WELCOME

The Disruptor - High performance messaging with Java

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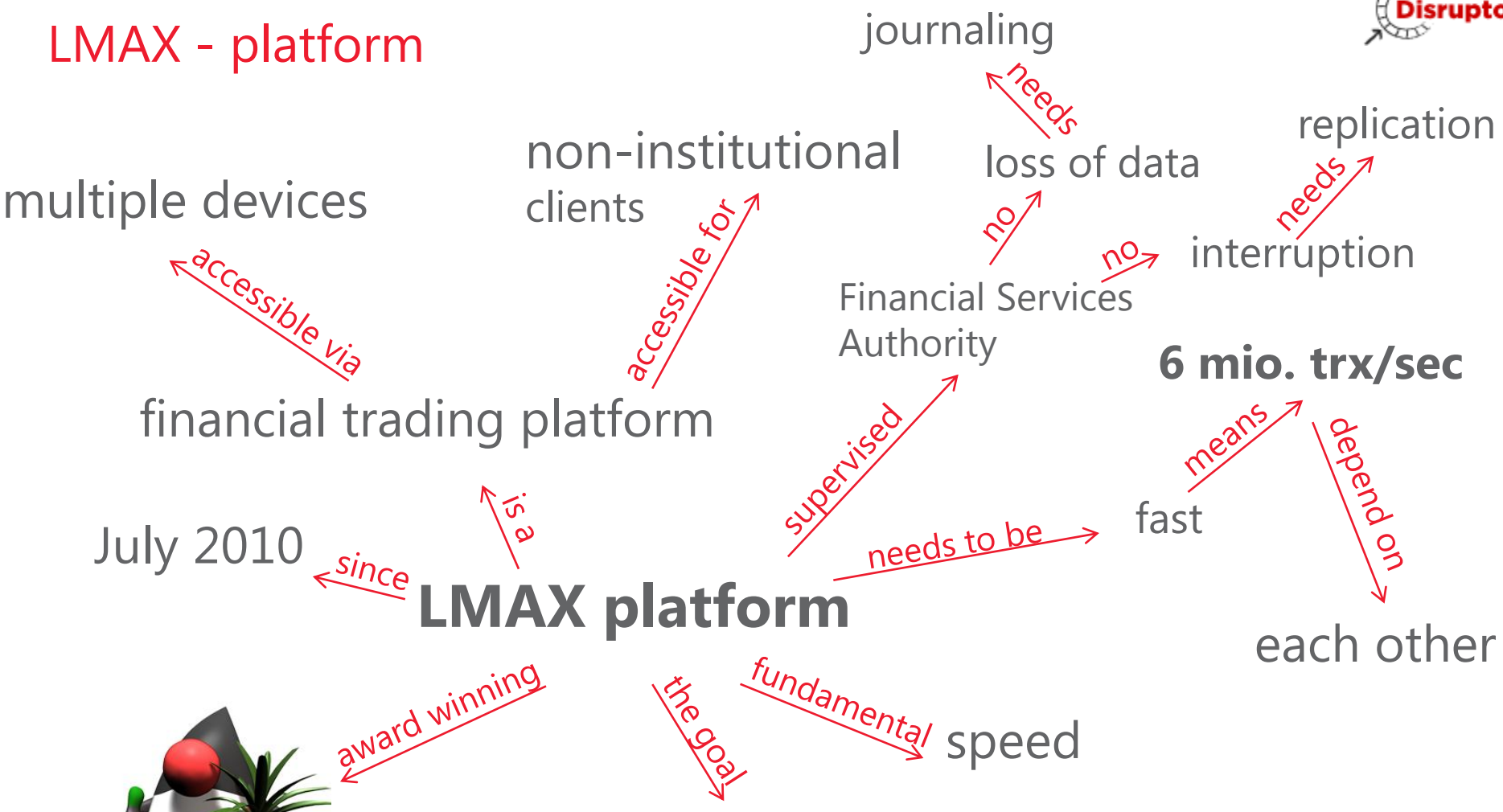
AGENDA

1. About LMAX
2. How to tackle 6’000’000 transactions/second
3. The Disruptor

Where does the Disruptor come from?

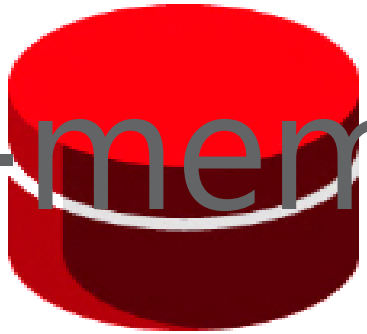
It was initially designed to setup a trading platform called LMAX.

LMAX - platform



How NOT to take 6'000'000 transactions per second?

in-memory



How to tackle 6 mio. transactions / second

Software Transactional Memory

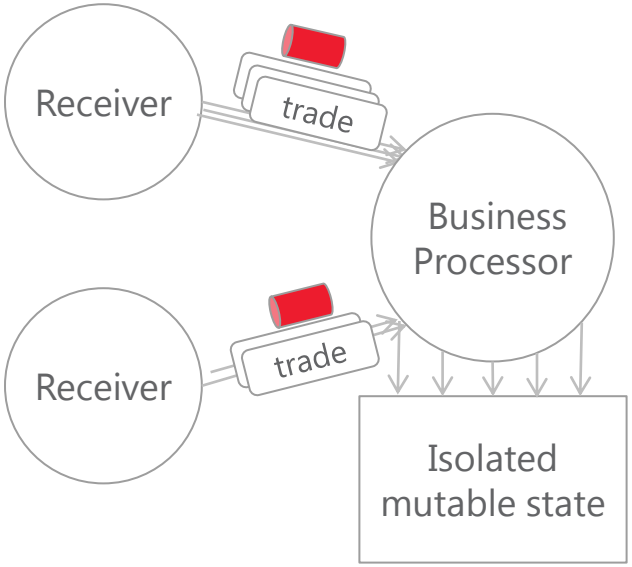
```
Ref<Integer> ref = new Ref<Integer>(0);

Atomic<Integer> atomic = new
                    Atomic<Integer>() {

  public Integer atomically() {

    final int inc = ref.get() + 1;

    ref.set(inc);

    return inc;

  }

};

atomic.execute();
```

- Turns Java heap into a transactional data set
- **A**tomicity
- **C**onsistency
- **I**solation: Serializable

does not scale

How to tackle 6 mio. transactions / second

Actors



- Message passing between threads
- Queueing of messages
- Single-threaded BusinessProcessor

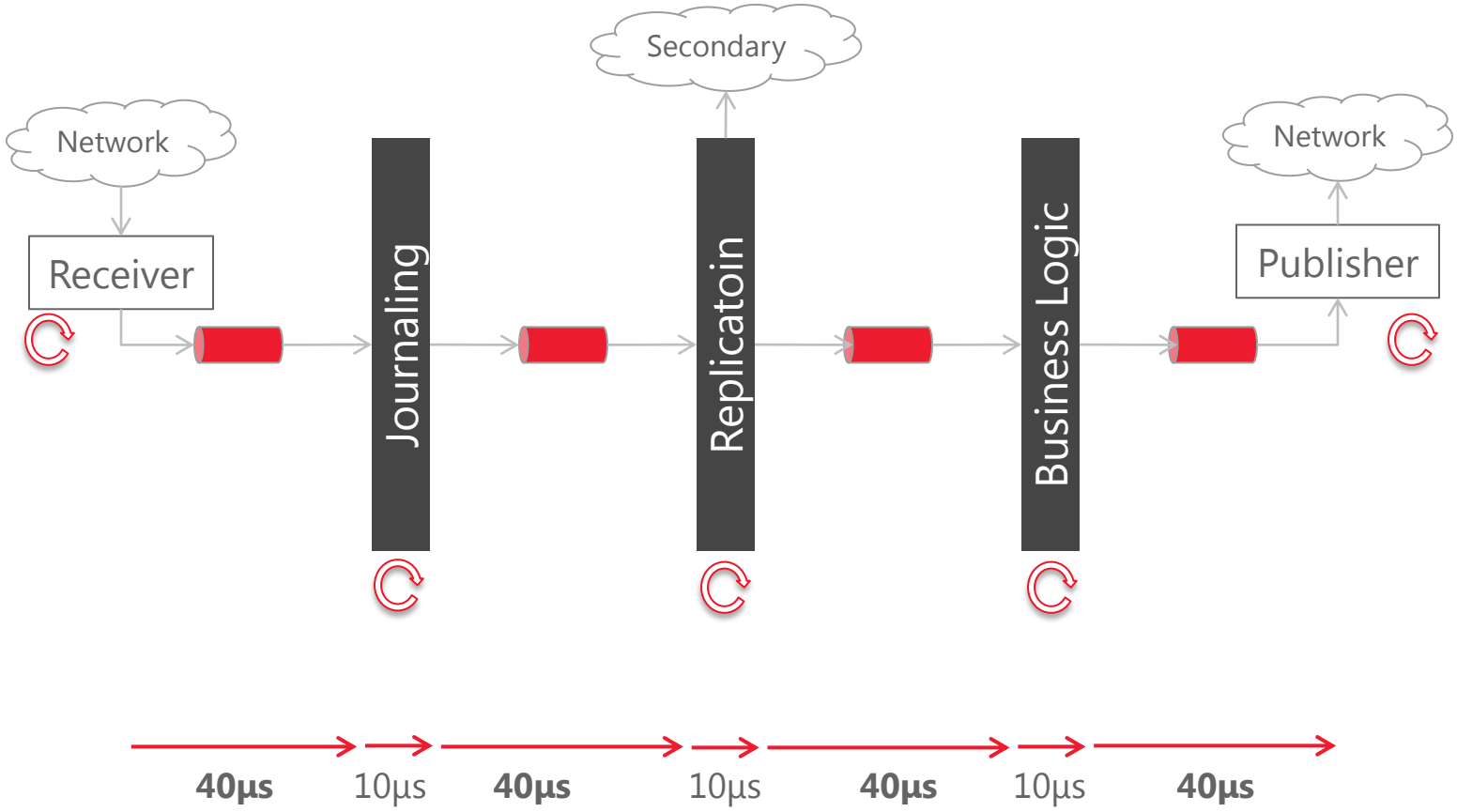
heavy contention on queues

no guarantee for the sequence of events

low predictable latency

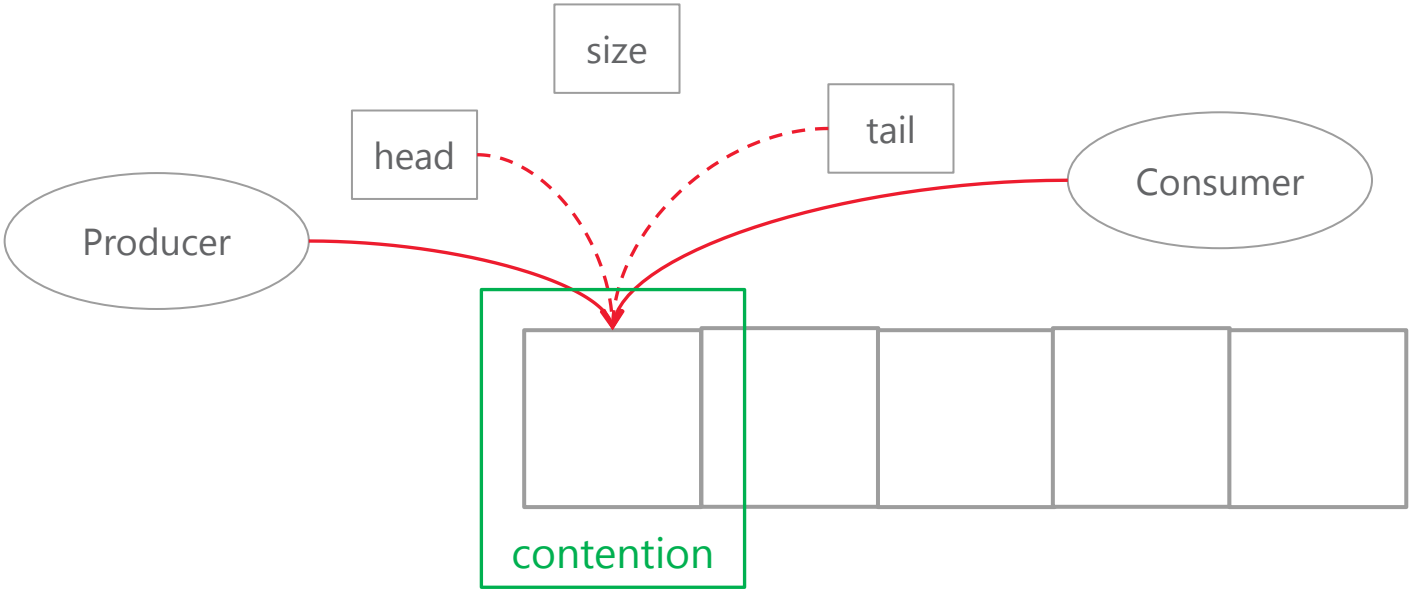
How to tackle 6 mio. transactions / second

Staged Event Driven Architecture



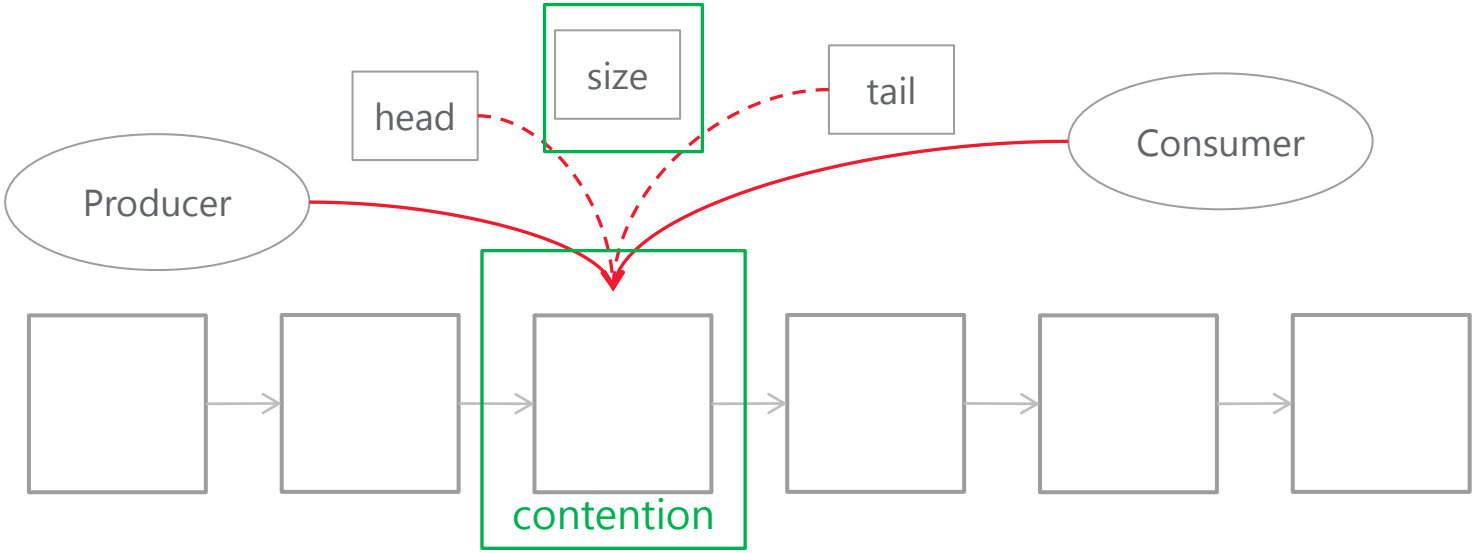
Why queues suck – Array backed

- Queues are never in steady state → **contention** on last or first element
- Head, tail may occupy same cache line → false sharing



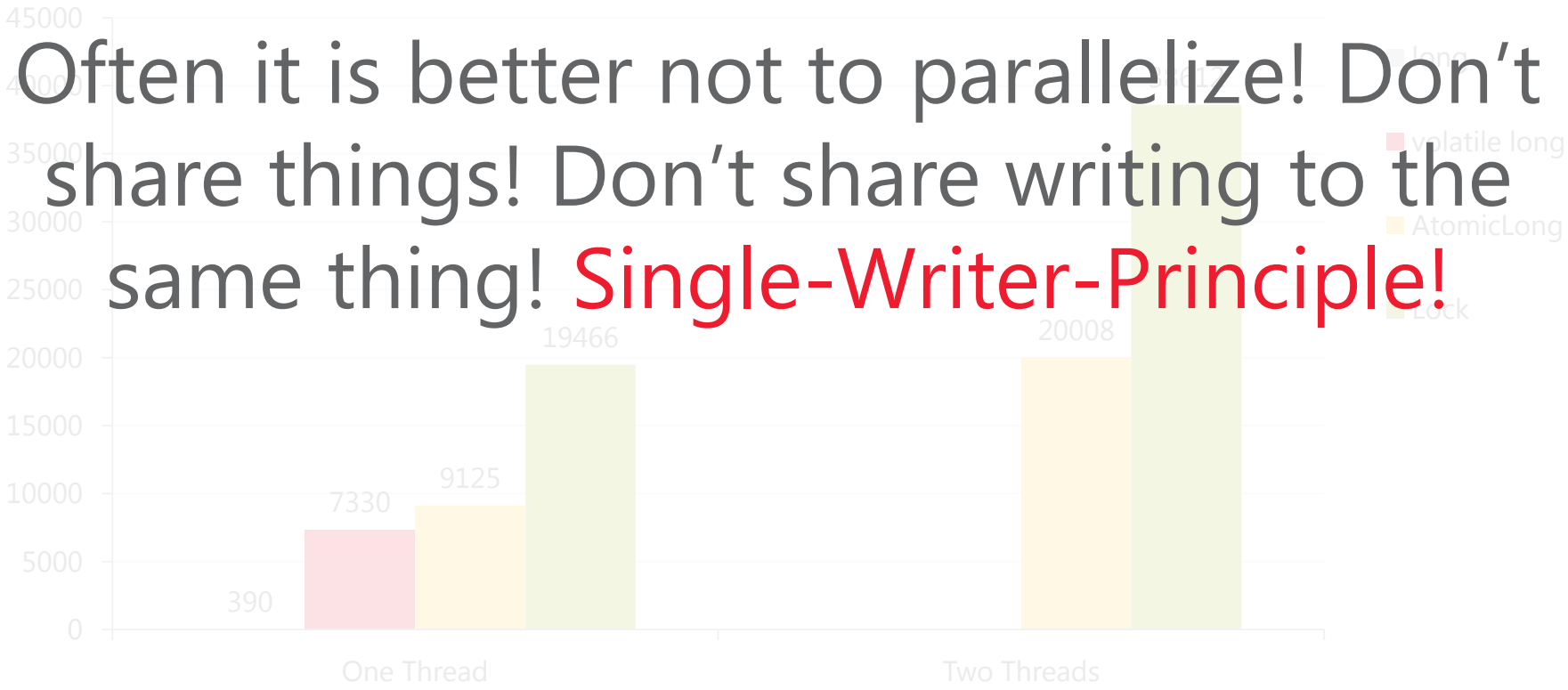
Why queues suck – LinkedList

- Not contiguous → do not support striding (prefetching)
- Needs to be bounded → contention on the size variable



Costs of contention

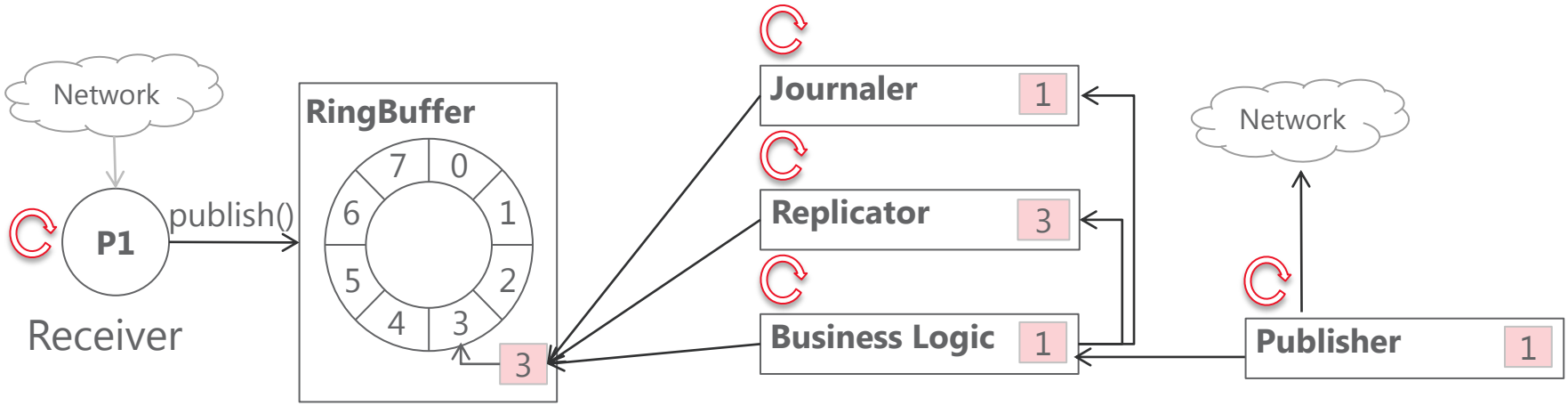
Incrementing a counter 500 000 000 times.



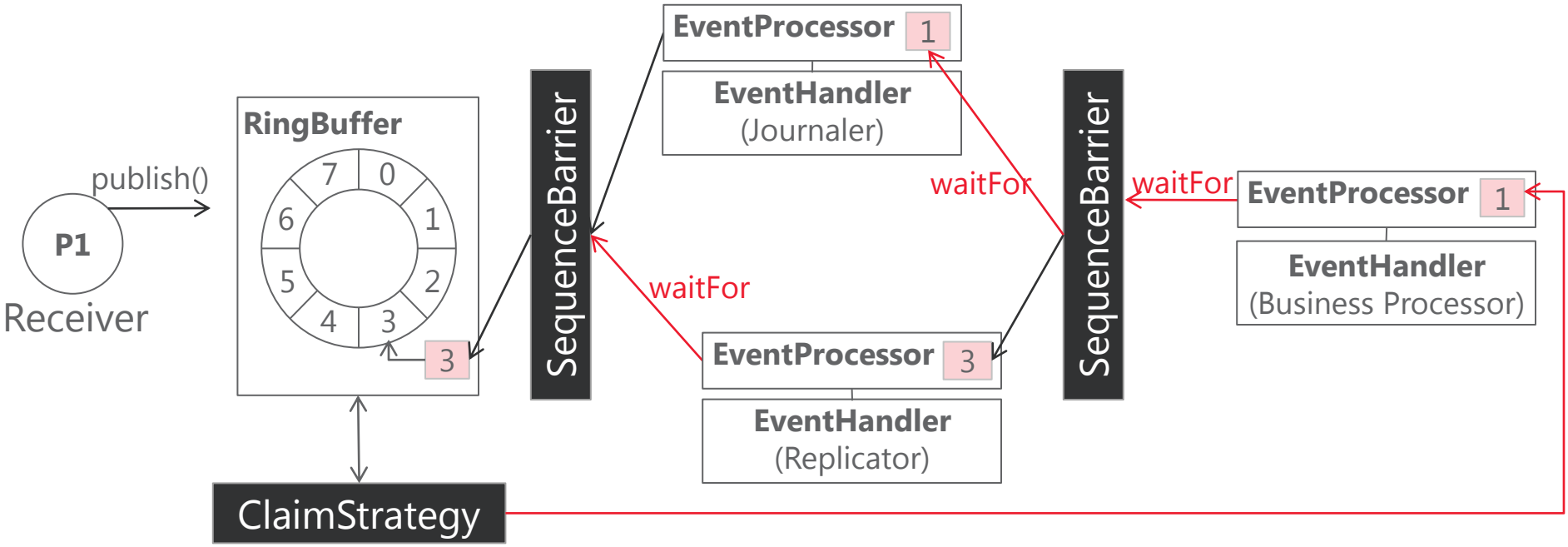
Often it is better not to parallelize! Don't share things! Don't share writing to the same thing! Single-Writer-Principle!

Results in milliseconds, run on a Intel Nehalem 2.93GHz

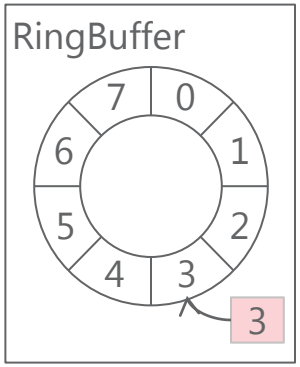
The Disruptor – contention-free design



The Disruptor – contention-free design



The Disruptor – RingBuffer

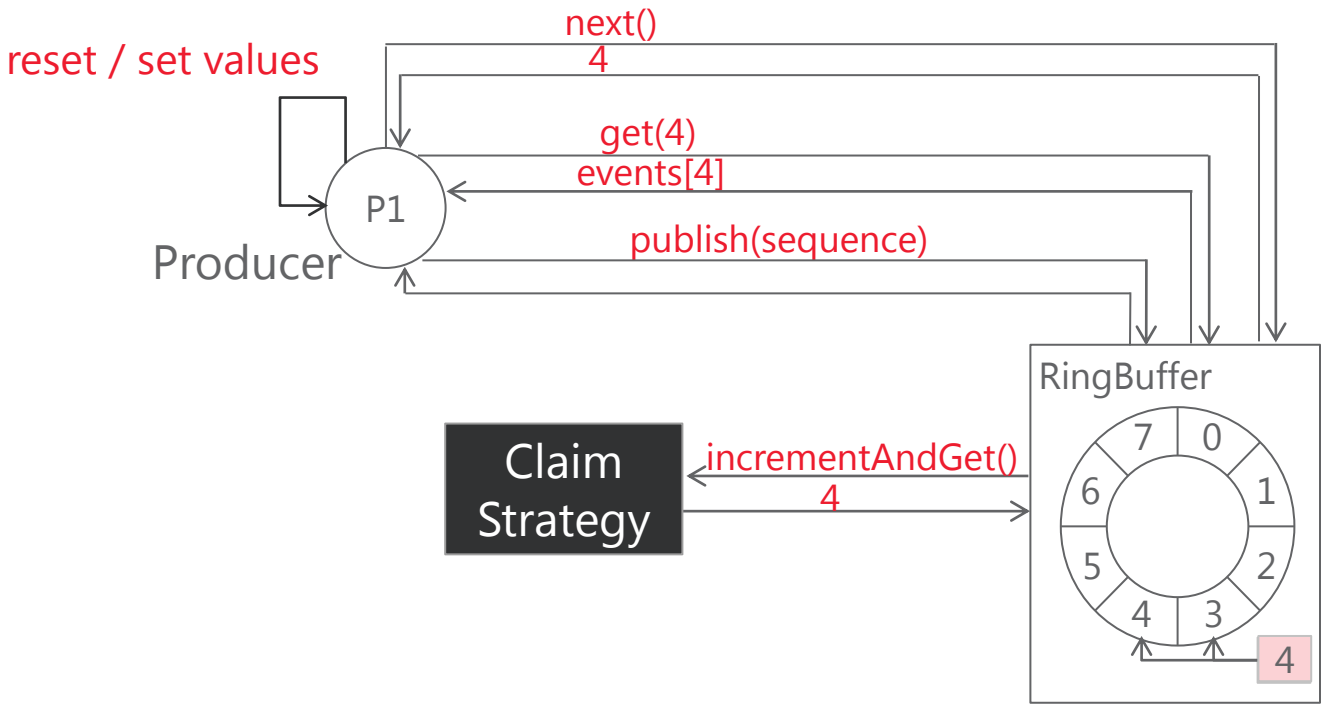


- **Garbage friendly**
- Based on an Array
  - Linear memory access → **prefetching**
  - Multiple entries per cache line
- Reliable messaging
- **Only** the thread writing to the RingBuffer is updating the cursor (Single-Writer-Principle)

Entries created once per slot

Only producers update the cursor

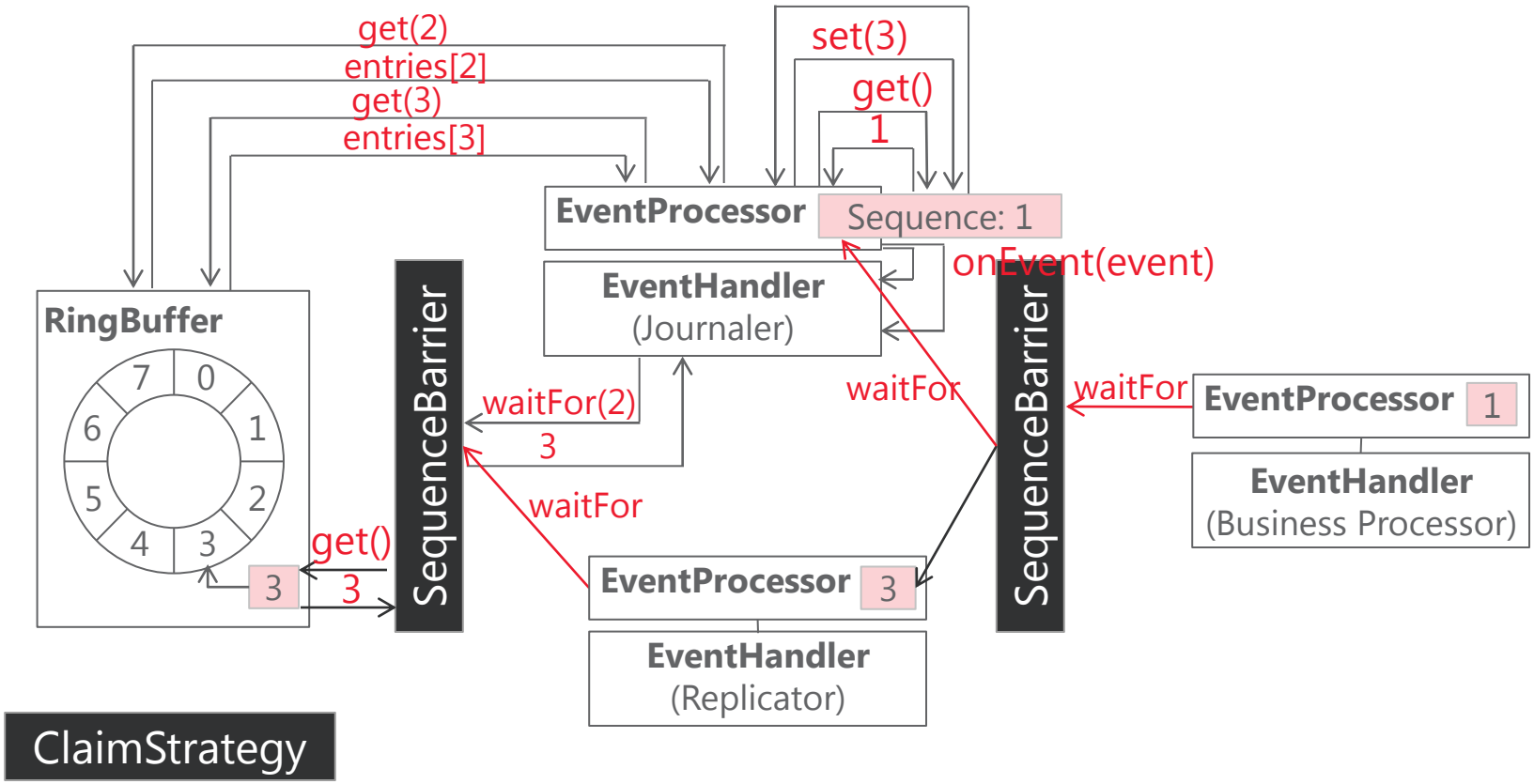
The Disruptor – writing to the RingBuffer



Two-Phase-Commit: claim, publish

ClaimStrategy inhibits wrapping

The Disruptor – Reading from the RingBuffer



Fields on a event should be written by only one EventProcessor!

Setup the Disruptor

```
RingBuffer<TradeEvent> buffer = new RingBuffer<TradeEvent>(
                                        eventFactory,
                                        claimStrategy,
                                        waitStrategy);

SequenceBarrier ringBarrier   = buffer.newBarrier();
```

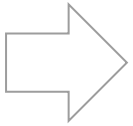
```
BatchEventProcessor<TradeEvent> replication = new BatchEventProcessor<TradeEvent>(
                                                  buffer,
                                                  ringBarrier,
                                                  new ReplicationHandler());
BatchEventProcessor<TradeEvent> journaling = new BatchEventProcessor<TradeEvent>(
                                                  buffer,
                                                  ringBarrier,
                                                  new JournalingHandler());
```

```
SequenceBarrier journalingReplicationBarrier = buffer.newBarrier(
                                                   replProcessor.getSequence(),
                                                   journProcessor.getSequence());
```

Publish messages

```
BatchEventProcessor<TradeEvent> businessLog = new BatchEventProcessor<TradeEvent>(
                                                    buffer,
                                                    journalingReplicationBarrier,
                                                    blHandler);
buffer.setGatingSequences(businessLog.getSequence());
```

```
long sequence = buffer.next();
buffer.get(sequence).setValue(i);
buffer.publish(sequence);
```



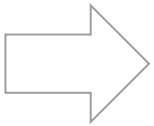
2-phase commit

Setup the Disruptor using the DSL

```
Disruptor<TradeEvent> disruptor = new Disruptor<TradeEvent>(
                                        TradeEvent.EVENT_FACTORY,
                                        EXECUTOR,
                                        claimStrategy,
                                        waitStrategy);
```

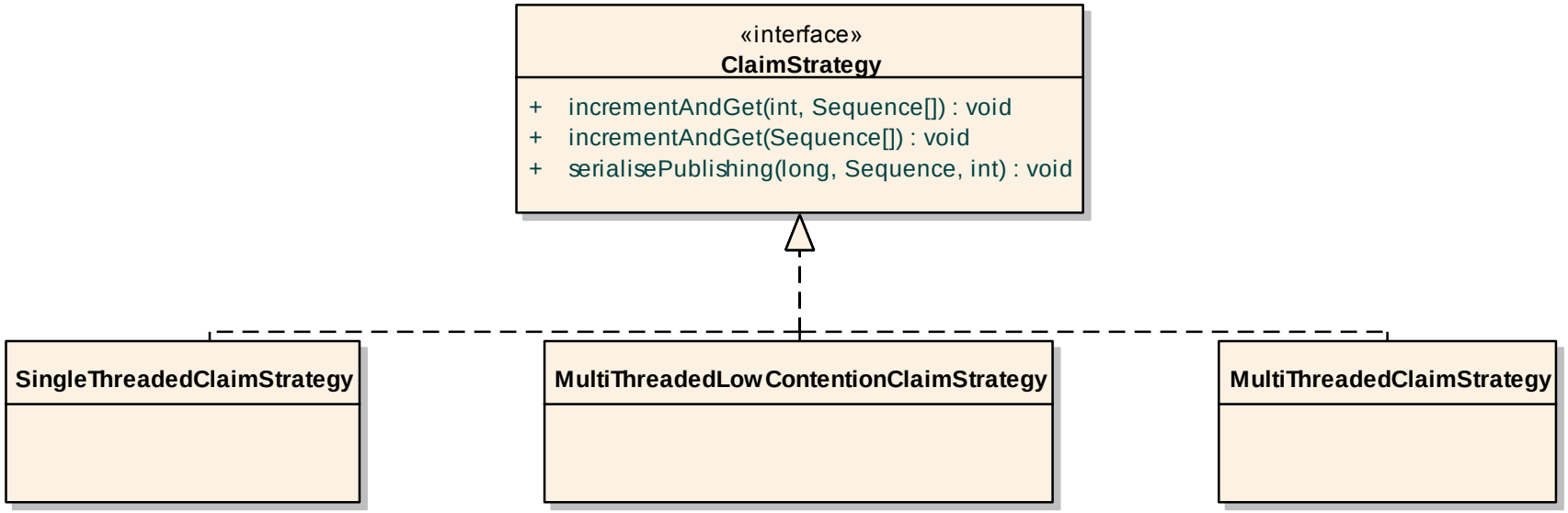
```
disruptor.handleEventsWith( new ReplicationHandler(), new JournalingHandler())
                    .then(  new BusinessLogicHandler());

disruptor.start();
```

```
disruptor.publishEvent(eventTranslator);
```



implicit Two-Phase-Commit

Which ClaimStrategy should I use?

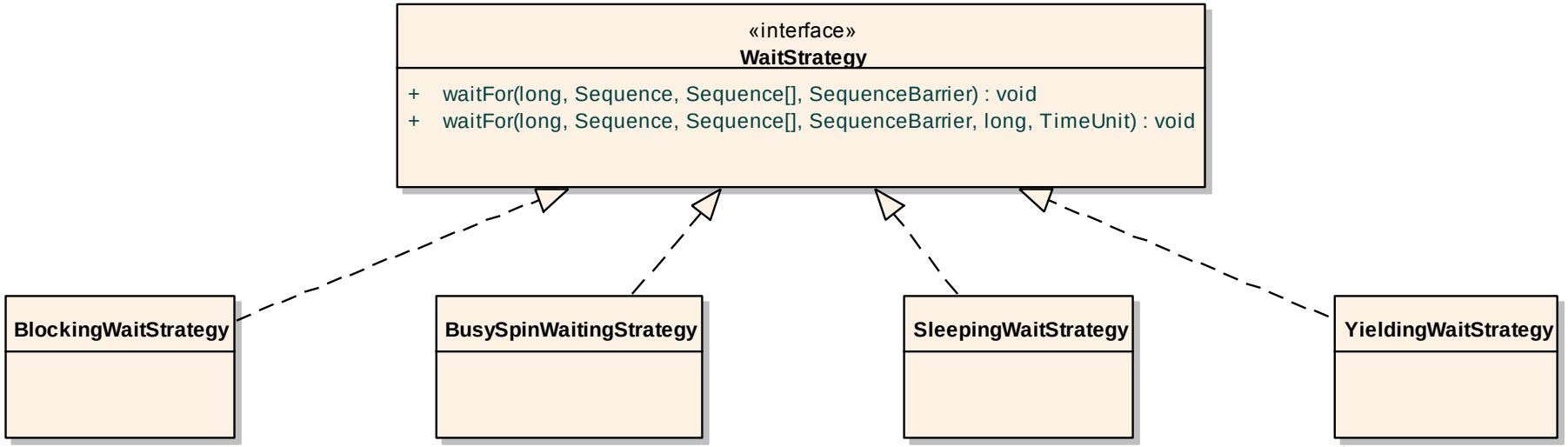


- assumes that **no one else** is publishing to the RingBuffer
- **doesn't use Compare and Swap (AtomicLong) for sequencing**

- assumes that there are **multiple publishers**
- based on an **AtomicLong**

- assumes that there are **multiple publishers**
- forgives when the multiple publisher threads are highly contended
- based on an **AtomicLong**

Decisions to be made - WaitStrategy



Puts current thread to state waiting until requested entry gets available

- ➕ CPU resource
- ➖ Throughput

Spins until requested entry gets available

- ➖ CPU resource
- ➕ Throughput

spin (100 times)→ yield (100 times) → timed waiting

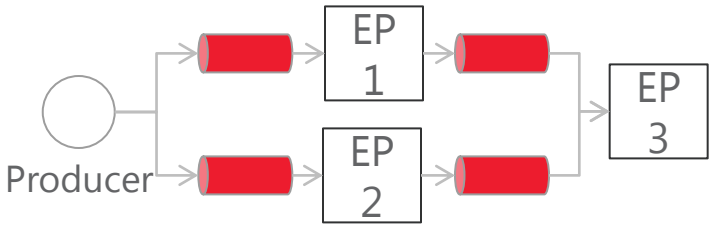
- 〓 CPU resource
- 〓 Throughput

yields current thread

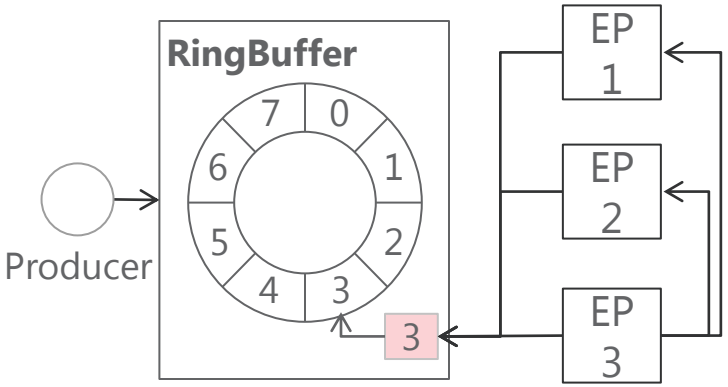
- 〓 CPU resource
- 〓 Throughput

Performance - LinkedBlockingQueue vs Disruptor

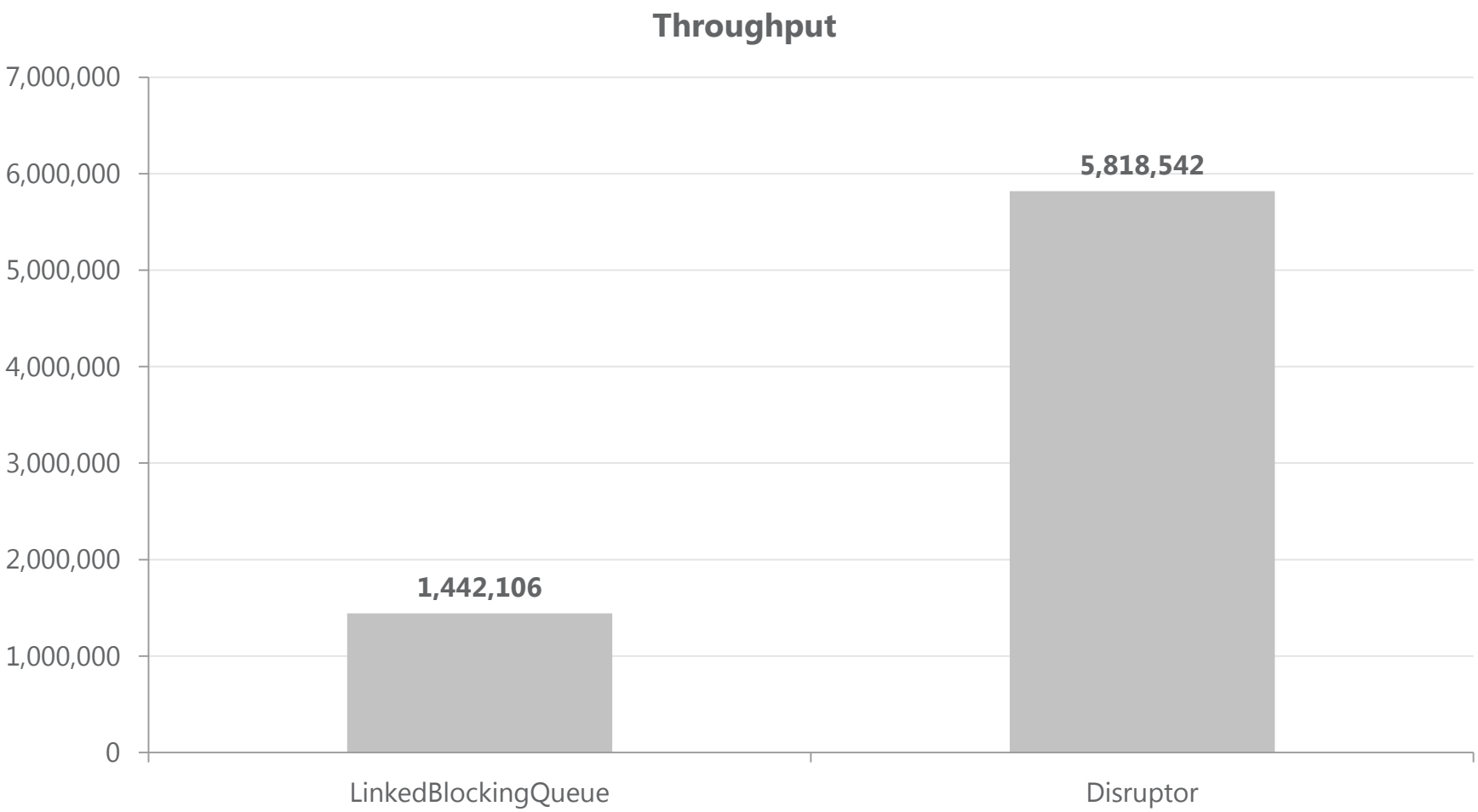
LinkedBlockingQueue



Disruptor



Performance - Throughput



Why is it so fast

1. No Locks
2. minimized use of memory barriers
3. One single place of contention: if multiple producers write to the RingBuffer
4. Multiple producers, consumers share the same data structure
5. Recycling of events→ less garbage → less garbage collection pauses
6. tracking sequences at each place + cache line padding → no false sharing → no unexpected contetion

Sources

- Blogs
  - Martin Thompson
    http://mechanical-sympathy.blogspot.com
  - Michael Barker
    http://bad-concurrency.blogspot.com
  - Trisha Gee
    http://mechanitis.blogspot.com
- Articles
  - Technical Paper
    http://disruptor.googlecode.com/files/Disruptor-1.0.pdf
  - Java Best Practices – Queue battle and the Linked ConcurrentHashMap
    http://www.javacodegeeks.com/2010/09/java-best-practices-queue-battle-and.html
- Presentations
  - Understanding the Disruptor: A Beginners Guide to Hardcore Concurrency
    http://www.youtube.com/watch?v=DCdGIxBbKU4

Questions

THANK YOU.

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