KubeCon | CloudNativeCon
North America 2022

BUILDING FOR THE ROAD AHEAD

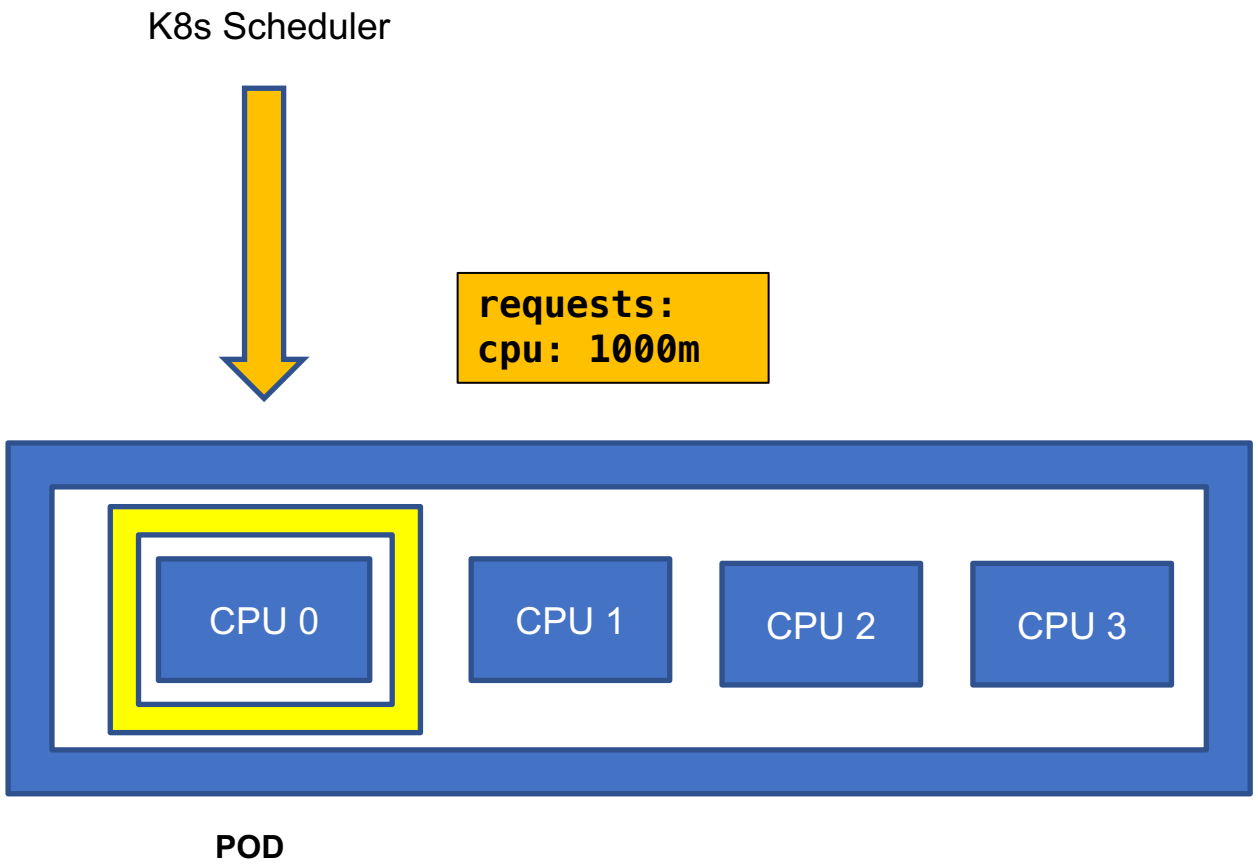
DETROIT 2022

73,000 Pods a Day Misadventures in Multi-Tenant

Wil Reed, Acquia
Shane Corbett, Amazon Web Services

Kubernetes vs. Linux

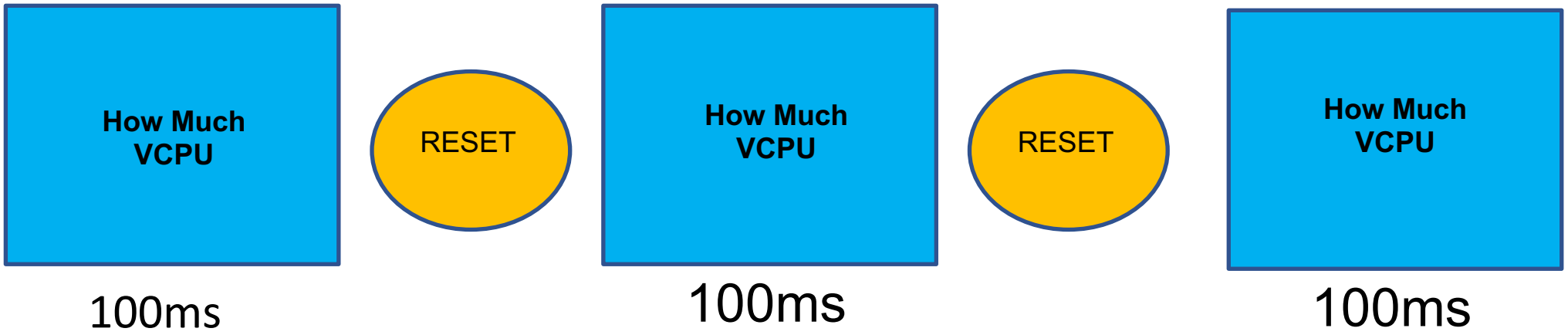
Cores




```
Capacity:
  cpu:              4
  pods:              110
Allocatable:
  cpu:              3000m
  pods:              110
```

Thinking in Time
Not Cores

Limits



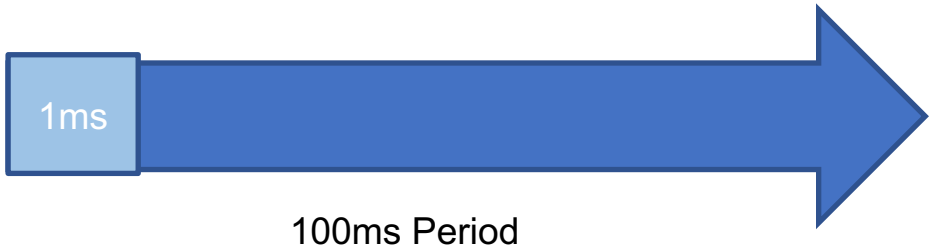
Period – 100ms

Conversion

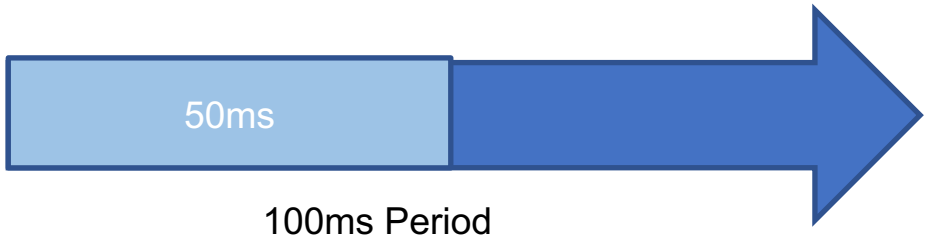
1 Core = 1000m

```
Resources:
  limits:
    cpu: 10m
```

10m/1000m = 1%



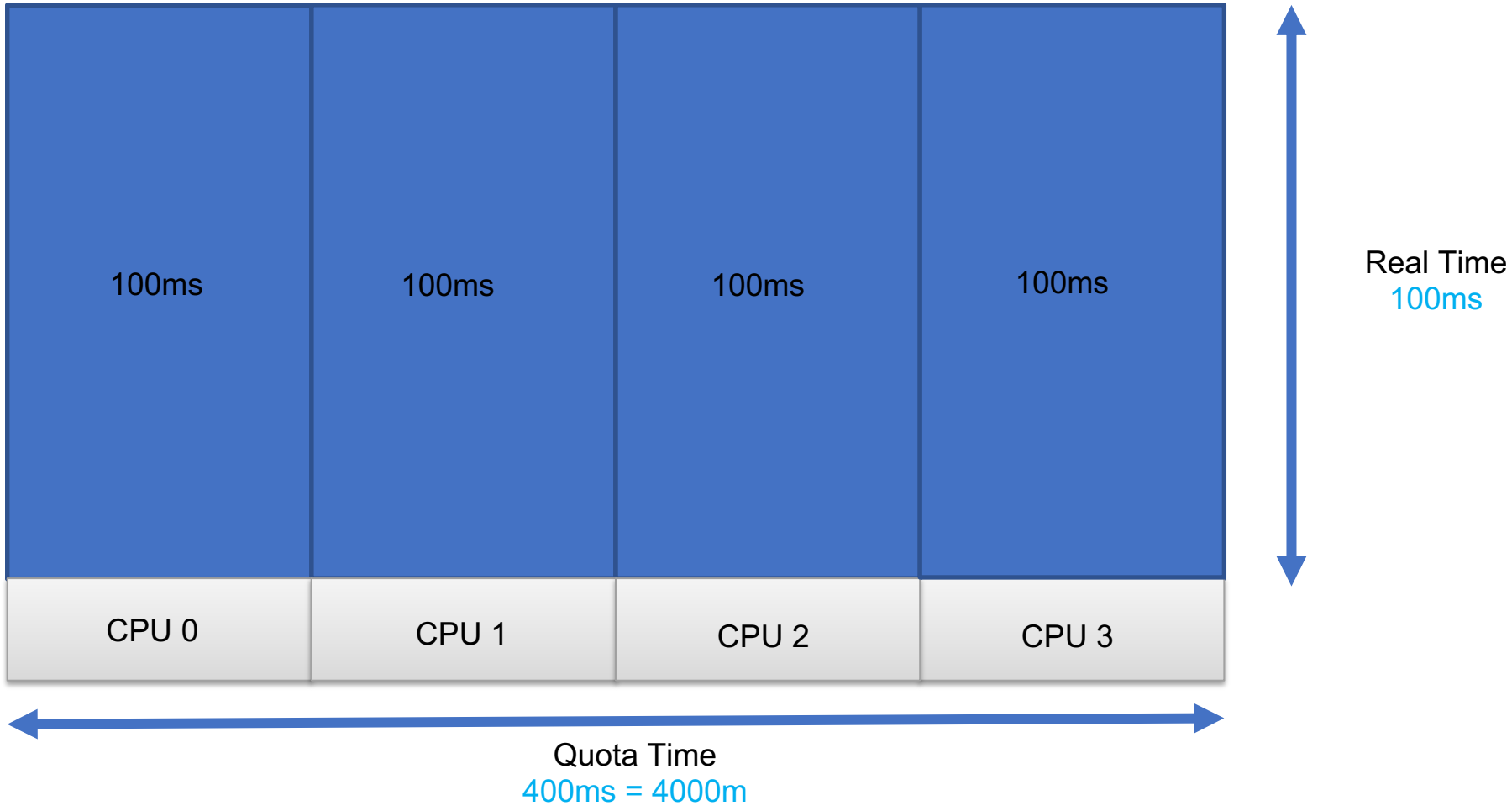
500m/1000m = 50%



Time

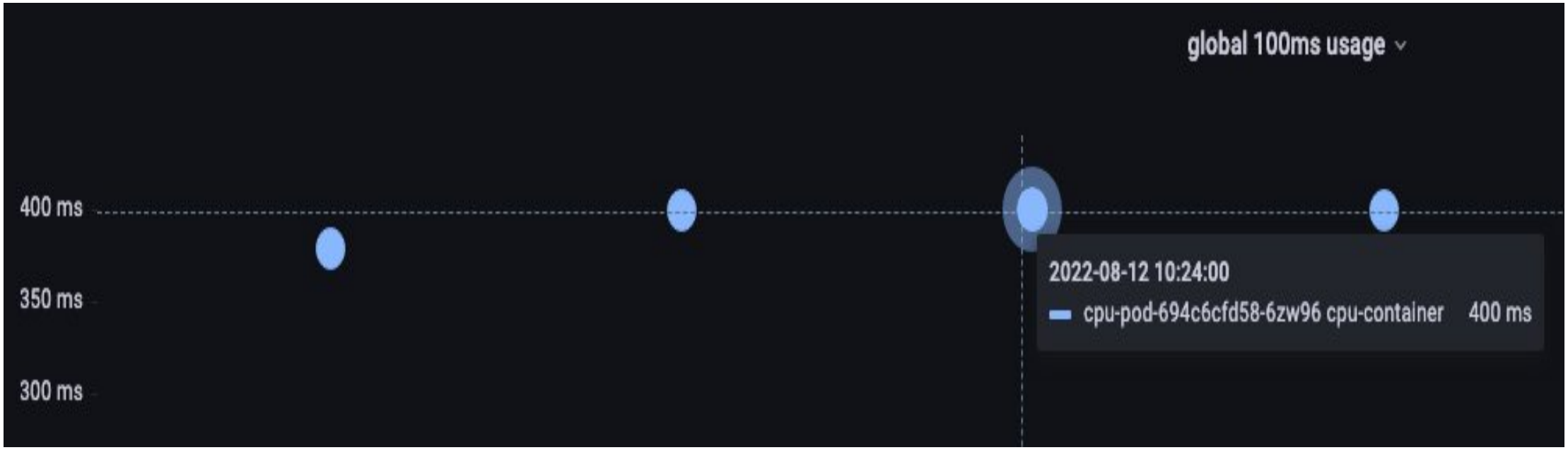
Four Thread app

4 Core Node



Thinking in Time

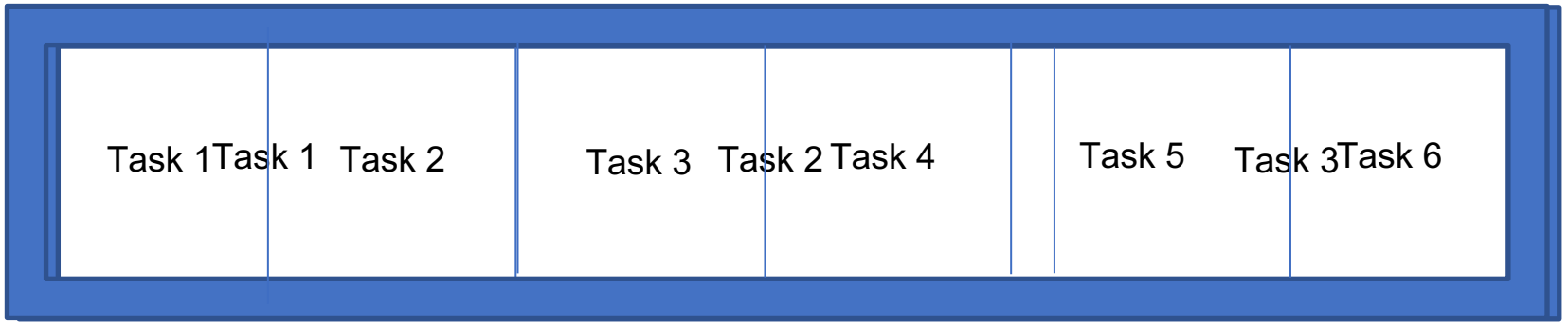
- **container_cpu_usage_seconds_total**



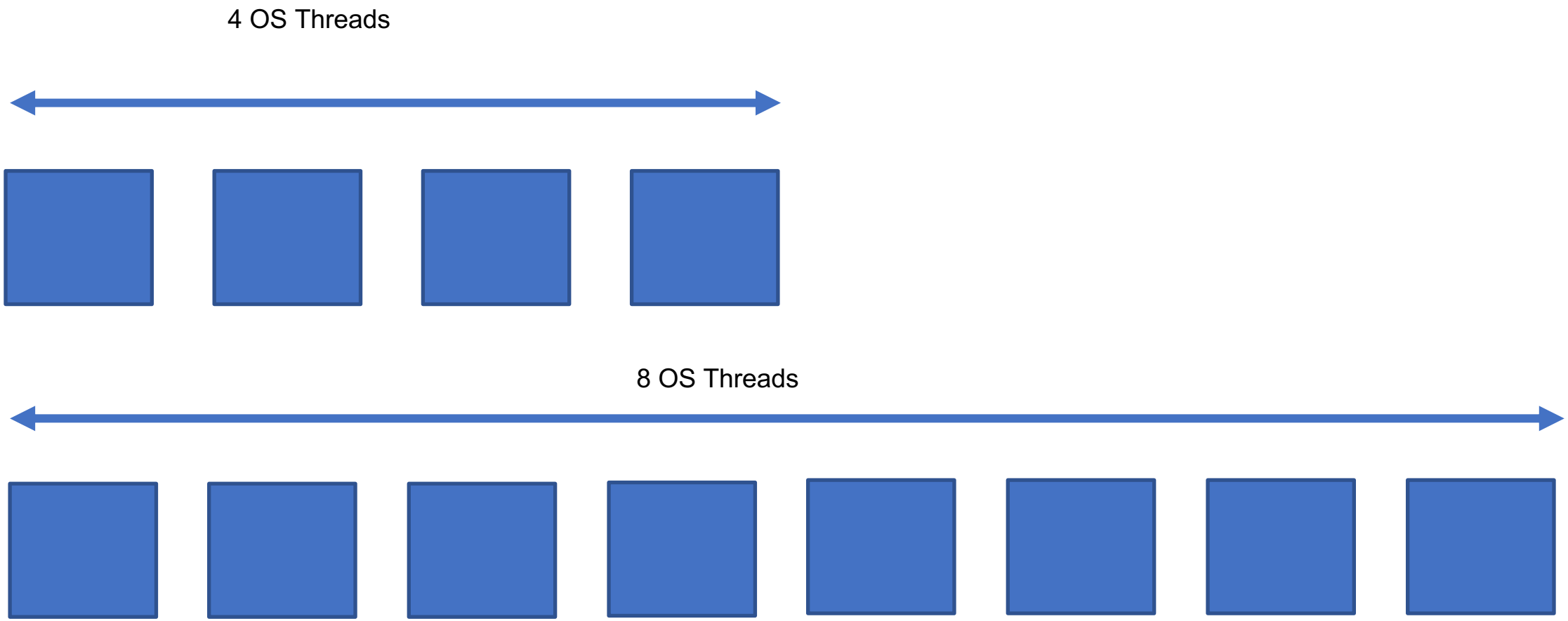
** Per Period*

Threads

Container 1



Swapping Cores



Throttles

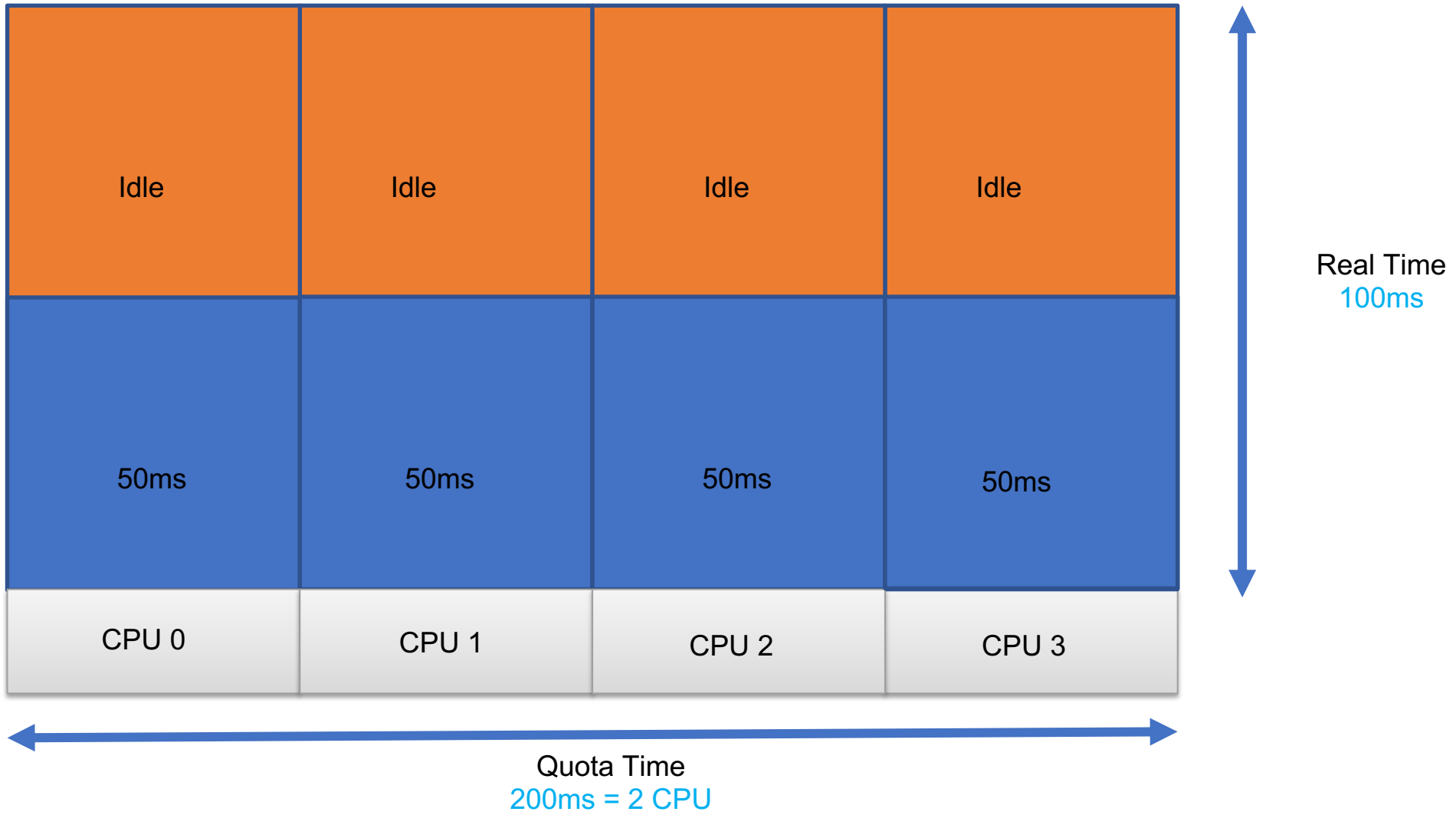
Throttles - Bad Pods Limits

pod full-test-27434725--1-b6qn7	99.8%
pod full-test-27434725--1-w55zh	99.8%
pod full-test-27434725--1-7zsdd	99.7%

Query 1 Transform 0

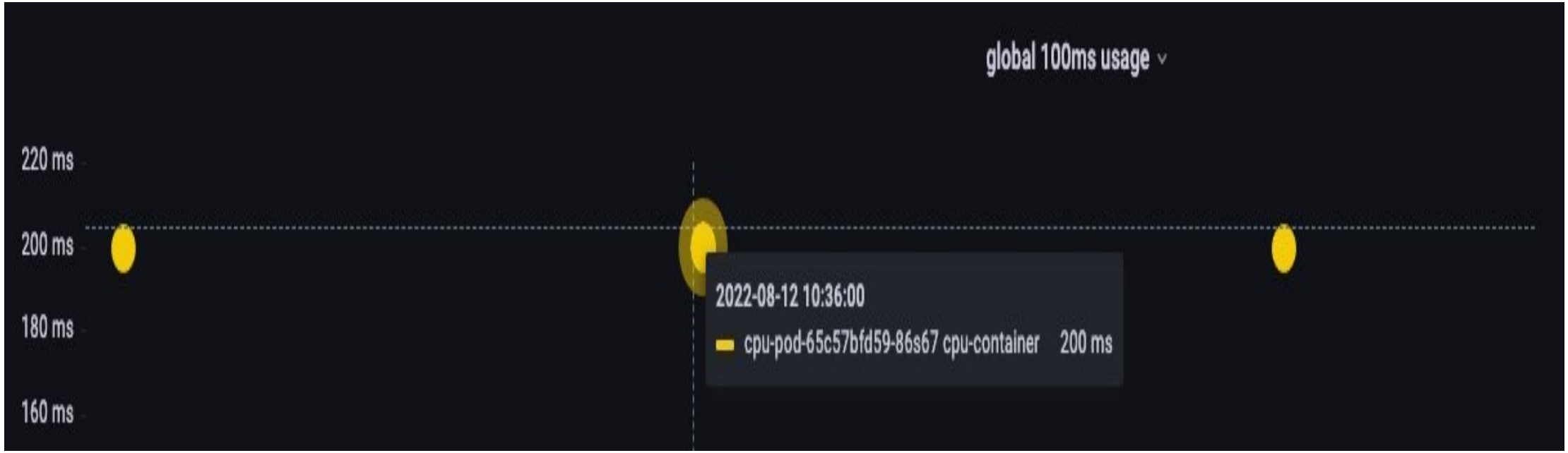
Double It!

```
Resources:
  limits:
    cpu: 2000m

    or

    200ms
```

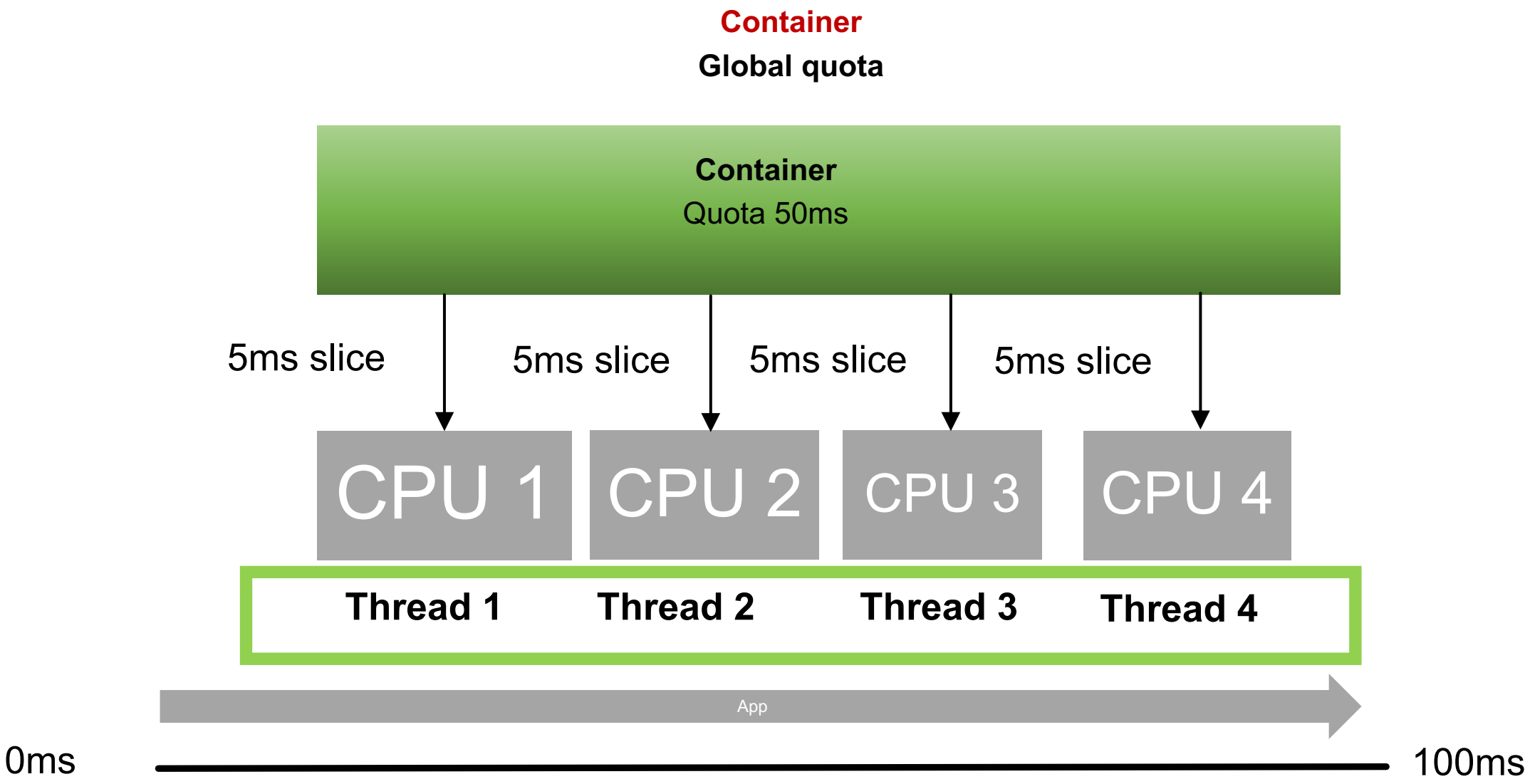


Thinking in Time

- **container_cpu_throttled_seconds_total**



** CPU Usage Per Period*


Container
Global quota
Container
Quota 50ms
5ms slice
5ms slice
5ms slice
5ms slice
CPU 1
CPU 2
CPU 3
CPU 4
Thread 1
Thread 2
Thread 3
Thread 4
App
0ms
100ms

aws

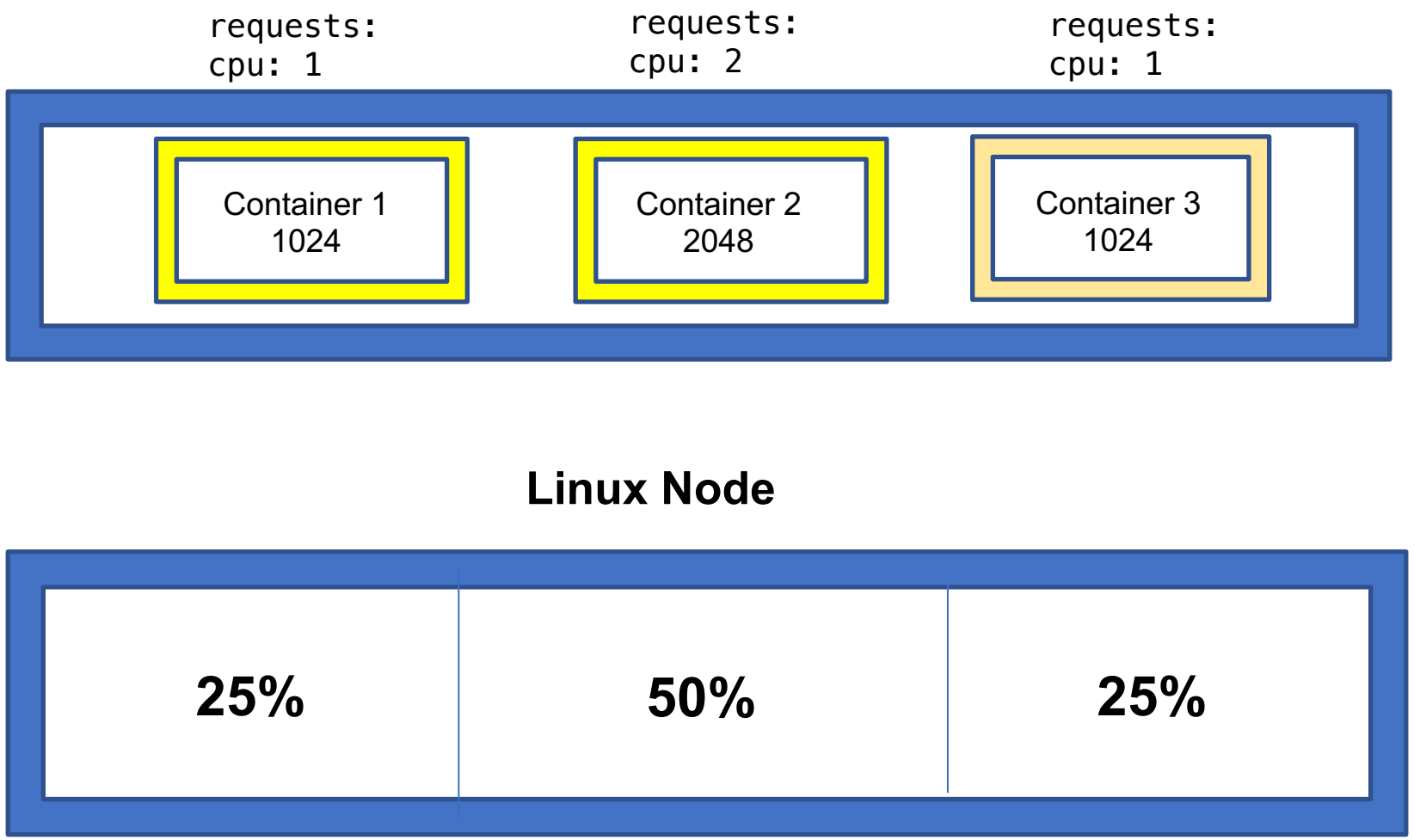
CONTAINERS

Using Prometheus to Avoid Disasters with Kubernetes CPU Limits

Read the blog post ›

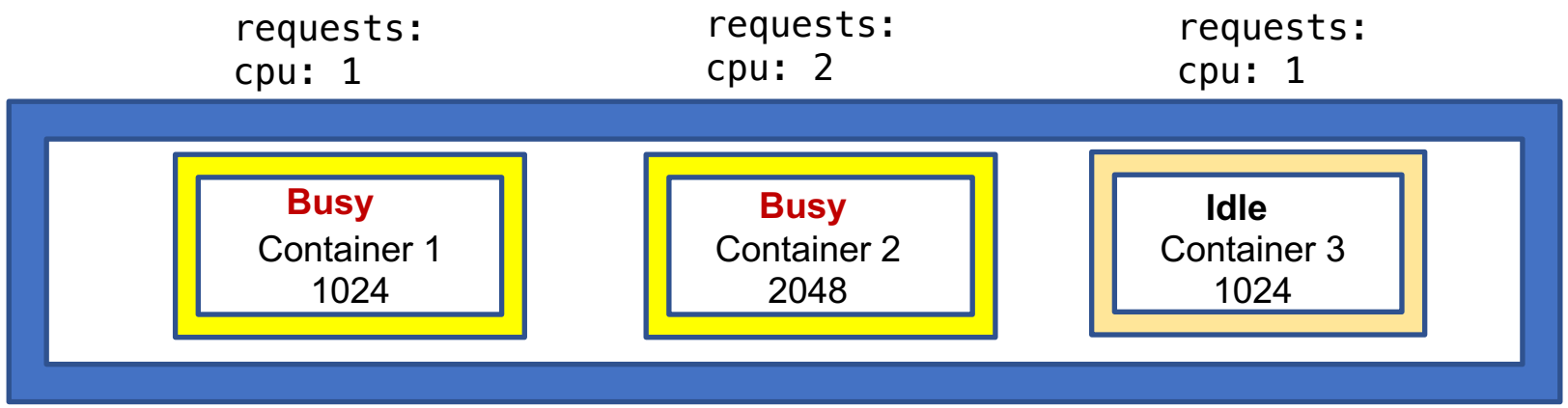
Static vs. Dynamic

Mixing Models



Dynamic Shares

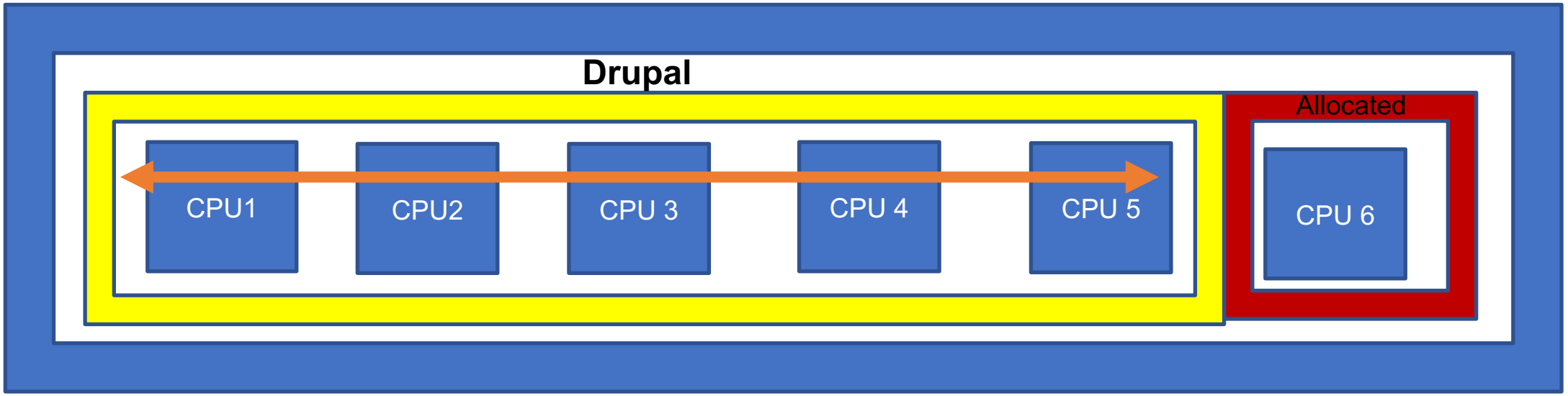
CPU * Container Shares / Busy shares



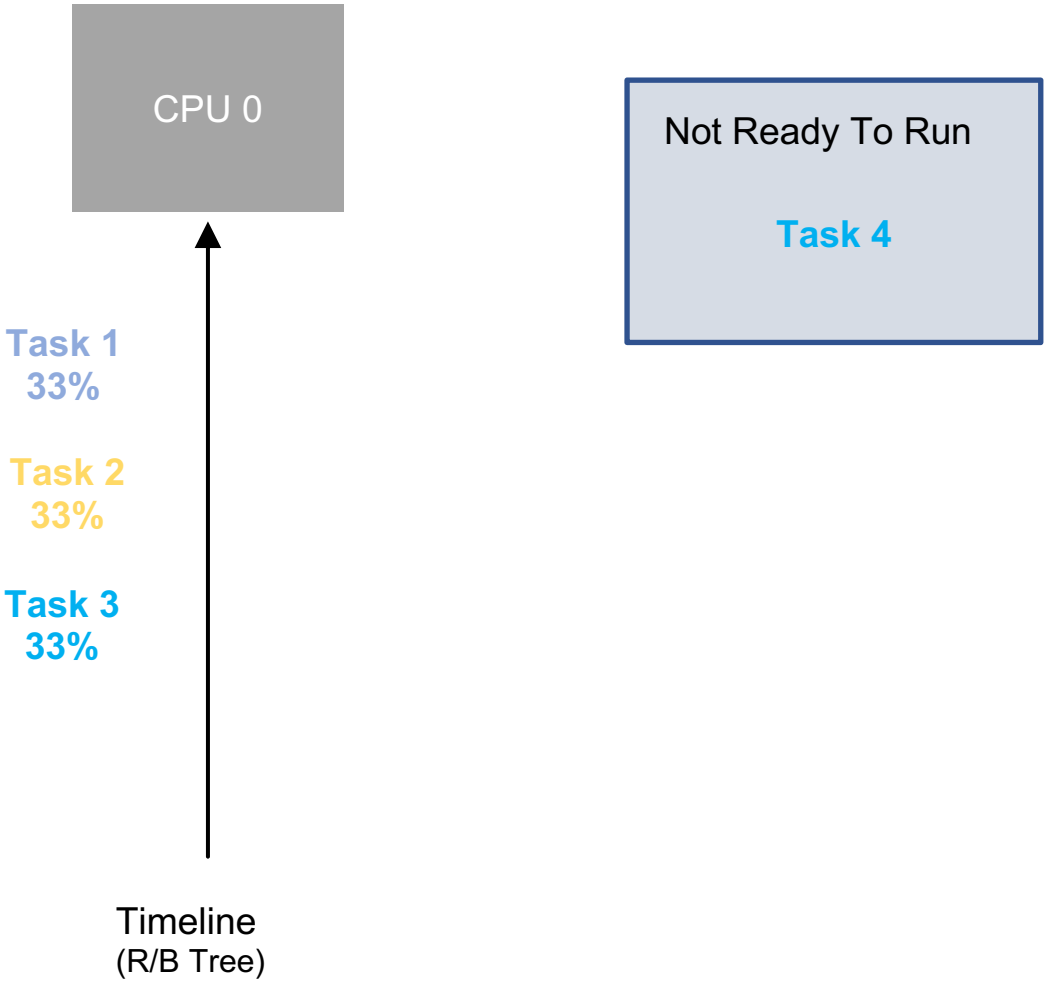
Linux Node

Only If It’s Busy

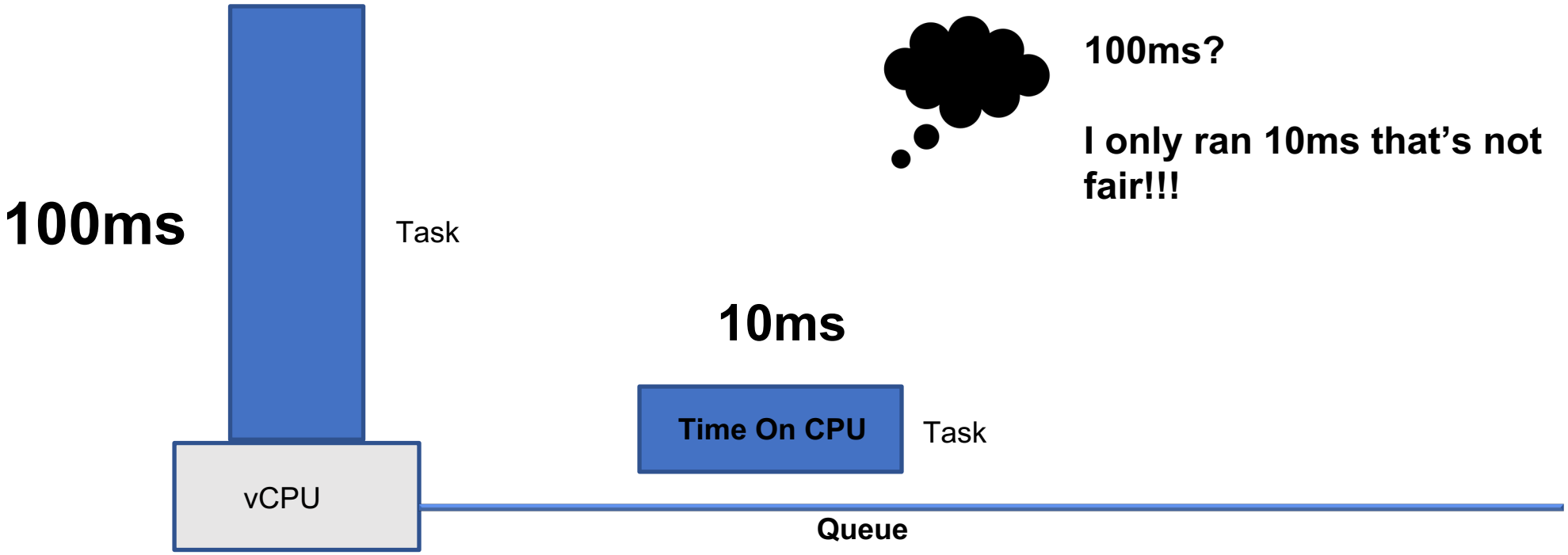
```
requests:
cpu: 1000m
```



Why?

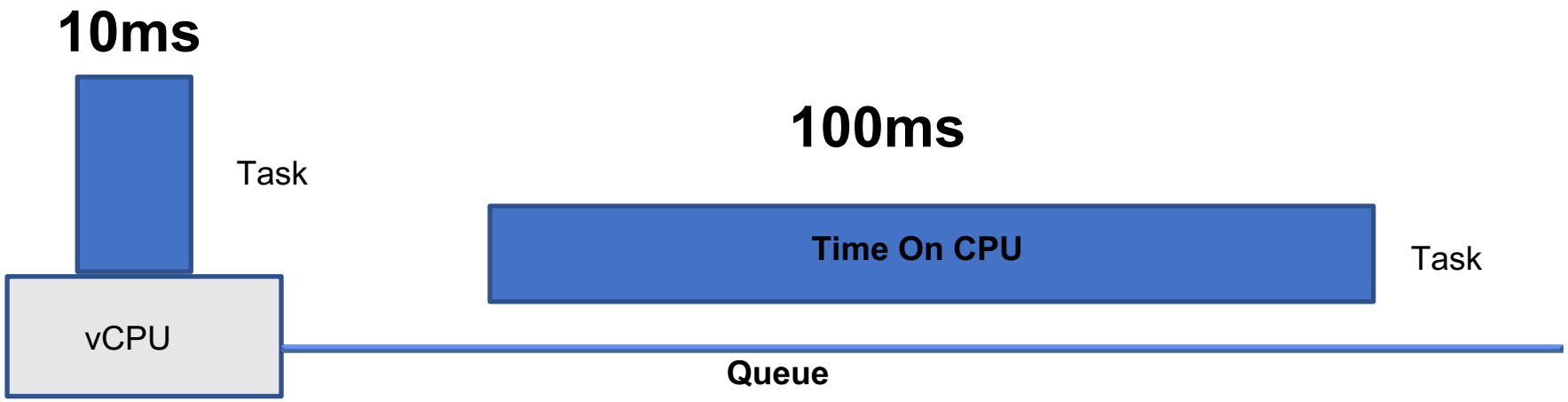

CPU 0
Not Ready To Run
Task 4
Task 1
33%
Task 2
33%
Task 3
33%
Timeline
(R/B Tree)

Linux is Fair



Linux is Fair

Lowest Time on CPU goes first!



Time Not Cores

TASK RUNTIME

100ms

```
requests:
cpu: 1
```

```
requests:
cpu: 2
```

TASK RUNTIME

TASK RUNTIME

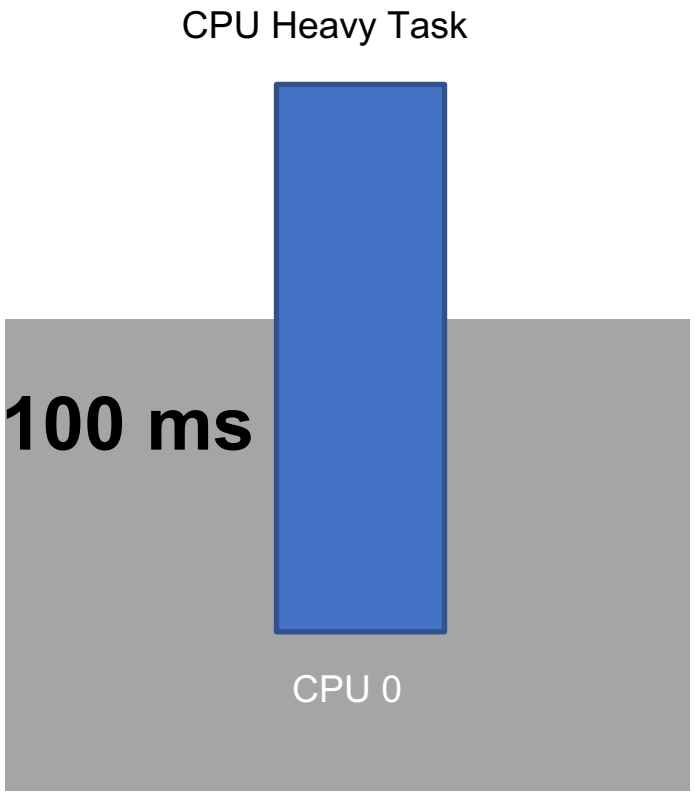
Runtime / 1024 shares

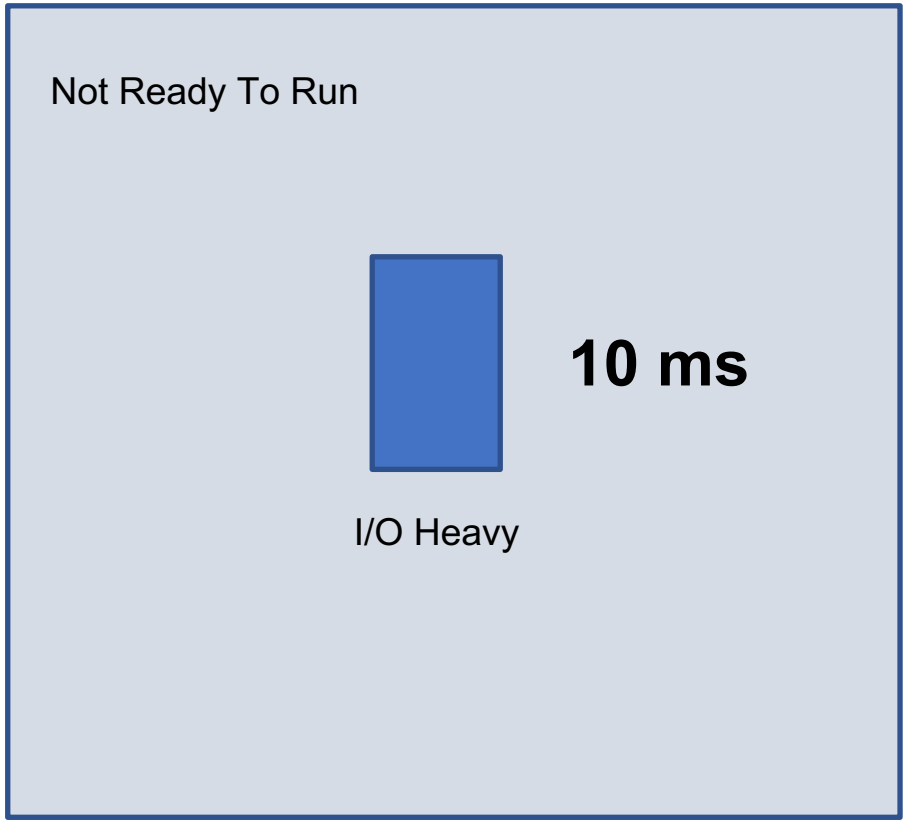
Runtime / 2048 shares

Shorter Runtime

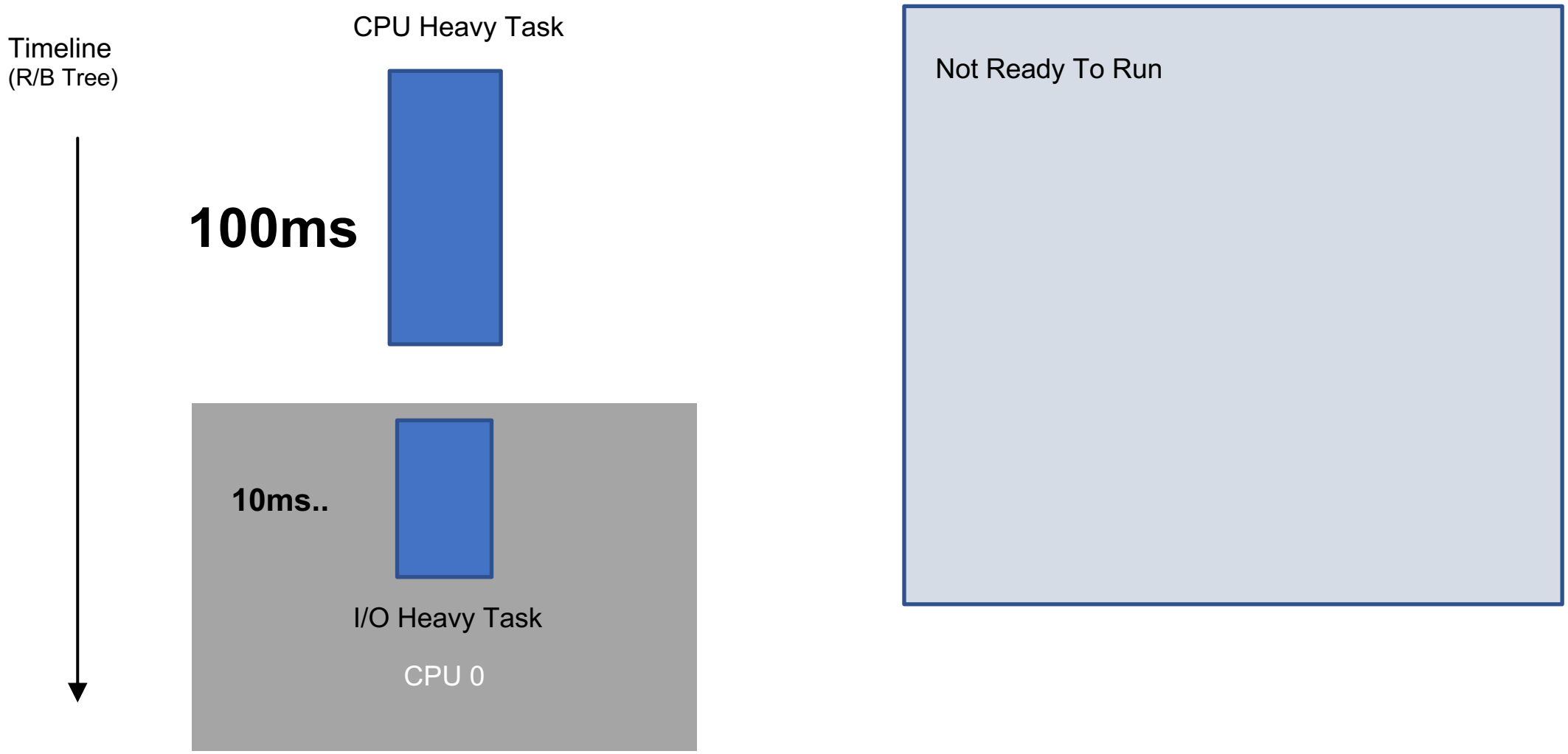
Shortest Runtime

Least Amount of Time

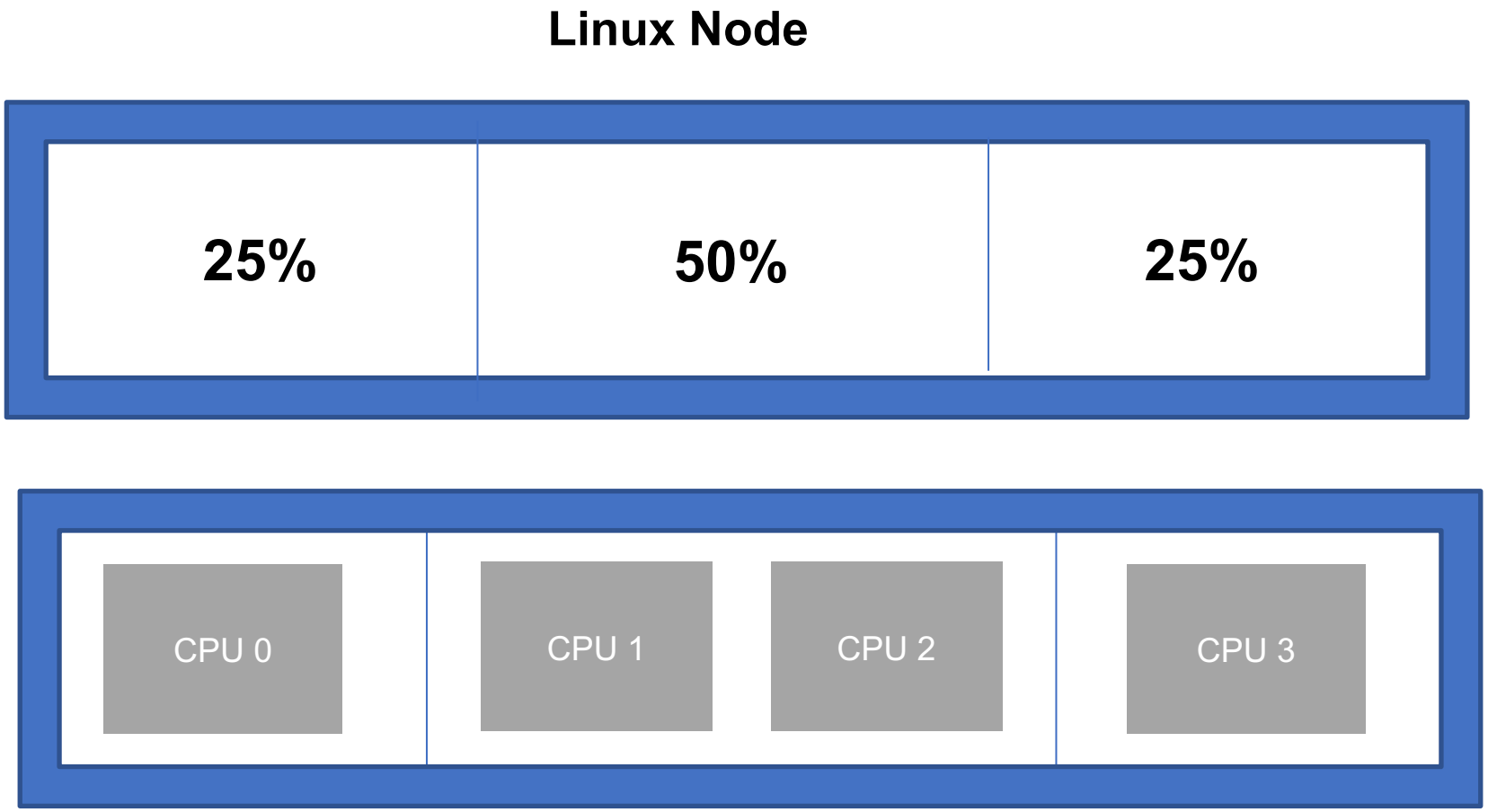




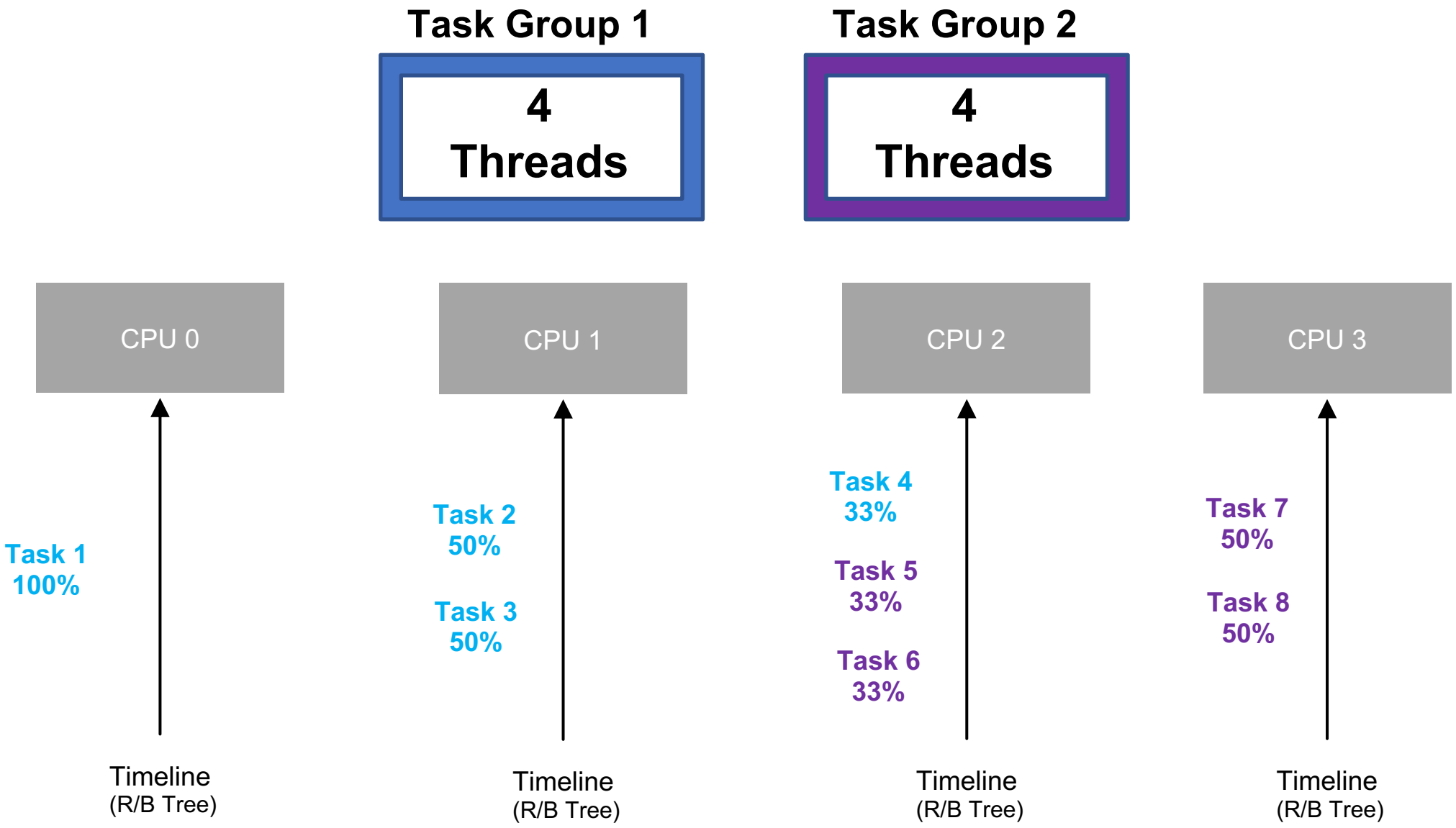
Don’t Forget the I/O Bound



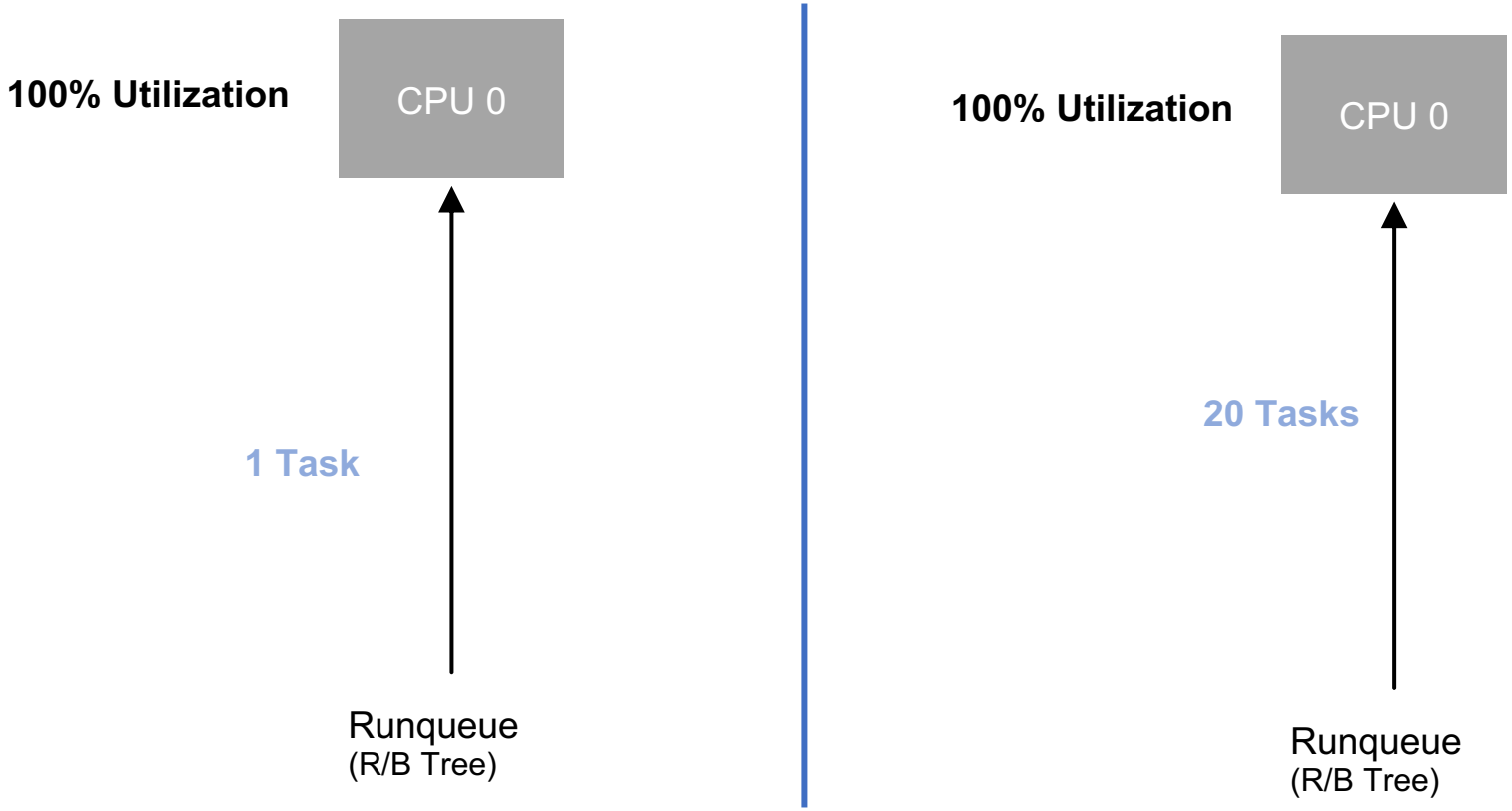
Not Cores



The New Picture

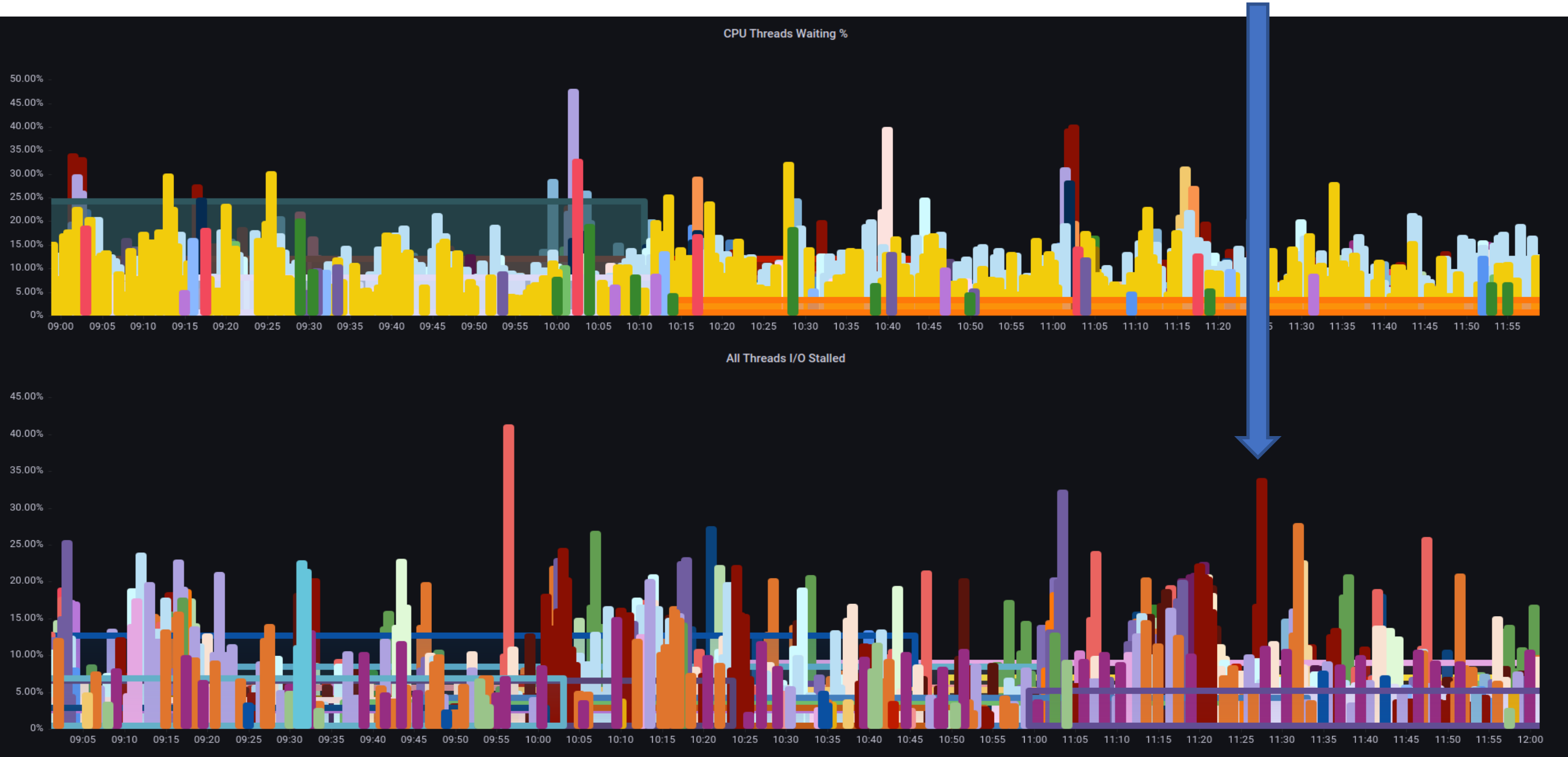


Utilization vs. Saturation

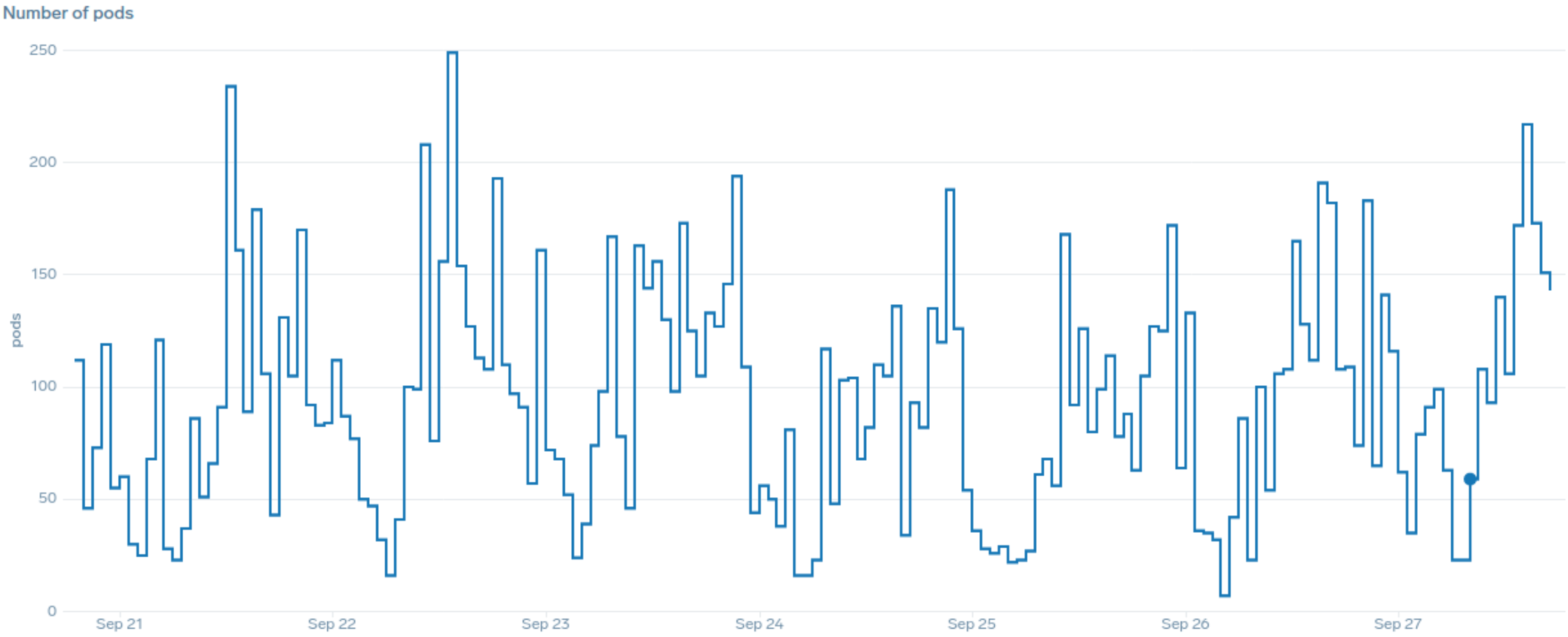


Pressure Stall Information

35% Stalled




IMPORTANT MESSAGE



Unnecessary Churn

Percent of Requests?

% Of Requests

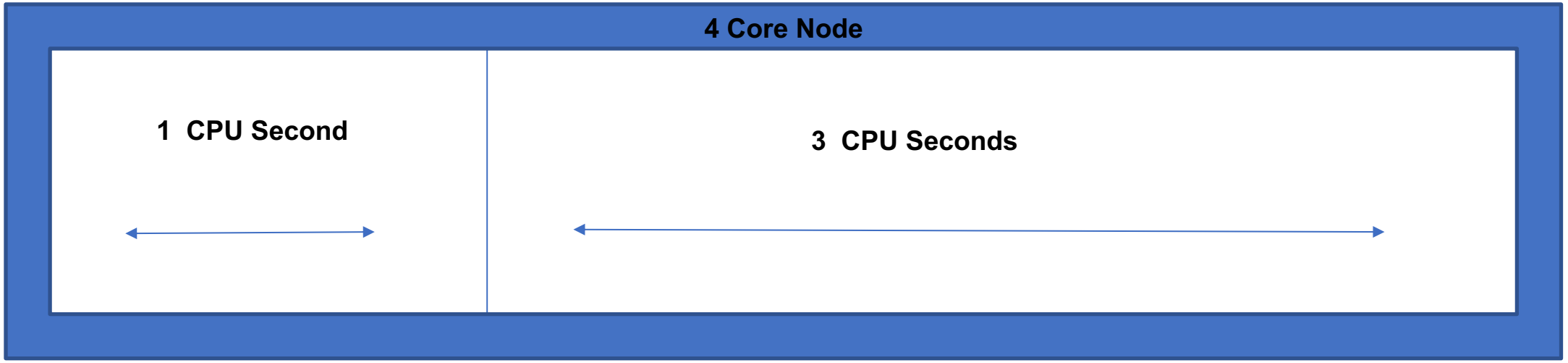
$$\frac{\textit{Actual CPU usage per second}}{\textit{CPU requests}} = \text{\% of Requests}$$

$$\frac{500\text{ms per second}}{1000\text{m}} = 50\text{\% of Requests}$$

100% of Request

```
requests:
cpu: 1
```

```
requests:
cpu: 3
```



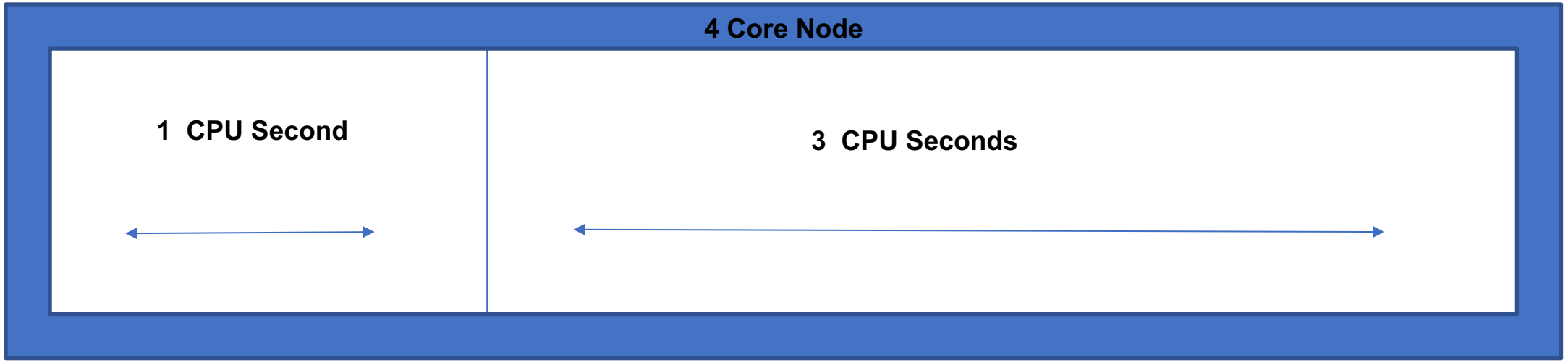
100% of Request

100% of Request

1,000% of Request

```
requests:
cpu: 100m
```

```
requests:
cpu: 300m
```

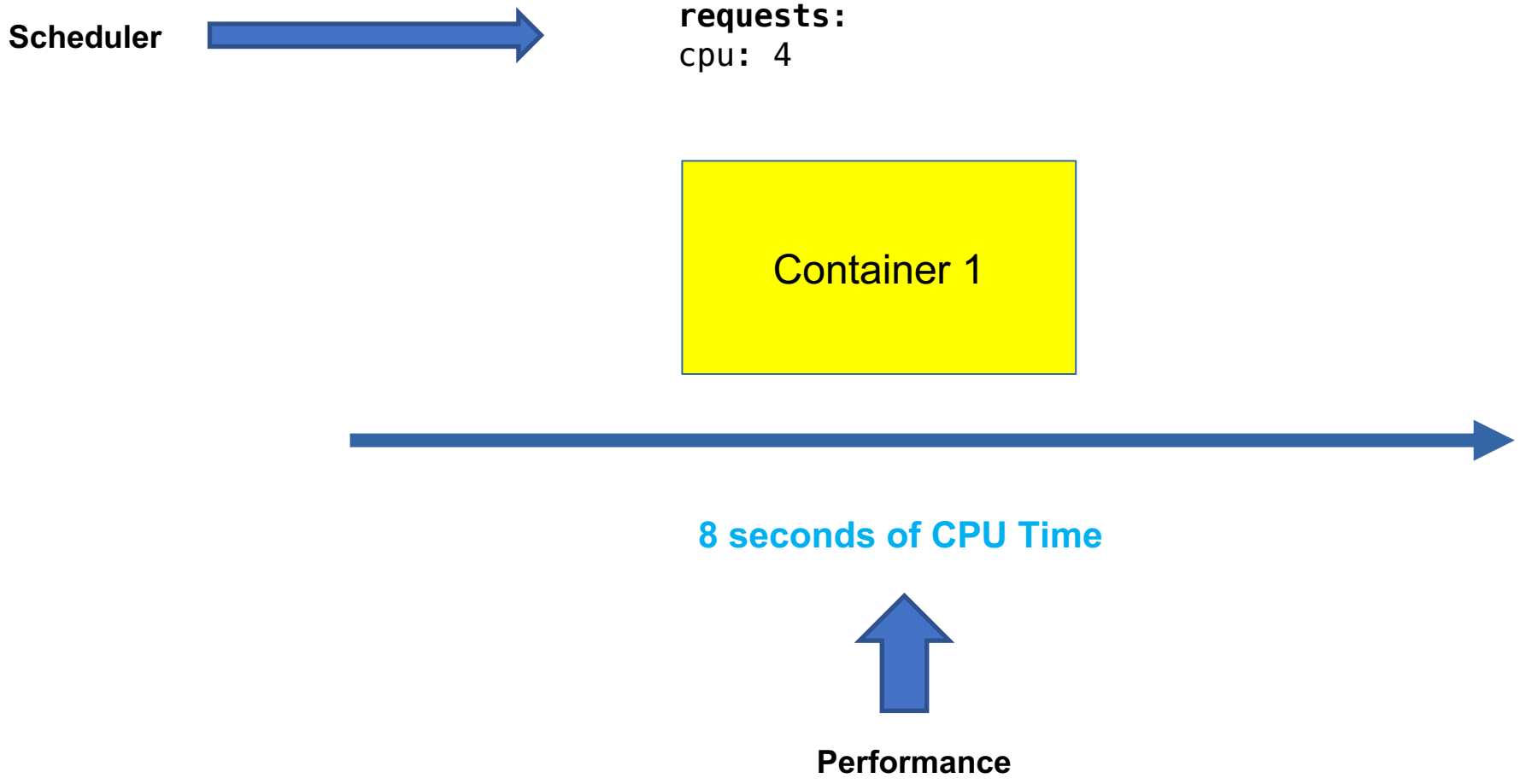


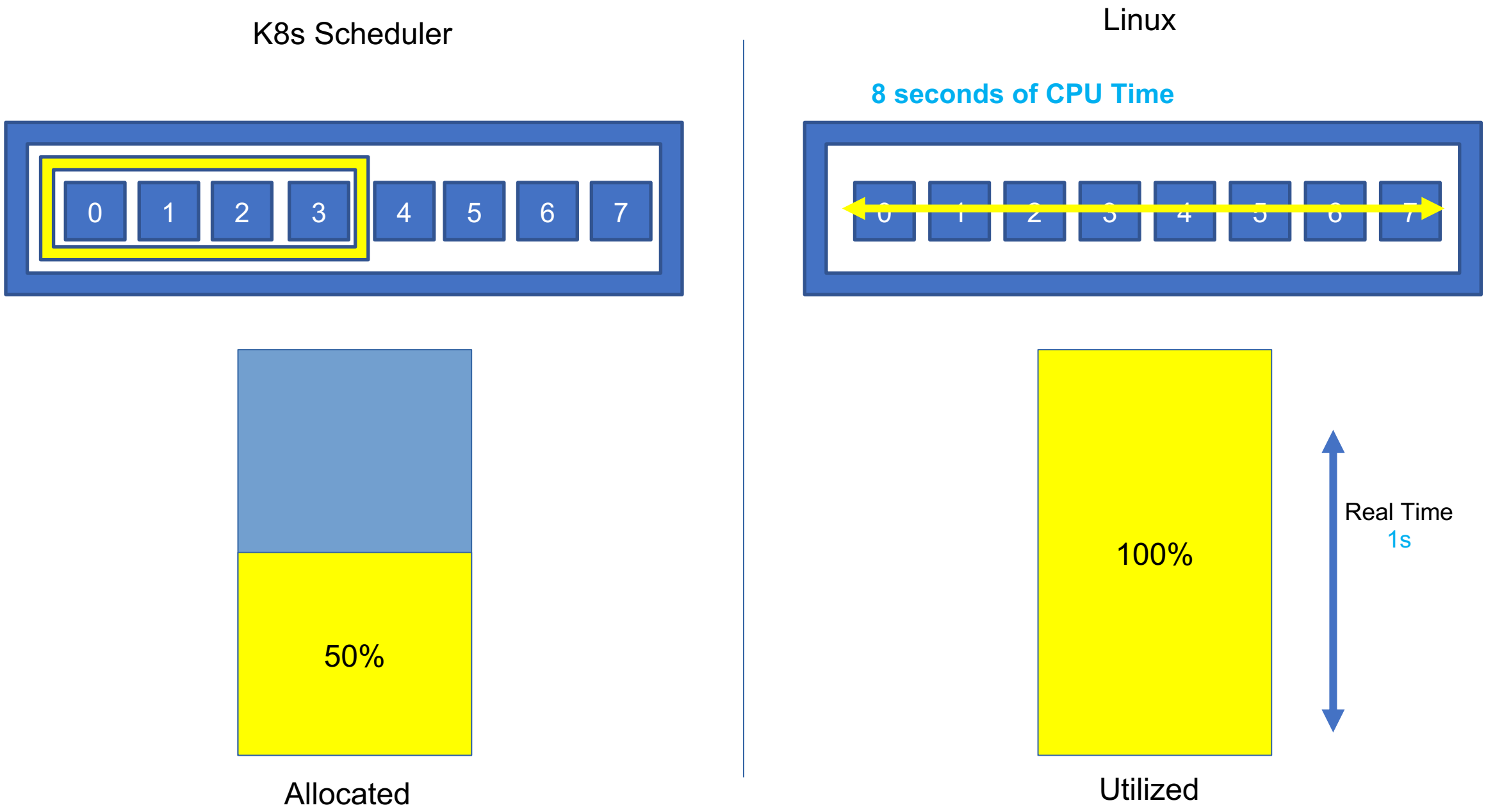
1,000% of Request

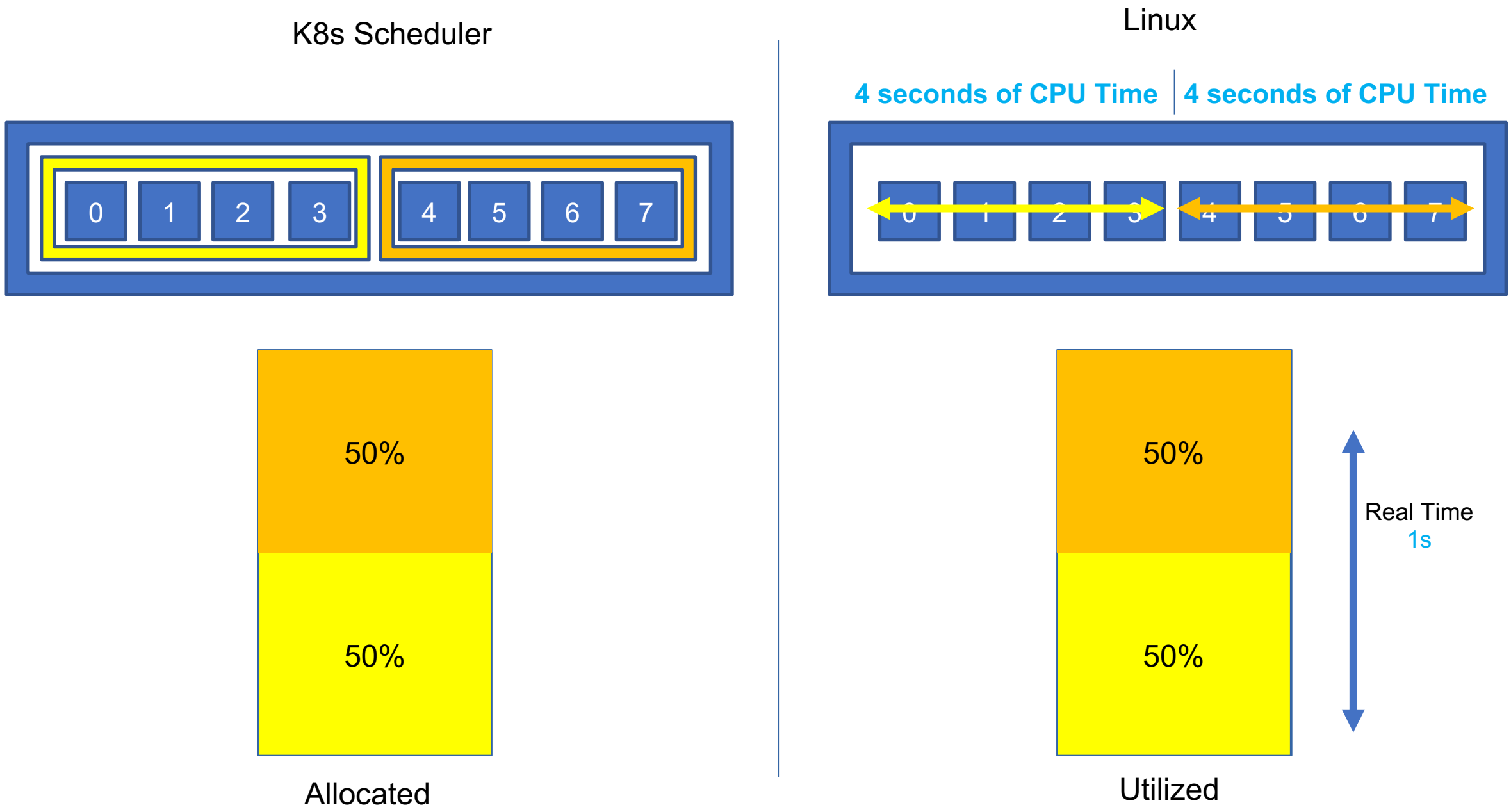
1,000% of Request

The Plot Thickens...

Scheduler vs. Performance




K8s Scheduler
0
1
2
3
4
5
6
7
50%
Allocated
Linux
8 seconds of CPU Time
0
1
2
3
4
5
6
7
100%
Real Time
1s
Utilized


K8s Scheduler
0
1
2
3
4
5
6
7
50%
50%
Allocated
Linux
4 seconds of CPU Time
4 seconds of CPU Time
0
1
2
3
4
5
6
7
50%
50%
Real Time
1s
Utilized

Did we help?

8 Seconds of Work

1 second of Real Time

200% of requests

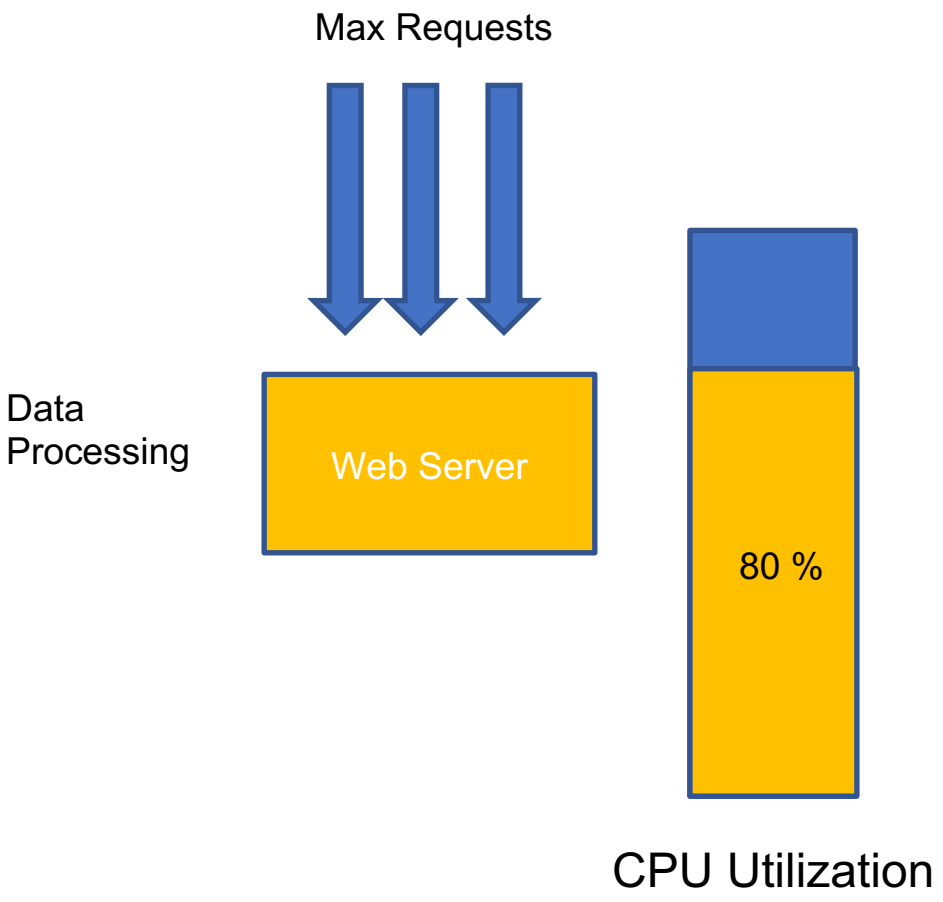
8 Seconds of Work

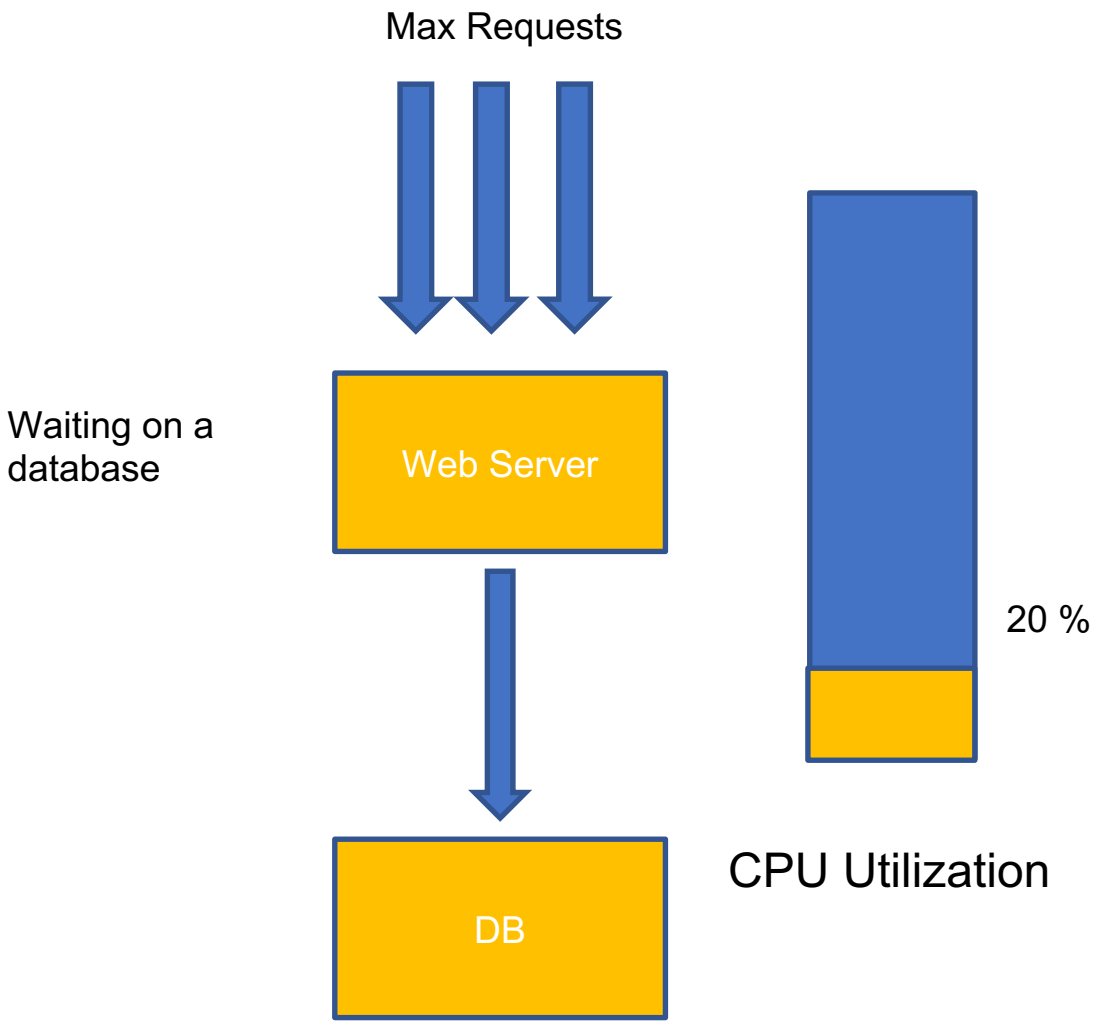
2 seconds of Real Time

100% of requests

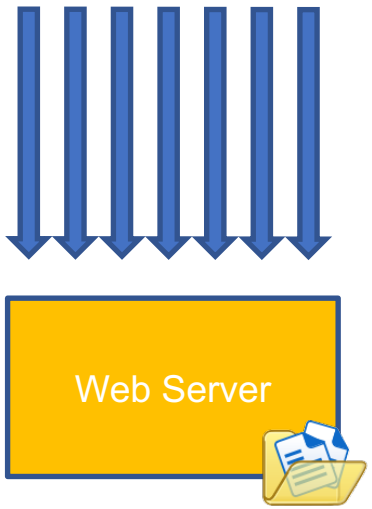
Is CPU The Right Metric At All?

Saturated


Max Requests
Data Processing
Web Server
80 %
CPU Utilization


Max Requests
Waiting on a database
Web Server
DB
20 %
CPU Utilization

Not All Requests Created Equal

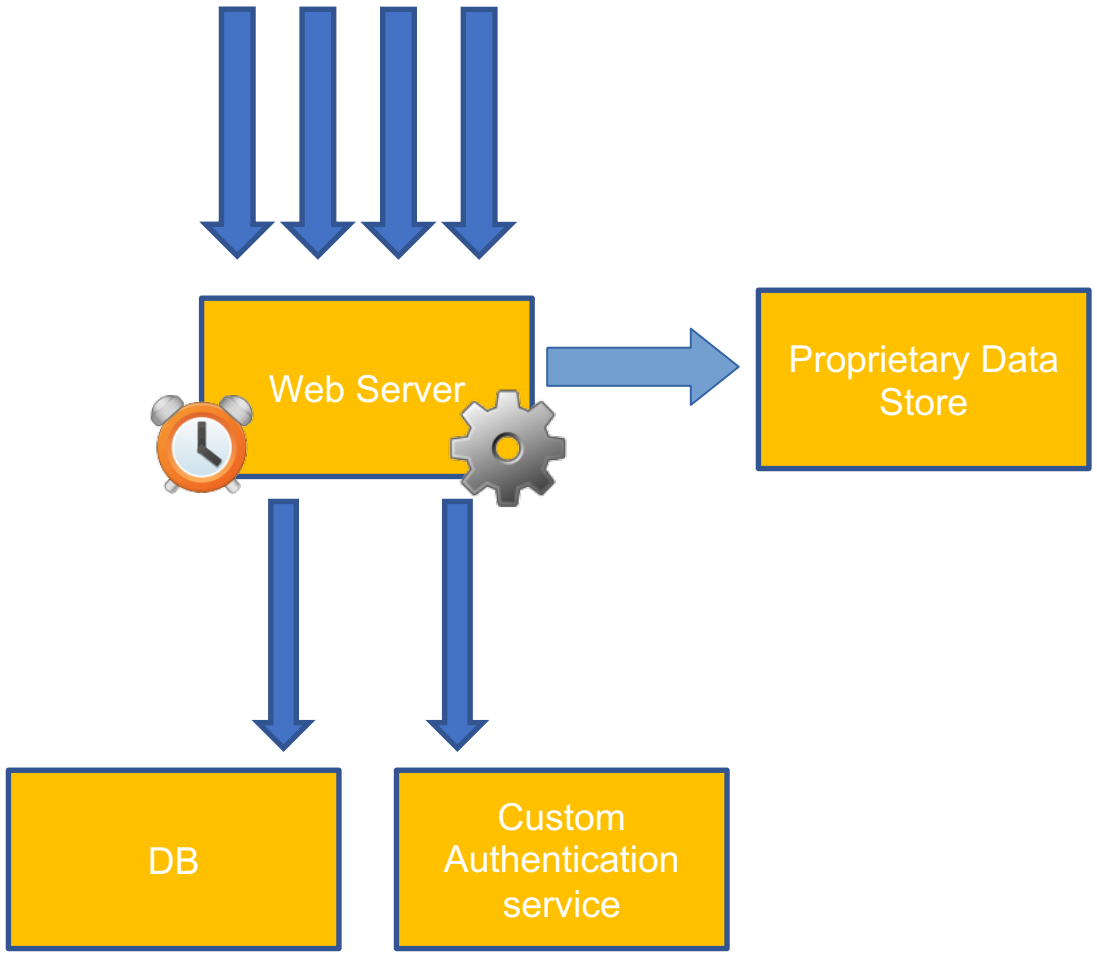


Simple Site

100 RPS

Complex site

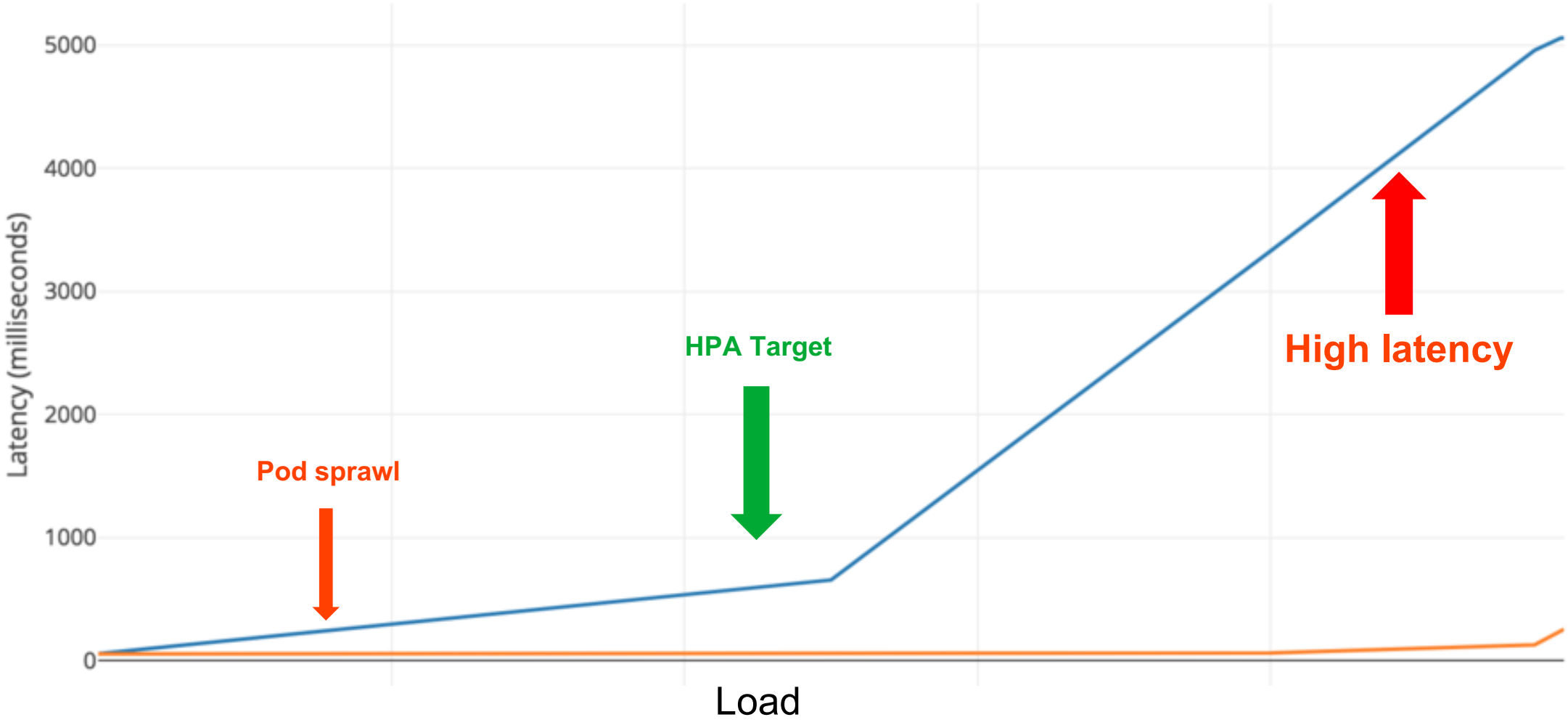
4 RPS



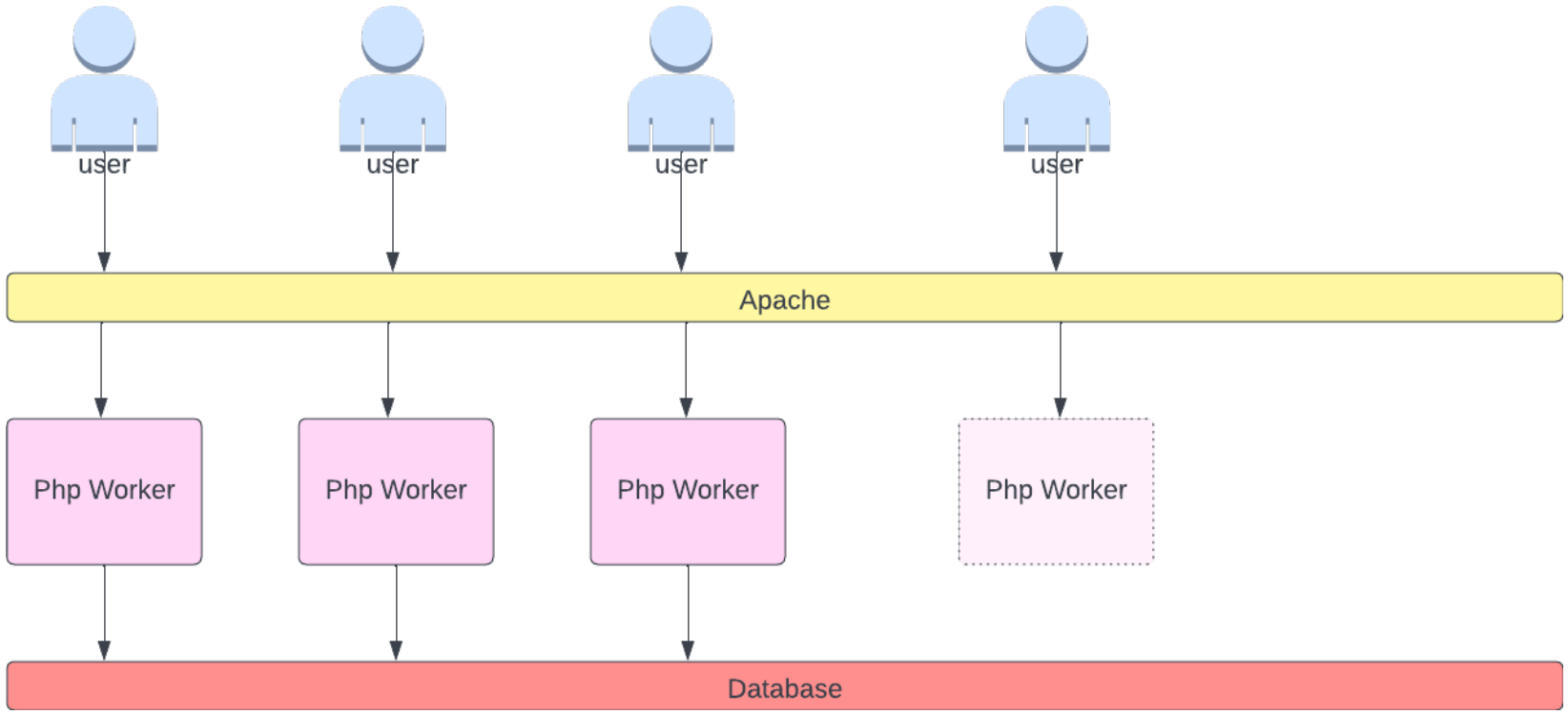
What is the right metric?

- Highly correlated
- Smooth
- Early Signal

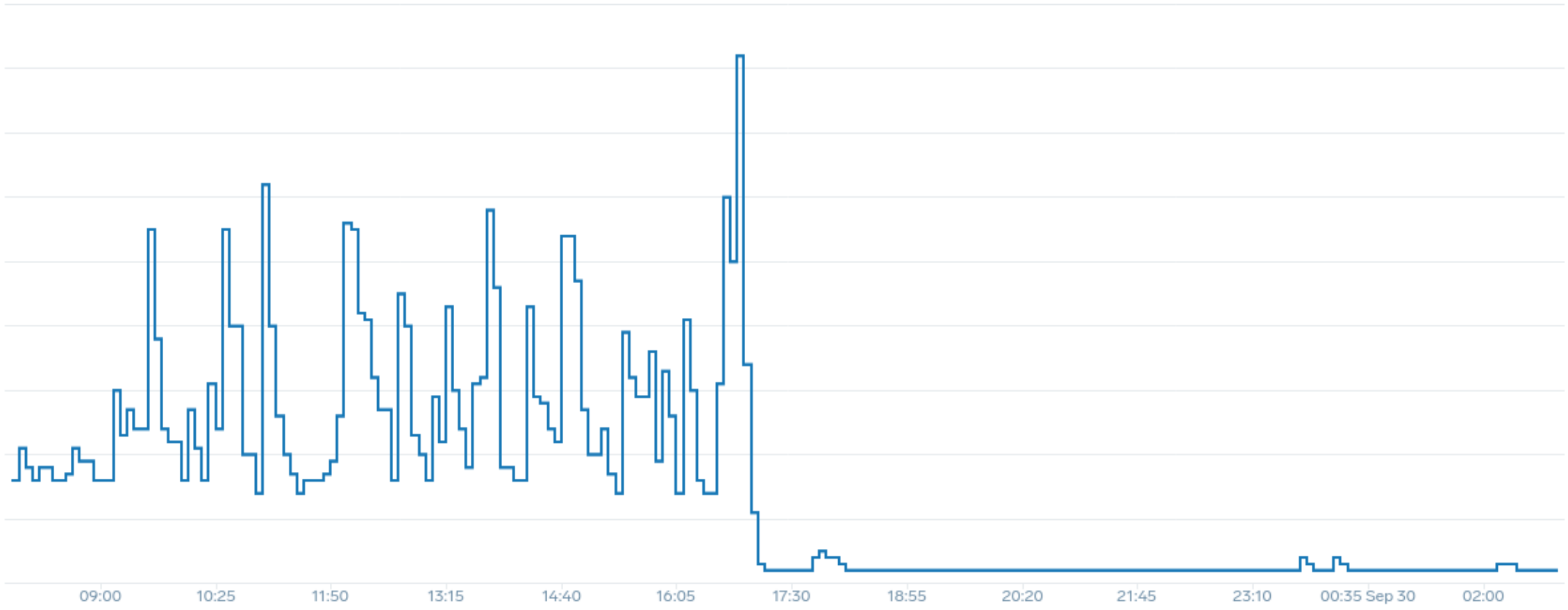
Workload Rightsizing



Active Threads



Success


09:00
10:25
11:50
13:15
14:40
16:05
17:30
18:55
20:20
21:45
23:10
00:35 Sep 30
02:00

Lessons

- Focus on the Fundamentals
- The Easy Answer is the Wrong One
- Measure Everything
- Don’t Think in “Cores”
- Don’t Scale on CPU/Memory
- Understand the Metrics

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