
CERN

Disruptor
Using High Performance, Low Latency Technology in the CERN Control System

ICALEPCS 2015

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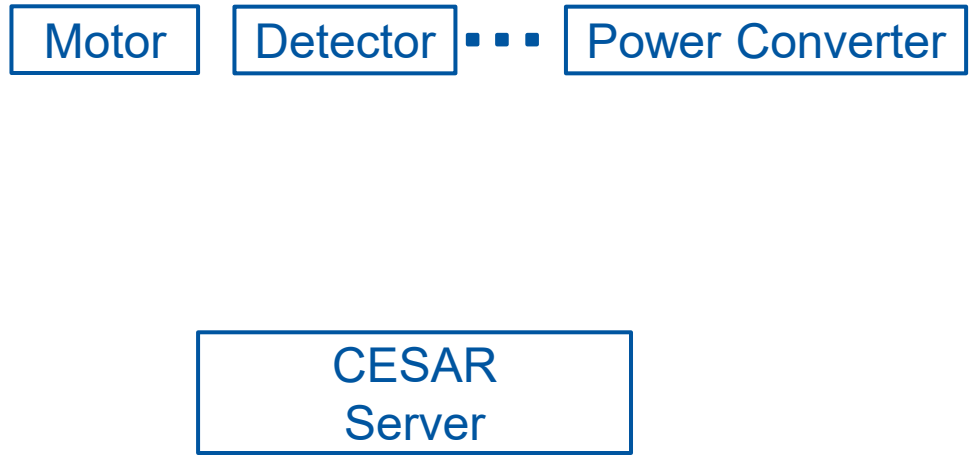

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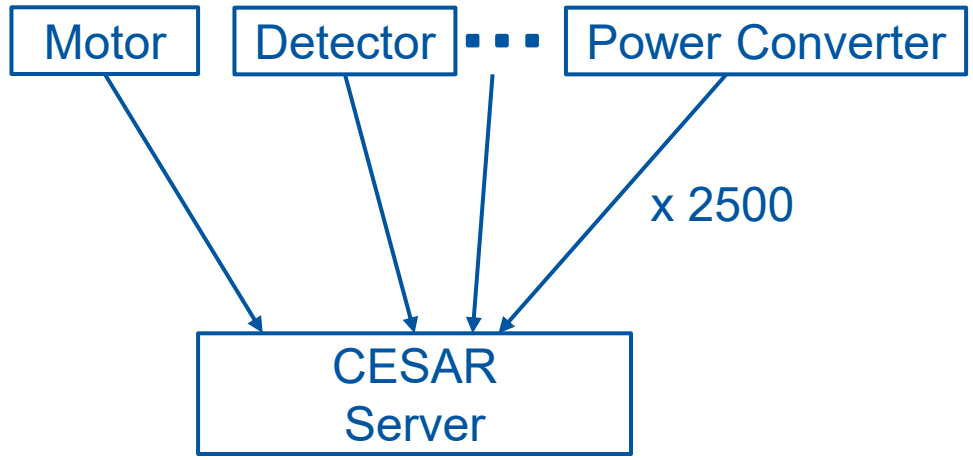

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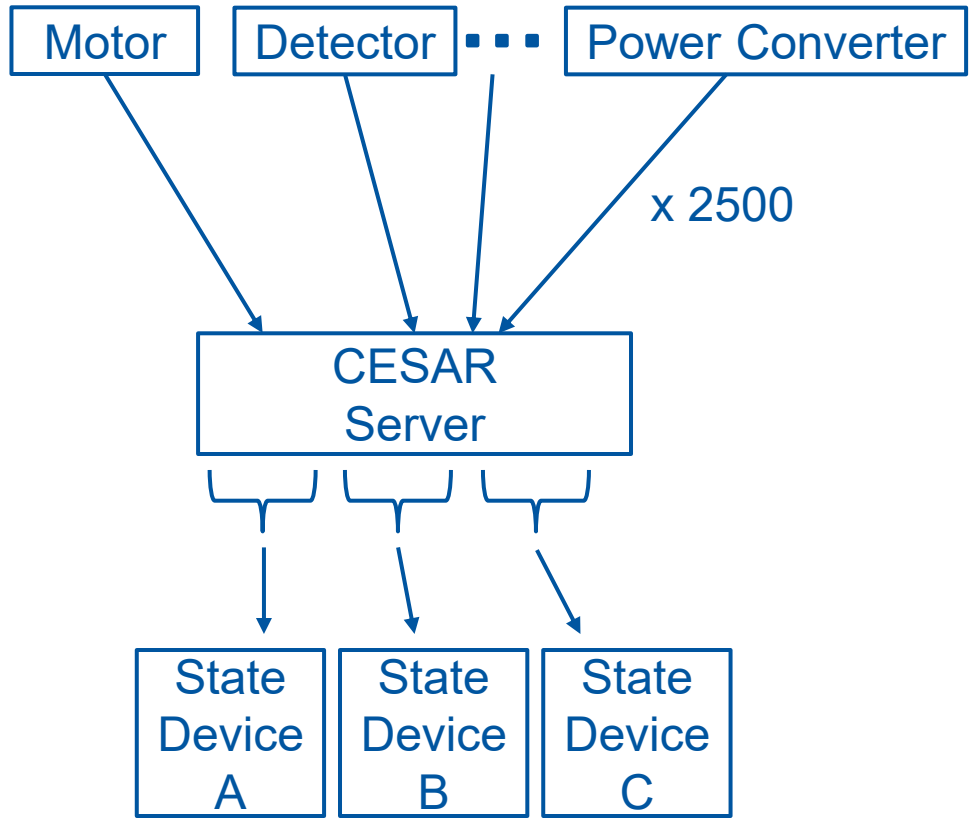
- The business logic on the CESAR server combines the data coming from these streams to calculate device states



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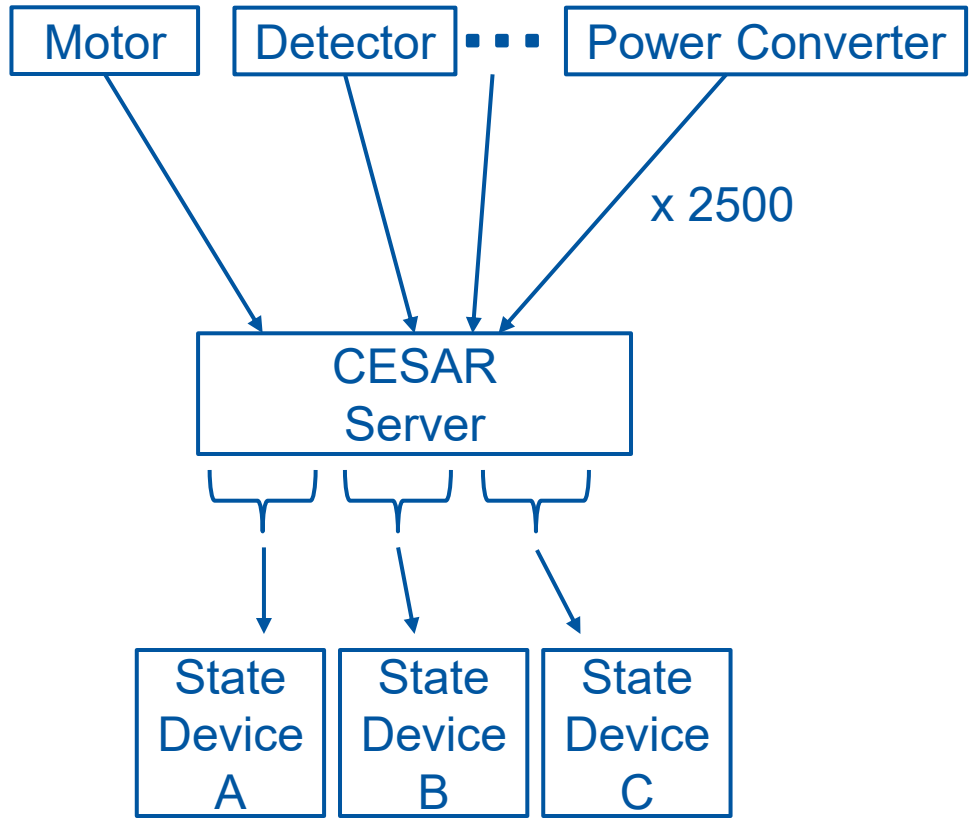
- This concurrent processing must be properly synchronized



What happens when all flows converge?


THE MAGIC ROUNDABOUT
Ring road
Cirencester
A4289
(M4)
Marlborough
Burford
Oxford
Town
centre
A&E
A4312

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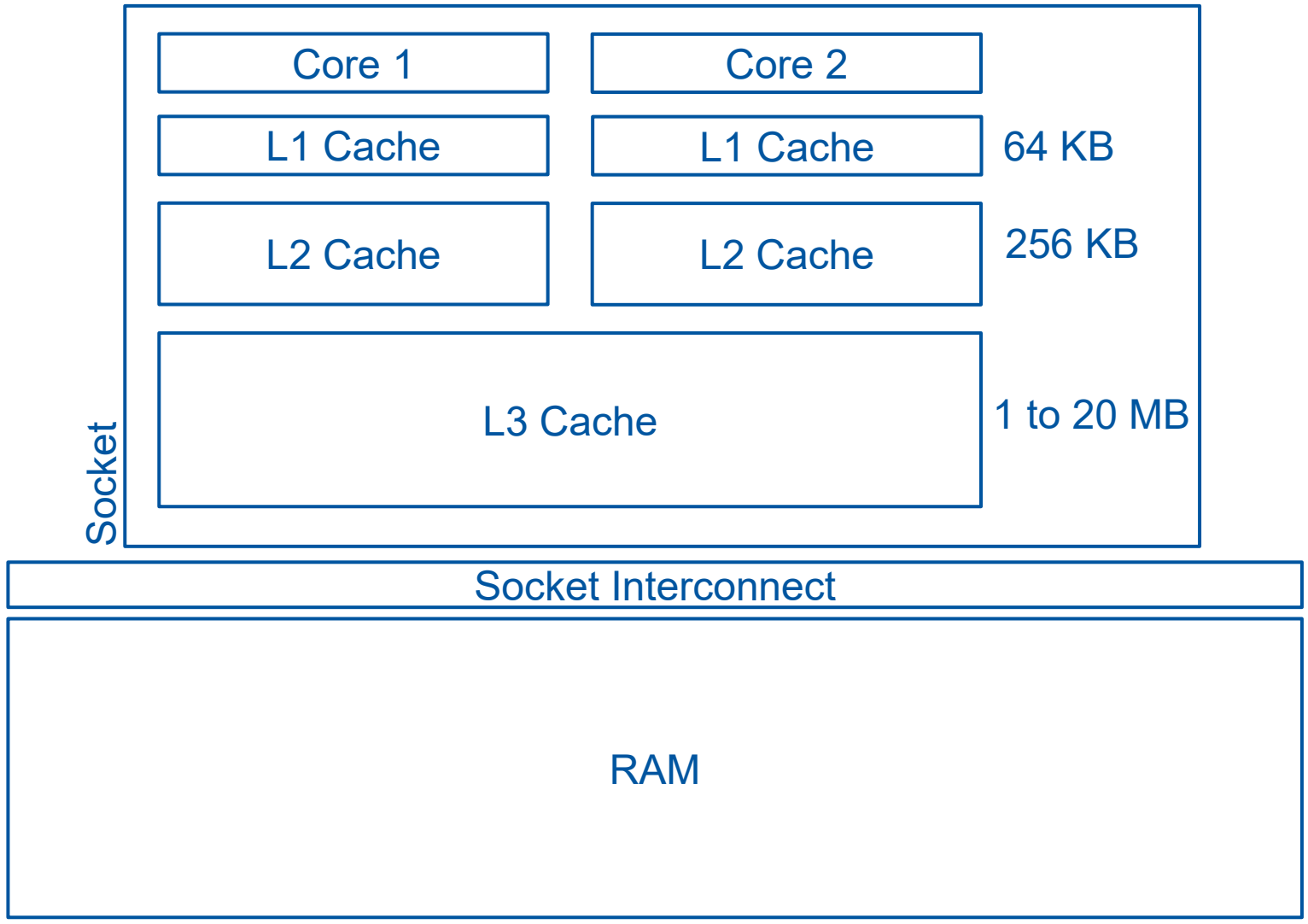
- Created by LMAX, a trading company, to build a high performance Forex exchange
- Is the result of different trials and errors
- Challenges the idea that “CPUs are not getting any faster”
- Designed to take advantage of the architecture of modern CPUs, following the concept of “mechanical sympathy”

Feed the cores – avoid cache misses



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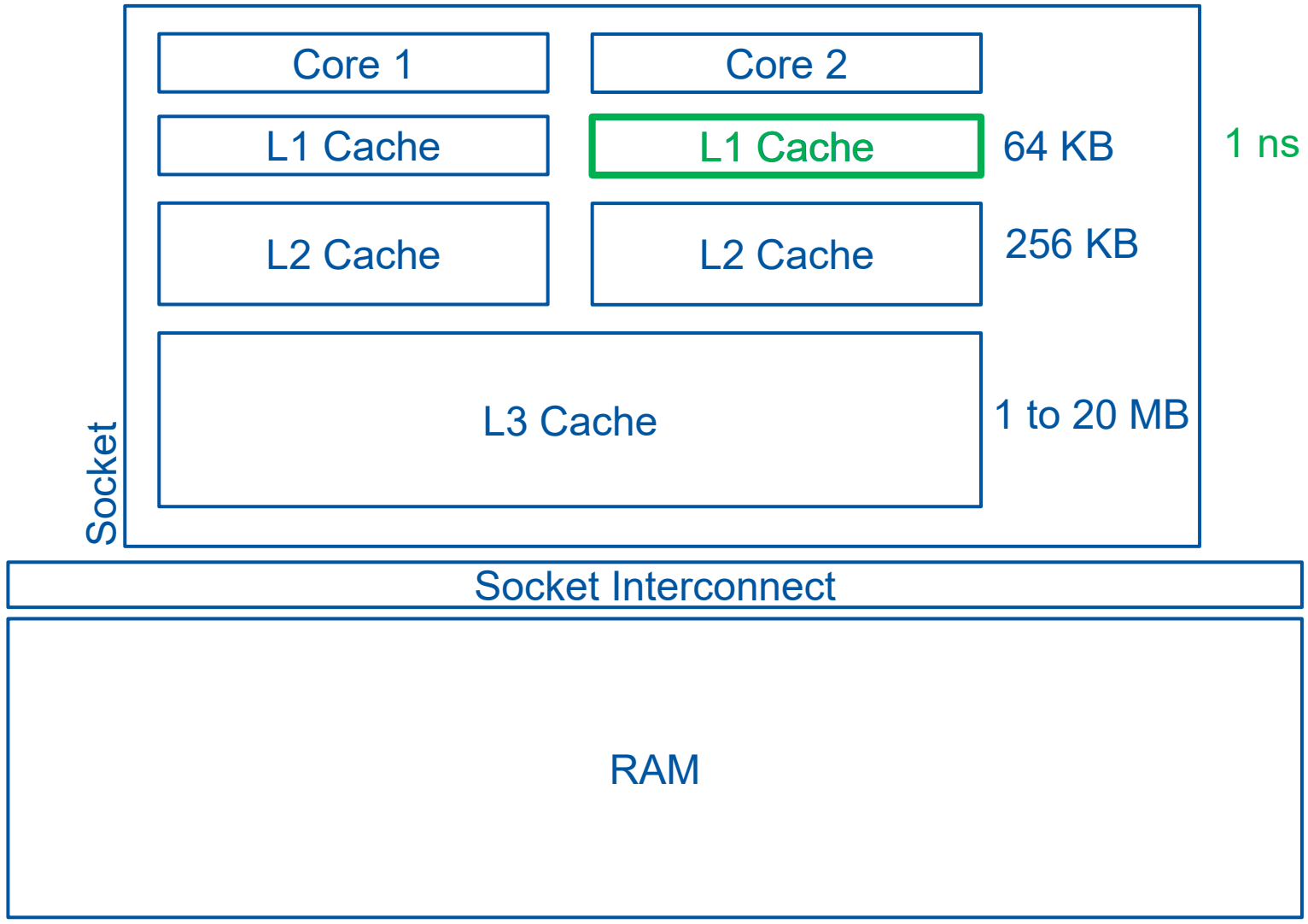

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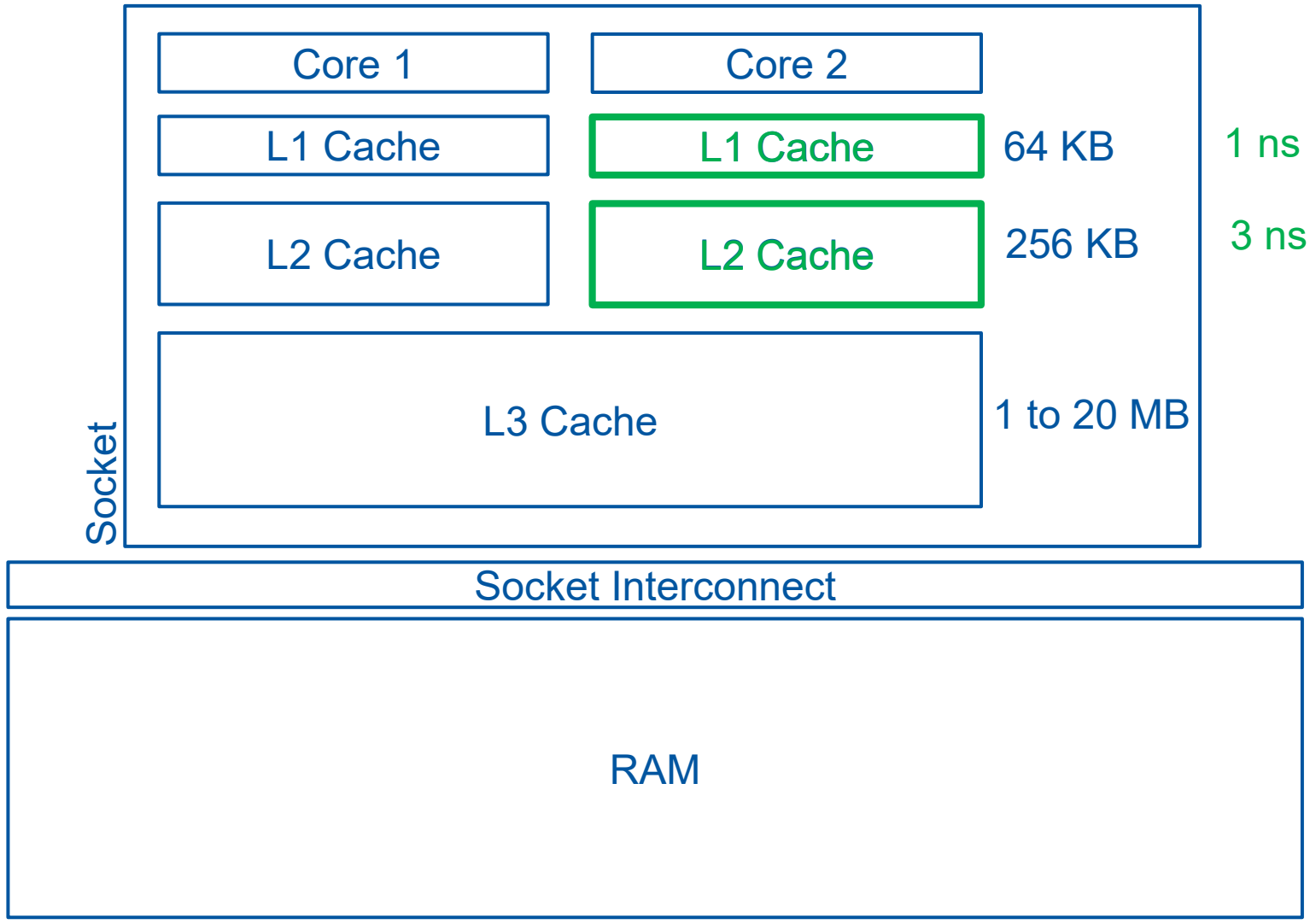

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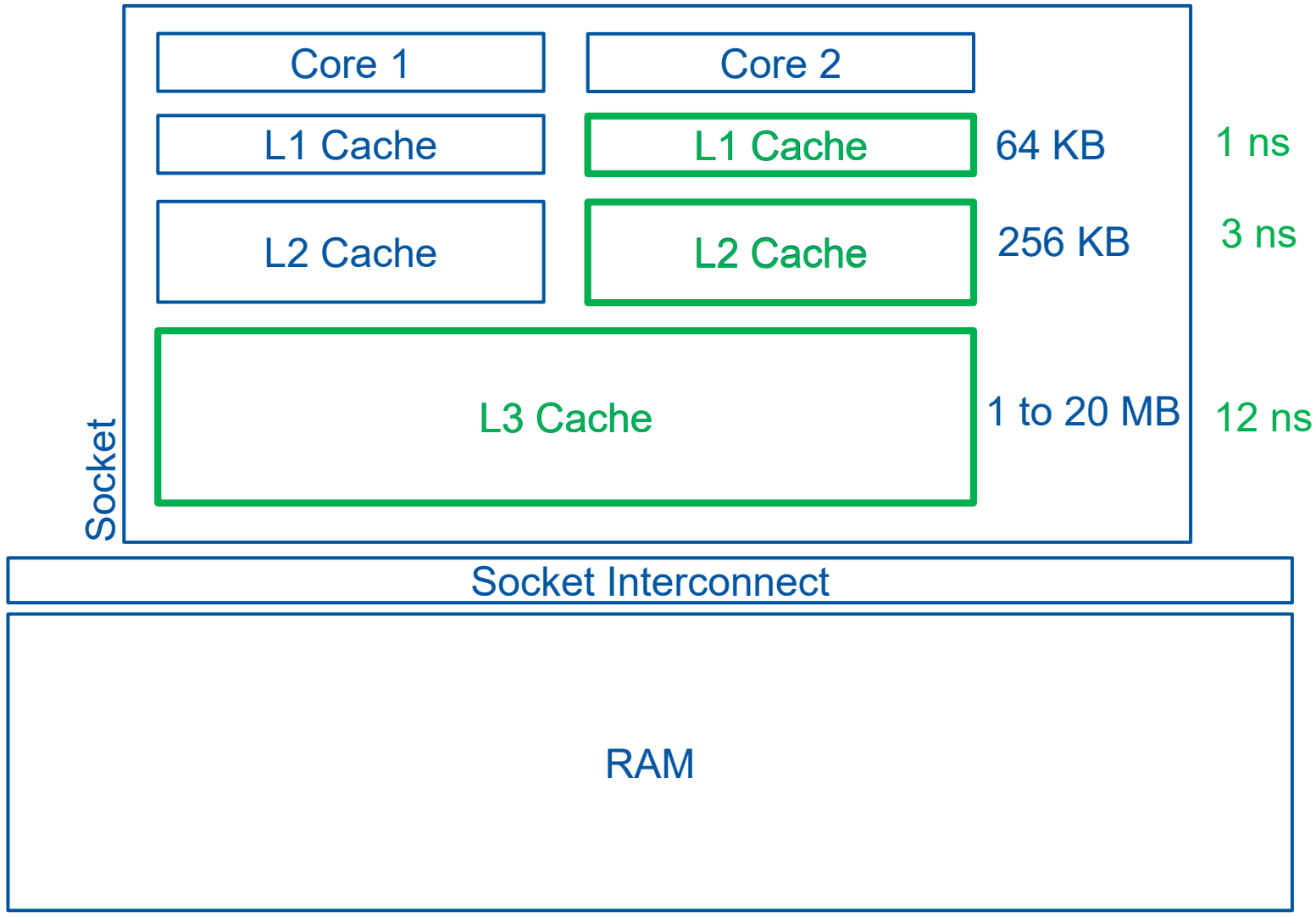

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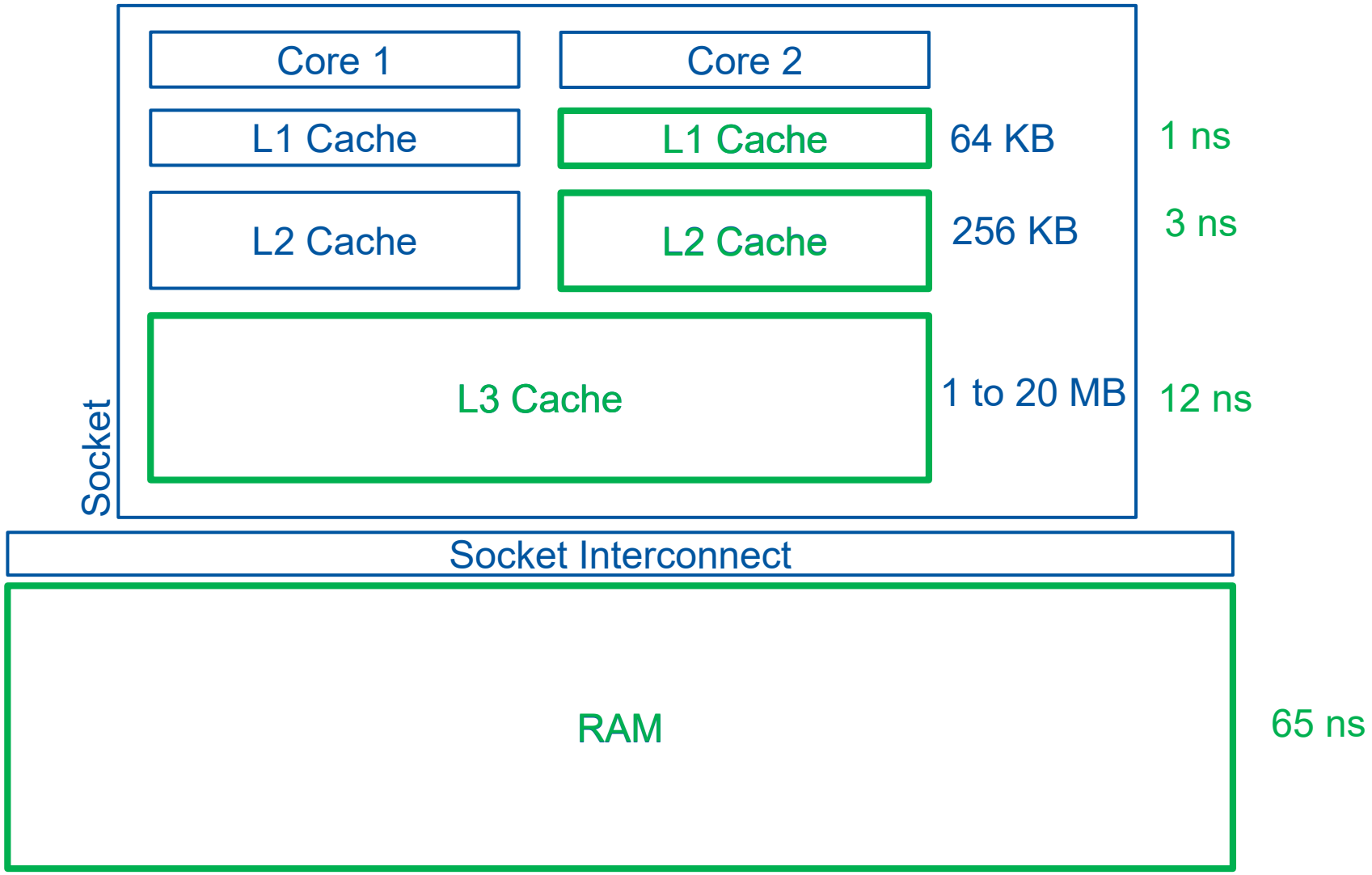
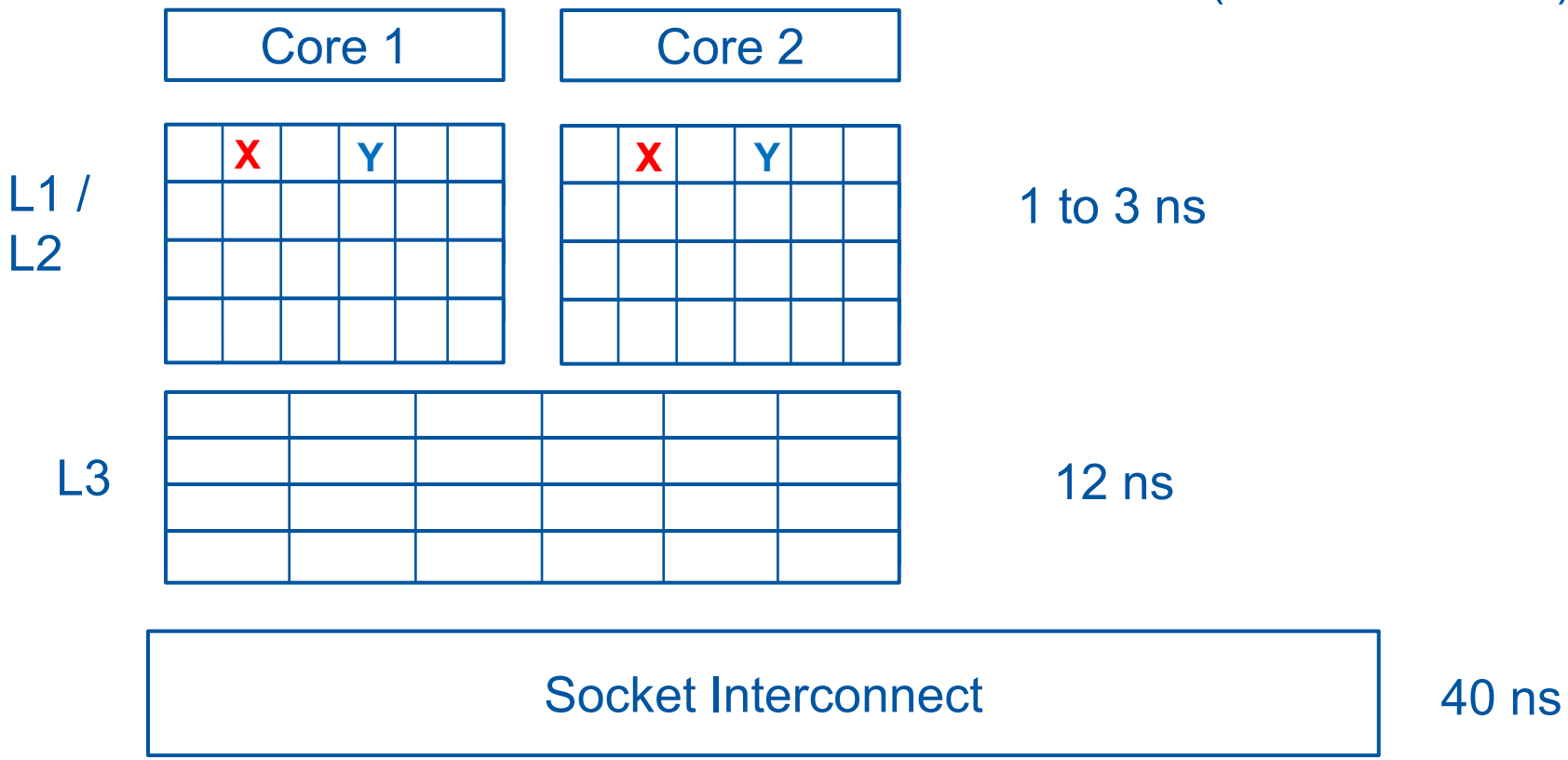


Avoiding false sharing

1 cache line = 64 bytes
(on modern x86)



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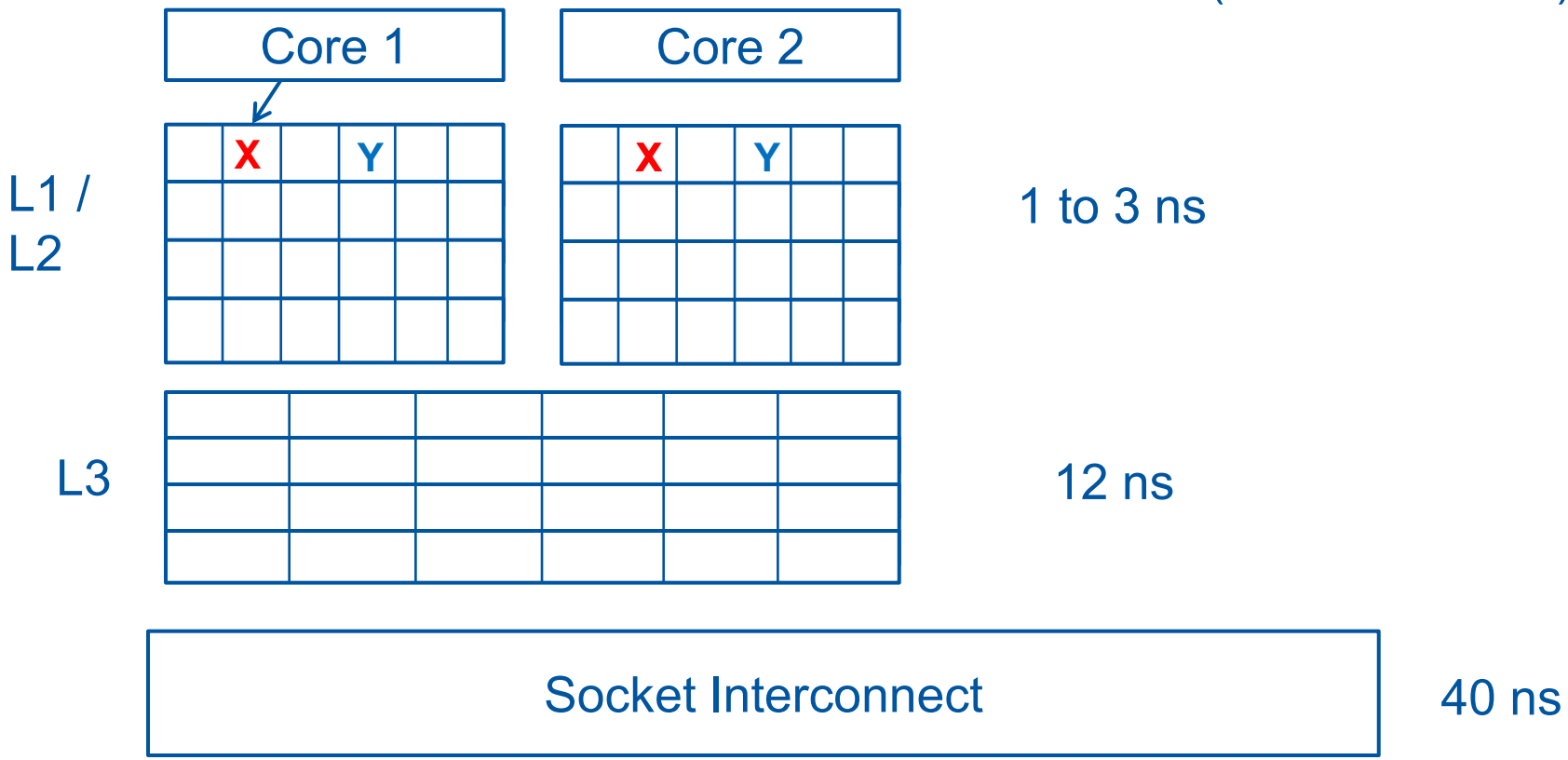

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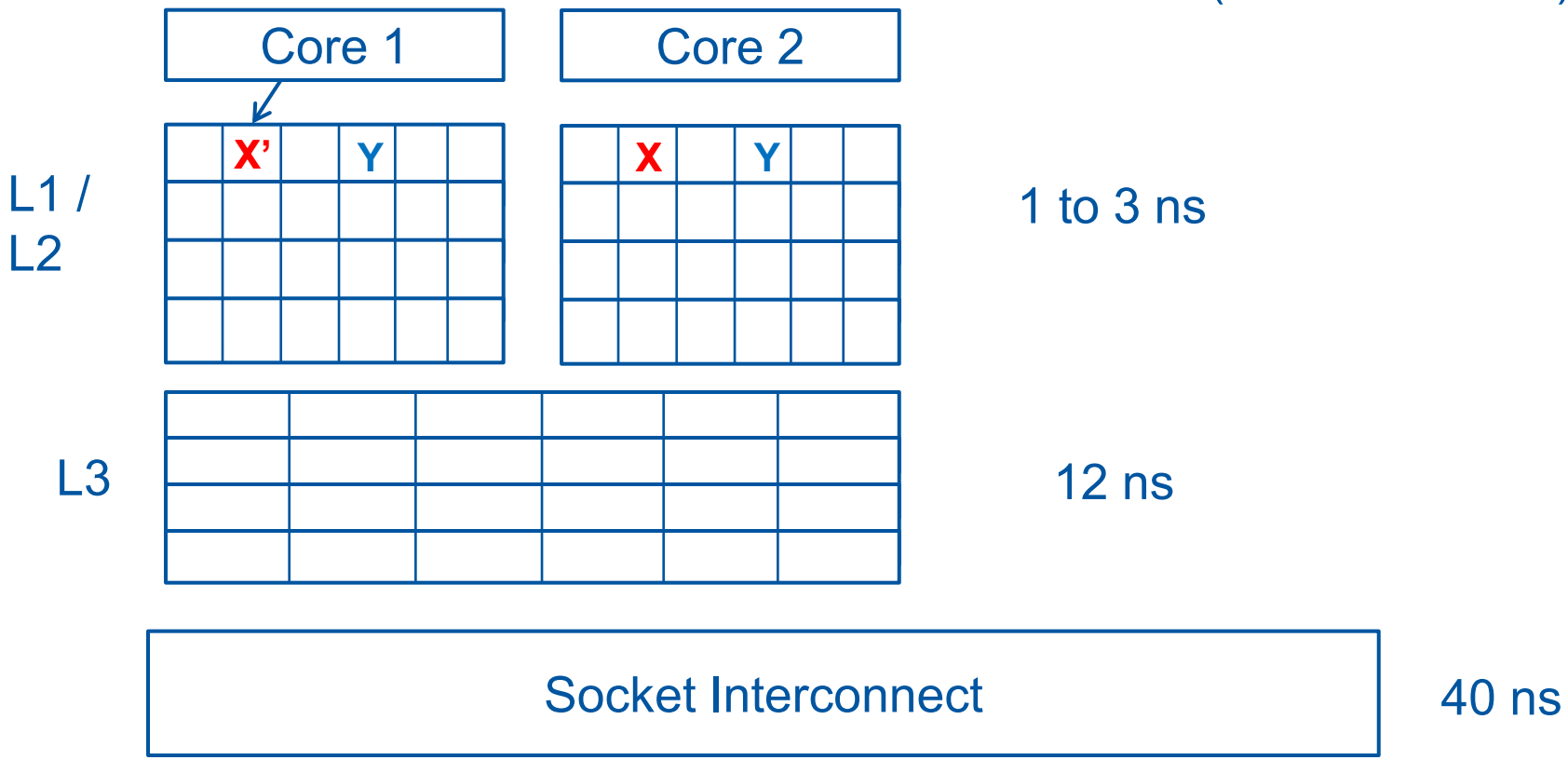

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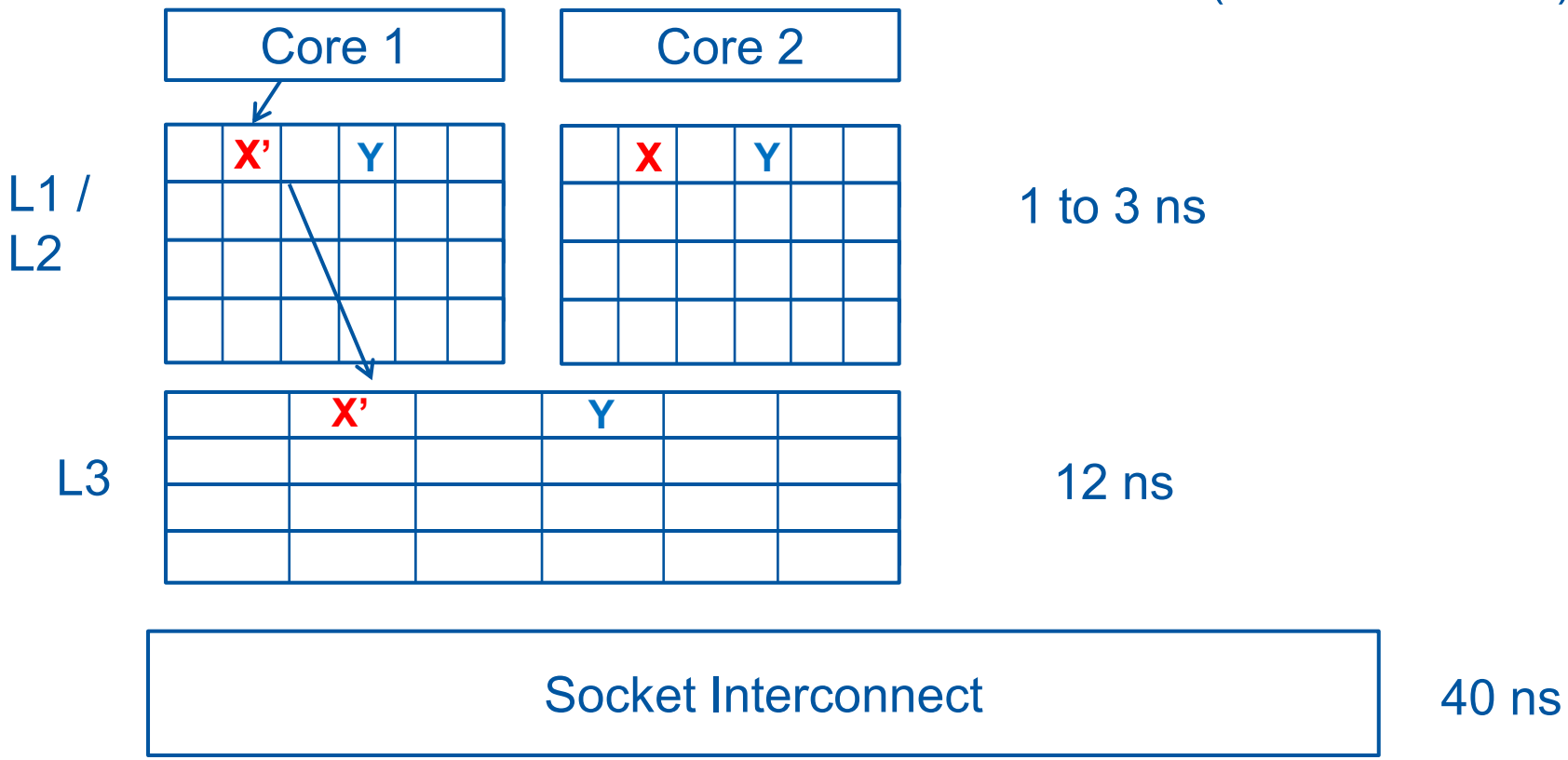

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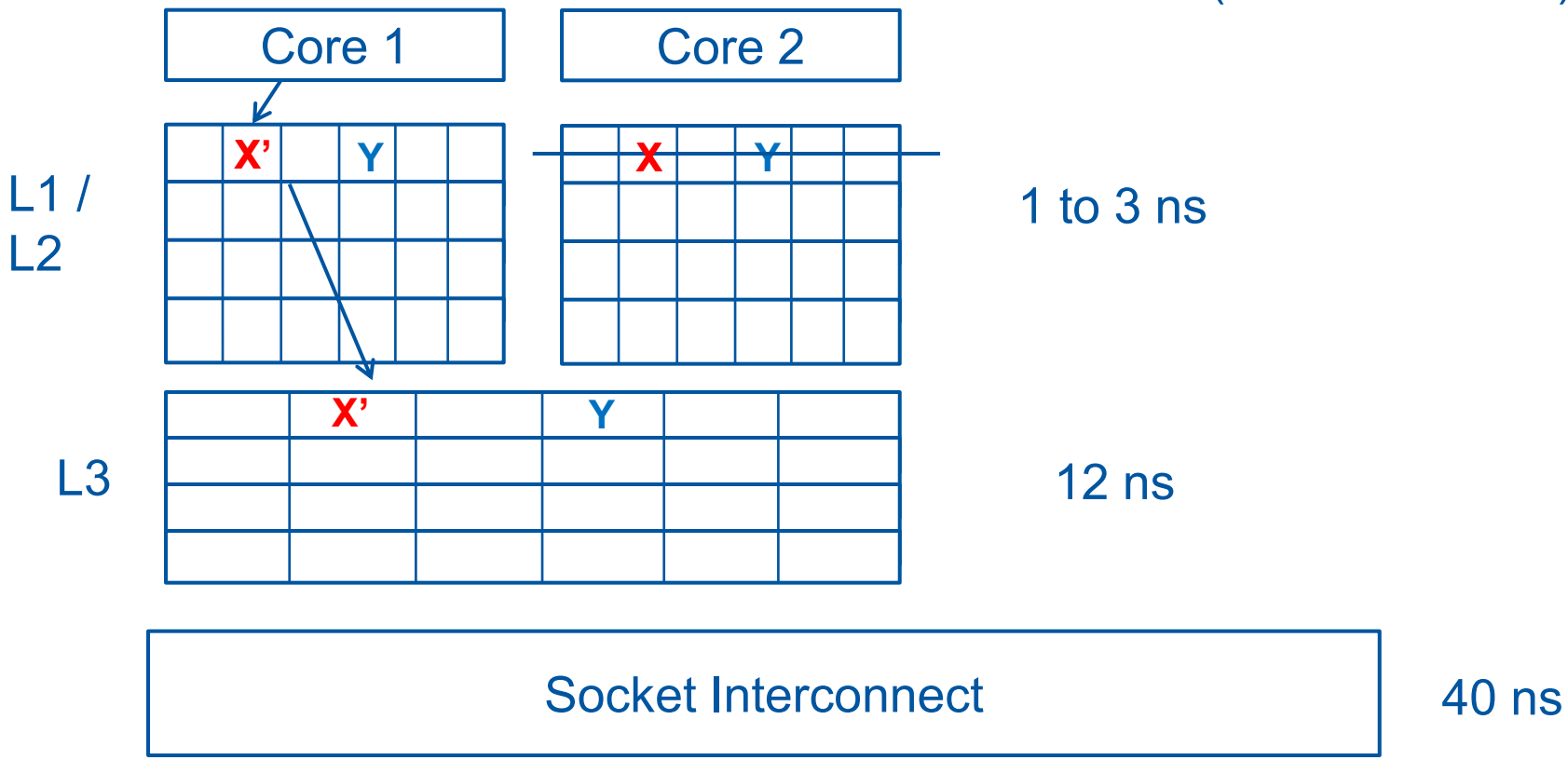

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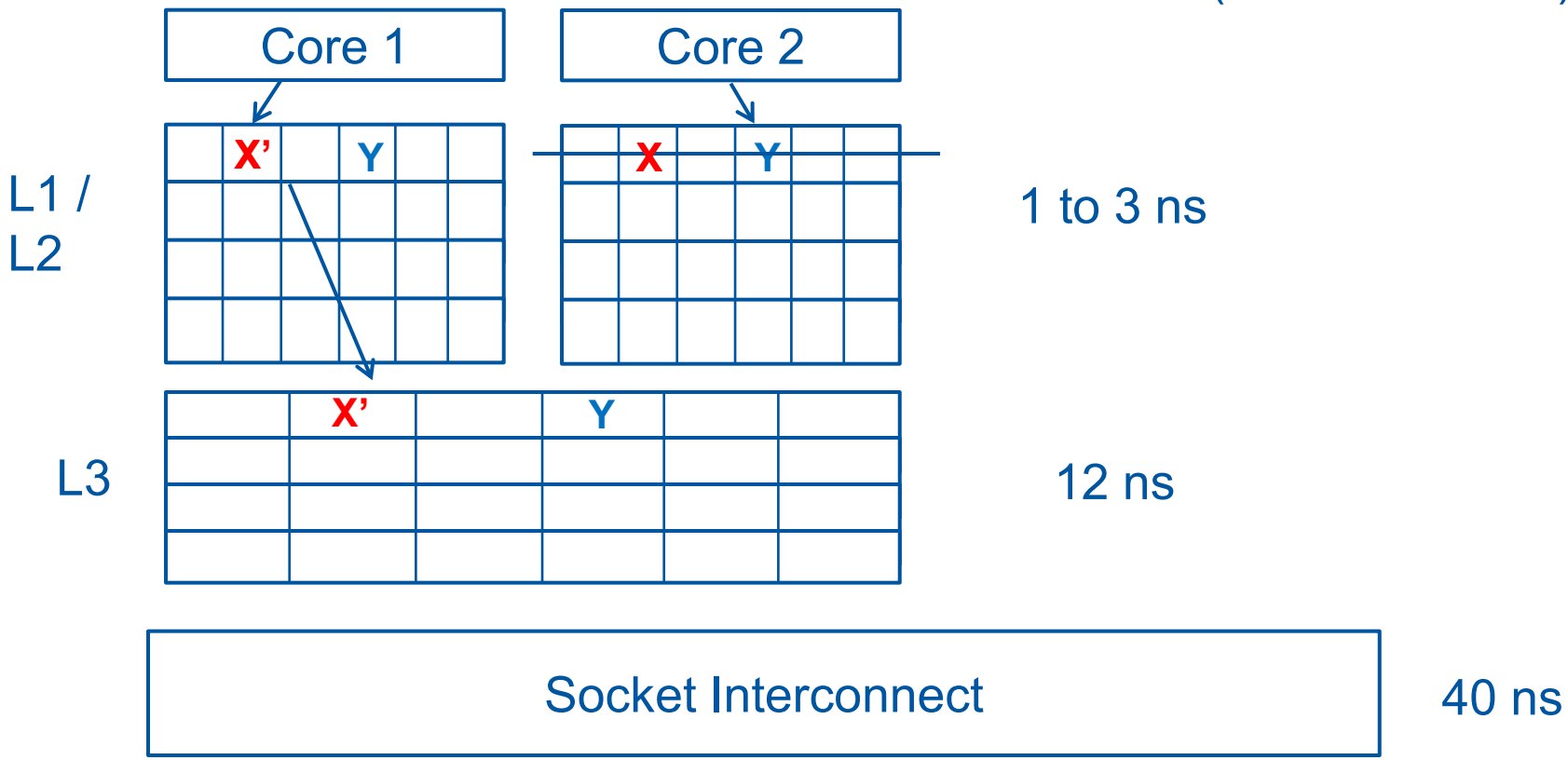

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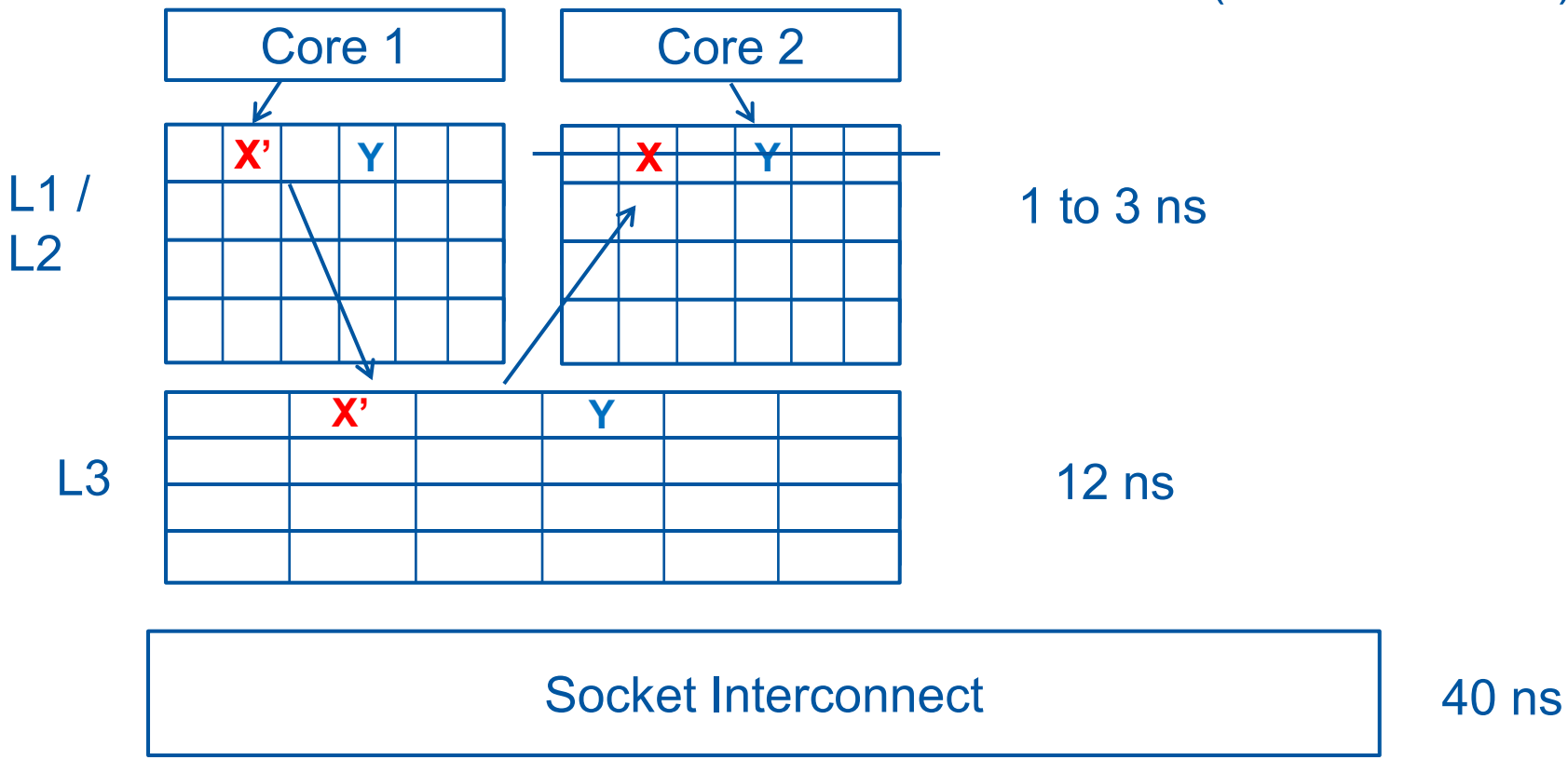

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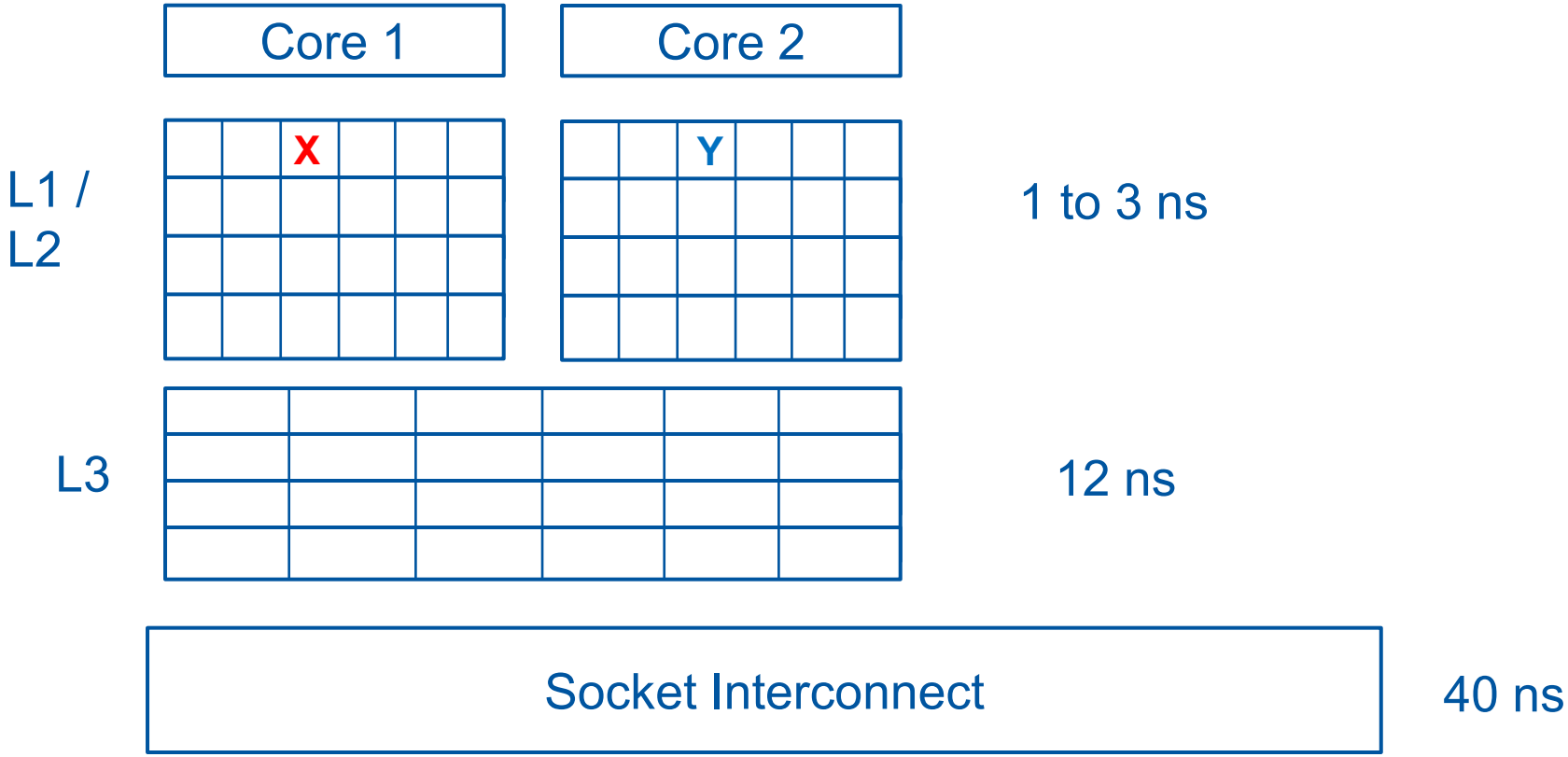

The solution?

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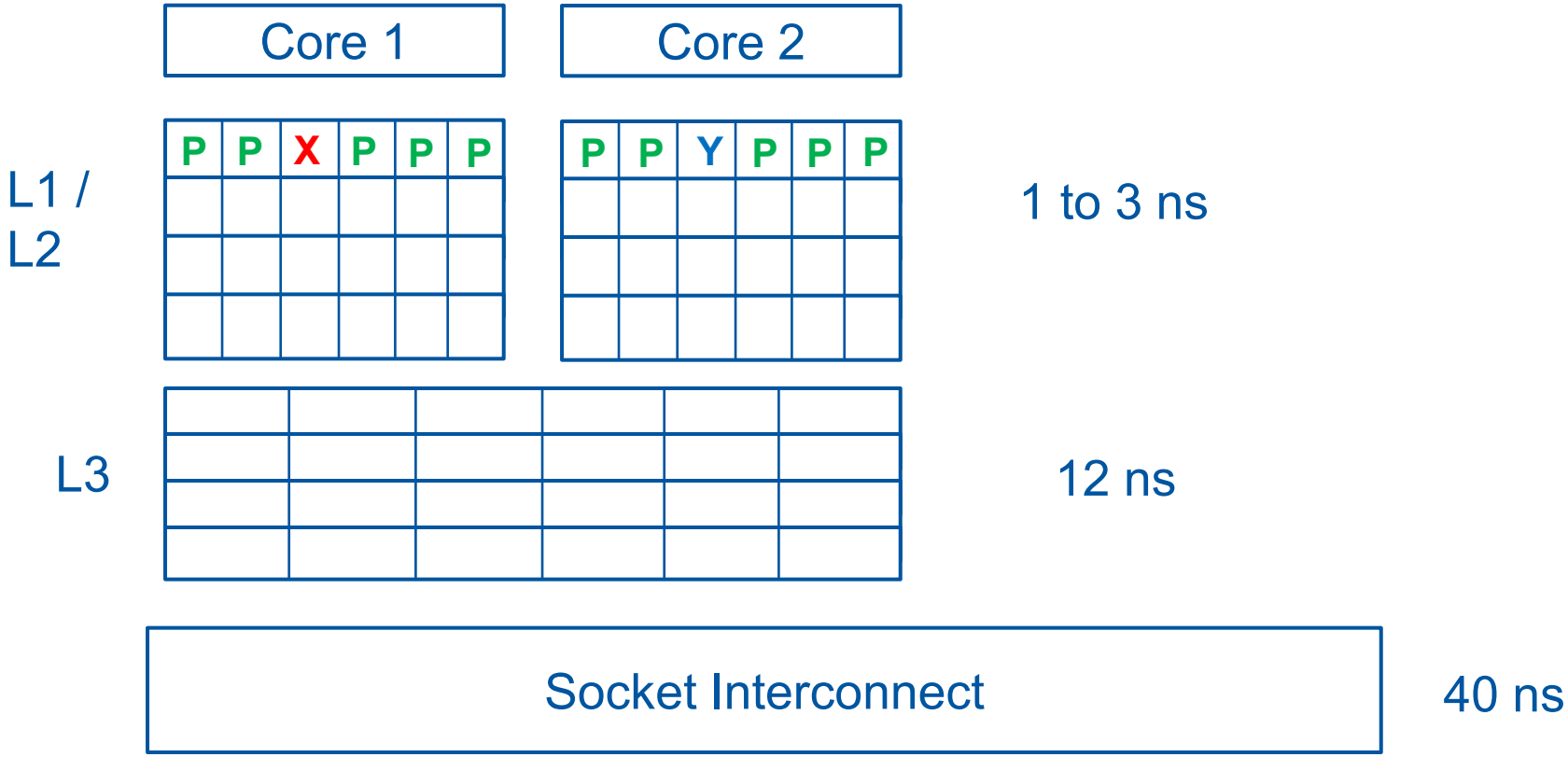


The solution? **Padding**

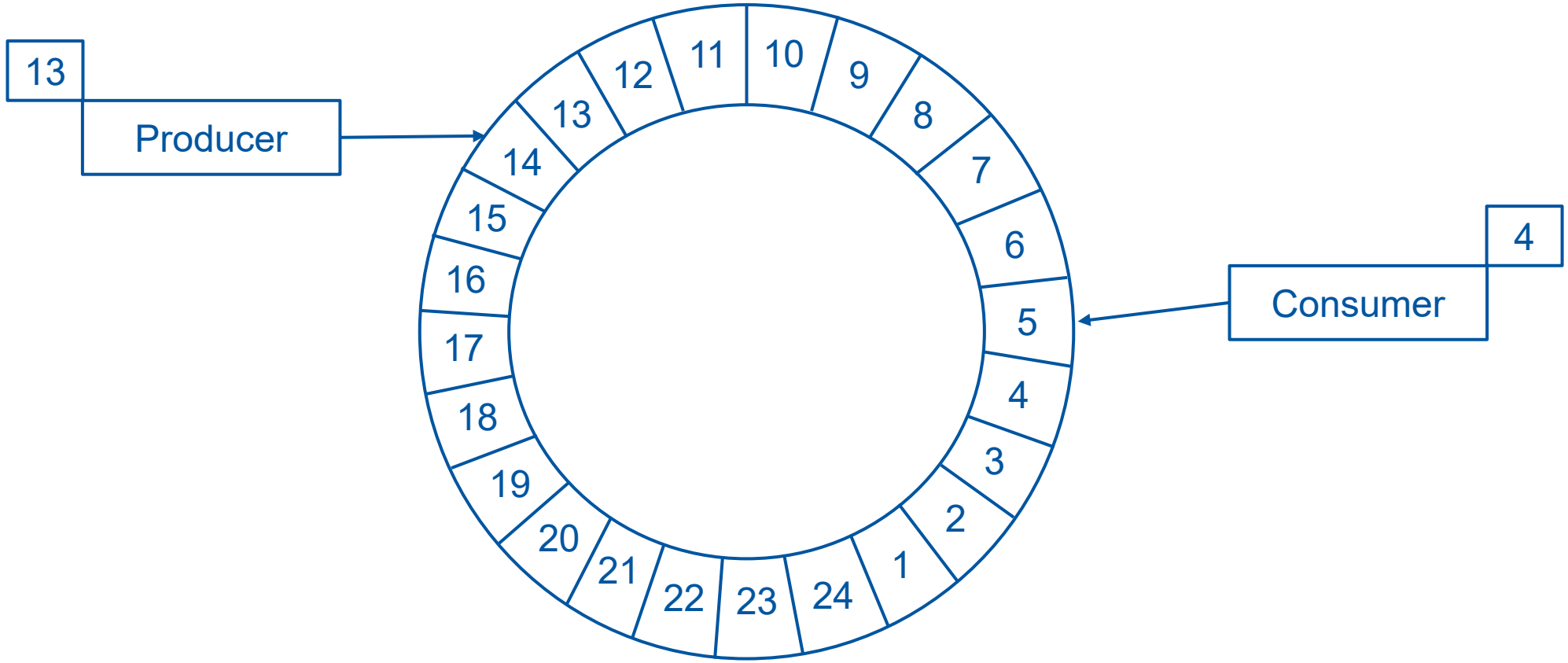
2 - Disruptor architecture

- **What is it?**

  → Can be viewed as a very efficient FIFO bounded queue

  → A data structure to pass data between threads, designed to avoid contention

The mighty ring buffer



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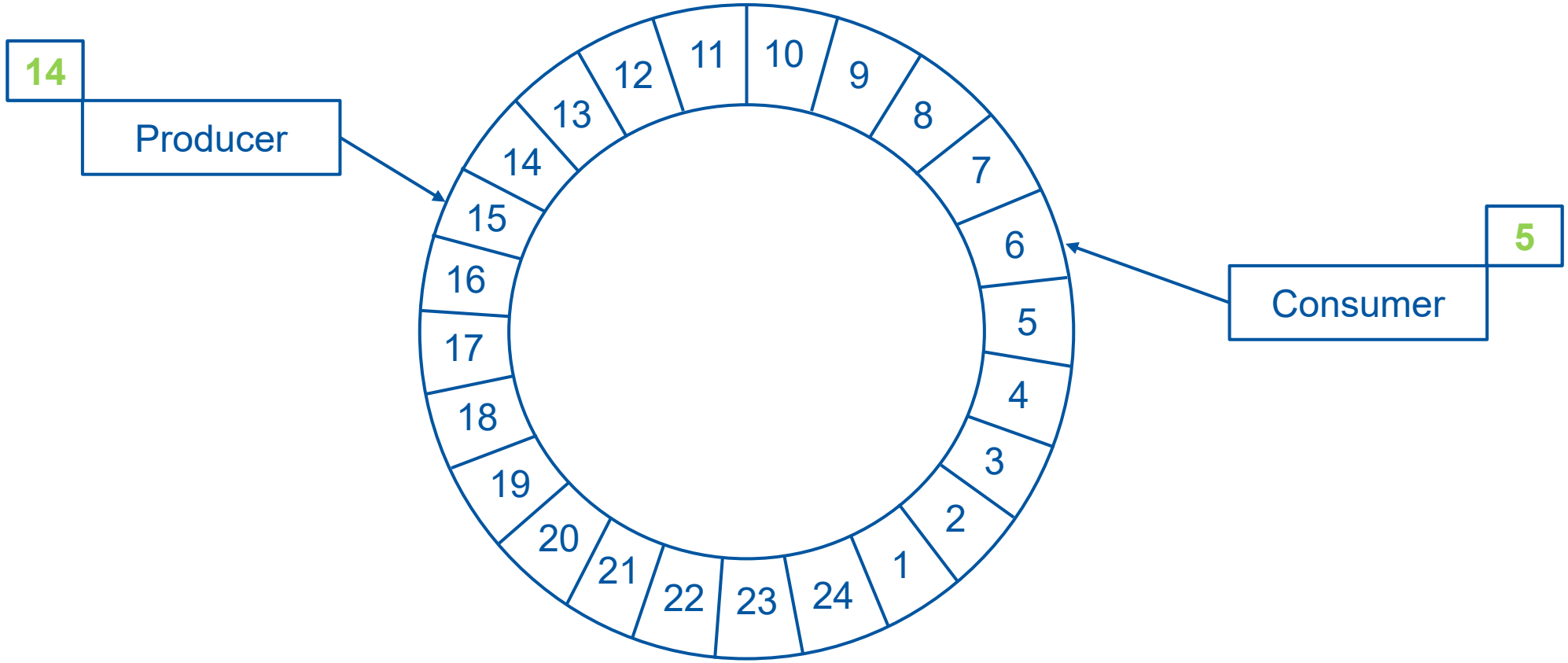

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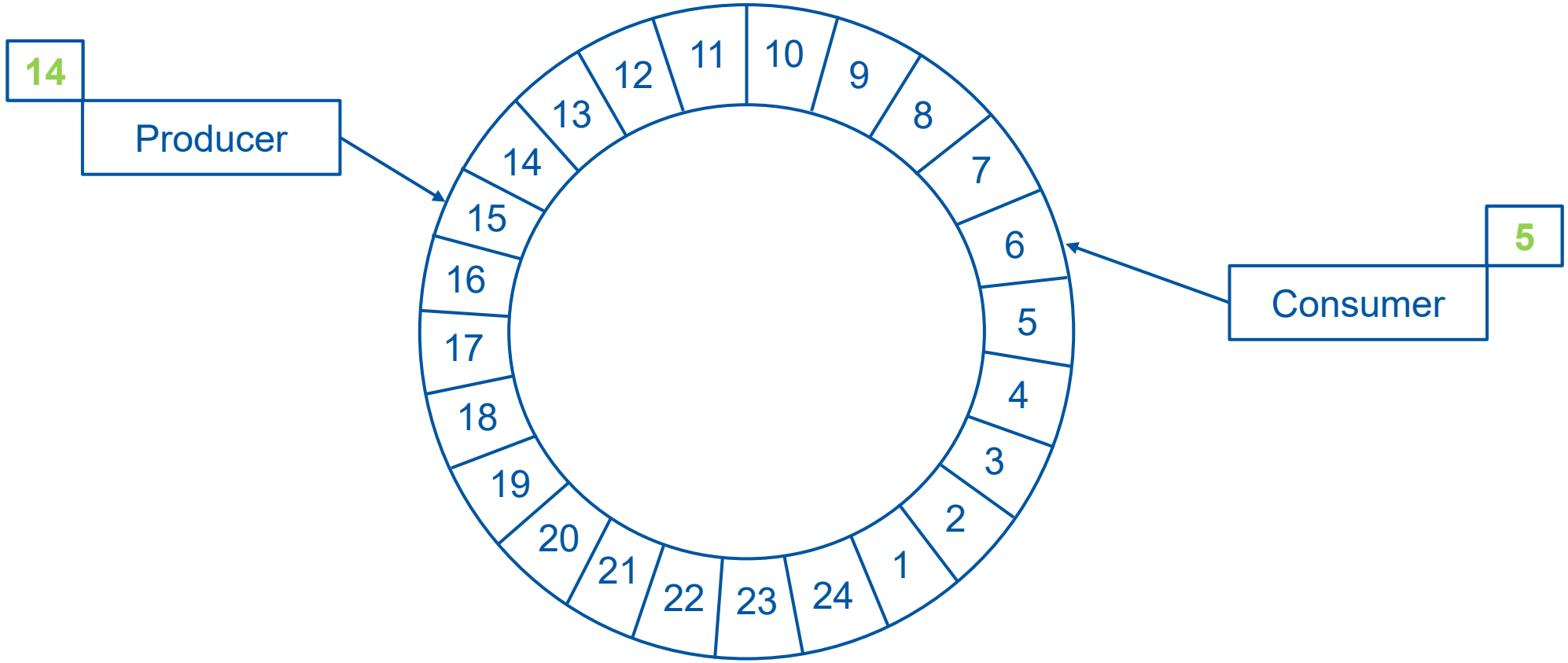

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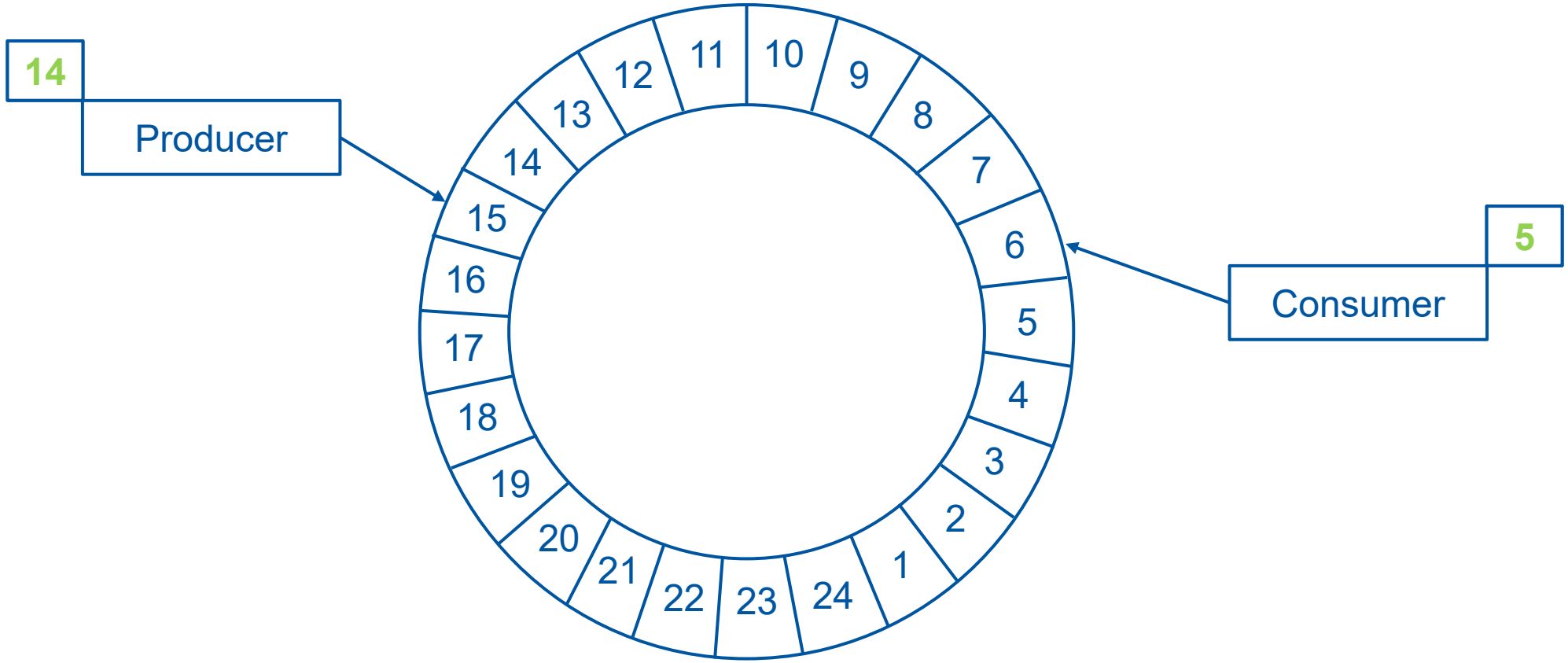

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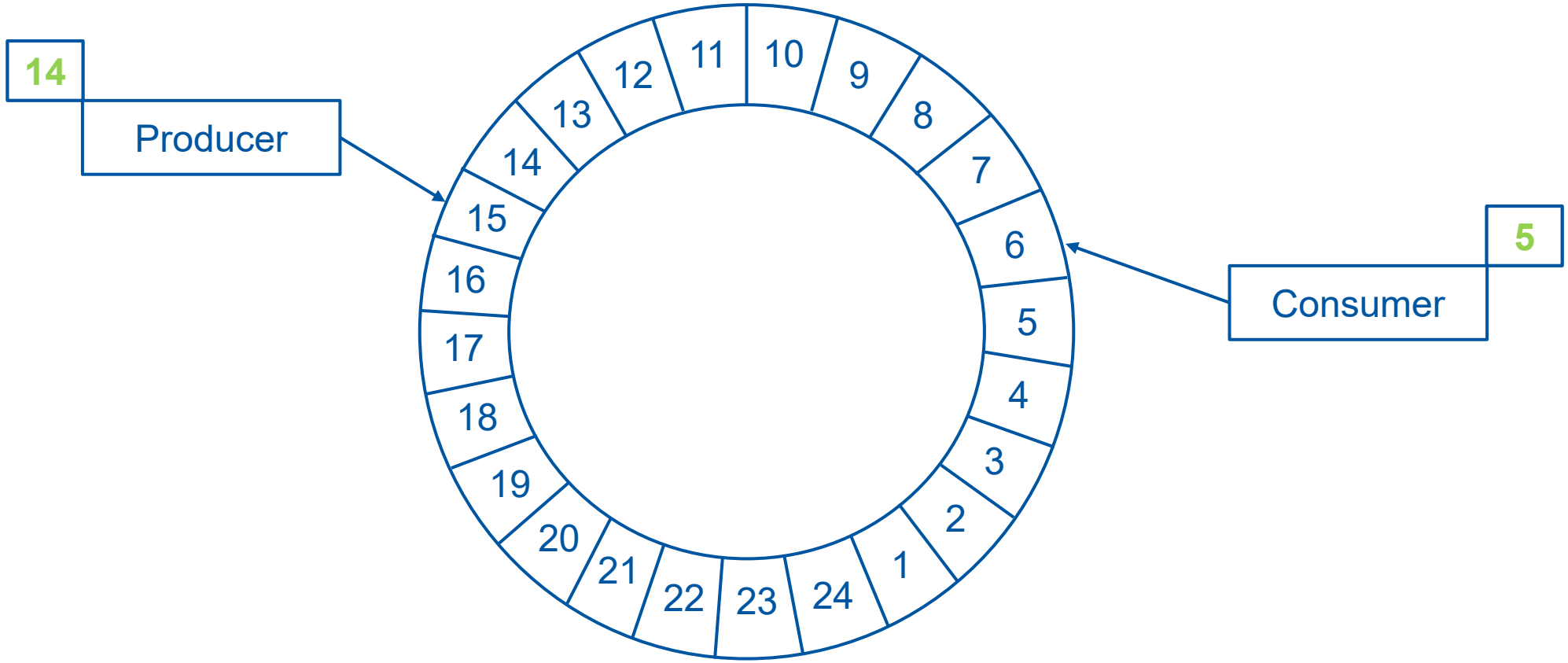

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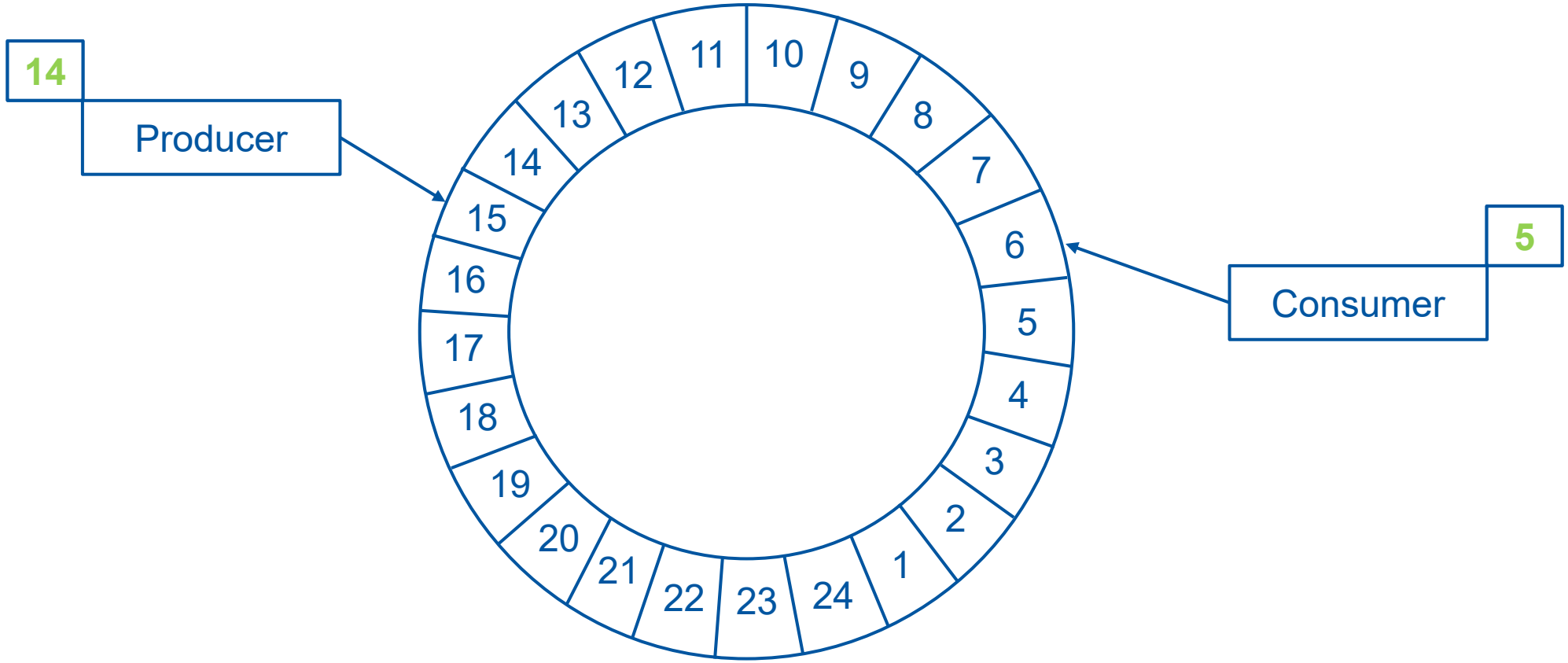

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- The memory visibility relies on the volatile sequence number → no locks
- Slots are preallocated → no garbage collection

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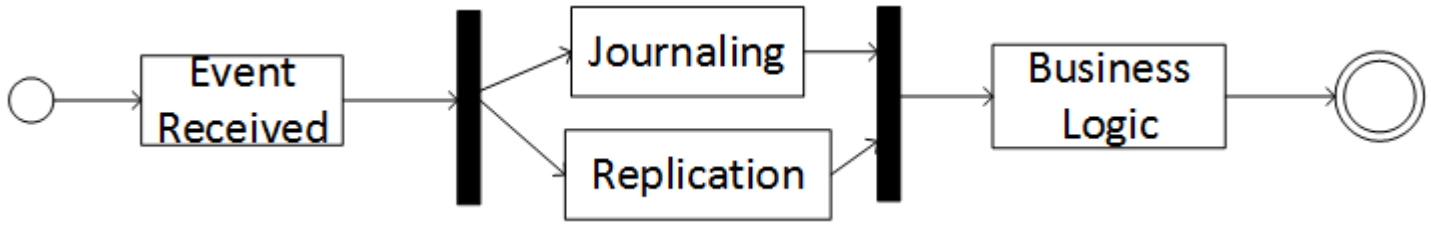

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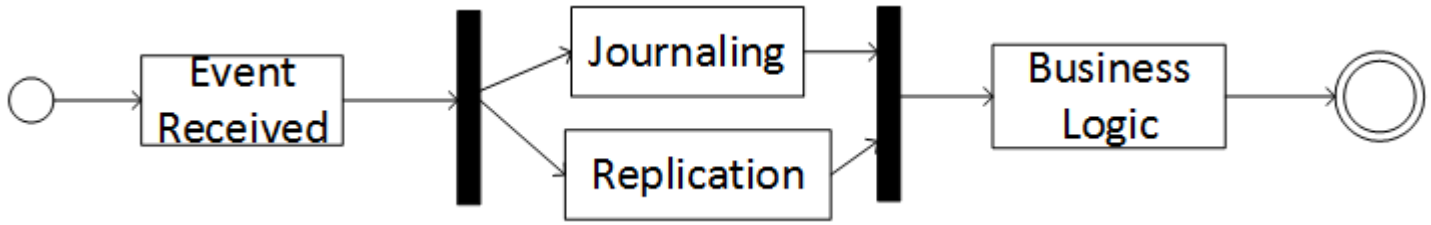

→ Consumers can use batching to catch up with producers

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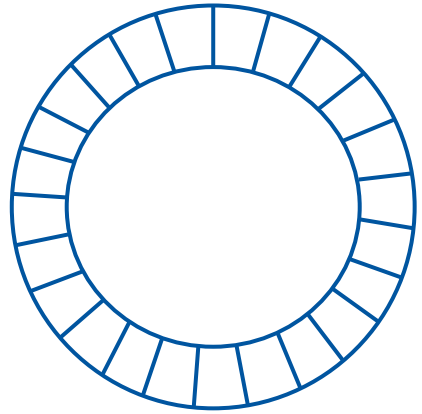
→ Simplification of the code base

Since the business logic runs on a single thread, there is no need to worry about concurrency

3 – The Disruptor in CESAR



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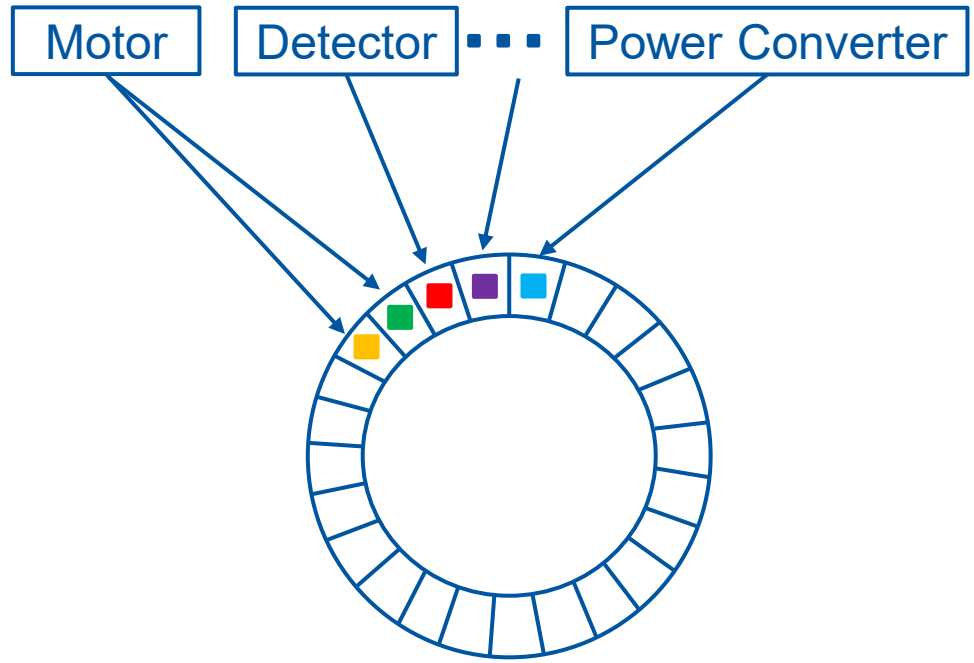

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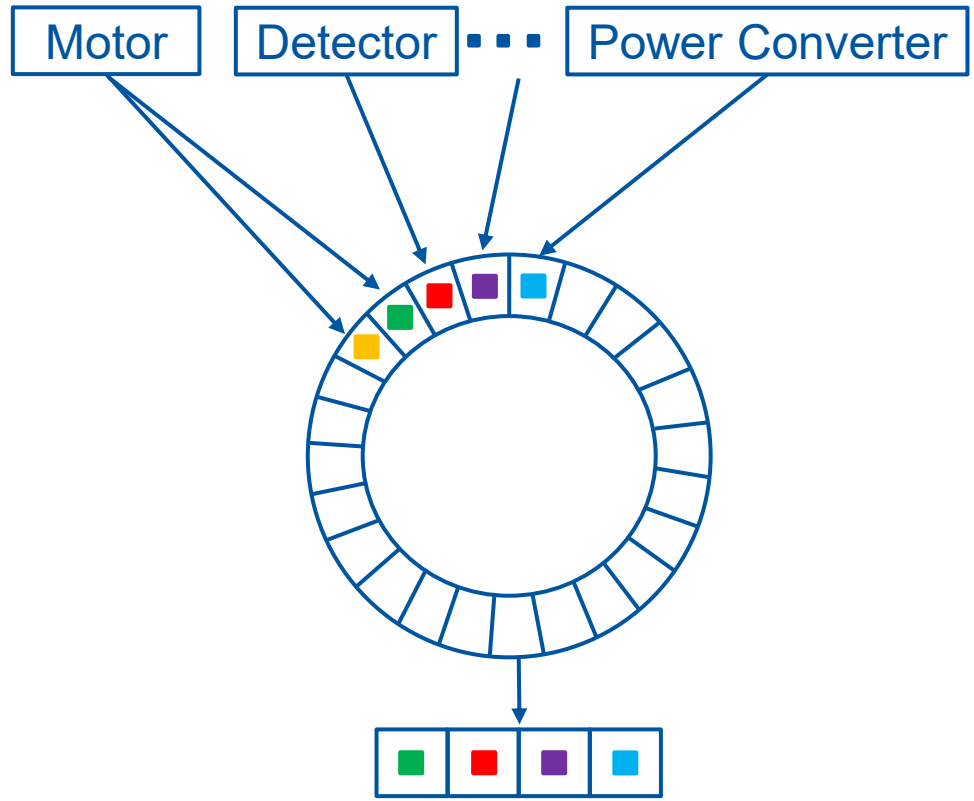

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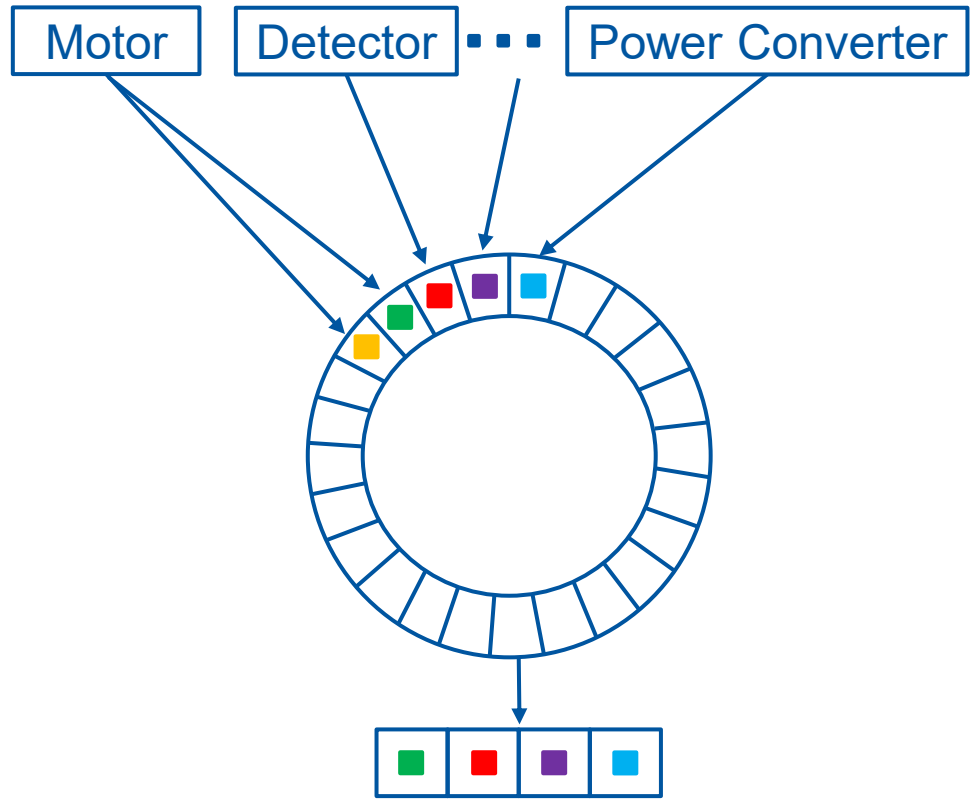

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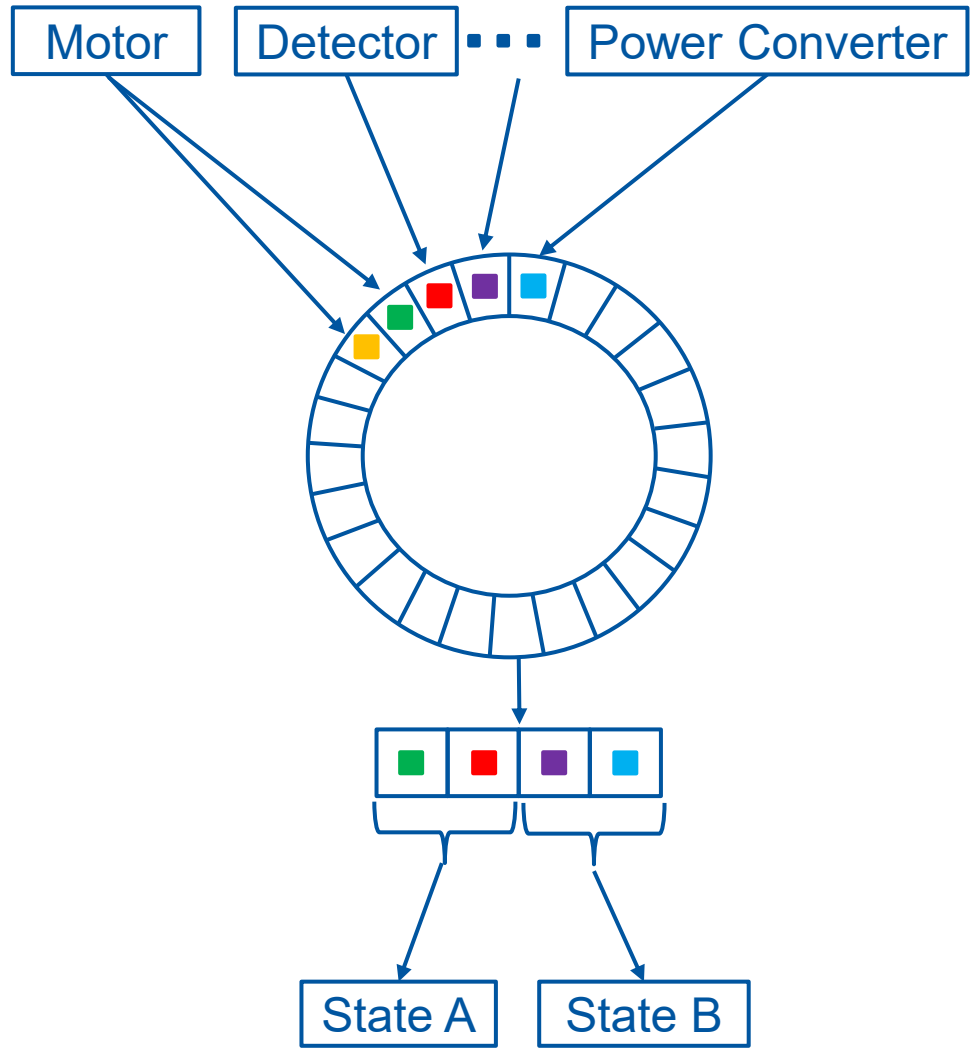

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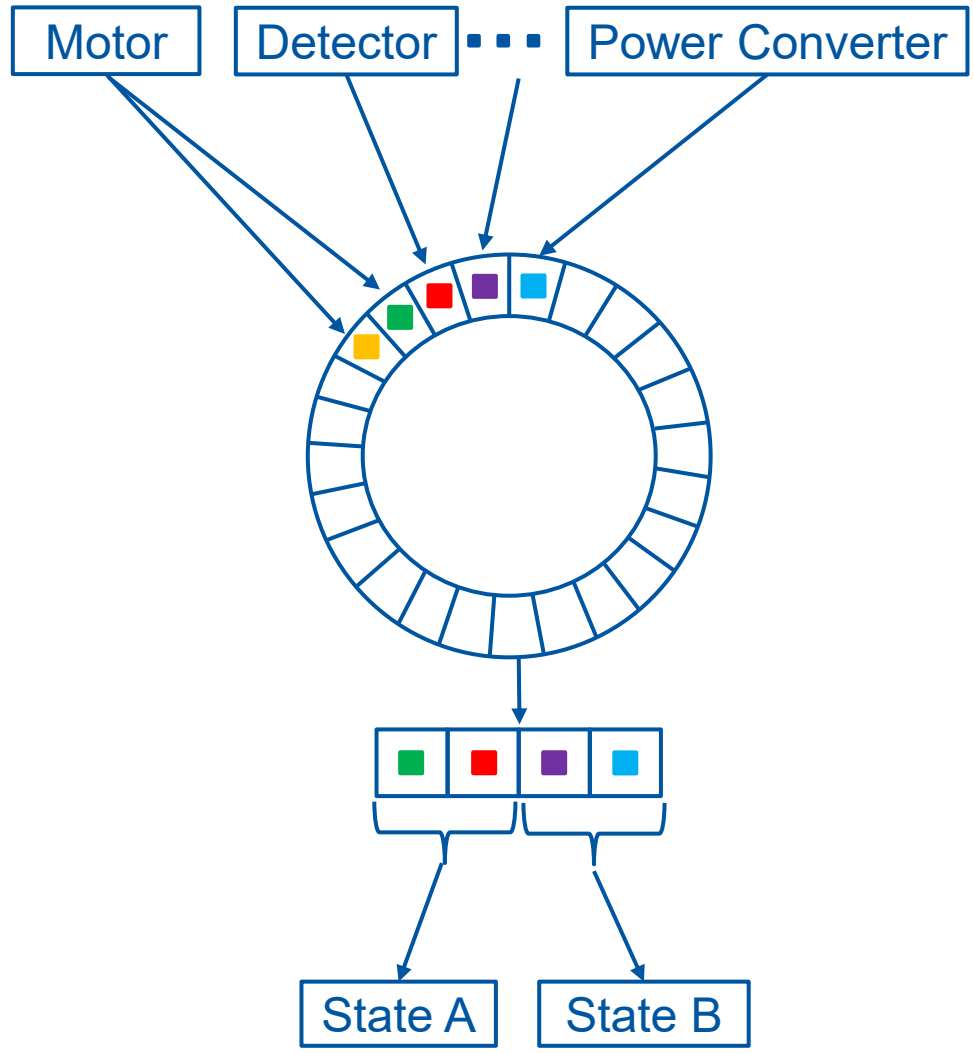
→ Publish the new states over the network, making sure that we do not block the Disruptor thread if the message broker is down



Conclusions

- The Disruptor, a tool from the world of finance, fits really well in an Accelerator control system
- It simplified the CERN CESAR code base while handling the flow of data more efficiently
- It is easily integrated in an existing design to replace a queue or a full pipeline of queues
- The main challenge faced was to switch the developers' mind-set to think in asynchronous terms

Useful Links

- The Disruptor main page with an introduction and code samples:

http://lmax-exchange.github.io/disruptor

- Presentation of the Disruptor at Qcon

http://www.infoq.com/presentations/LMAX

- An article from Martin Fowler:

http://martinfowler.com/articles/lmax.html

- A useful presentation on Latency by Gil Tene who shows that most of what we measure during performance test is wrong:

http://www.infoq.com/presentations/latency-pitfalls

- New Async logger in Log4J 2

http://logging.apache.org/log4j/2.x/manual/async.html

www.cern.ch