THE TROUBLE WITH

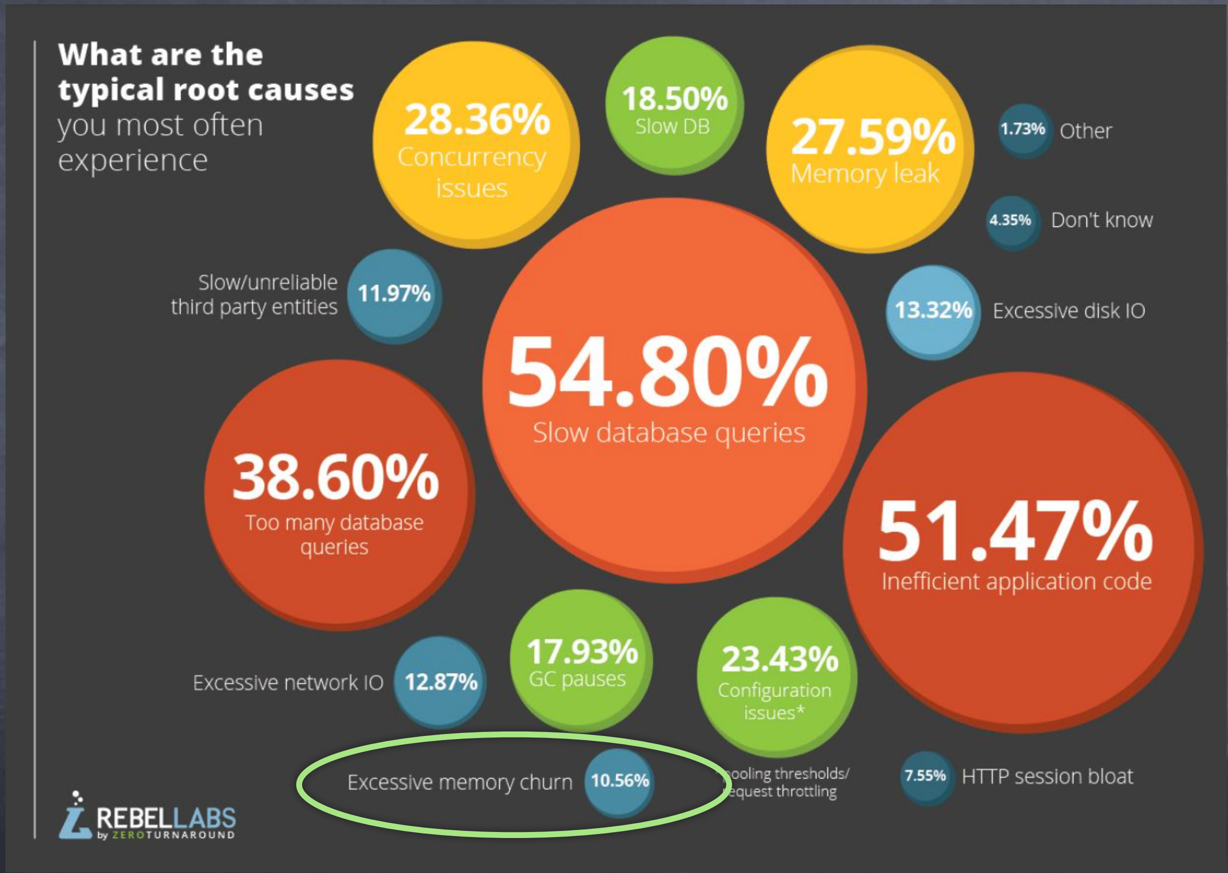
MEMORY

OUR MARKETING SLIDE

- Kirk Pepperdine
  - Author of jPDM, a performance diagnostic model
  - Author of the original Java Performance Tuning workshop
- Co-founded jClarity
  - Building the smart generation of performance diagnostic tooling
    - Bring predictability into the diagnostic process
- Co-founded JCrete
  - The hottest unconference on the planet
- Java Champion(s)

What is your performance trouble spot

INDUSTRY SURVEY



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> 70% of all applications are bottlenecked on memory

and no,
Garbage Collection
is not a fault!!!!

DO YOU USE

DO YOU USE

Spring Boot

DO YOU USE

Cassandra

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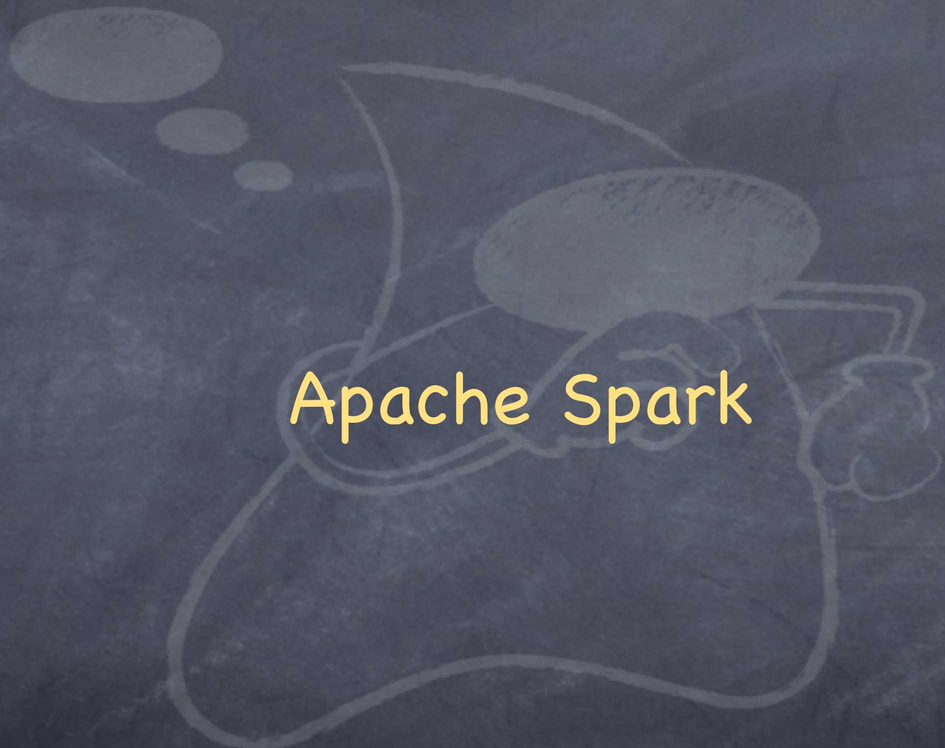
DO YOU USE

Cassandra

or any big nosql solution

DO YOU USE



Apache Spark

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DO YOU USE

Apache Spark
or any big data framework

DO YOU USE

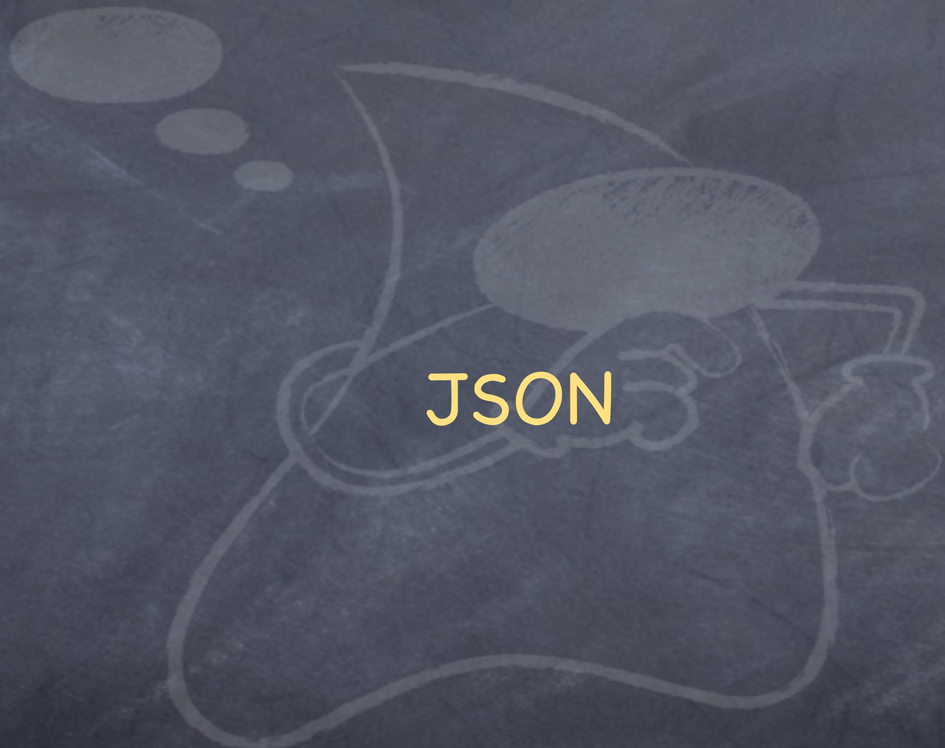
Log4J

DO YOU USE

Log4J

or any Java logging framework

DO YOU USE



JSON

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DO YOU USE

JSON

With almost any Marshalling protocol

DO YOU USE

ECom caching products

DO YOU USE

ECom caching products

Hibernate

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ECom caching products

Hibernate

and so on

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then you are very likely in this 70%

WAR STORIES

- Reduced allocation rates from 1.8gb/sec to 0
  - tps jumped from 400,000 to 25,000,000!!!
- Stripped all logging our of a transactional engine
  - Throughput jumped by a factor of 4x
- Wrapped 2 logging statements in a web socket framework
  - Memory churn reduced by a factor of 2
- and .....

ALLOCATION SITE

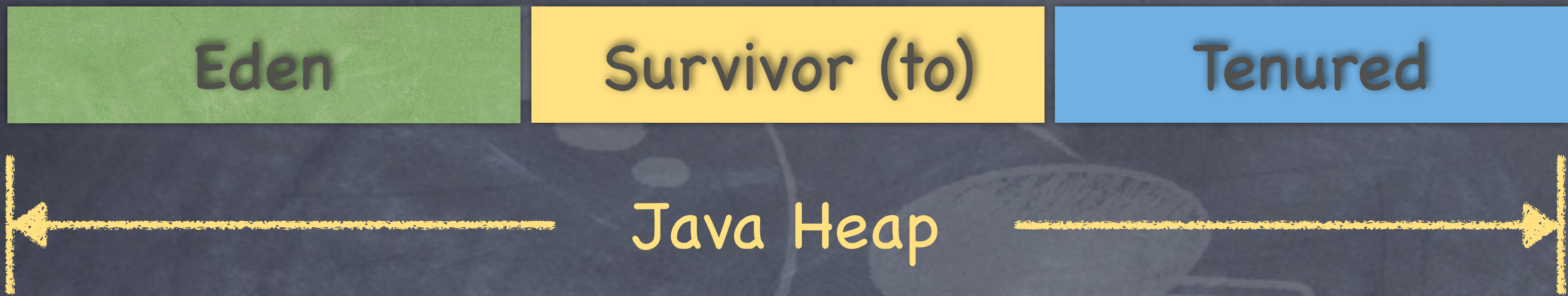
```
Foo foo = new Foo();
```

forms an allocation site

```
0: new              #2    // class java/lang/Object
2: dup
4: invokespecial #1    // Method java/lang/Object."<init>":()V
```

- Allocation will (mostly) occur in Java heap
  - fast path
  - slow path
  - small objects maybe optimized to an on-stack allocation

JAVA HEAP



- Java Heap is made of;
  - Eden - nursery
  - Survivor - intermediate pool designed to delay promotion
  - Tenured - to hold long lived data
- Each space contributes to a different set of problems
  - All affect GC overhead

EDEN ALLOCATIONS

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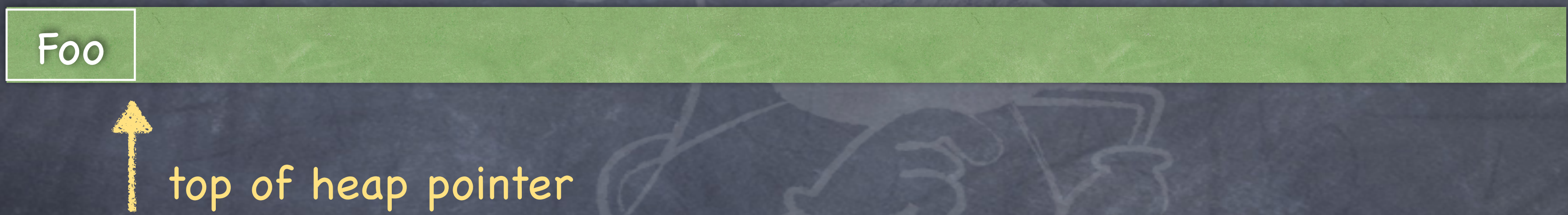
OBJECT ALLOCATION


```
Foo foo = new Foo();
Bar bar = new Bar();
byte[] array = new byte[N];
```

OBJECT ALLOCATION

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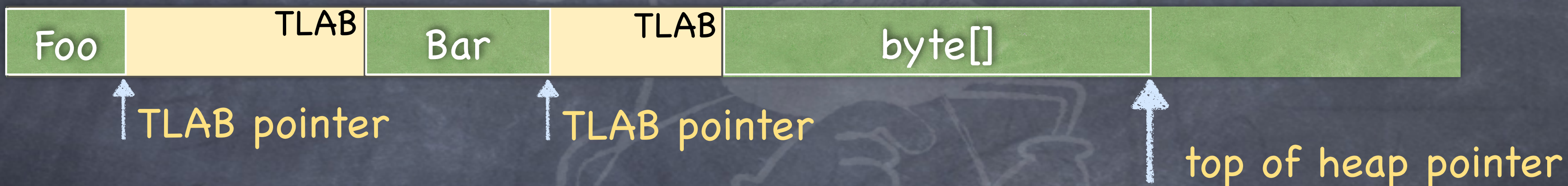
OBJECT ALLOCATION

- In multi-threaded apps, top of heap pointer must be surrounded by barriers
  - single threads allocation
  - hot memory address
    - solved by stripping (Thread local allocation blocks)

TLAB ALLOCATION

- Assume 2 threads
  - each thread will have it's own (set of) TLAB(s)

TLAB ALLOCATIONS



- Thread 1 -> Foo foo = new Foo(); byte[] array = new byte[N];
  - byte[] doesn't fit in a TLAB
- Thread 2 -> Bar bar = new Bar();

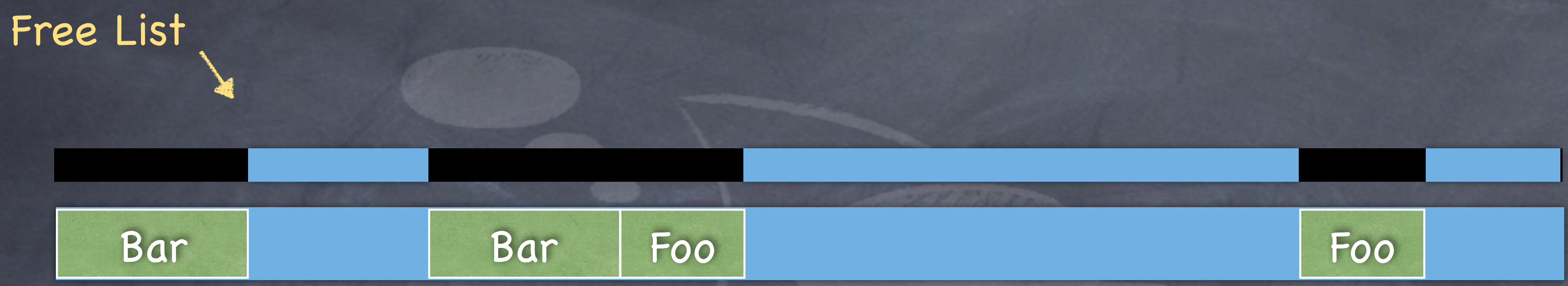
TLAB WASTE %

- Threshold defining when to request a new TLAB
  - prevent buffer overflows
- waste up to 1% of a TLAB

TLAB WASTE %

- Allocation failure to prevent buffer overflow
  - some what expensive failure path

TENURED SPACE



- Allocations in tenured make use of a free list
  - free list allocation is ~10x the cost of bump and run
- Data in tenured tends to be long lived
  - amount of data in tenured do affect GC pause times

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PROBLEMS

- High memory churn rates
  - many temporary objects

PROBLEMS

- High memory churn rates
  - many temporary objects

→

- Quickly fill Eden
  - frequent young gc cycles
  - speeds up aging
  - premature promotion
    - more frequent tenured cycles
    - increased copy costs
    - increased heap fragmentation
- Allocation is quick
  - quick * large number = slow

REDUCING ALLOCATIONS

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PROBLEMS

- High memory churn rates
  - many temporary objects
- Large live data set size
  - inflated live data set size
    - loitering

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PROBLEMS

- High memory churn rates
  - many temporary objects

- Large live data set size
  - inflated live data set size
    - loitering

→

- inflated scan for root times
- reduced page locality
- Inflated compaction times
  - increase copy costs
  - likely less space to copy too

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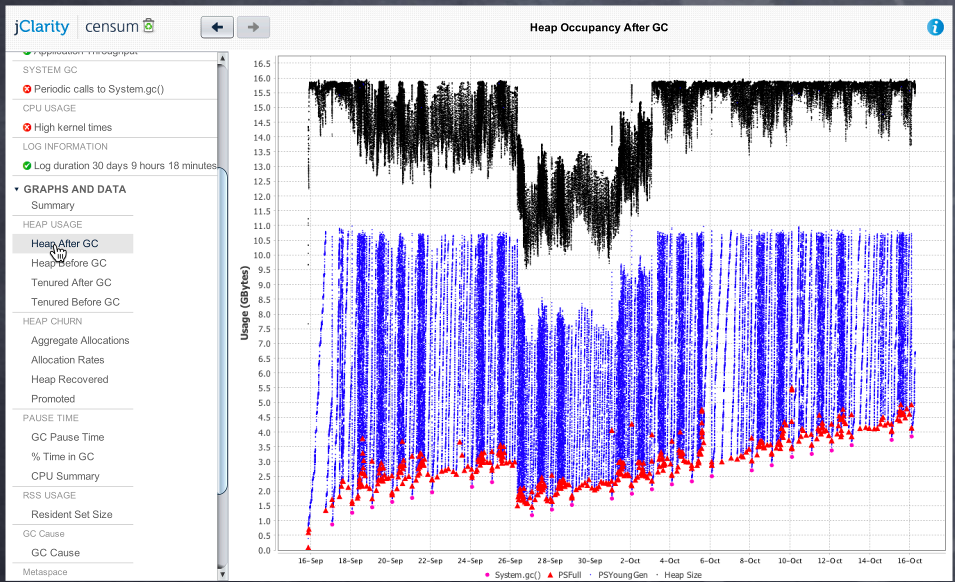
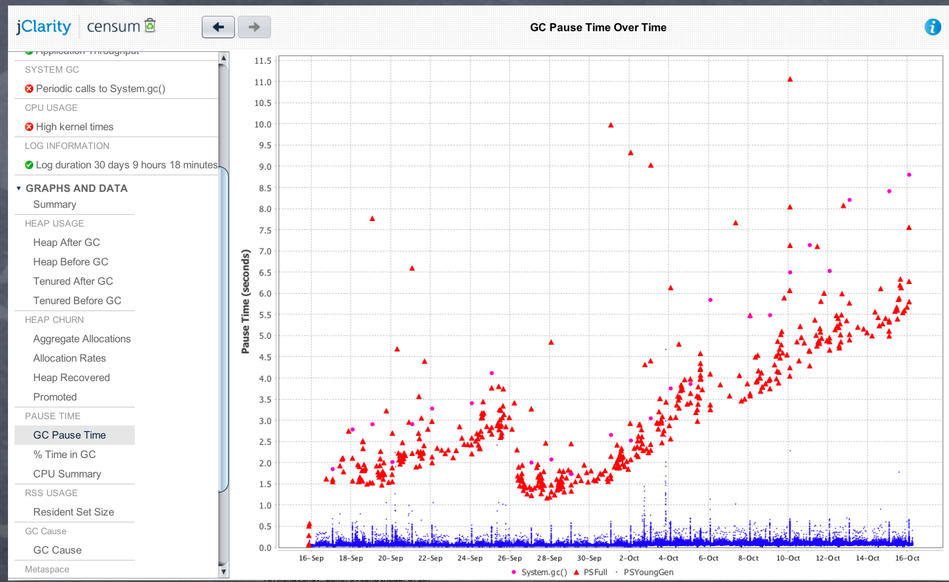
PAUSE VS OCCUPANCY





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PROBLEMS

- High memory churn rates
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- Large live data set size
  - inflated live data set size
    - loitering
- Unstable live data set size
  - memory leak

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PROBLEMS

- High memory churn rates
  - many temporary objects
- Large live data set size
  - inflated live data set size
    - loitering
- Unstable live data set size →
  - memory leak
- Eventually you run out of heap space
  - each app thread throws an OutOfMemoryError and terminates
    - JVM will shutdown with all non-daemon threads terminate

Escape Analysis

Demo time

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@kcpeppe
kirk@jclarity.com
Ask me about our
Java Performance Tuning Workshops