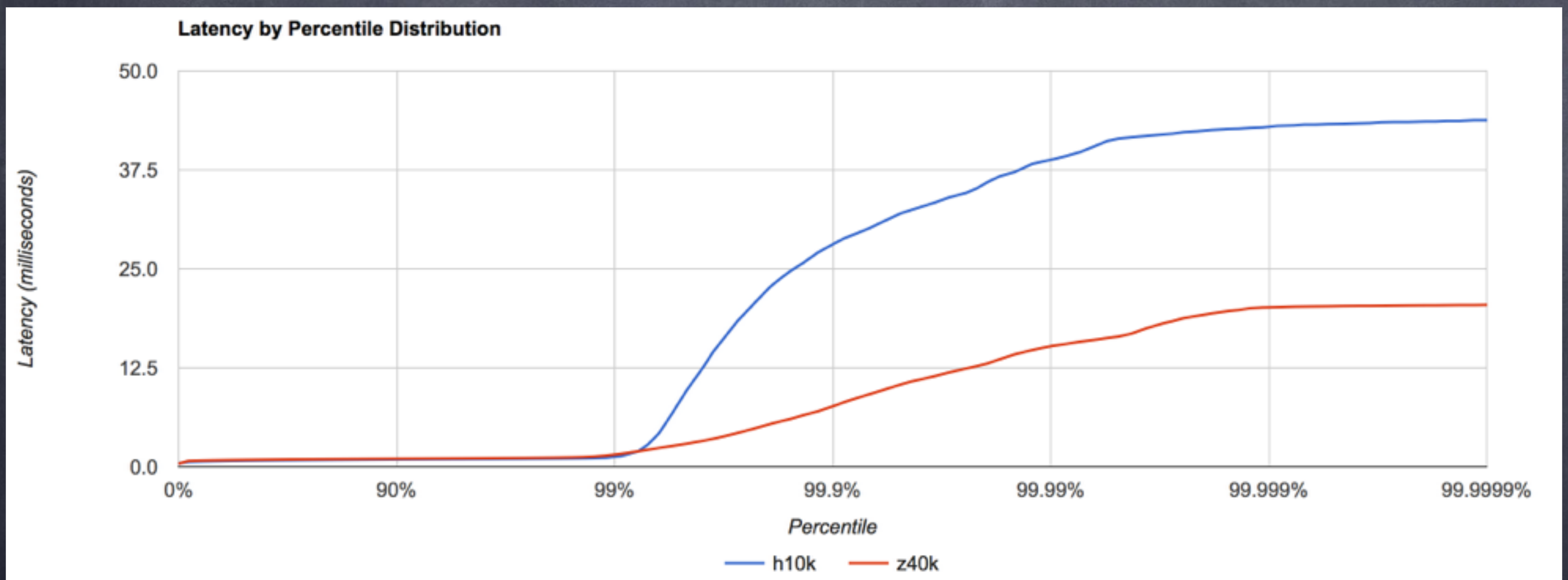
System A @10K/s vs. System B @40K/s



E.g. if “99%’ile < 5msec” was a goal:
System B delivers similar 99%’ile and superior 99.9%’ile+ while carrying 4x the throughput

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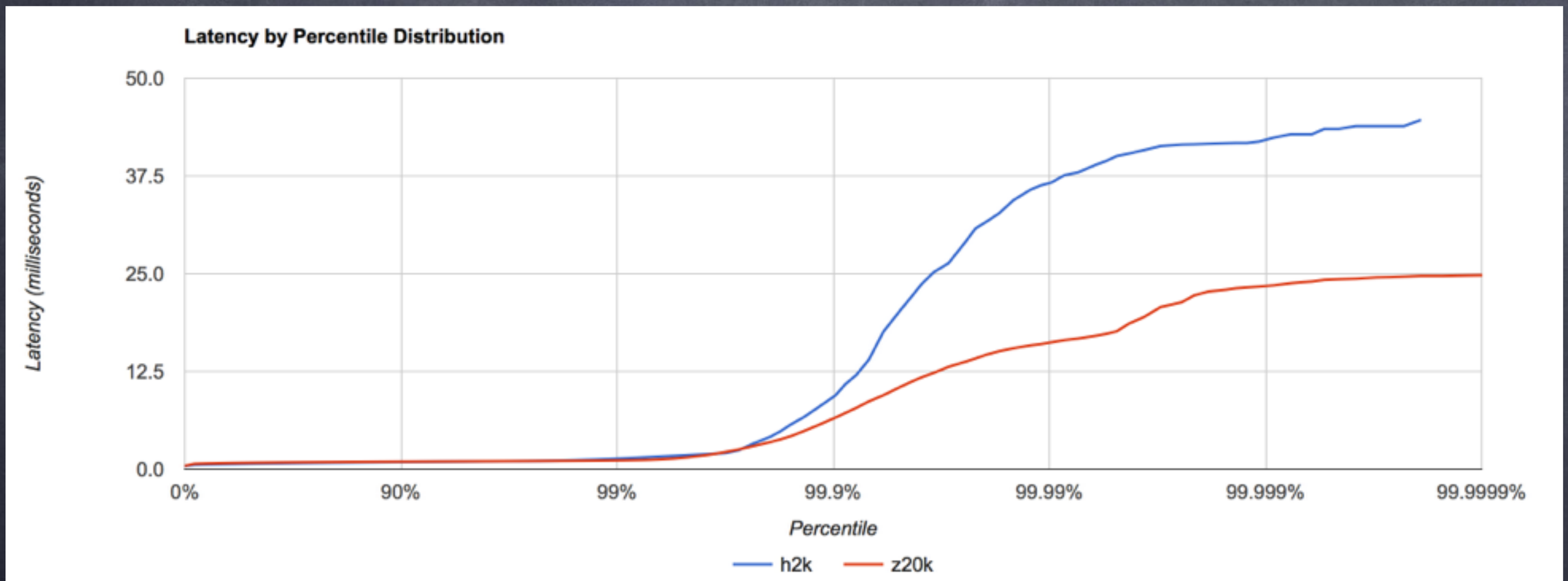
System A @2K/s vs. System B @20K/s



E.g. if “99.9%’ile < 10msec” was a goal:
System B delivers similar 99%’ile and 99.9%’ile
while carrying 10x the throughput

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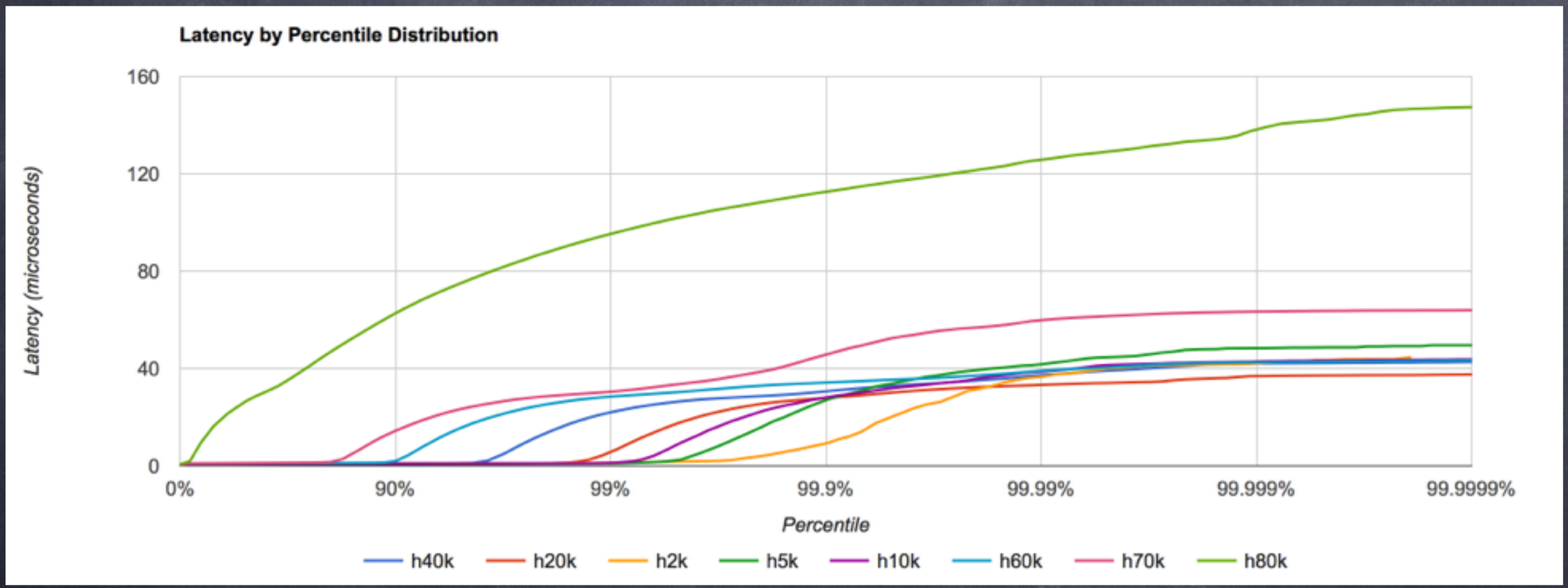
System A @2k thru 80k



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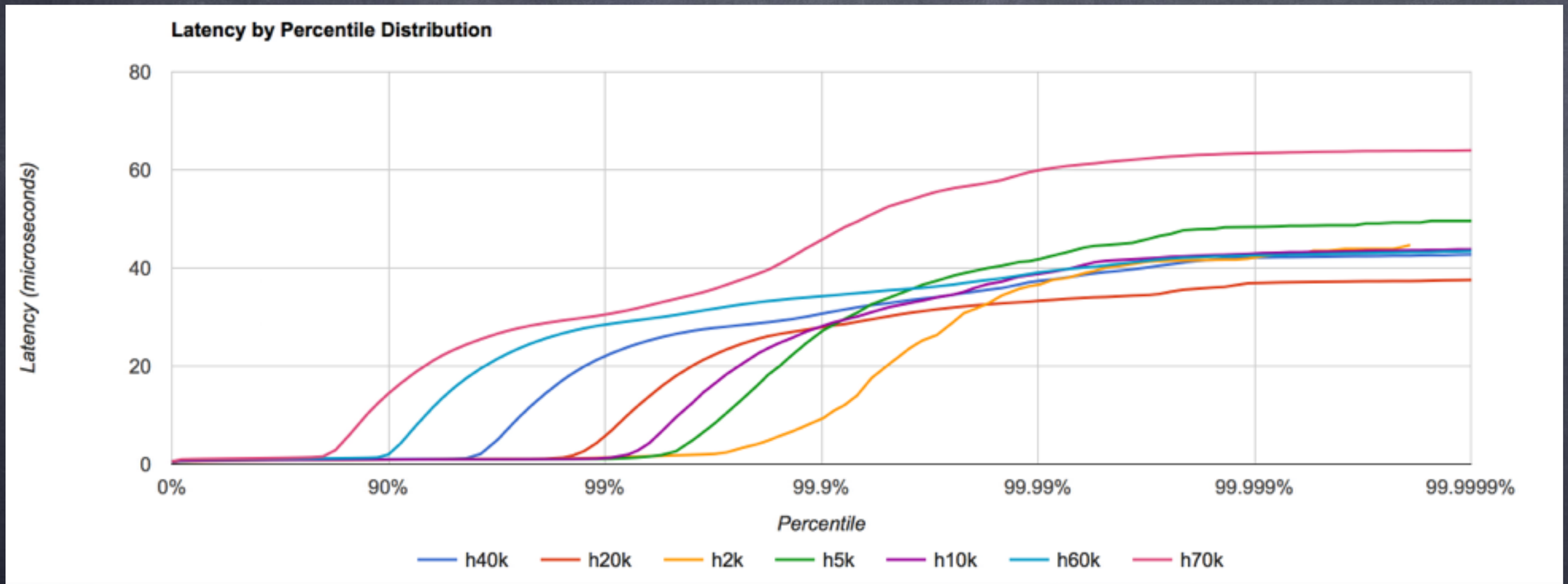
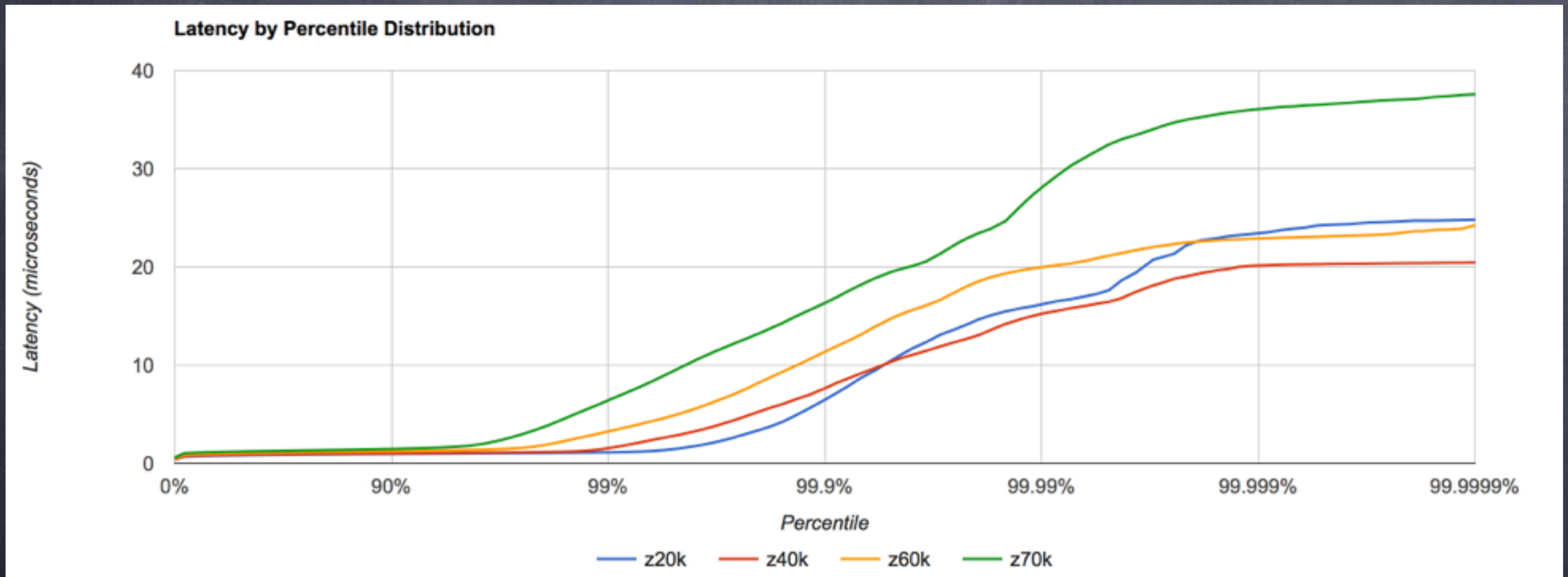
System A @2k thru 70k



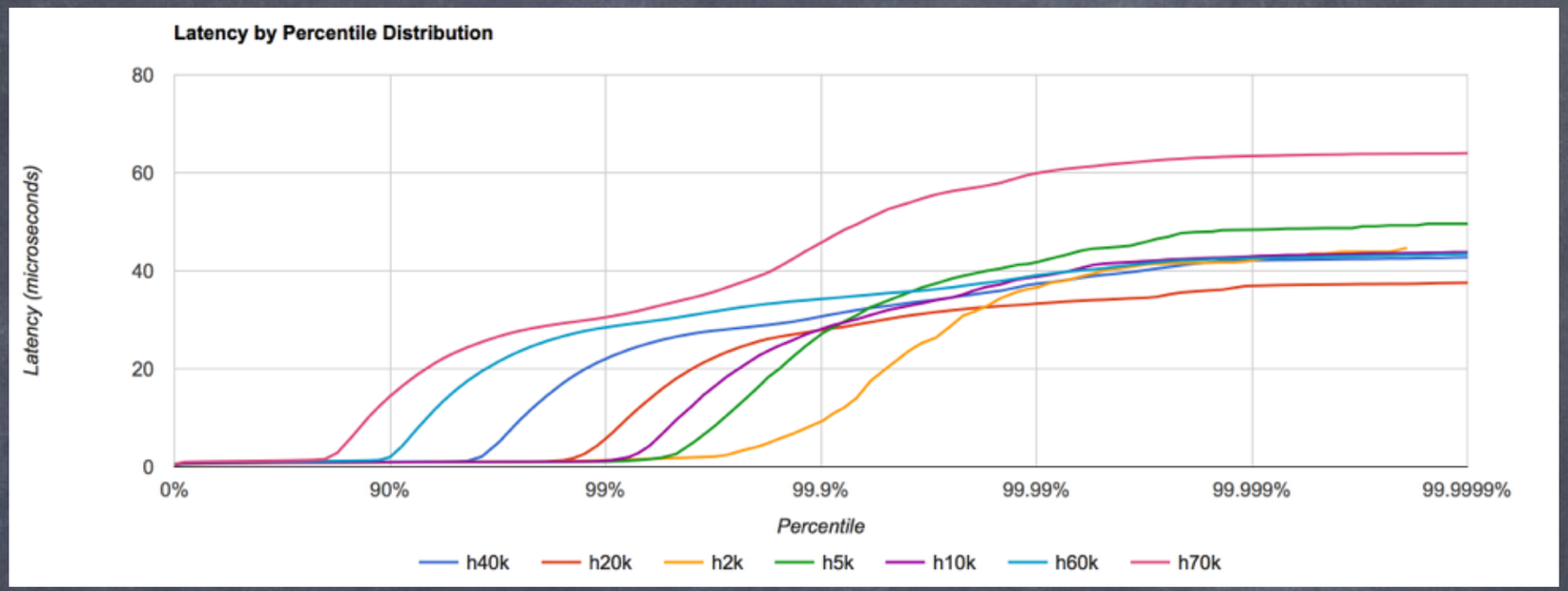
AZUL SYSTEMS

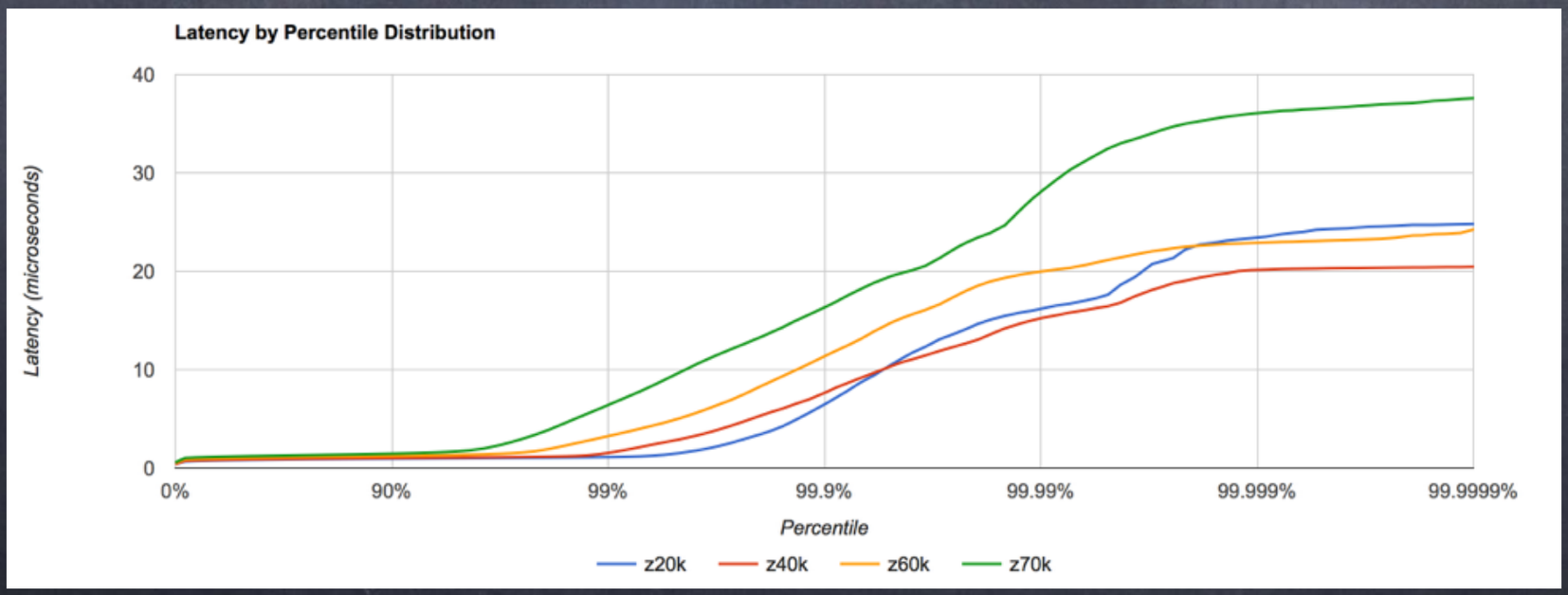
System B @20k thru 70k



AZUL SYSTEMS

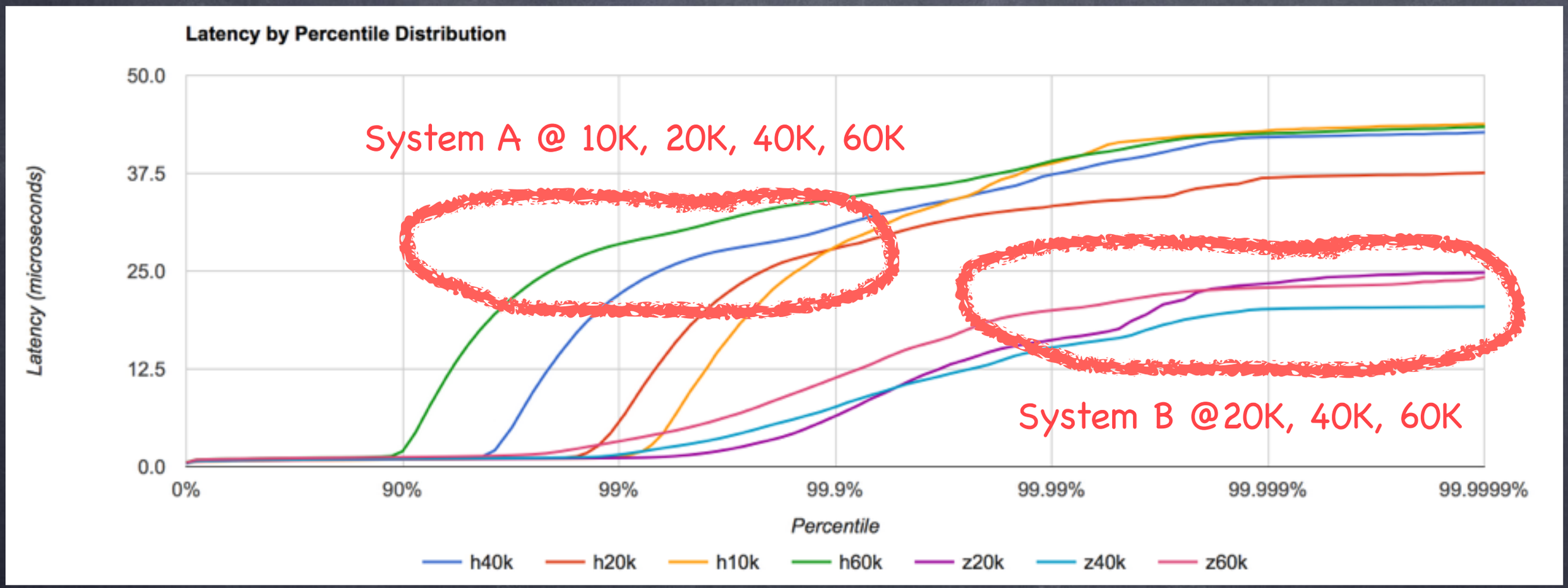
System A & System B @2k thru 70k





AZUL SYSTEMS

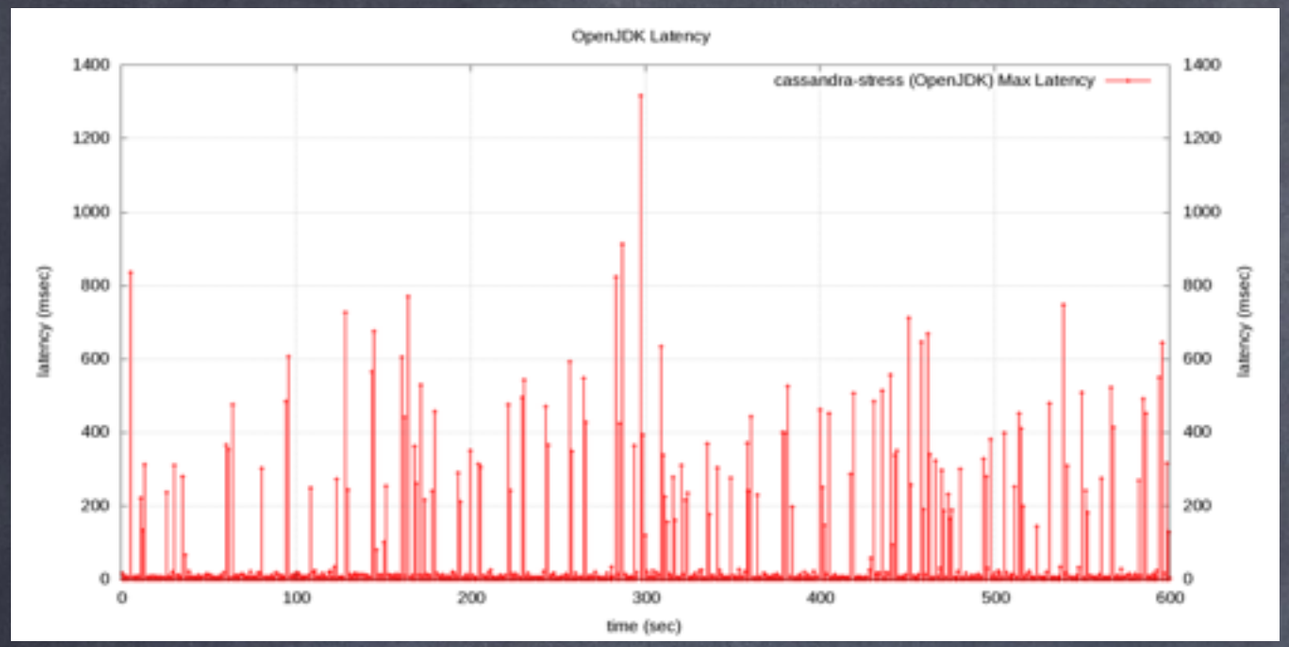
System A & System B
10K/s thru 60K/s



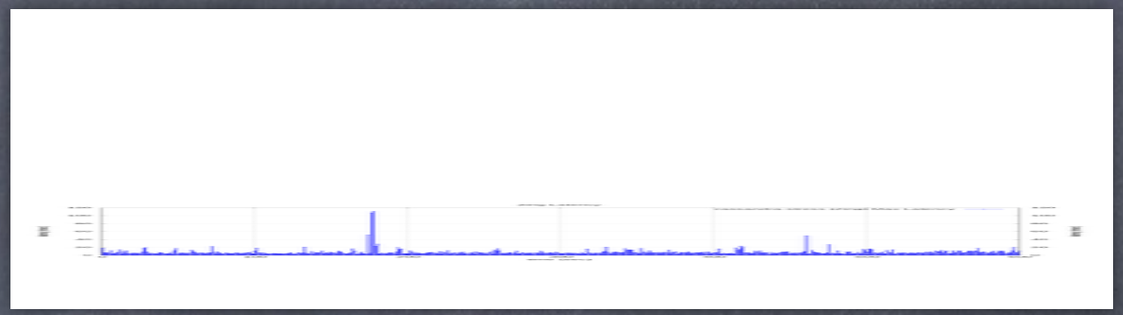
Lots of conclusions can be drawn from the above…
E.g. System B delivers a consistent 100x reduction in the rate of occurrence of >20msec response times

AZUL SYSTEMS

System A: 200-1400 msec stalls



System B drawn to scale



```
op rate                   : 40001
partition rate            : 26996
row rate                  : 26996
latency mean              : 30.6 (0.7)
latency median            : 0.5 (0.5)
latency 95th percentile   : 244.4 (1.1)
latency 99th percentile   : 537.4 (2.0)
latency 99.9th percentile : 1052.2 (8.4)
latency max               : 1314.9 (1312.8)
```

Response Time Service time

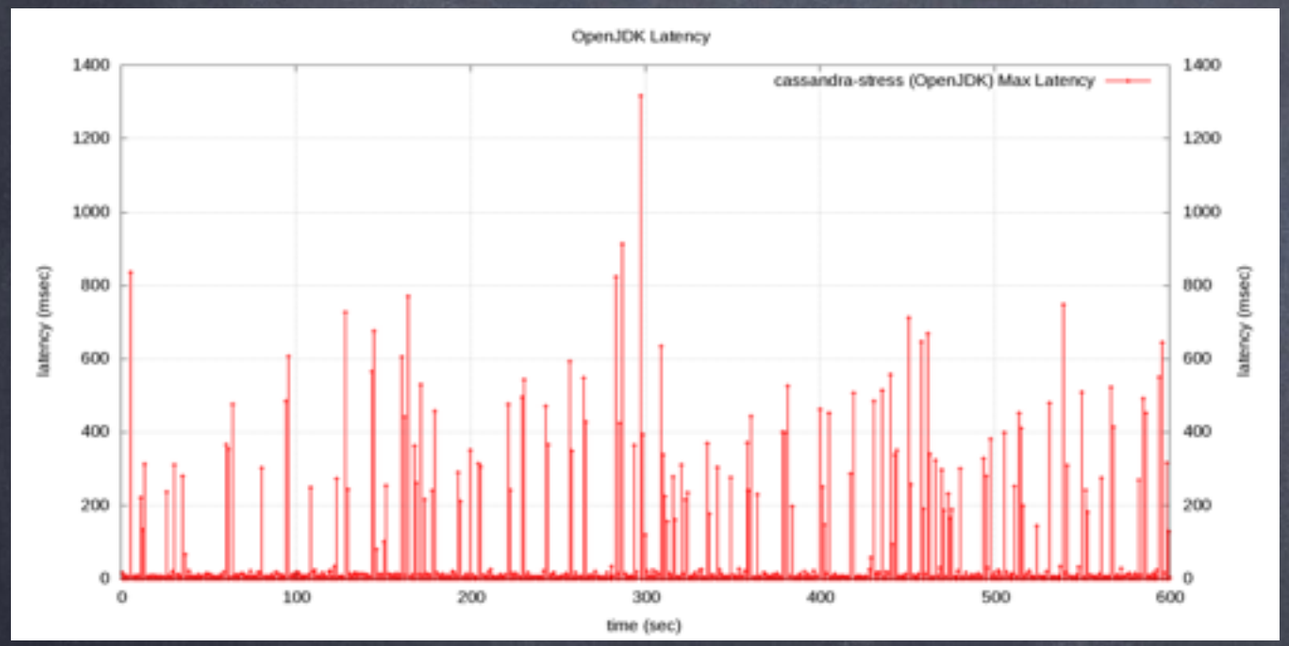
```
op rate                   : 40001
partition rate            : 26961
row rate                  : 26961
latency mean              : 0.6 (0.5)
latency median            : 0.5 (0.5)
latency 95th percentile   : 1.0 (0.9)
latency 99th percentile   : 2.7 (1.9)
latency 99.9th percentile : 13.3 (3.8)
latency max               : 110.6 (28.2)
```

Response Time Service time

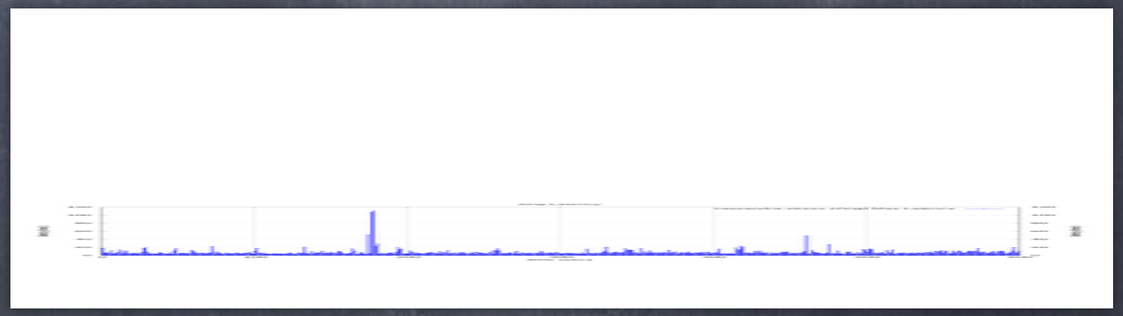
AZUL SYSTEMS

A simple visual summary

This is Your Load on System A



This is Your Load on System B



Any Questions?

AZUL SYSTEMS