Understanding Application Hiccups

and what you can do about them

An introduction to the Open Source jHiccup tool

Gil Tene, CTO & co-Founder, Azul Systems

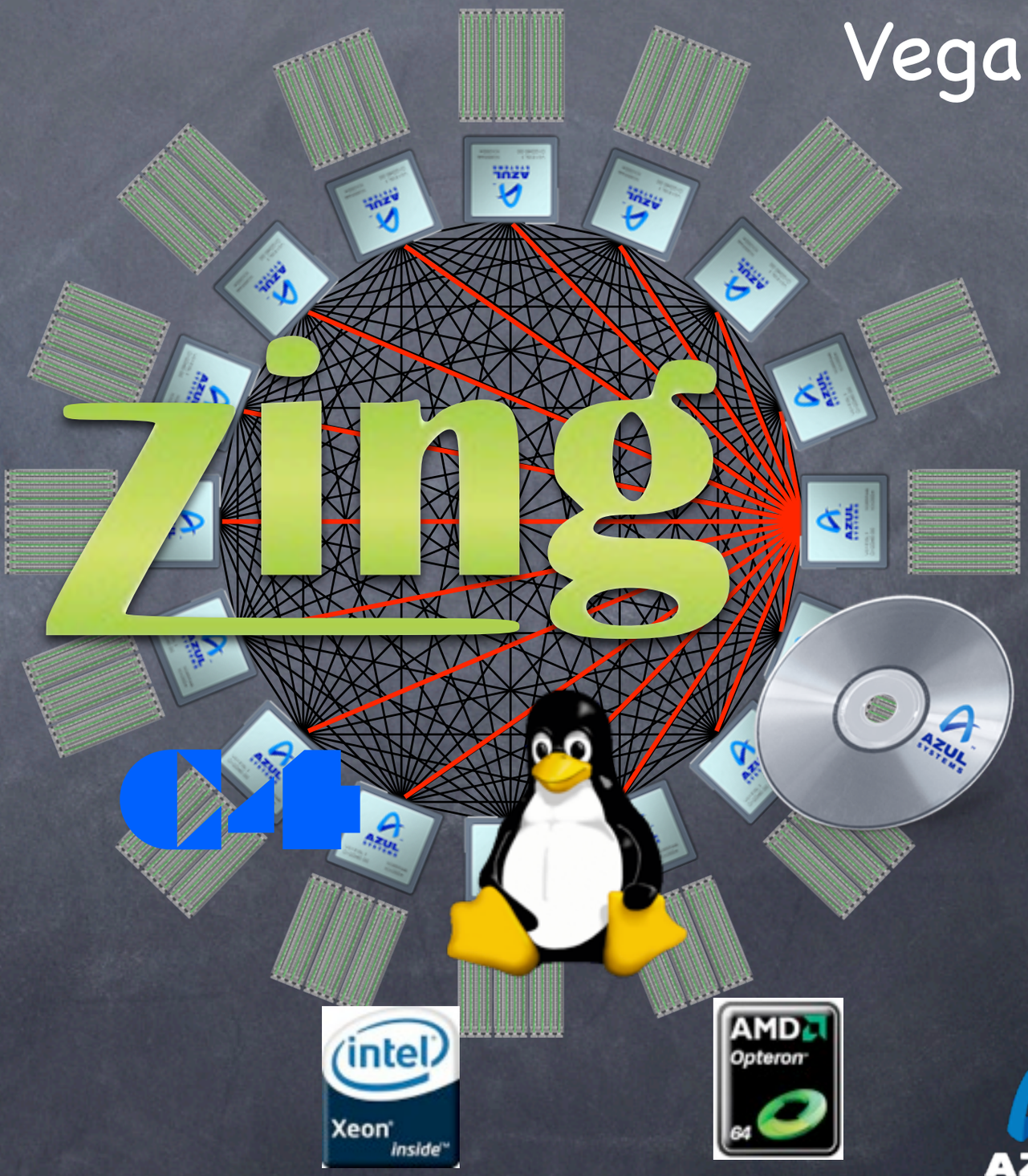
About me: Gil Tene

- co-founder, CTO @Azul Systems
- Have been working on "think different" GC approaches since 2002
- Created Pauseless & C4 core GC algorithms (Tene, Wolf)
- A Long history building Virtual & Physical Machines, Operating Systems, Enterprise apps, etc...

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

About Azul

- We make scalable Virtual Machines
- Have built "whatever it takes to get job done" since 2002
- 3 generations of custom SMP Multi-core HW (Vega)
- **Now Pure software for commodity x86 (Zing)**
- "Industry firsts" in Garbage collection, elastic memory, Java virtualization, memory scale



A classic look at response time behavior

Key Assumption: Response time is a function of load

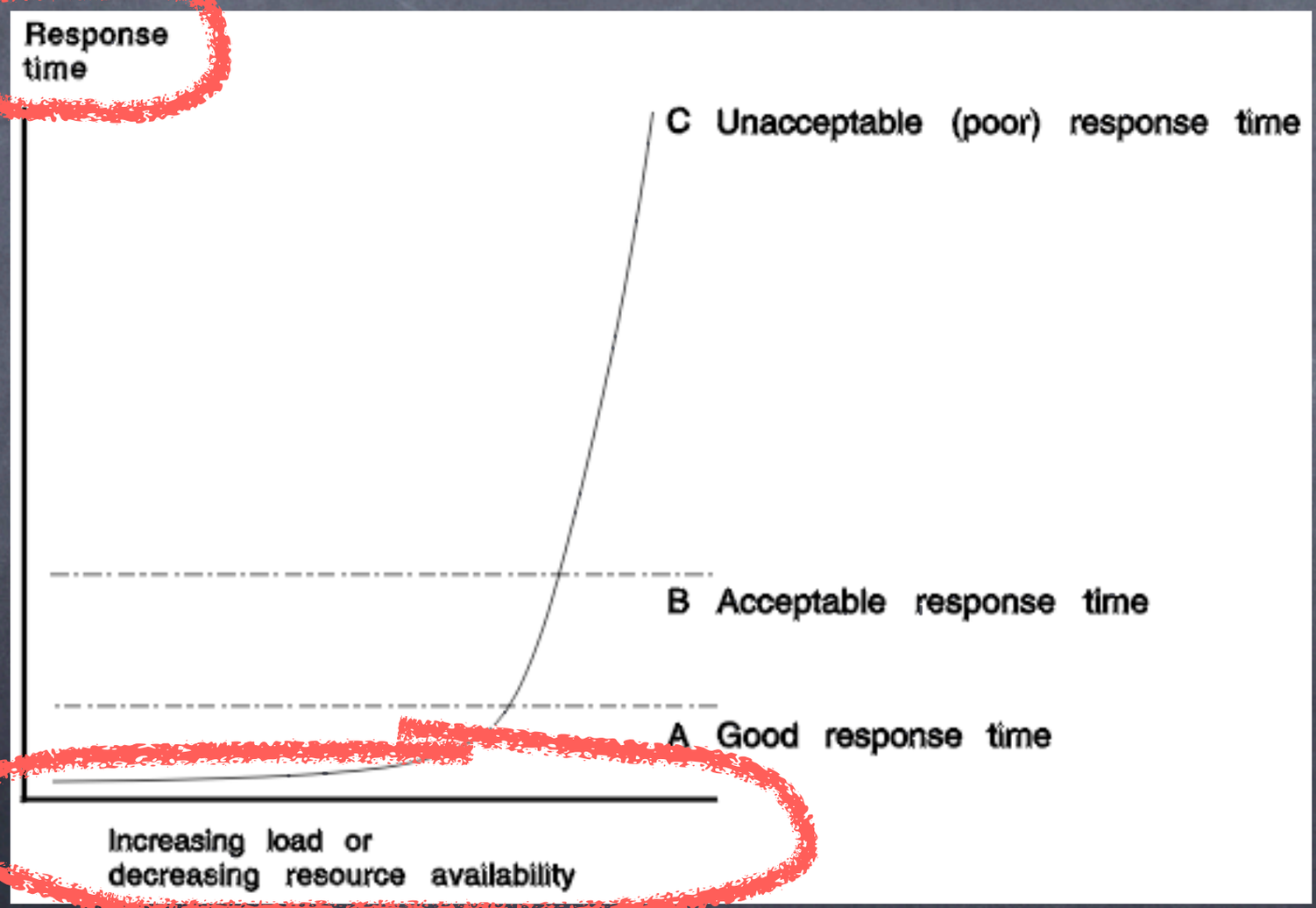
Average?

Max?

Median?

90%?

99.9%



* source: IBM CICS server docuementation, "understanding response times"

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Common fallacies

- Computers run application code continuously
  - CPUs stop processing application code for all sorts of reasons
  - e.g: Interrupts. Scheduling of other work, swapping, etc.
  - Modern system architectures add more: Power management, Virtualization (cross-image context switching, physical VM motion), Garbage Collection, etc.
- Response time can be measured as work units/time.
- Response time exhibits a normal distribution
  - Leading to attempts to represent with average + std. deviation

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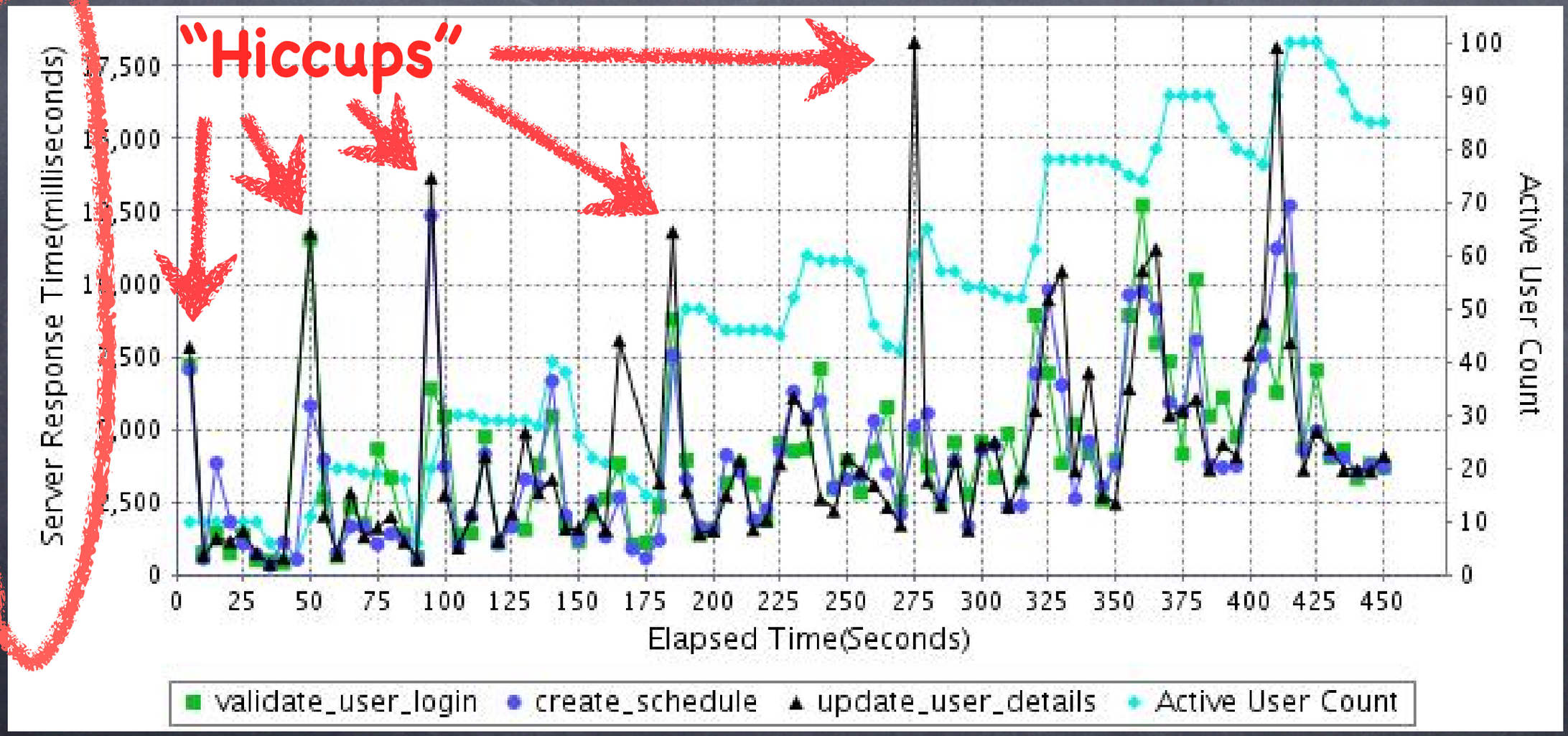
Response time over time

When we measure behavior over time, we often see:



* source: ZOHO QEngine White Paper: performance testing report analysis

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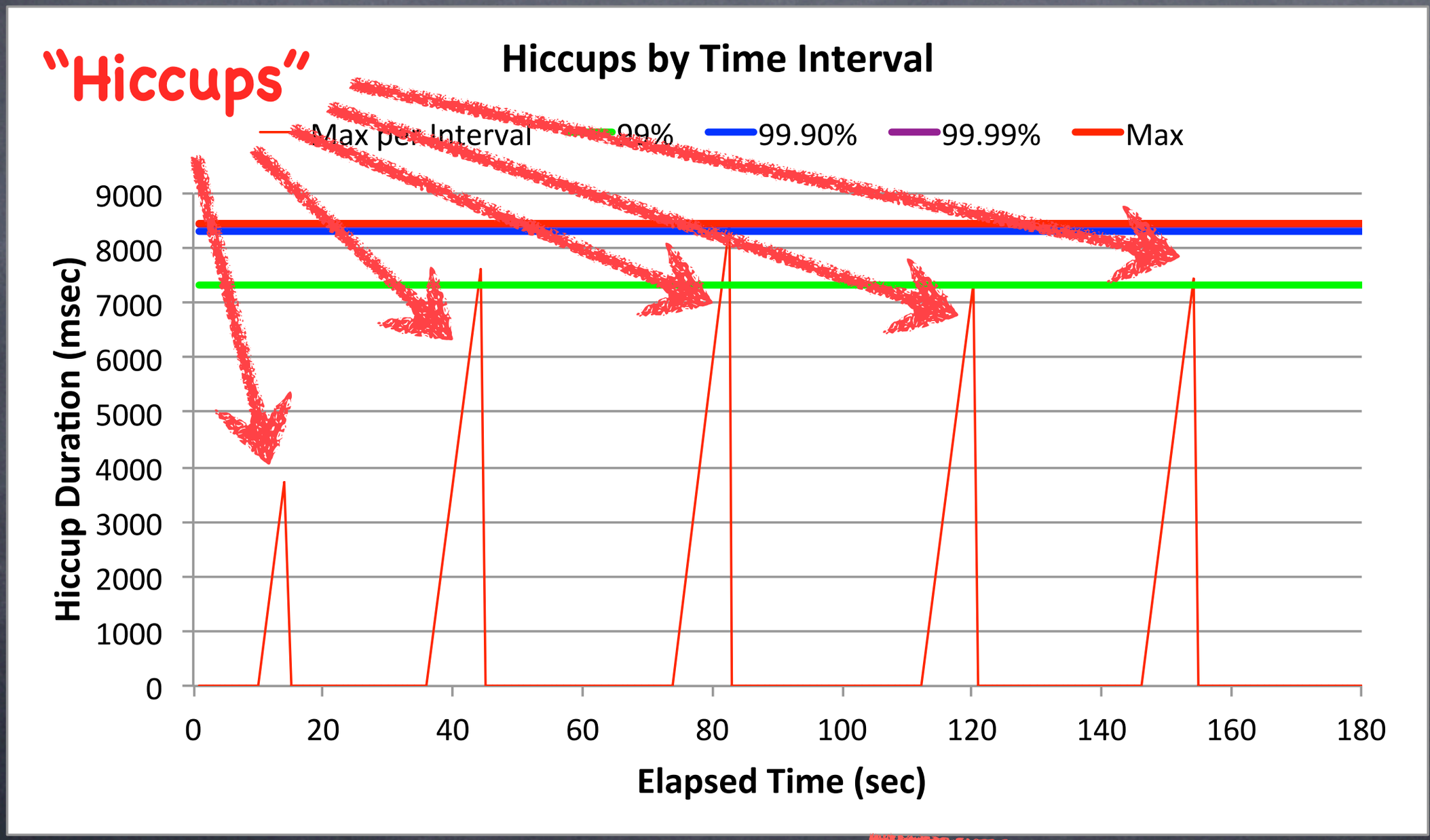
Application Hiccups

- Where do they come from?
  - Usually a factor of outside of the individual transaction work
  - E.g: Queueing, accumulated work, platform inconsistency
- Do they matter?
  - That depends. What are your end-user's expectations?
  - Hiccups often dominate response time behavior
- How can/should we measure them?
  - Average? Max? 99.9%? Mean with Std. deviation?
- Hiccup magnitude is often not a function of load

What happened here?



* Source: Gil running an idle program and suspending it five times in the middle

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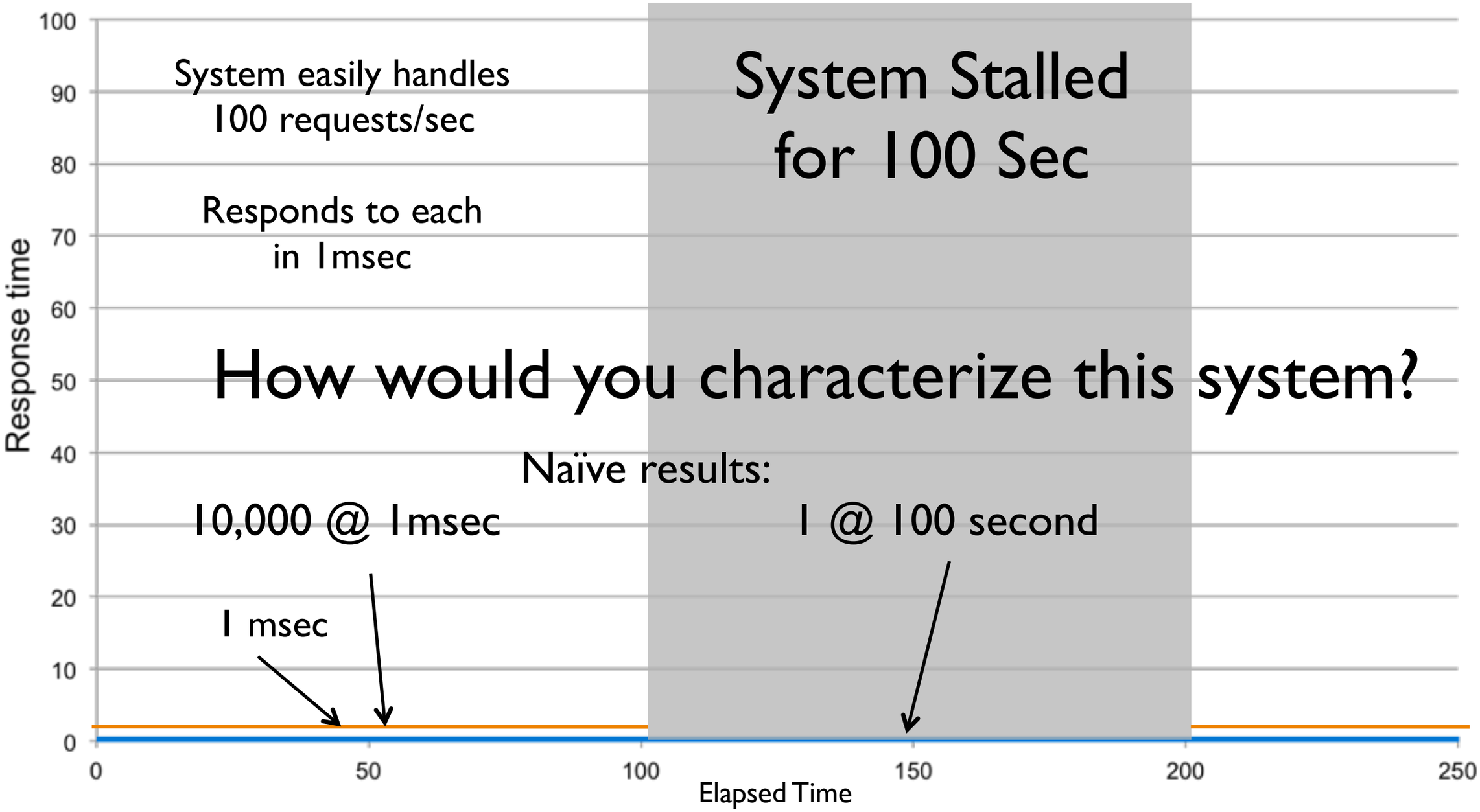
Pitfall: Calulating %'iles "naïvely"

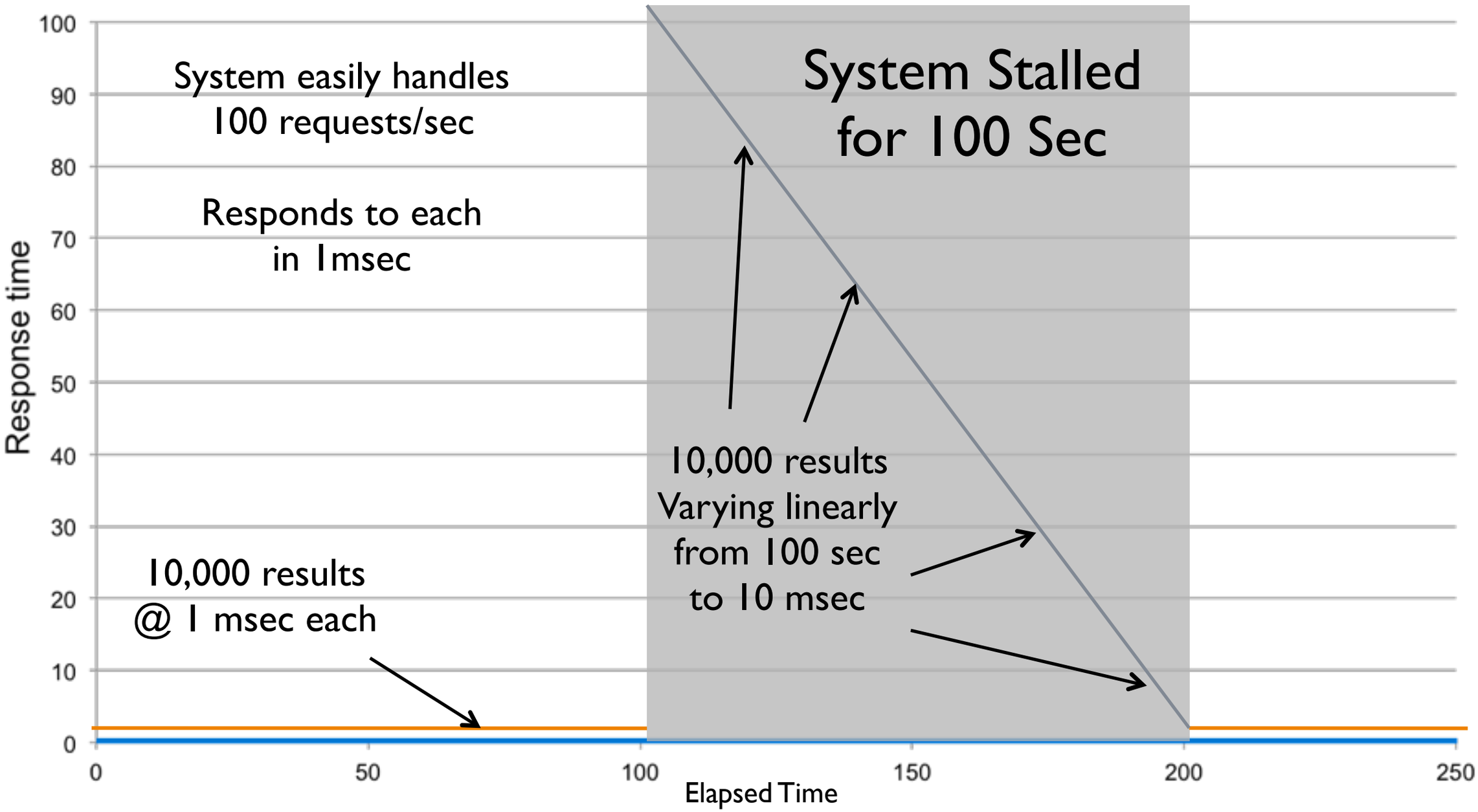
- Common Example:
  - build/buy simple load tester to measure throughput
  - issue requests one by one at a certain rate
  - measure and log response time for each request
  - results log used to produce histograms, percentiles, etc.
- So what's wrong with that?
  - works well only when all responses fit within in rate interval
  - technique includes "automatic backoff" and coordination
  - But requirements interested in random, uncoordinated requests
- Bad how bad can this get, really?

Example of naïve %'ile



Naïve characterization: 99.99% below 1 sec !!!

Proper measurement



Proper characterization: 50% below 1 second

jHiccup

- A tool for capturing and displaying platform hiccups
  - Records any observed non-continuity of the underlying platform
  - plots results in simple, consistent format
- Simple, non-intrusive
  - As simple as adding the word "jHiccup" to your java launch line
  - % jHiccup java myflags myApp
  - Adds a background thread that samples time @ 1000/sec
- Open Source
  - released to the public domain, creative commons CC0

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what jHiccup measures

- jHiccup measures the platform, not the application
  - Experiences whatever delays application threads would see
  - Highlights inconsistency in platform execution of "nothing"
  - No attempt to identify cause (e.g. scheduling, GC, swapping, etc.)
- An application cannot behave better than it's platform
  - If the platform stalls, the application stalled as well.
  - jHiccup provides a lower bound for "best application behavior"
- Useful control measurements
  - Comparing jHiccup results for an idle application running on the same platform, at the same time, narrows down behavior to process-specific artifacts (-c option)

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The anatomy of Hiccup Charts

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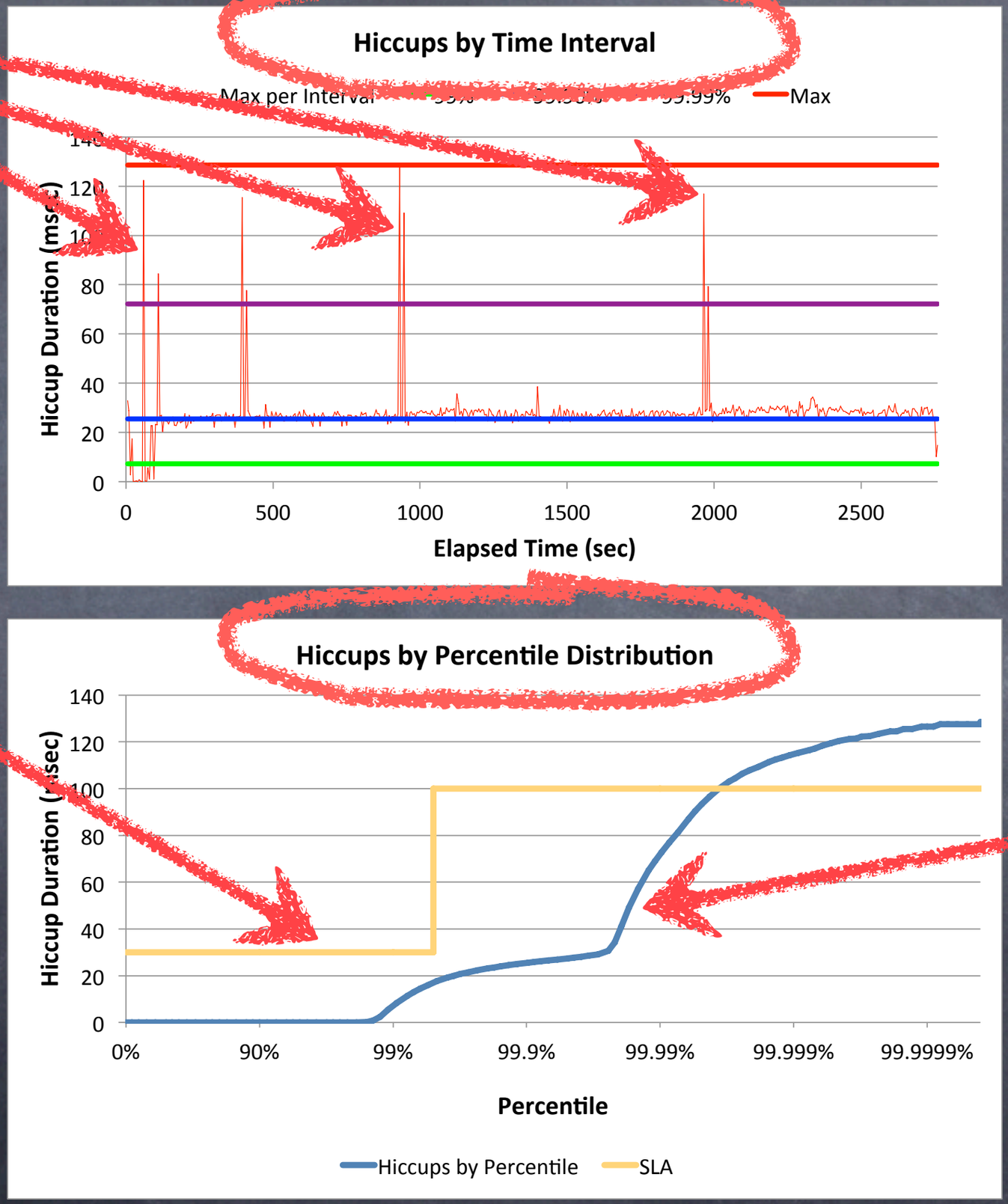
Telco App Example

Max Time per interval



Optional SLA plotting

Hiccup duration at percentile levels

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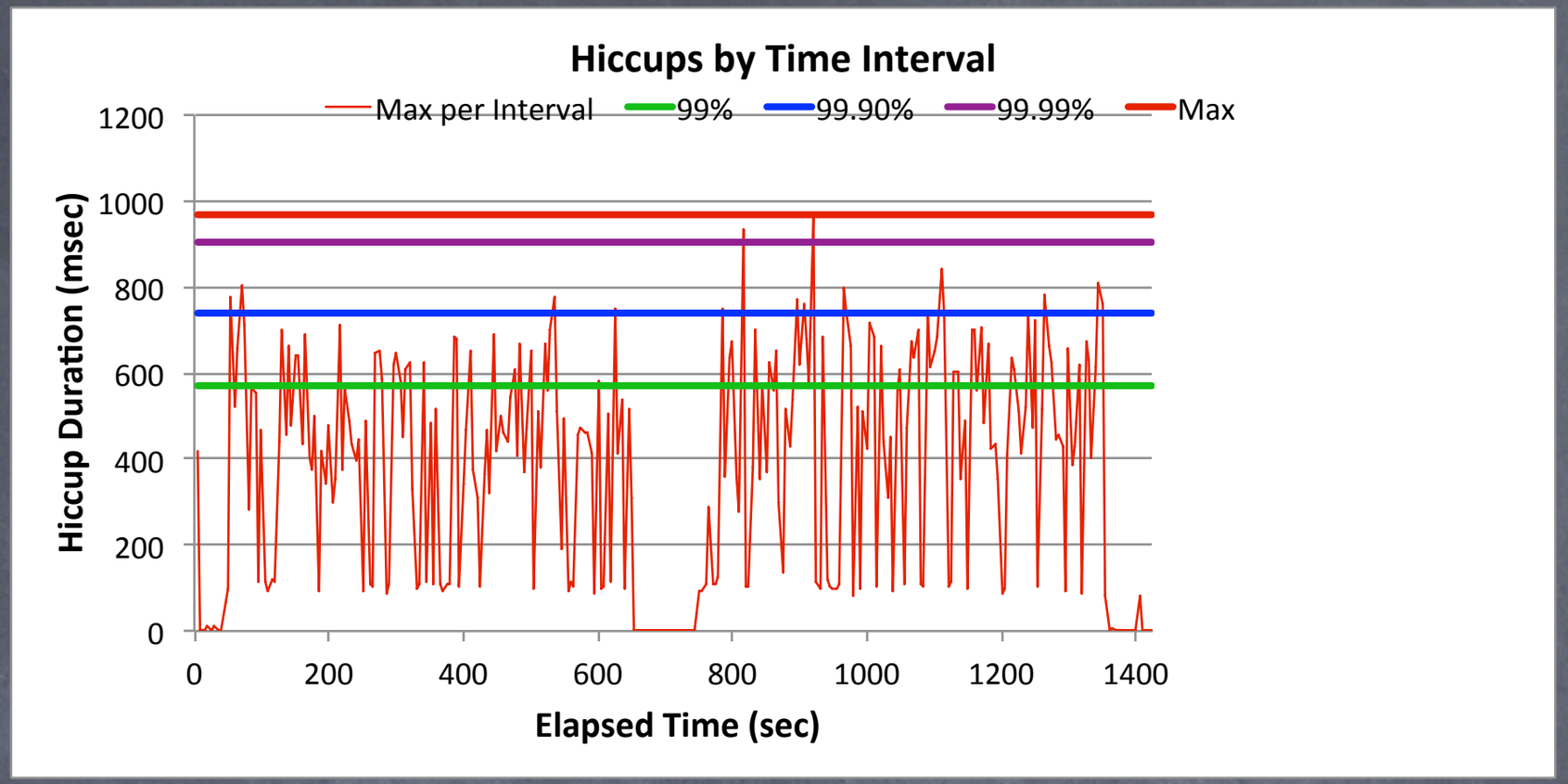

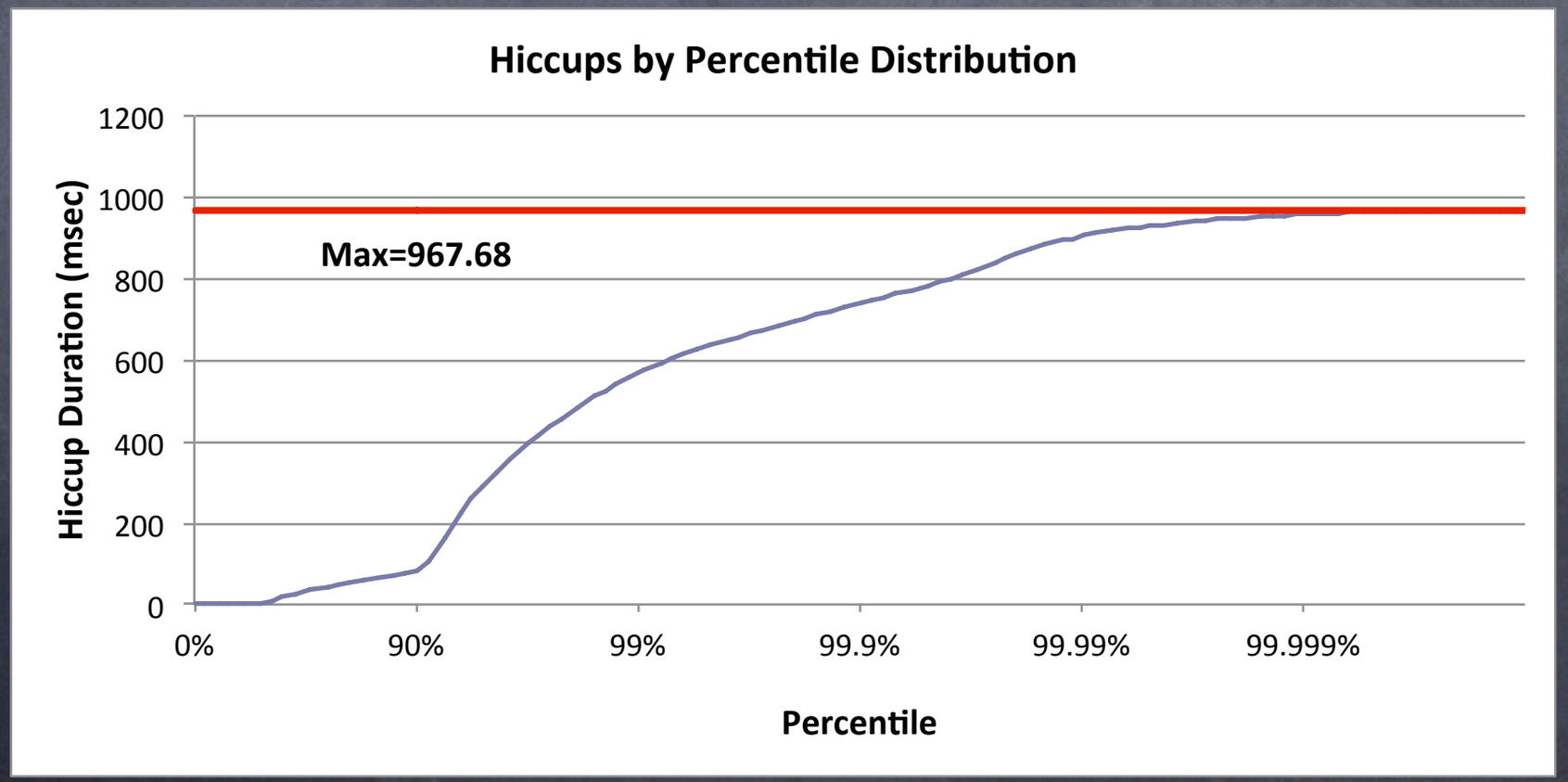

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How jHiccup works

- Background thread, measures time to do "nothing"
  - Sleeps for 1 milliseconds, allocates 1 object, records time gap
  - Collects detailed "floating point" histogram of observed times
  - Constant, small memory footprint, virtually no cpu load
  - No effect on application threads
- Outputs two files
  - A time-based log with 1 line per interval (default 5 sec interval).
  - A percentile distribution log of accumulated histogram data
- Spreadsheet imports files and plots data
  - A standard, simple chart format

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%'iles

- Computing percentiles
  - Sleeps for 1 milliseconds, allocates 1 object, records time gap
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Some fun with jHiccup

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Examples

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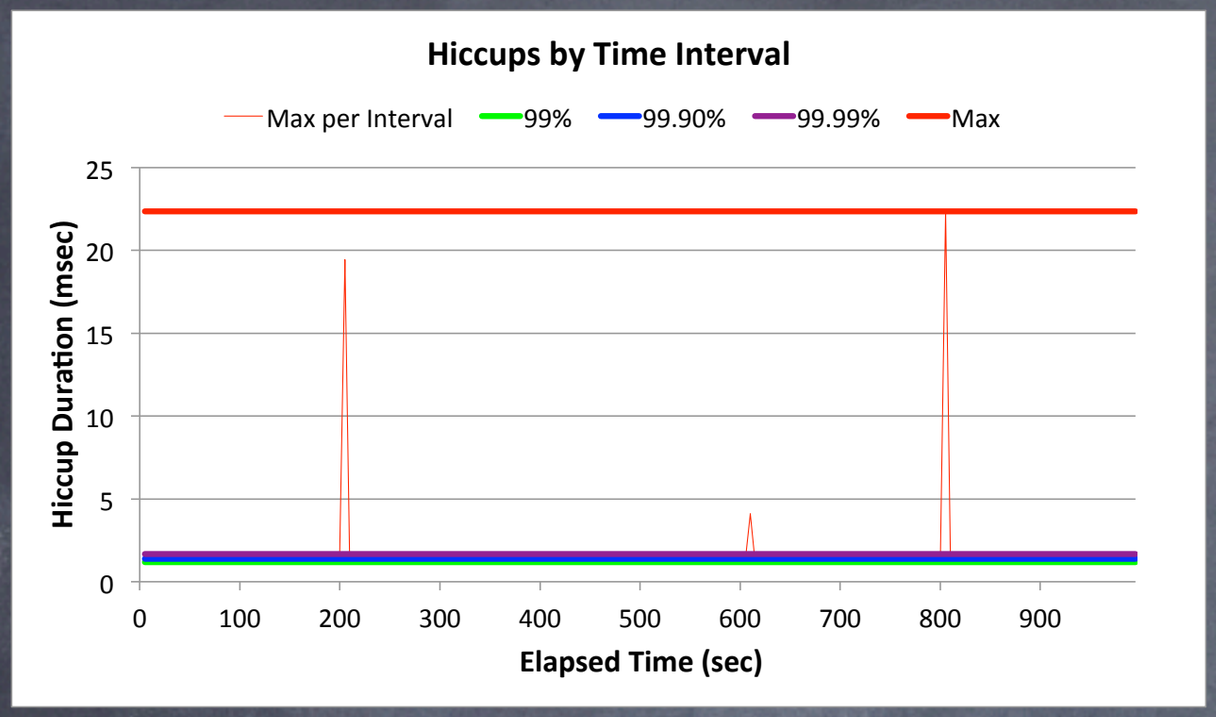
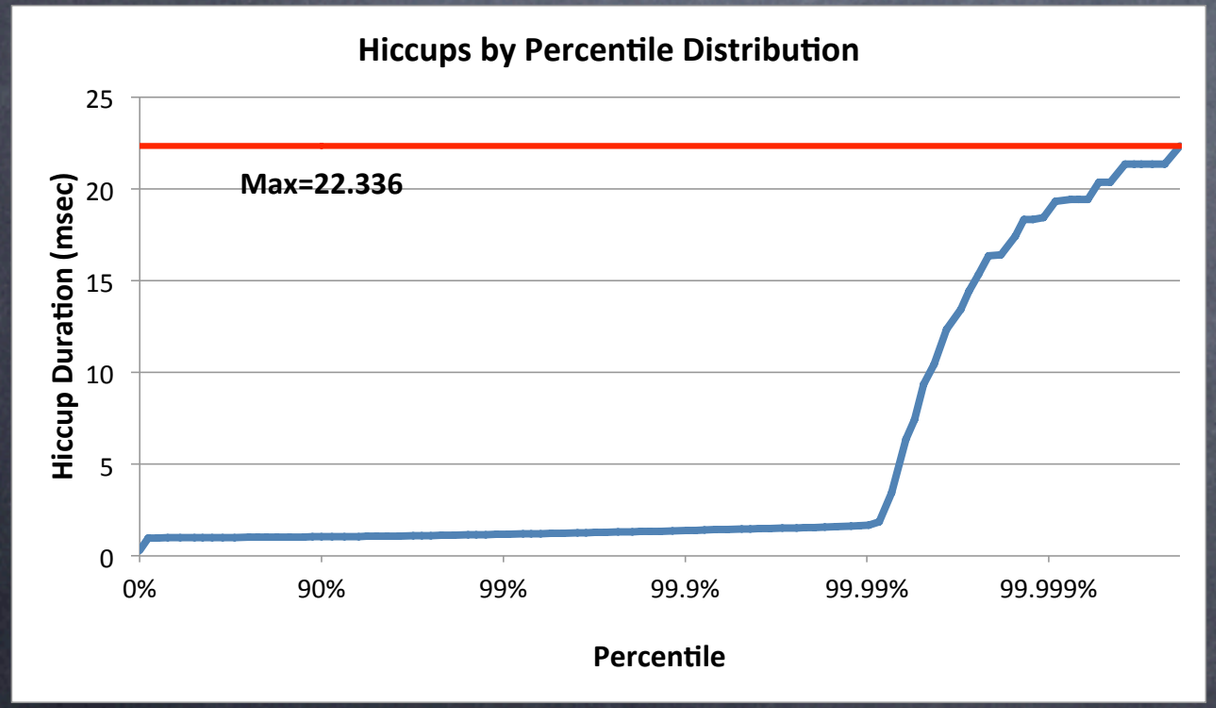
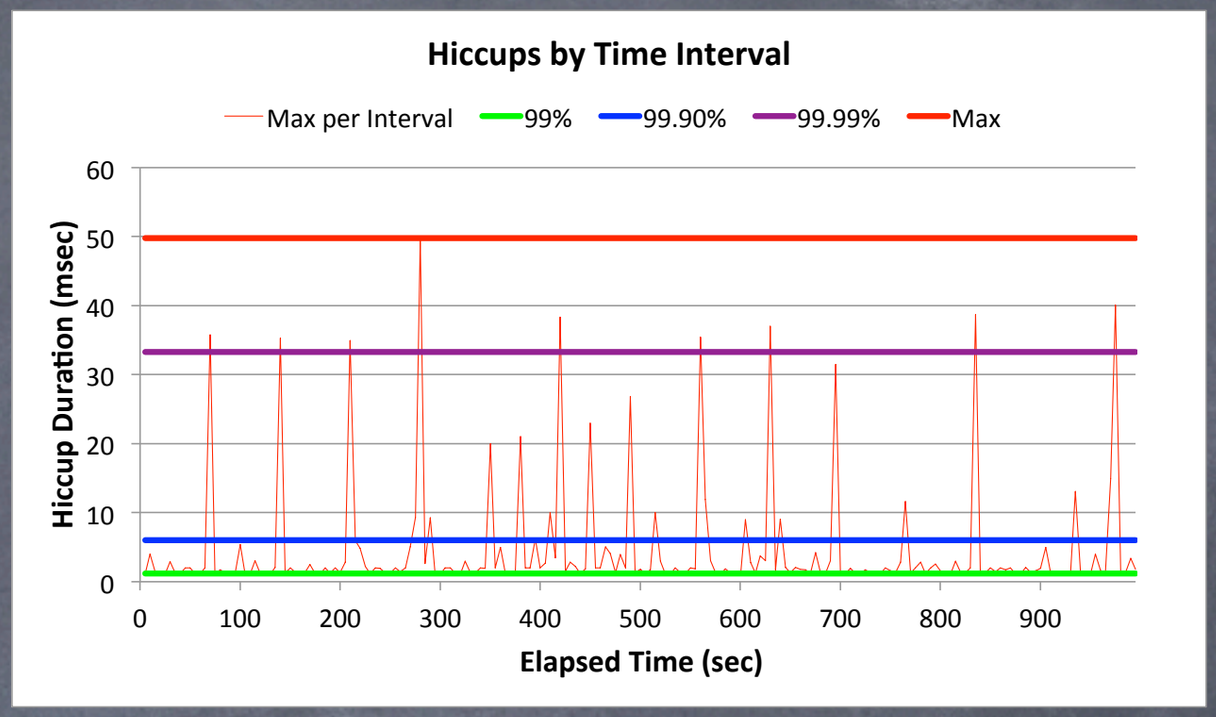
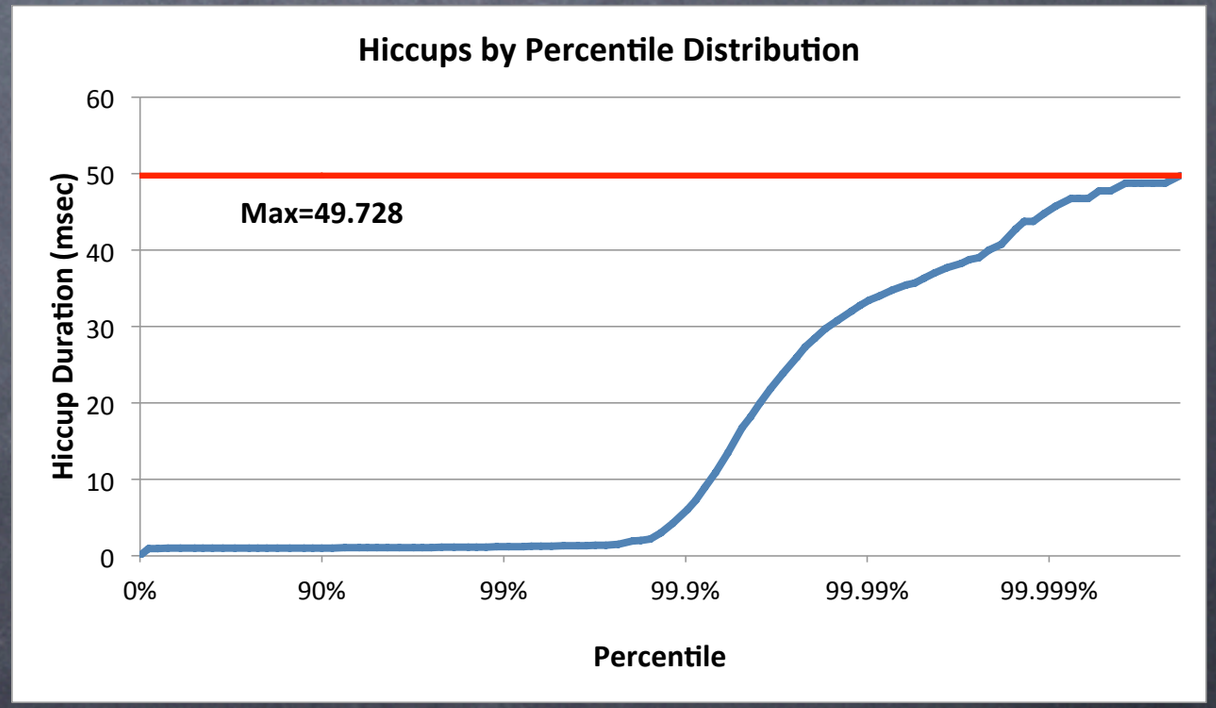
Idle App on Quiet System





Idle App on Busy System





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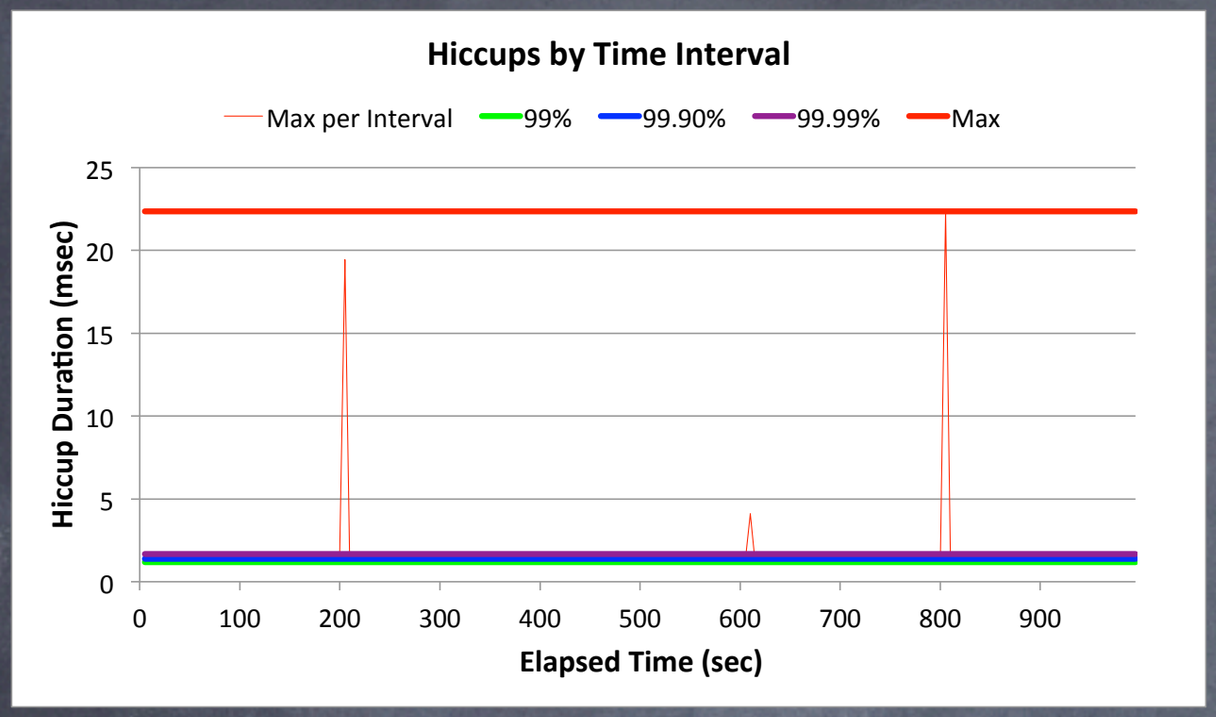
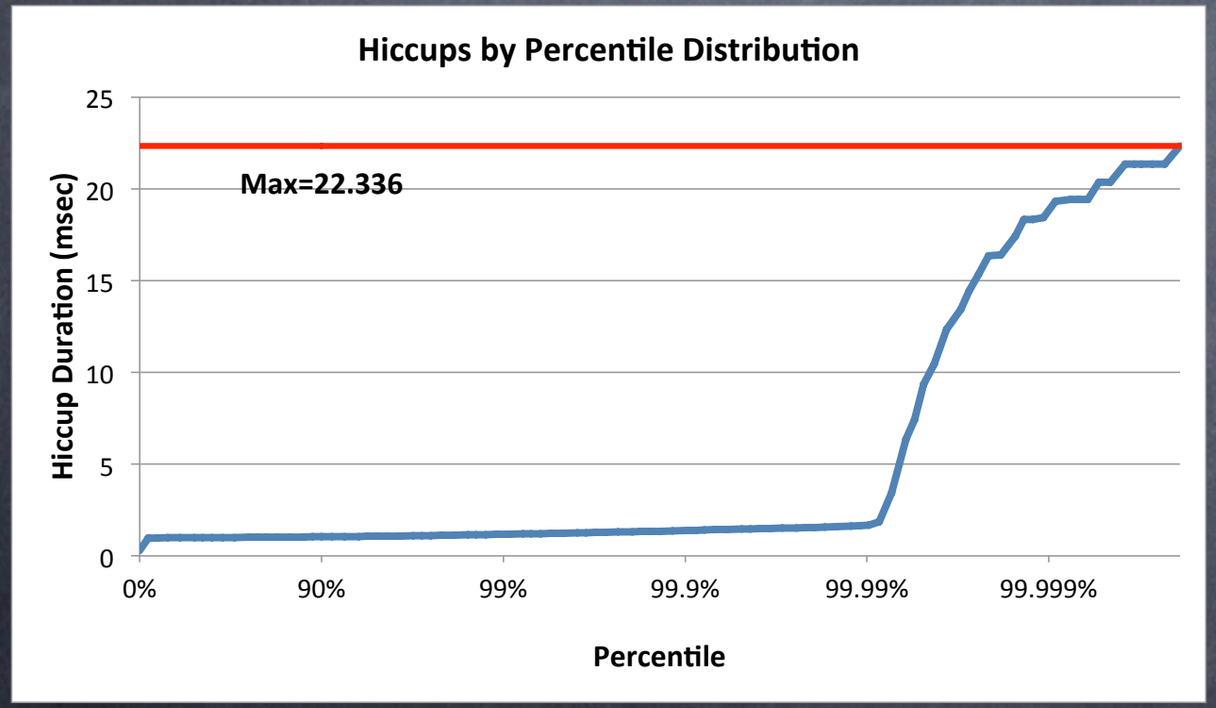
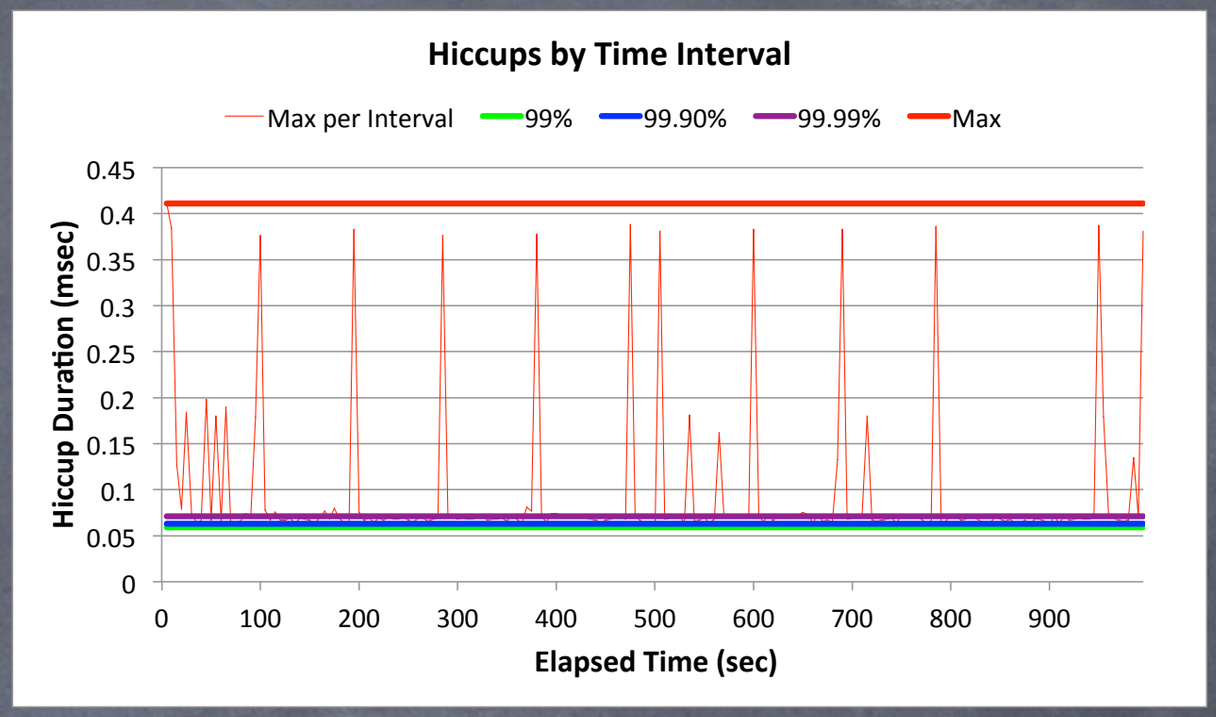
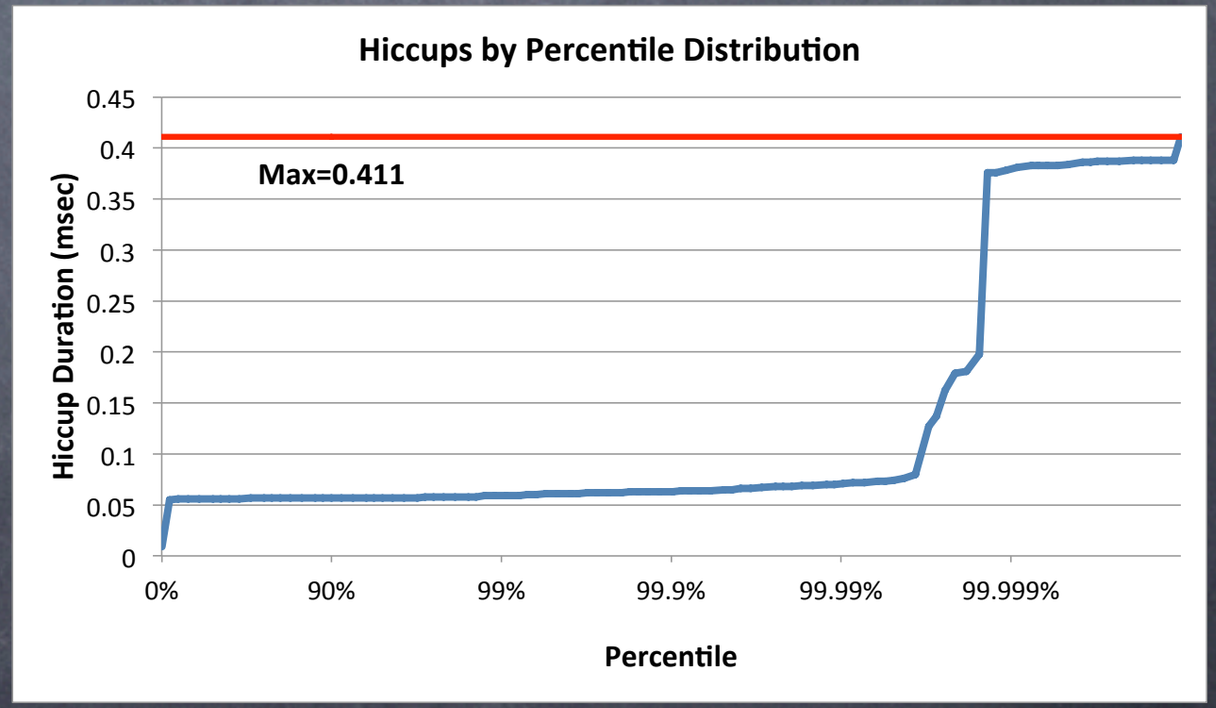
Idle App on Quiet System





Idle App on Dedicated System





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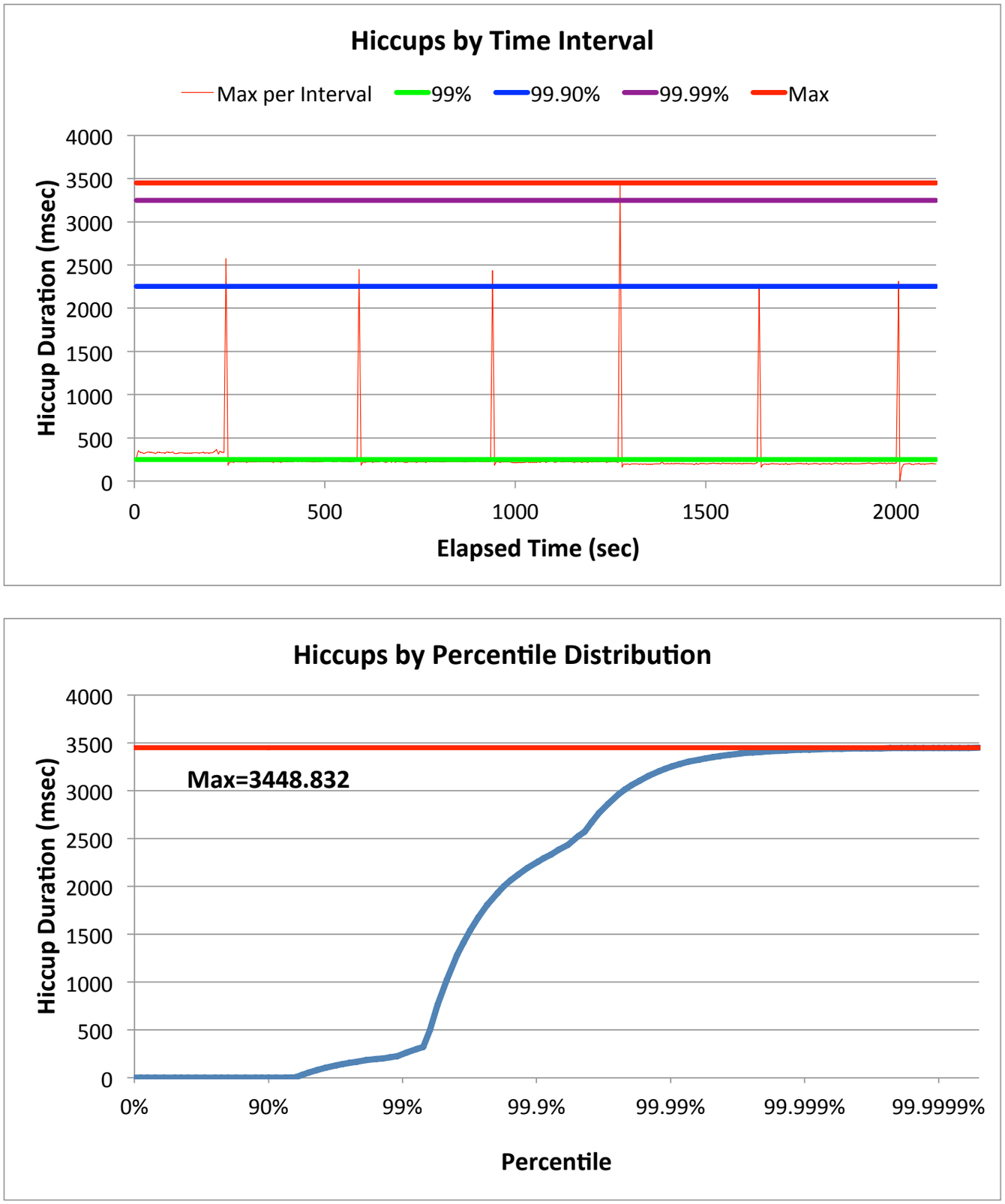
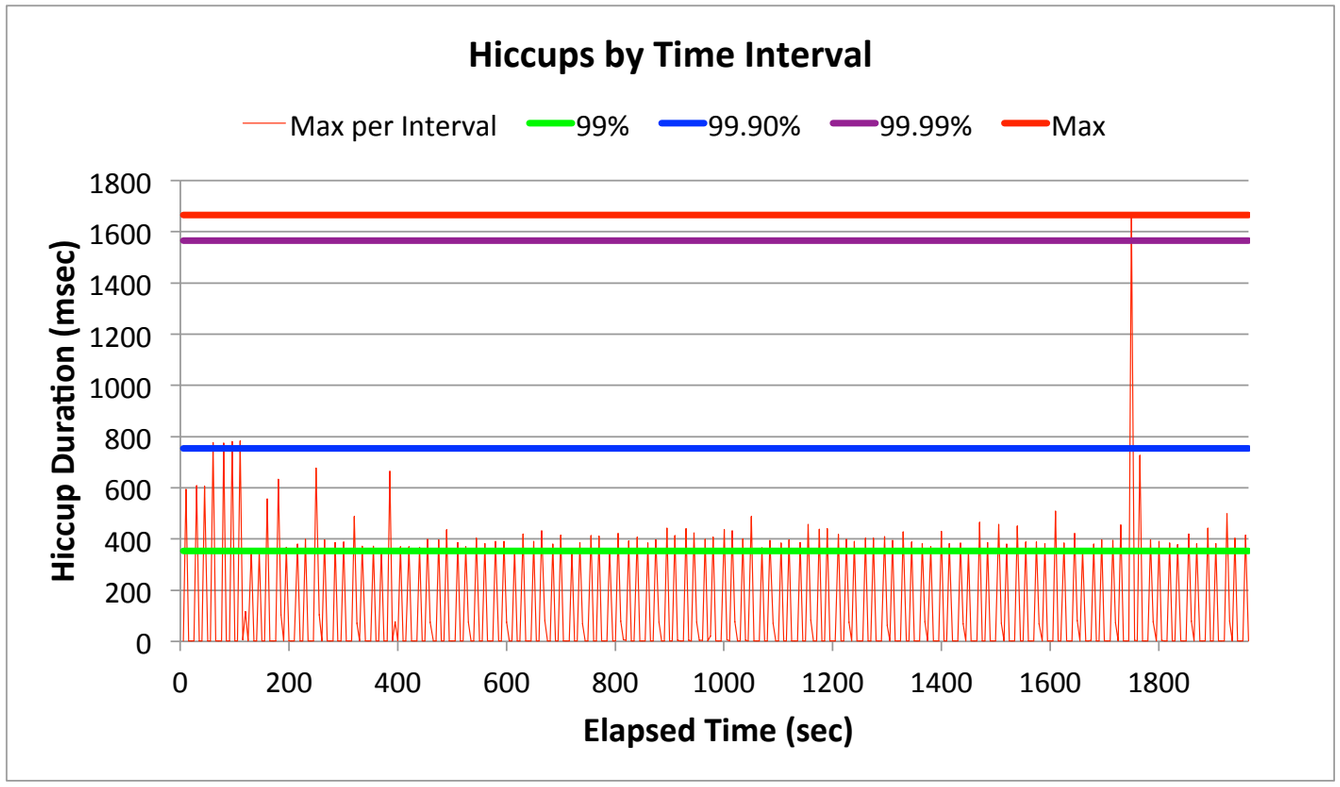
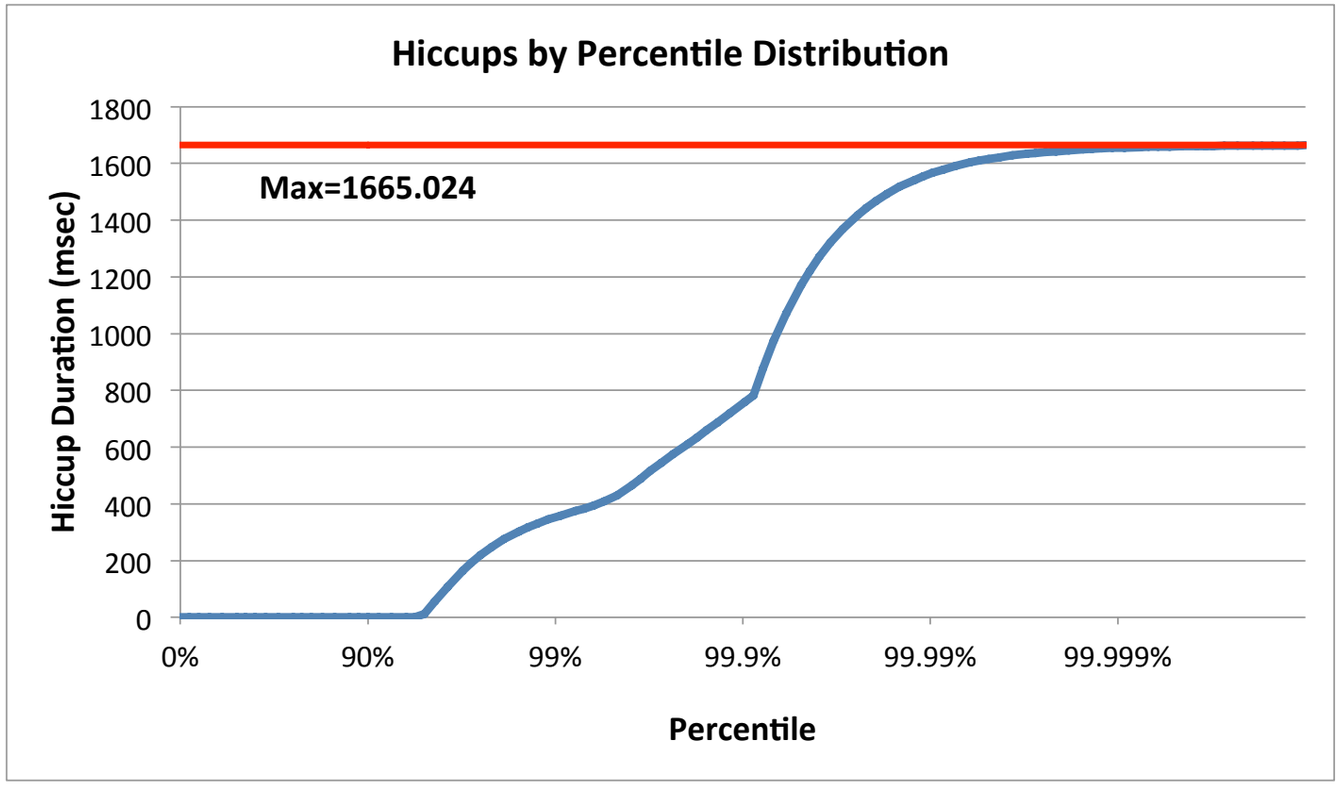
A 1GB Java Cache under load



Telco App


Hiccups by Time Interval
Max per Interval
99%
99.90%
99.99%
Max
Hiccup Duration (msec)
1800
1600
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
1600
1800
Elapsed Time (sec)


Hiccups by Percentile Distribution
Max=1665.024
Hiccup Duration (msec)
1800
1600
1400
1200
1000
800
600
400
200
0
0%
90%
99%
99.9%
99.99%
99.999%
Percentile

Fun with jHiccup

Charles Nutter @headius 20 Jan

jHiccup, @AzulSystems' free tool to show you why your JVM sucks compared to Zing: bit.ly/wsH5A8 (thx @bascule)

Retweeted by Gil Tene

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Obviously, we can use it for comparison purposes

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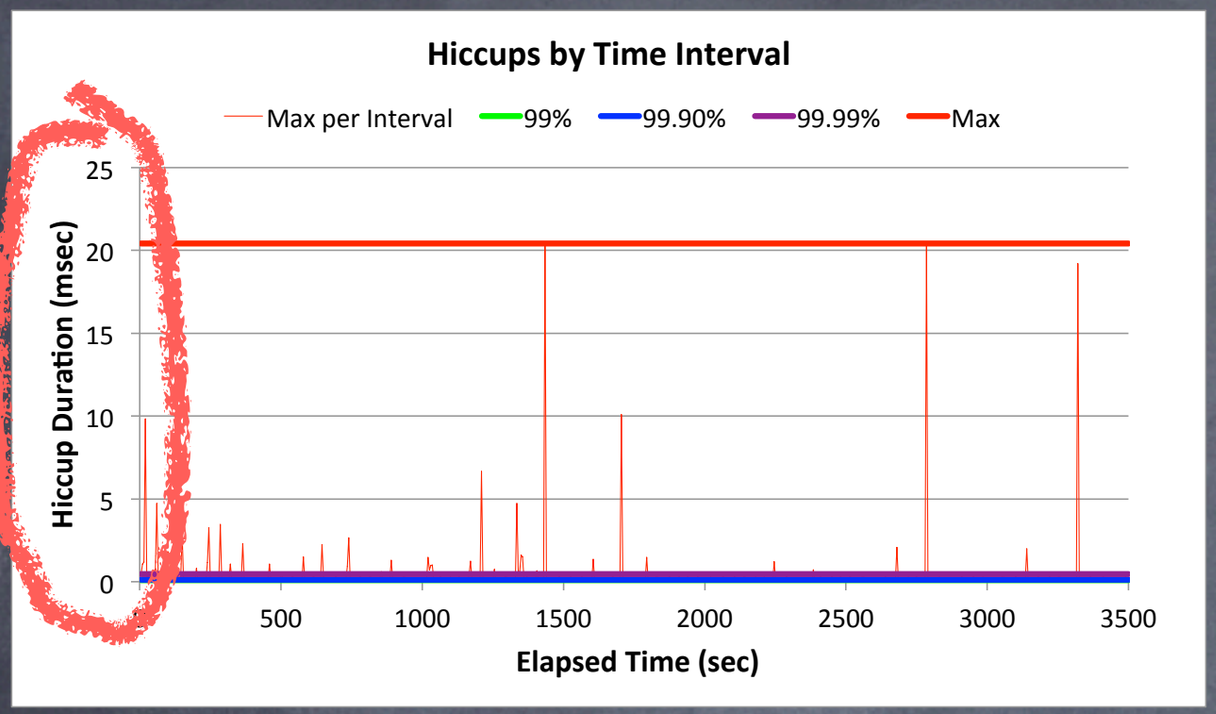
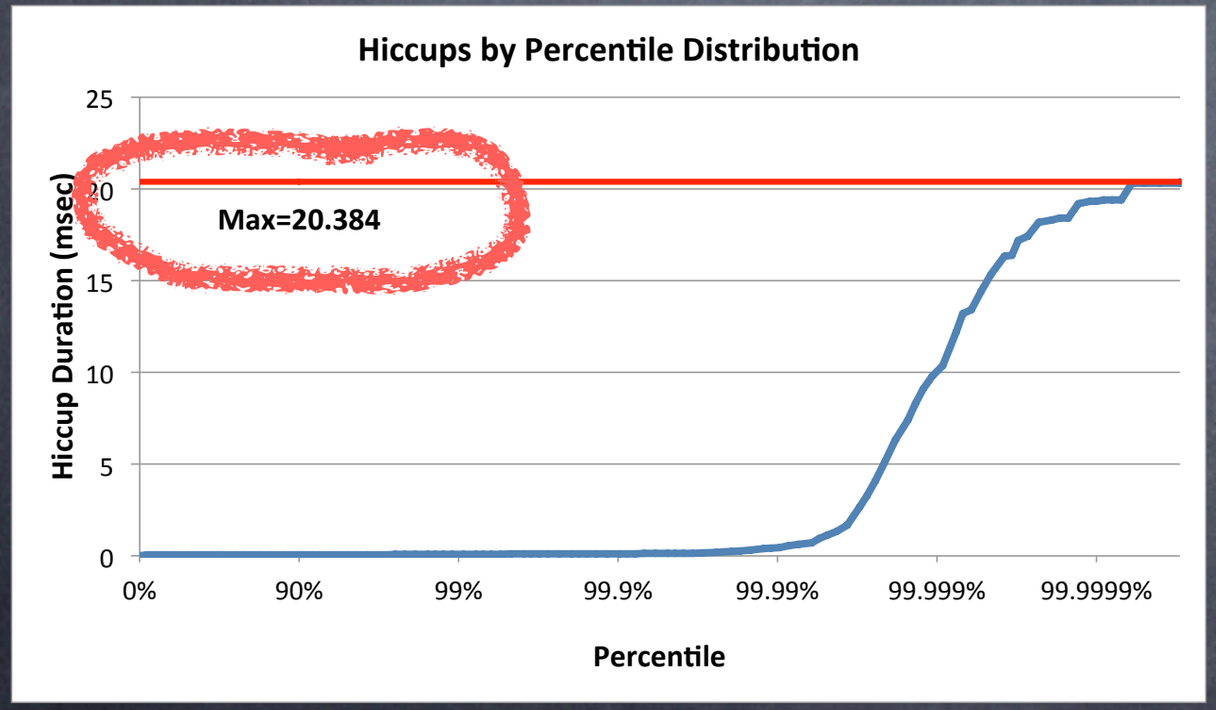
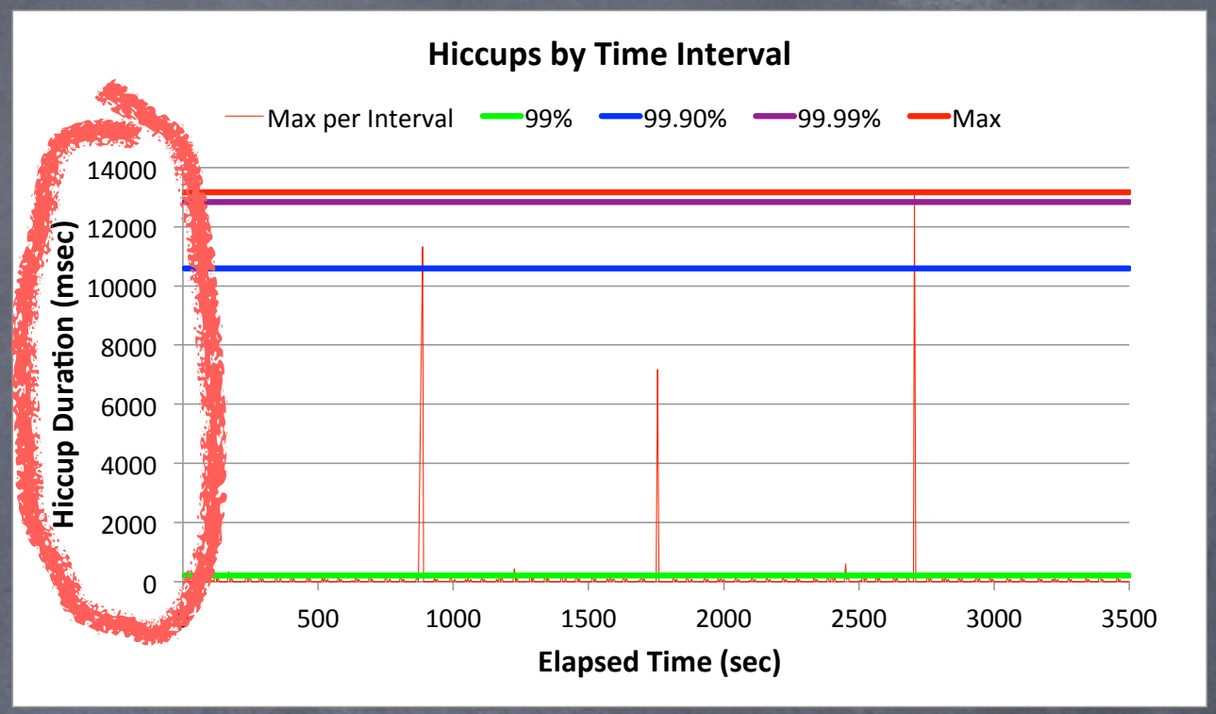
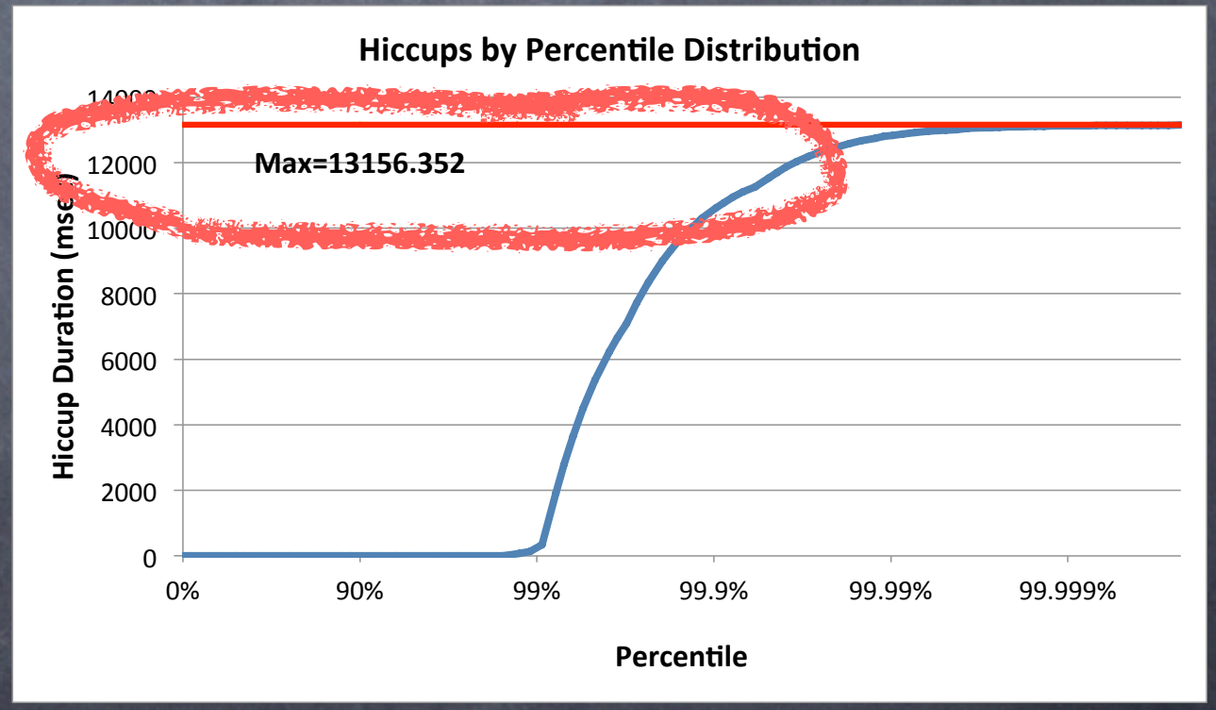
Zing 5, 1GB in an 8GB heap





Oracle HotSpot CMS, 1GB in an 8GB heap





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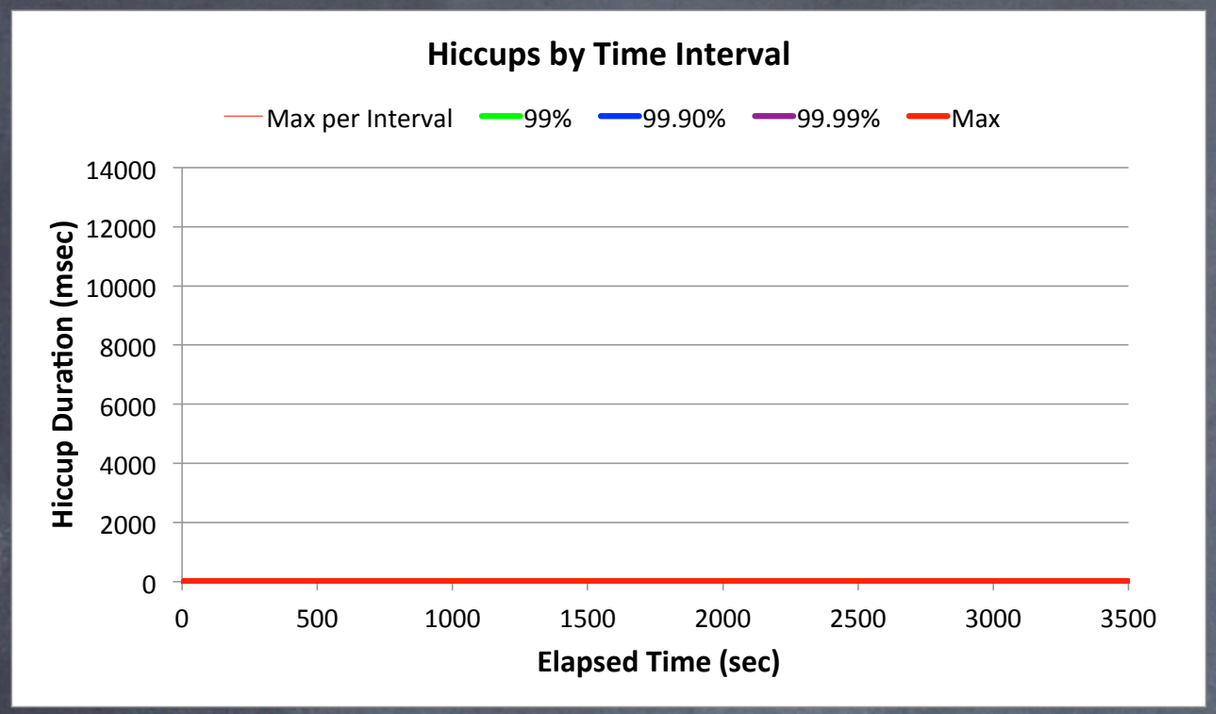
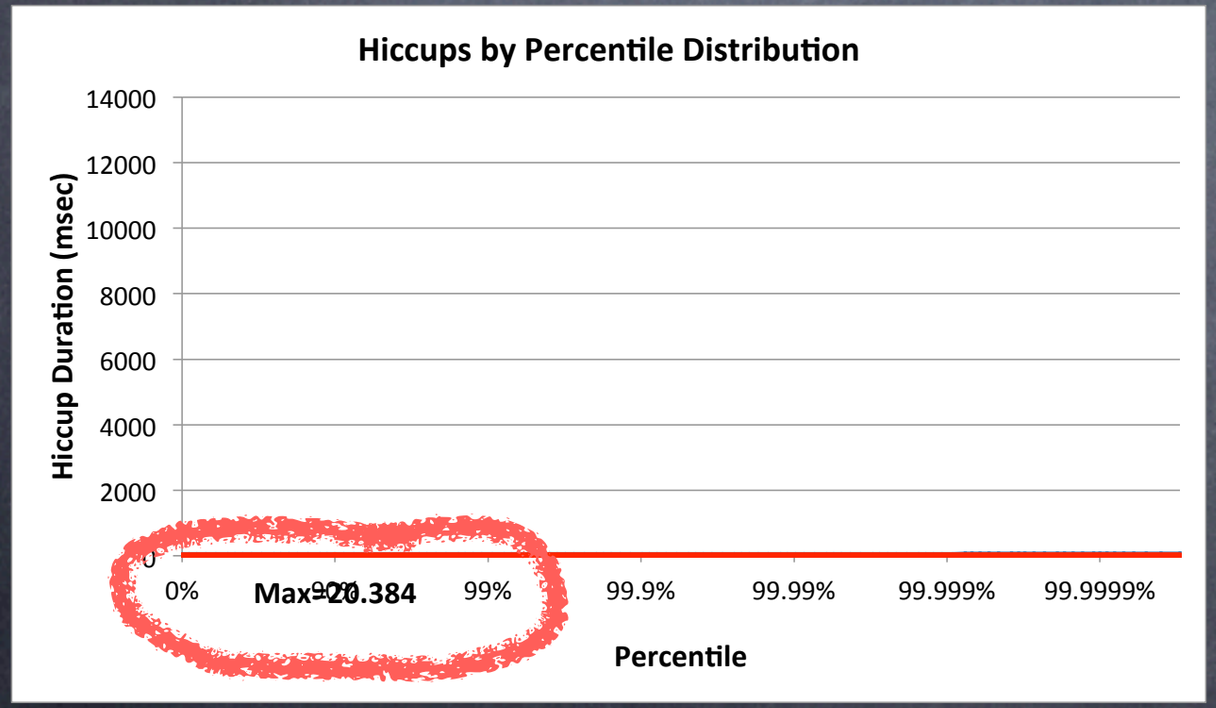
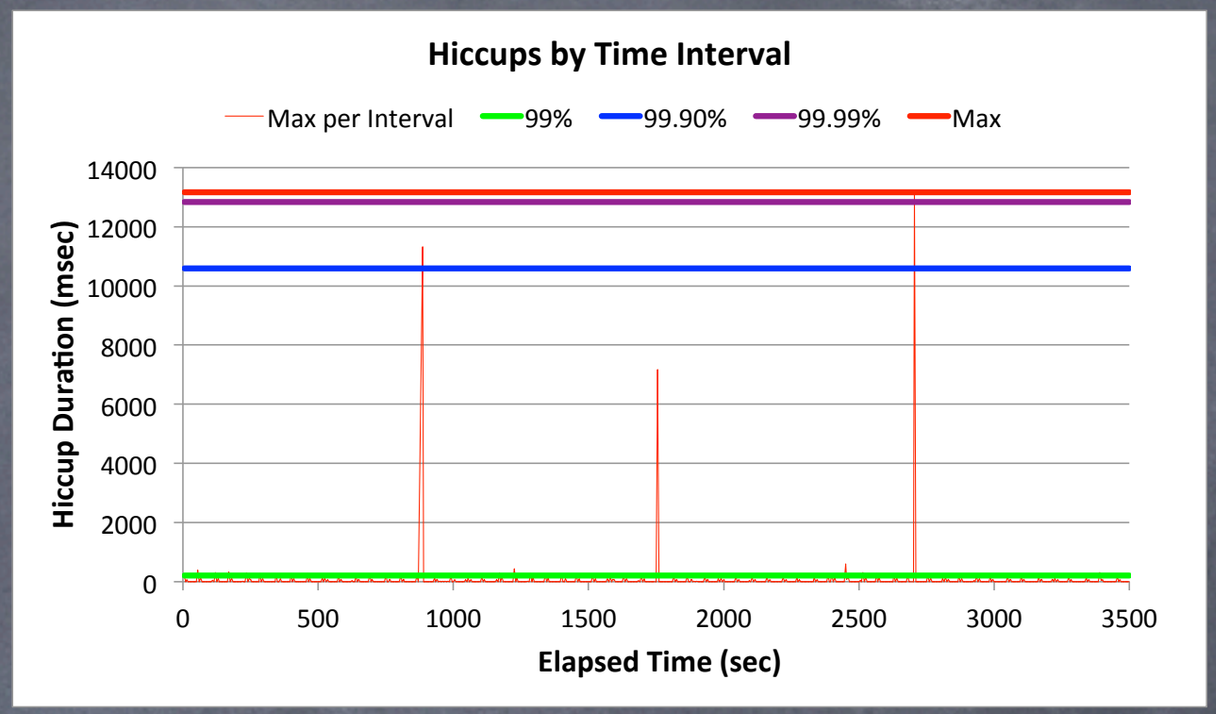
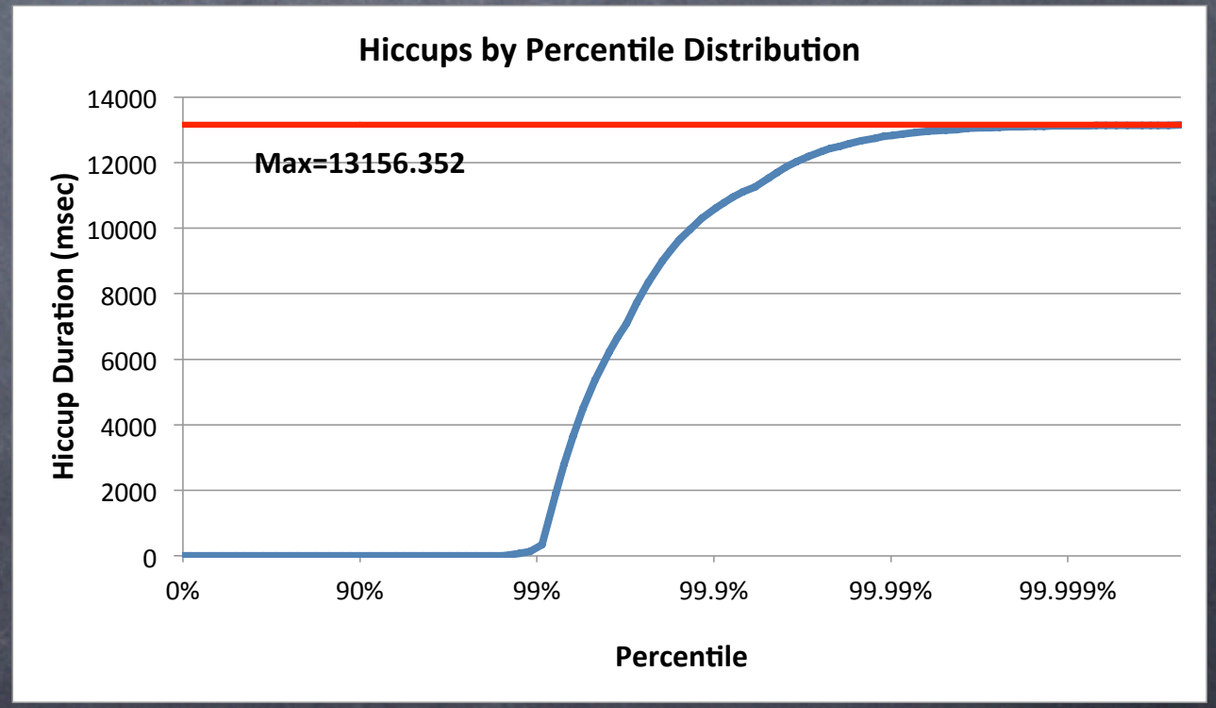
Zing 5, 1GB in an 8GB heap





Oracle HotSpot CMS, 1GB in an 8GB heap





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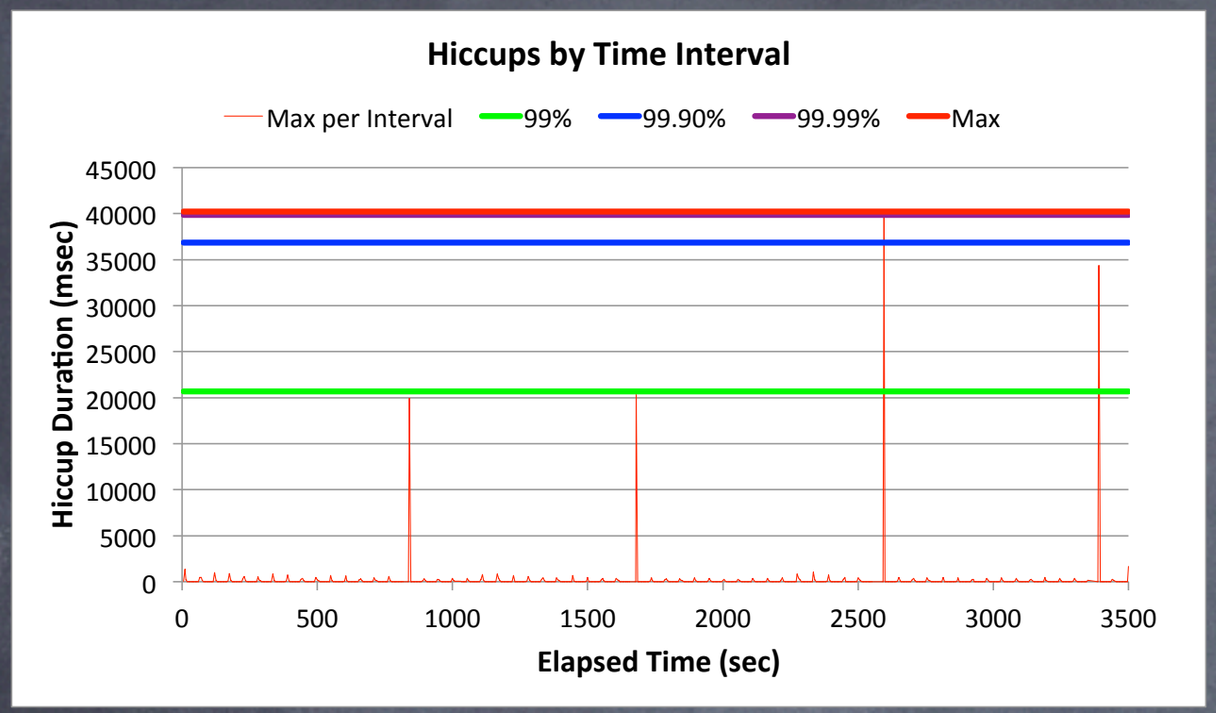
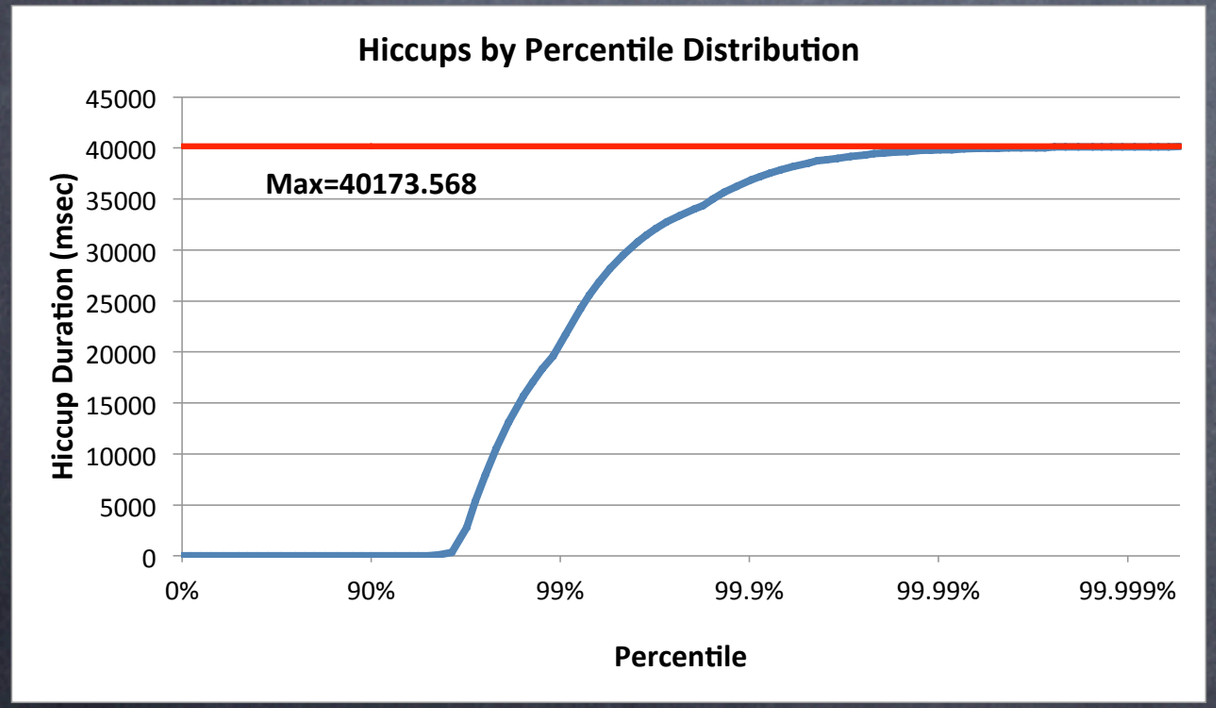
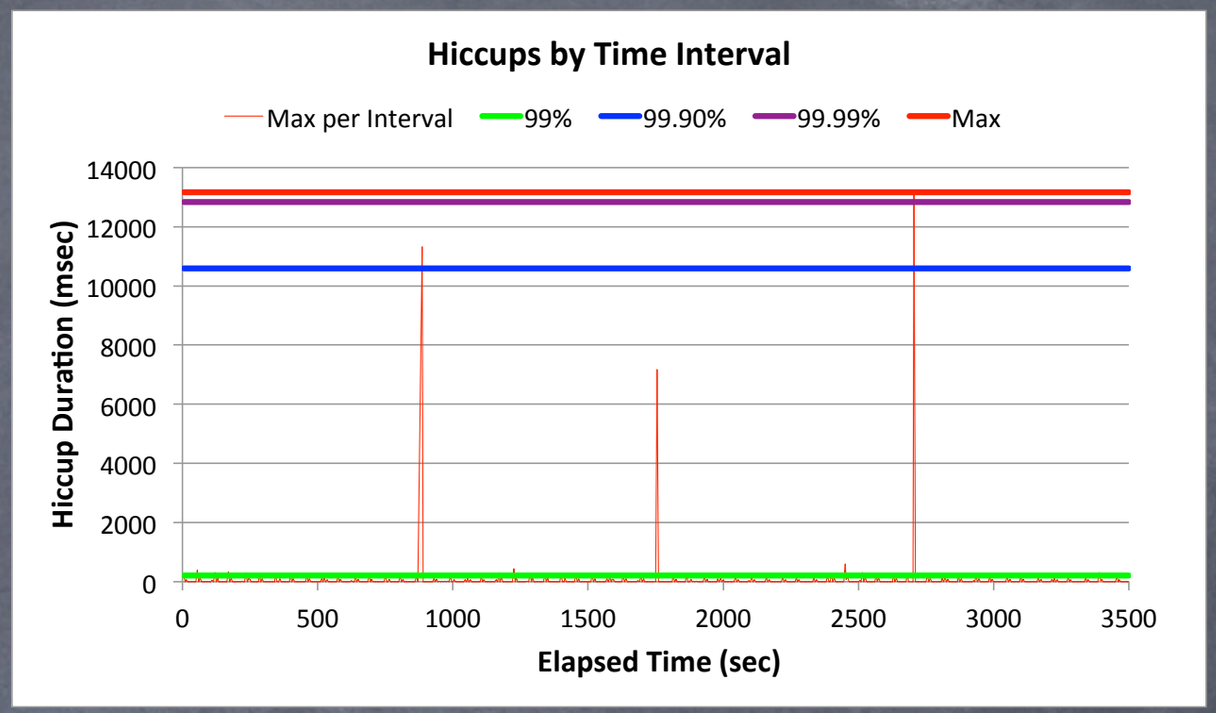
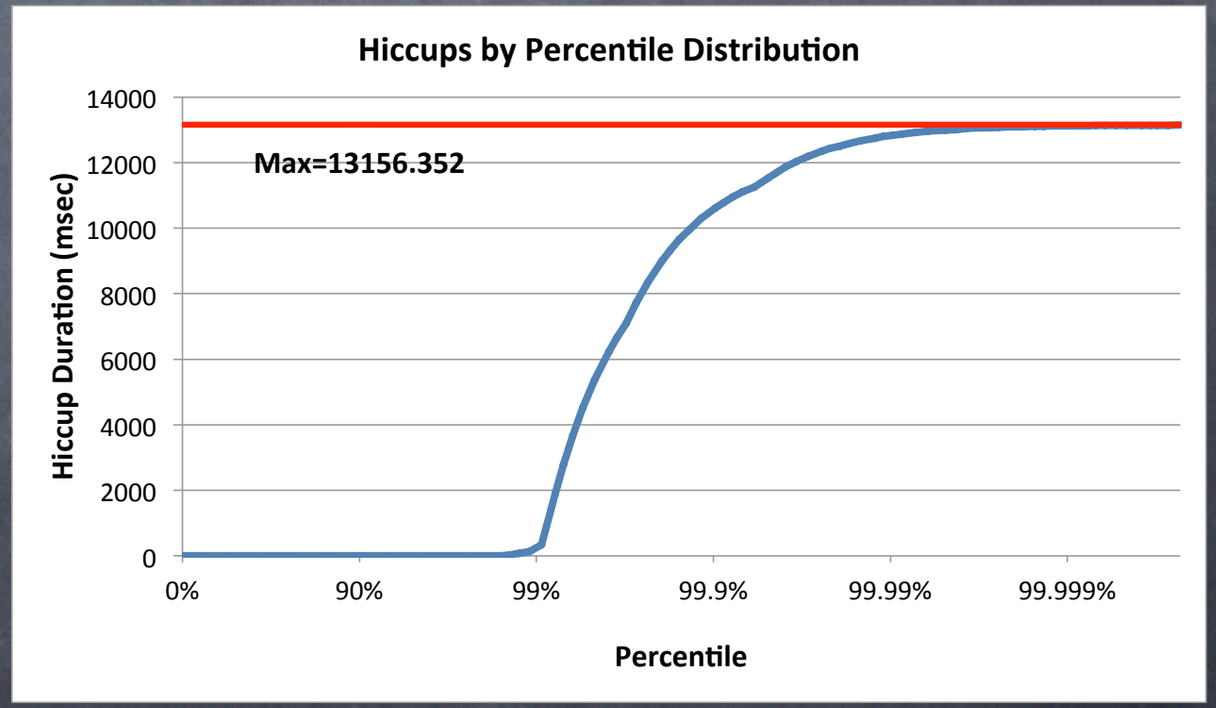
Oracle HotSpot CMS, 4GB in a 18GB heap





Oracle HotSpot CMS, 1GB in an 8GB heap





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Q & A

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