Sparrow

Distributed Low-Latency Spark Scheduling

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amplab

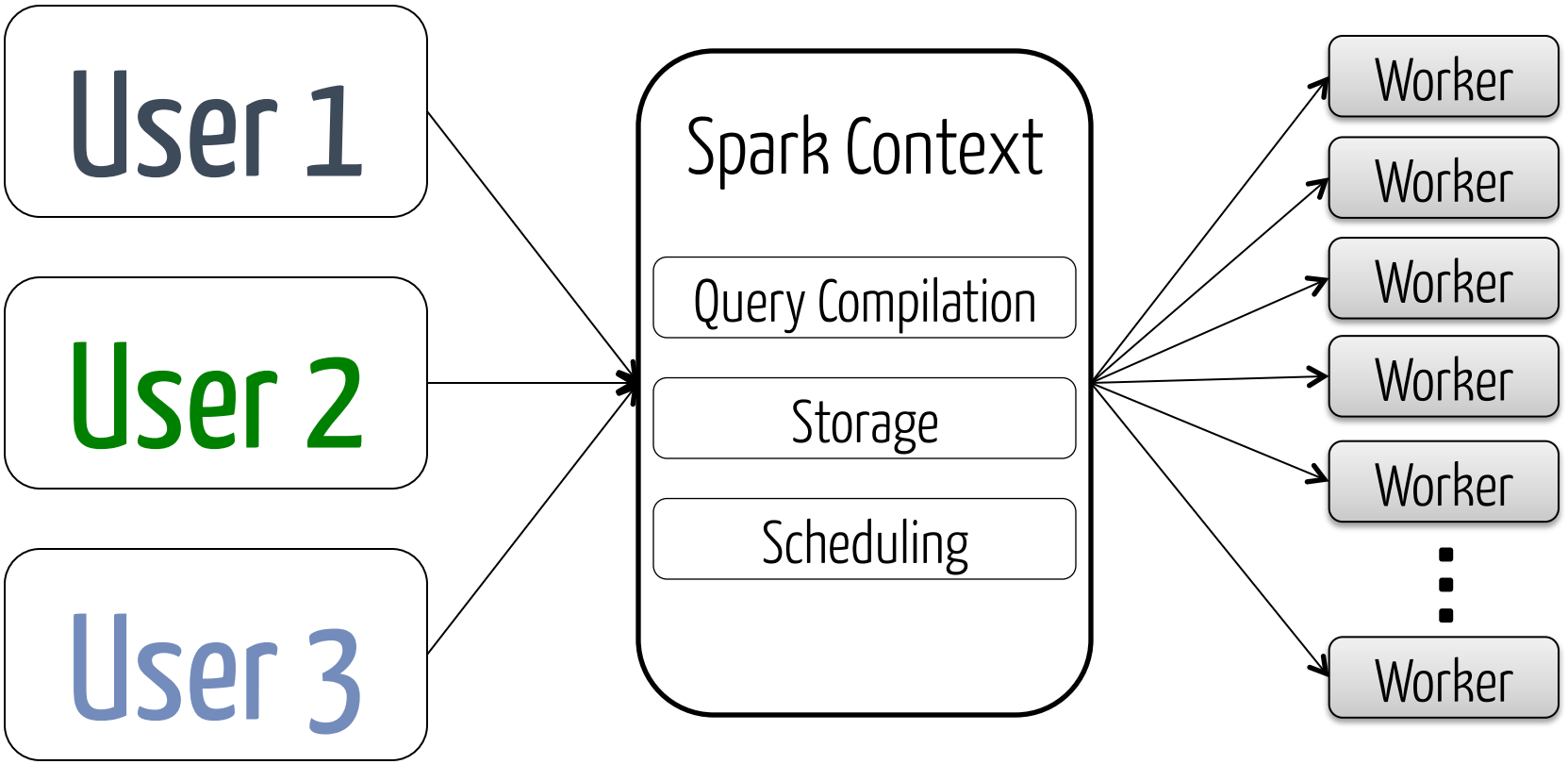
Outline

The Spark scheduling bottleneck

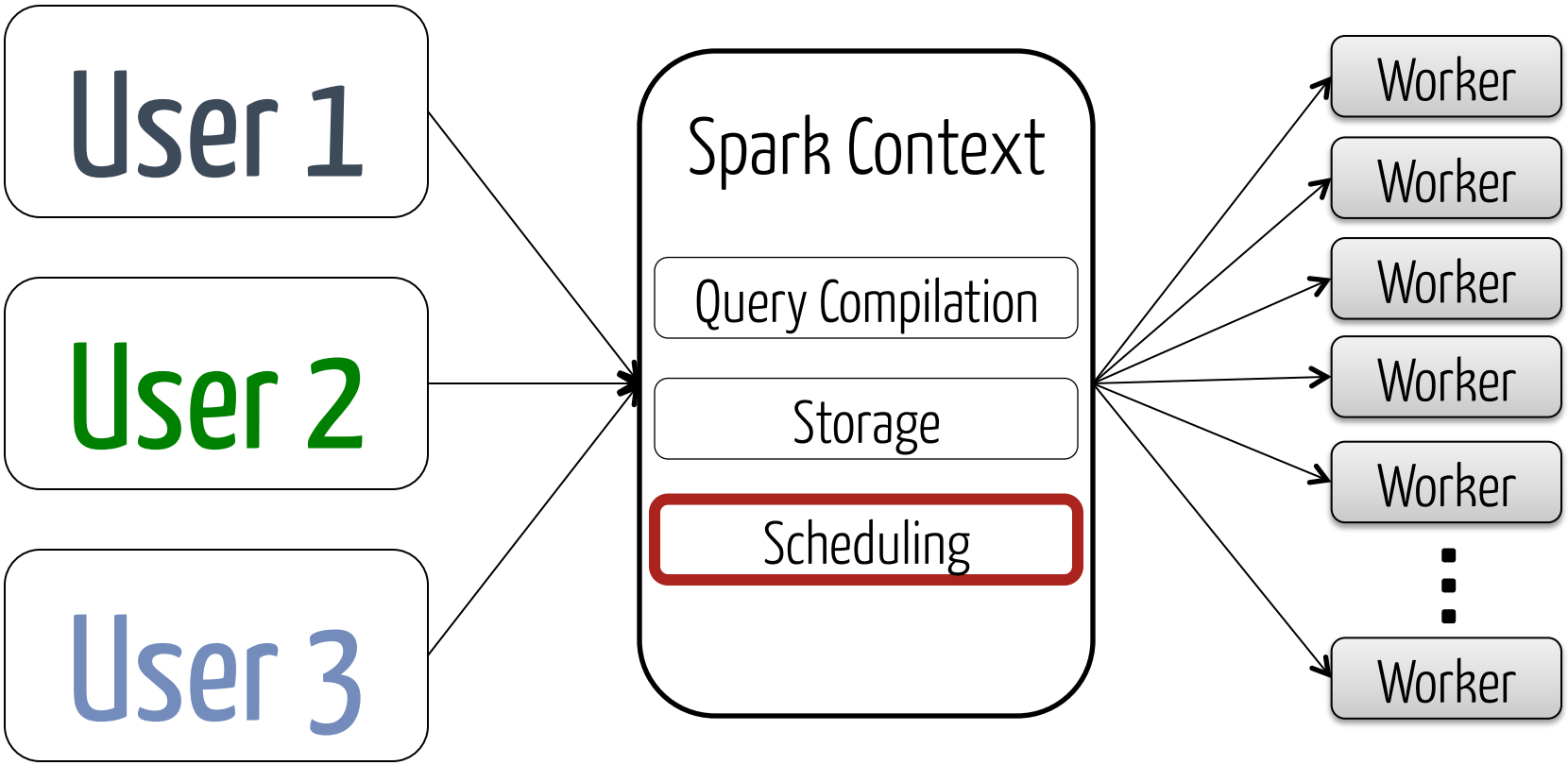
Sparrow's fully distributed, fault-tolerant technique

Sparrow's near-optimal performance

Spark Today


User 1
User 2
User 3
Spark Context
Query Compilation
Storage
Scheduling
Worker
Worker
Worker
Worker
Worker
Worker

Spark Today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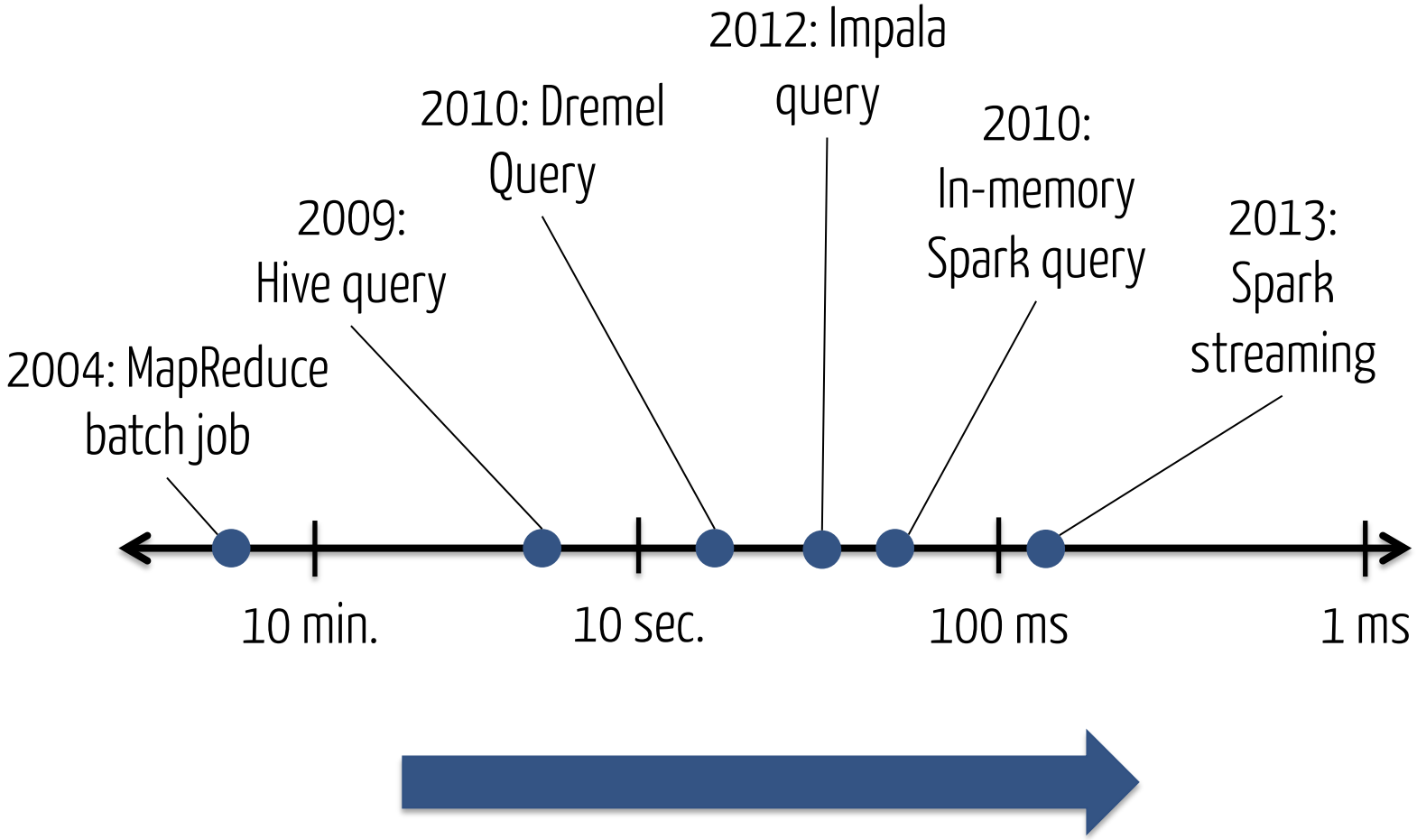

Job Latencies Rapidly Decreasing

Job latencies rapidly decreasing

Job latencies rapidly decreasing

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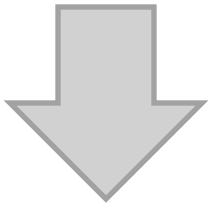
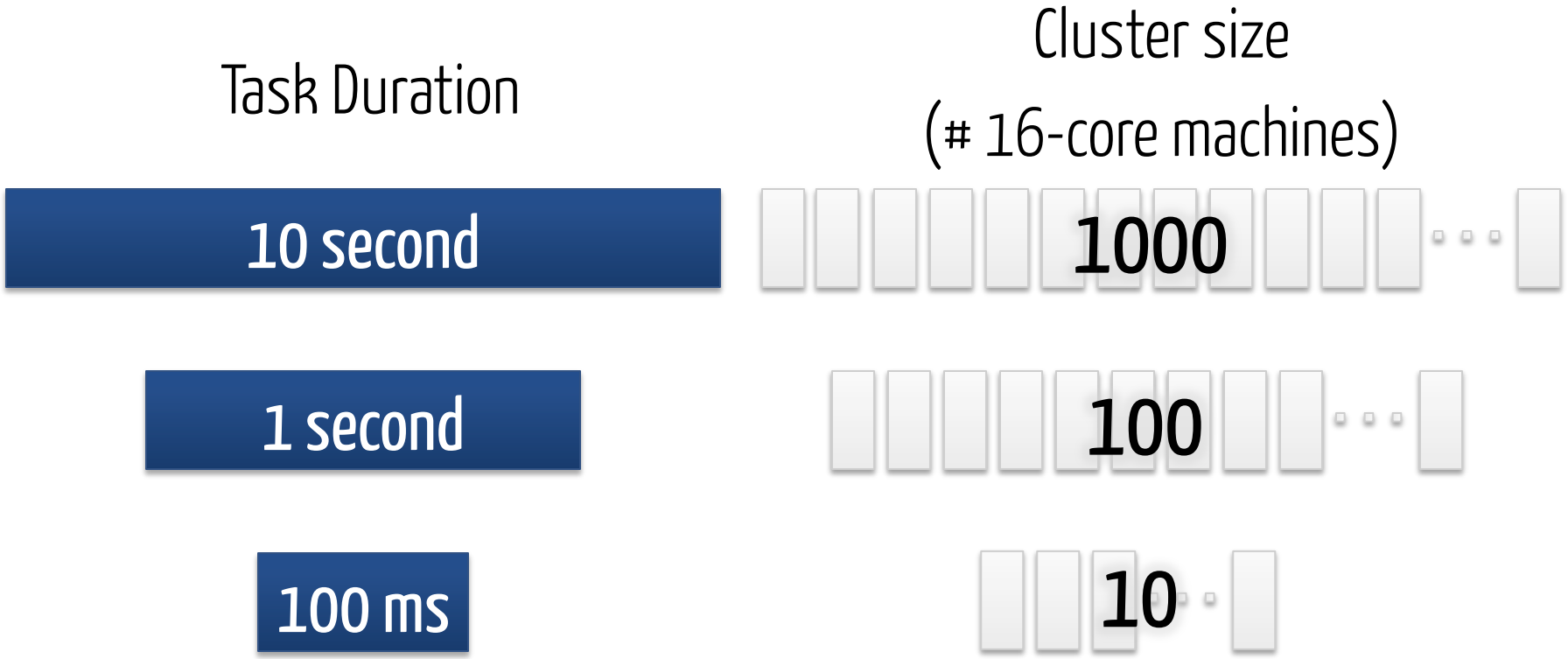
Spark deployments growing in size



Scheduling bottleneck!

Spark scheduler throughput:

1500 tasks / second



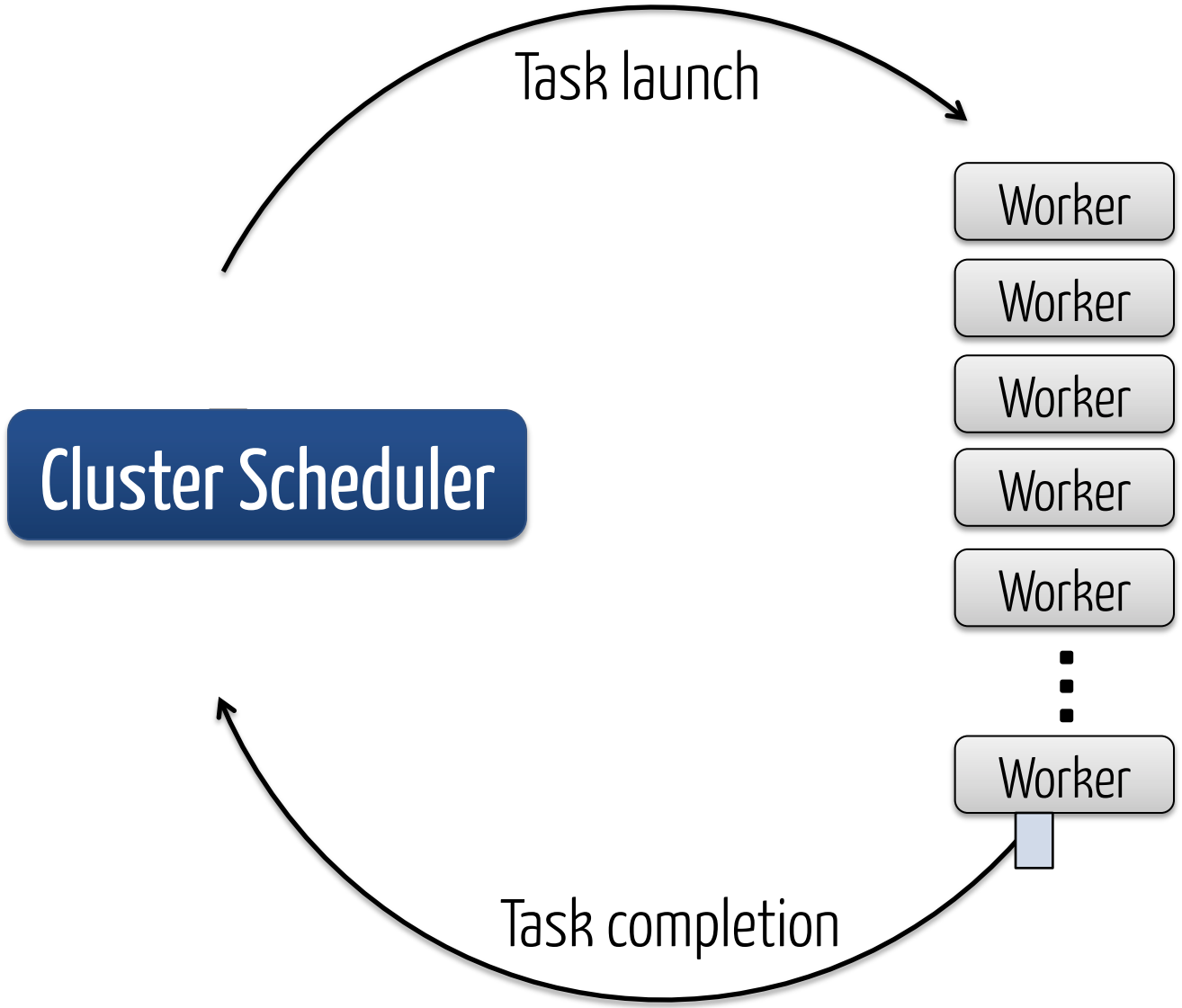
Optimizing the Spark Scheduler

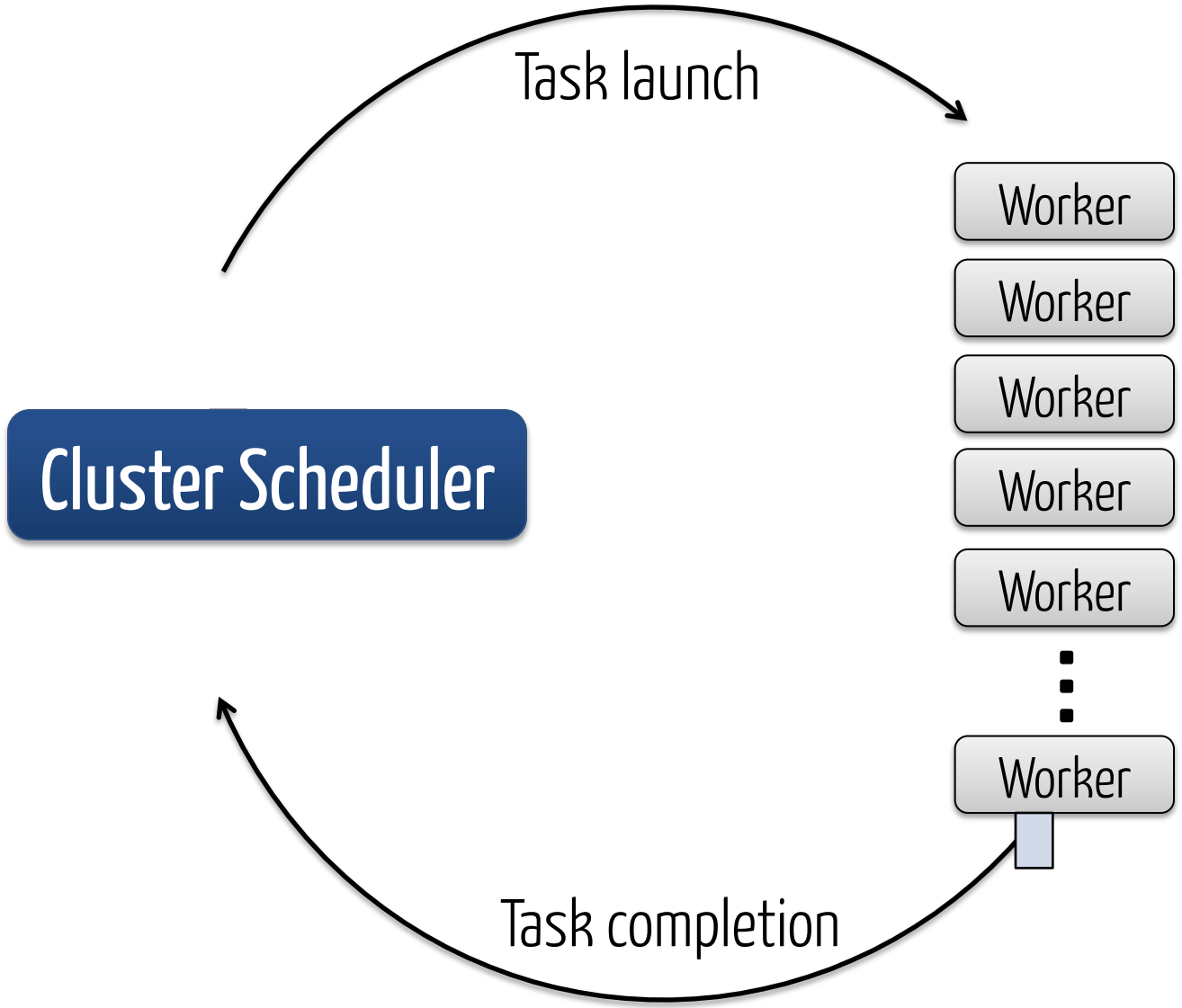
0.8: Monitoring code moved off critical path

0.8.1: Result deserialization moved off critical path

Future improvements may yield 2-3x higher throughput

Is the scheduler the bottleneck in my cluster?


Task launch
Cluster Scheduler
Worker
Worker
Worker
Worker
Worker
Worker
Task completion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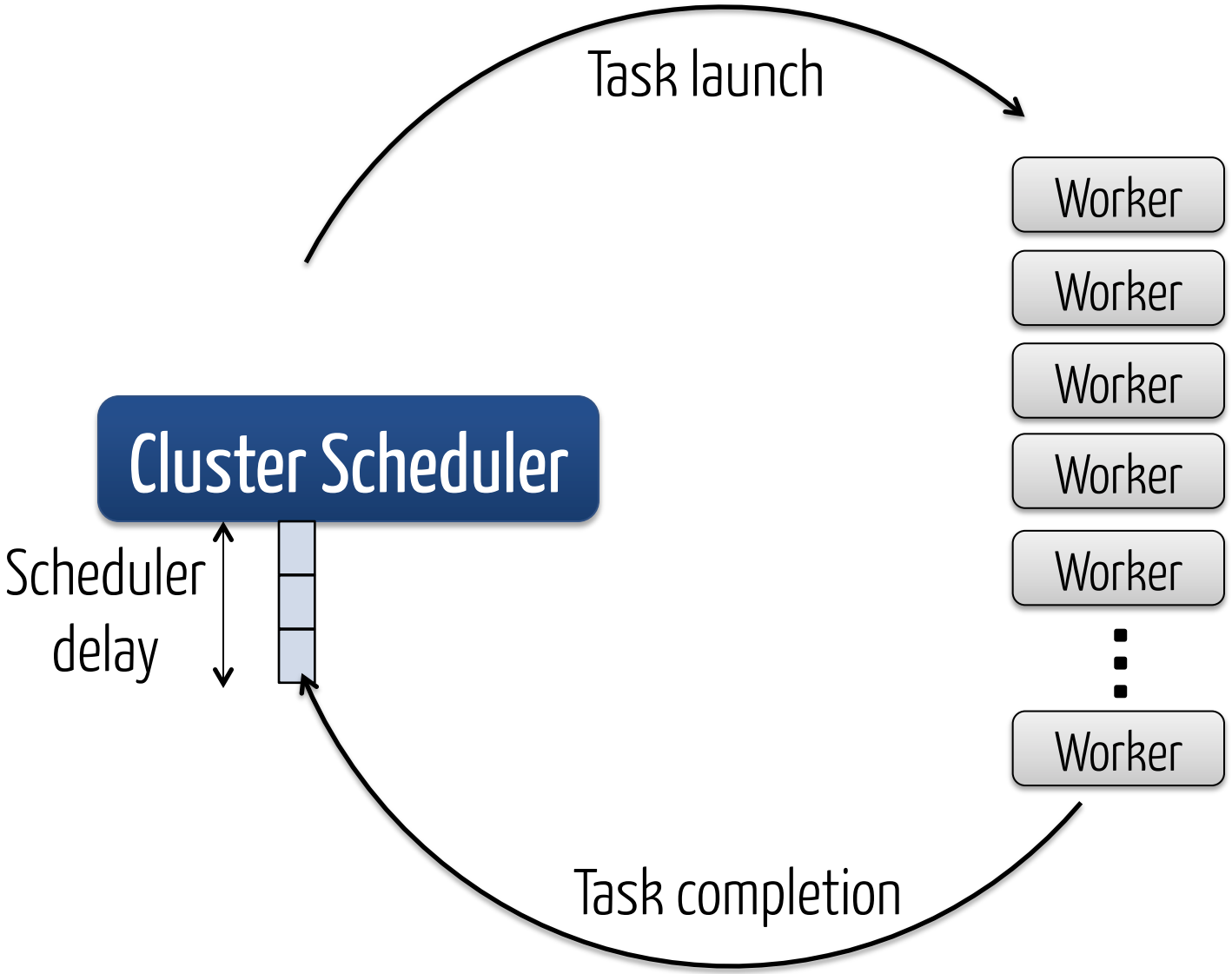
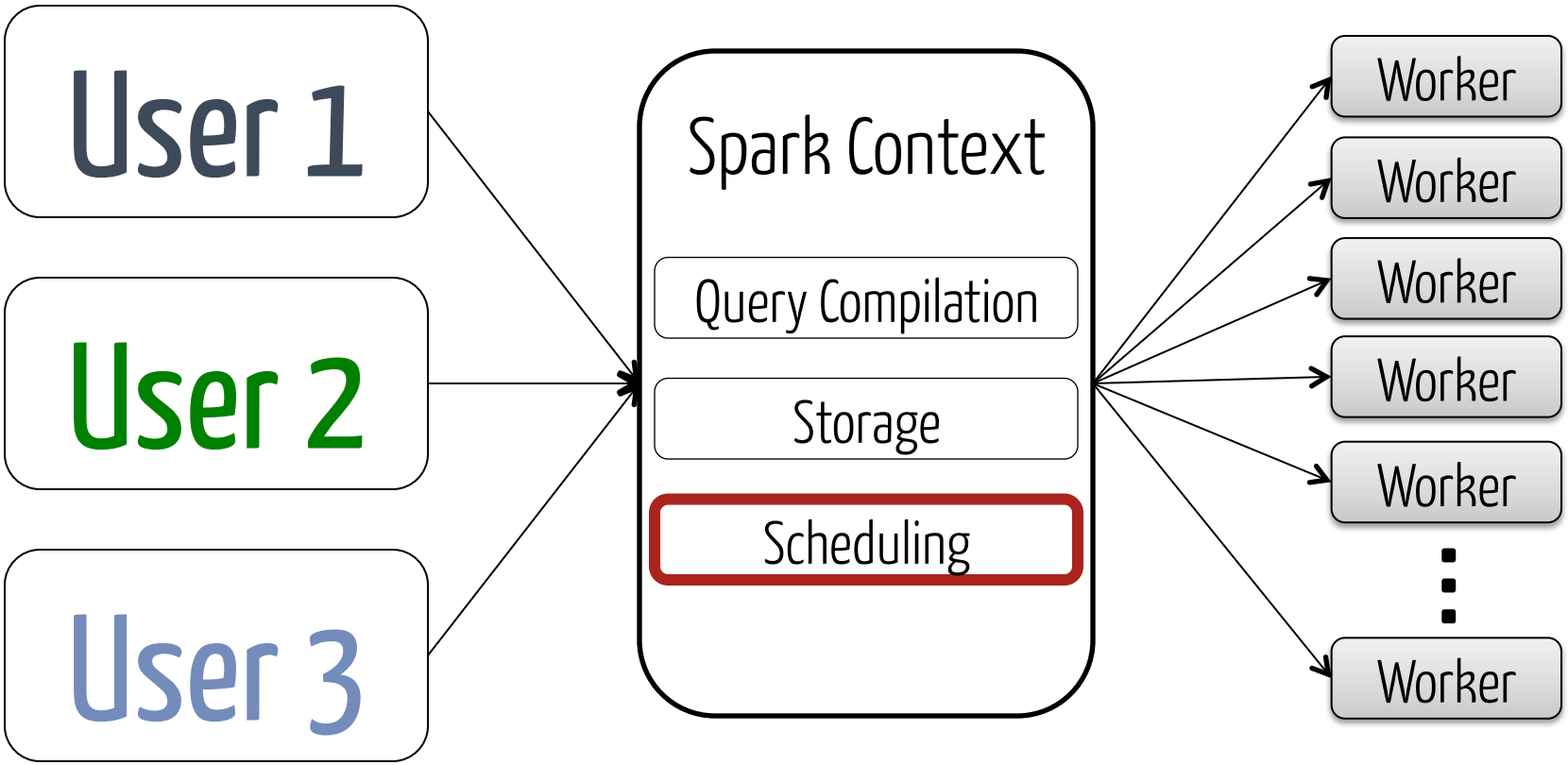

Task launch
Worker
Worker
Worker
Worker
Worker
Worker
Cluster Scheduler
Scheduler delay
Task completion

Spark Today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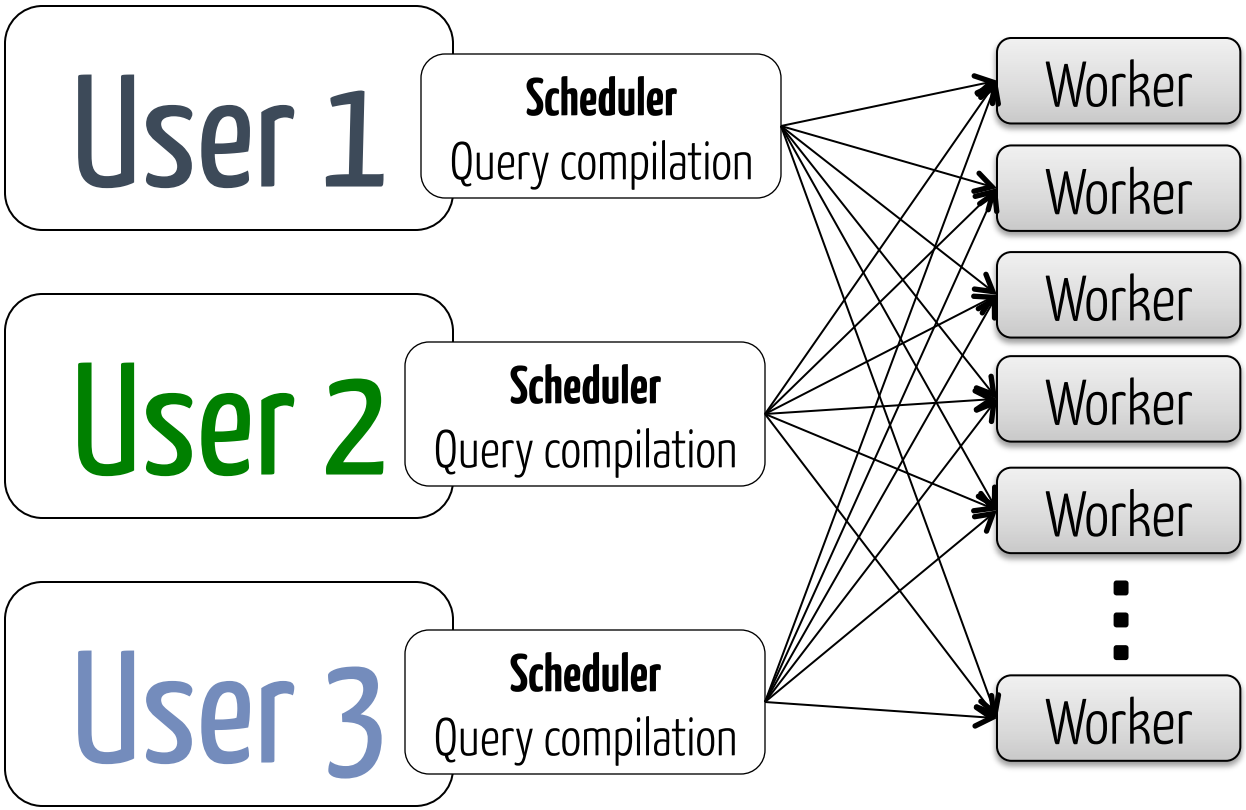
Future Spark

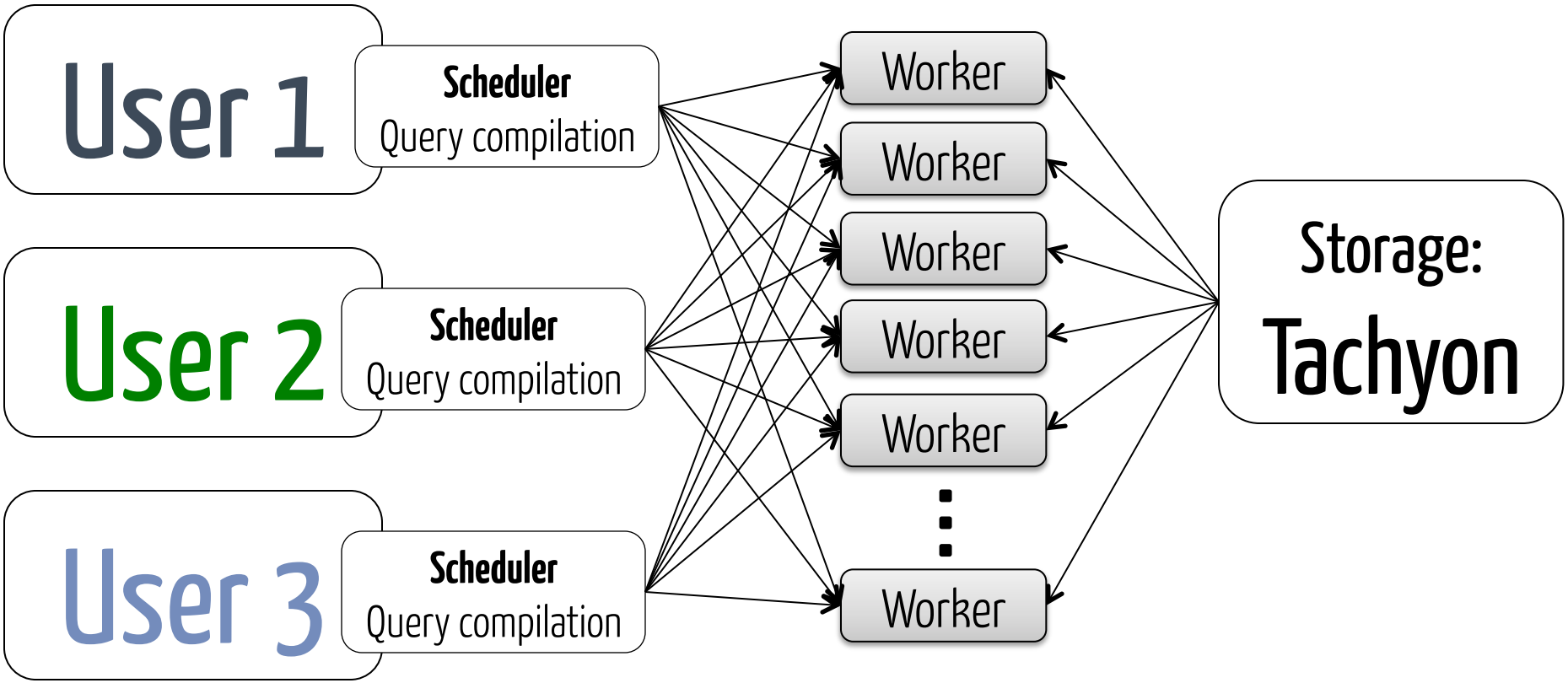


Benefits:

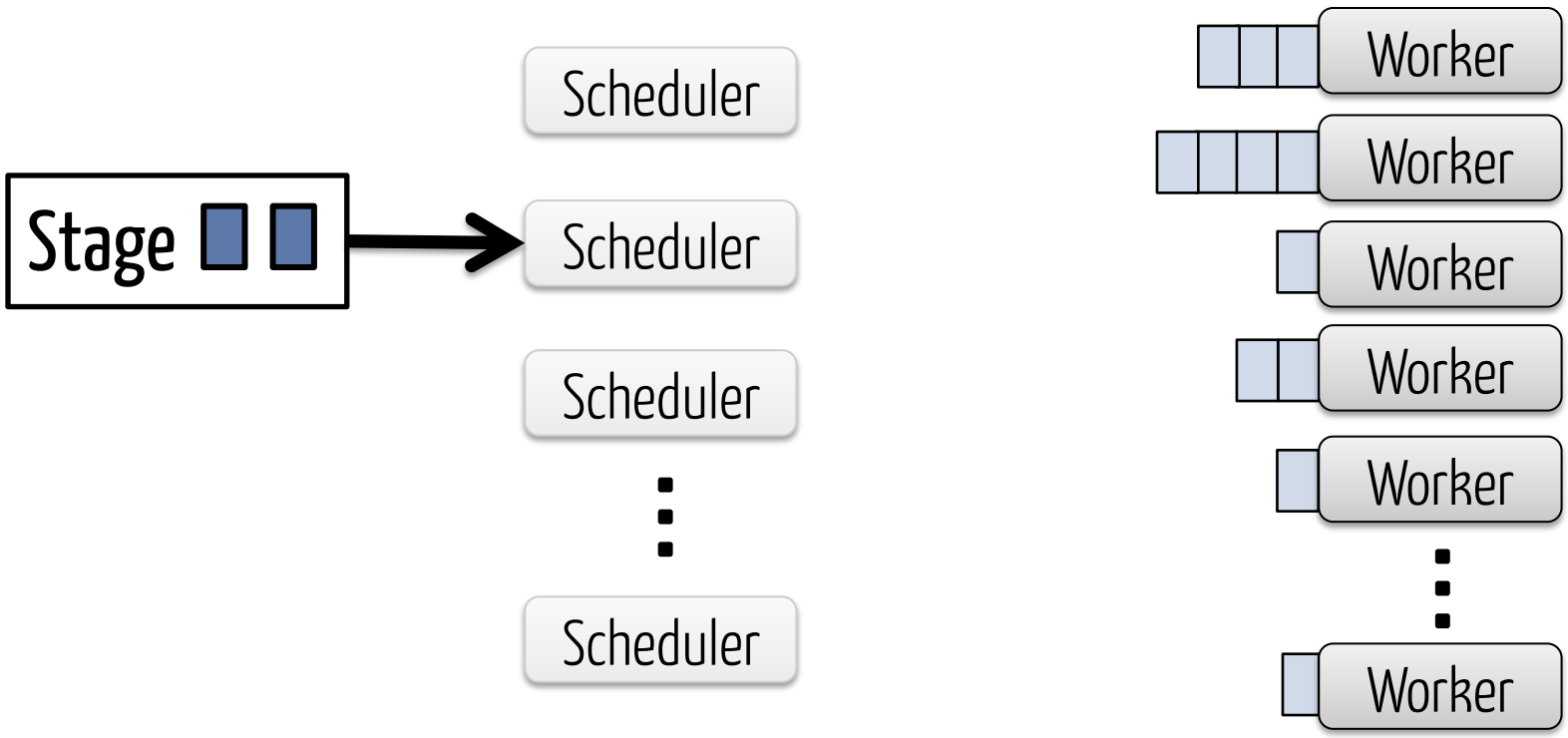
High throughput

Fault tolerance

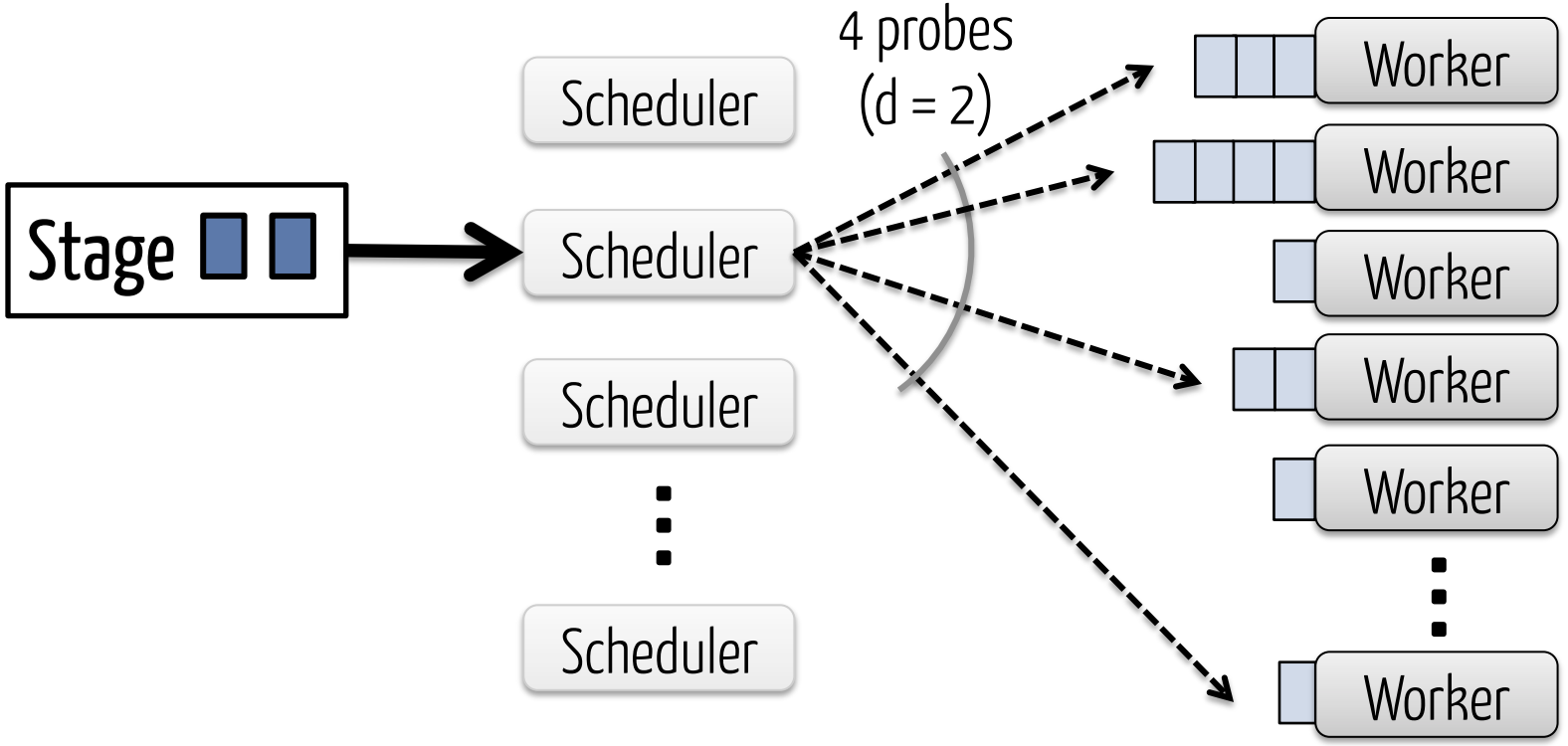
Future Spark



Scheduling with Sparrow

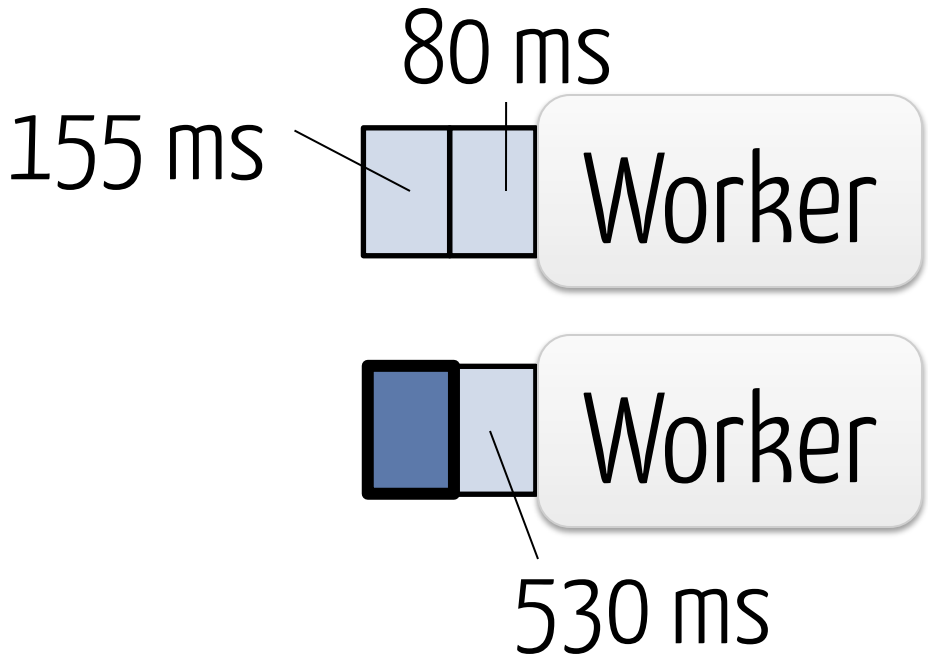


Batch Sampling



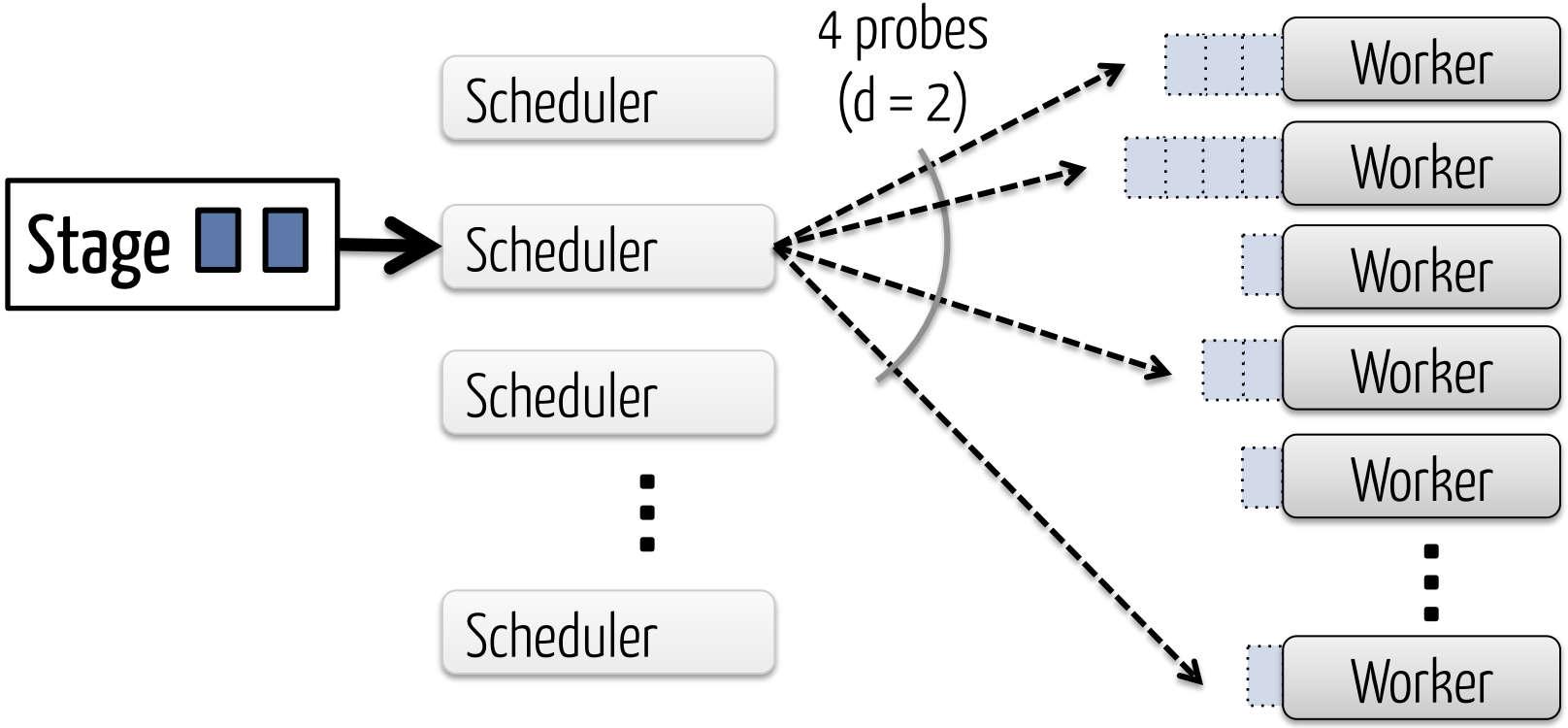
Place m tasks on the least loaded of $d \bullet m$ workers

Queue length poor predictor of wait time



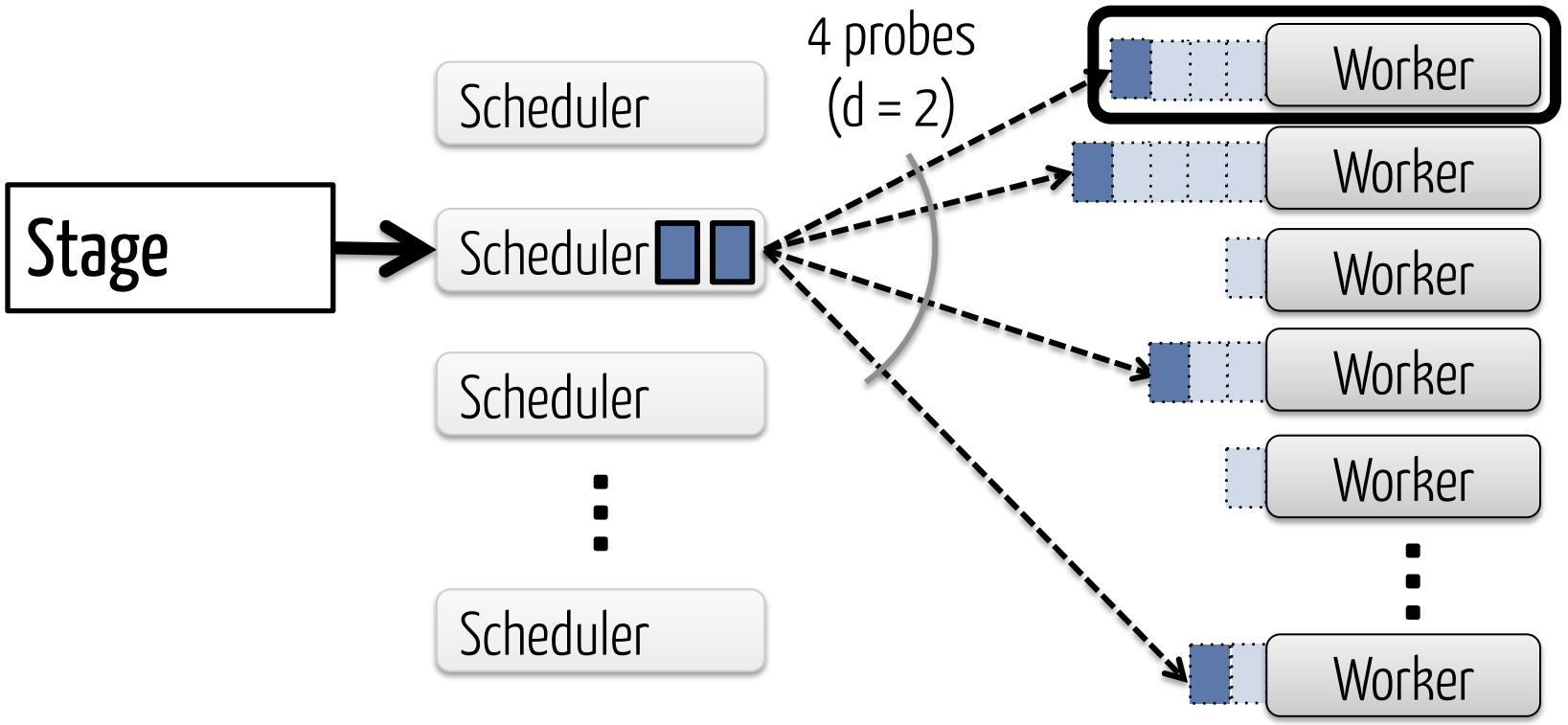
Poor performance on heterogeneous workloads

Late Binding



Place *m* tasks on the least loaded of *d*•*m* workers

Late Binding



Place m tasks on the least loaded of $d \bullet m$ workers

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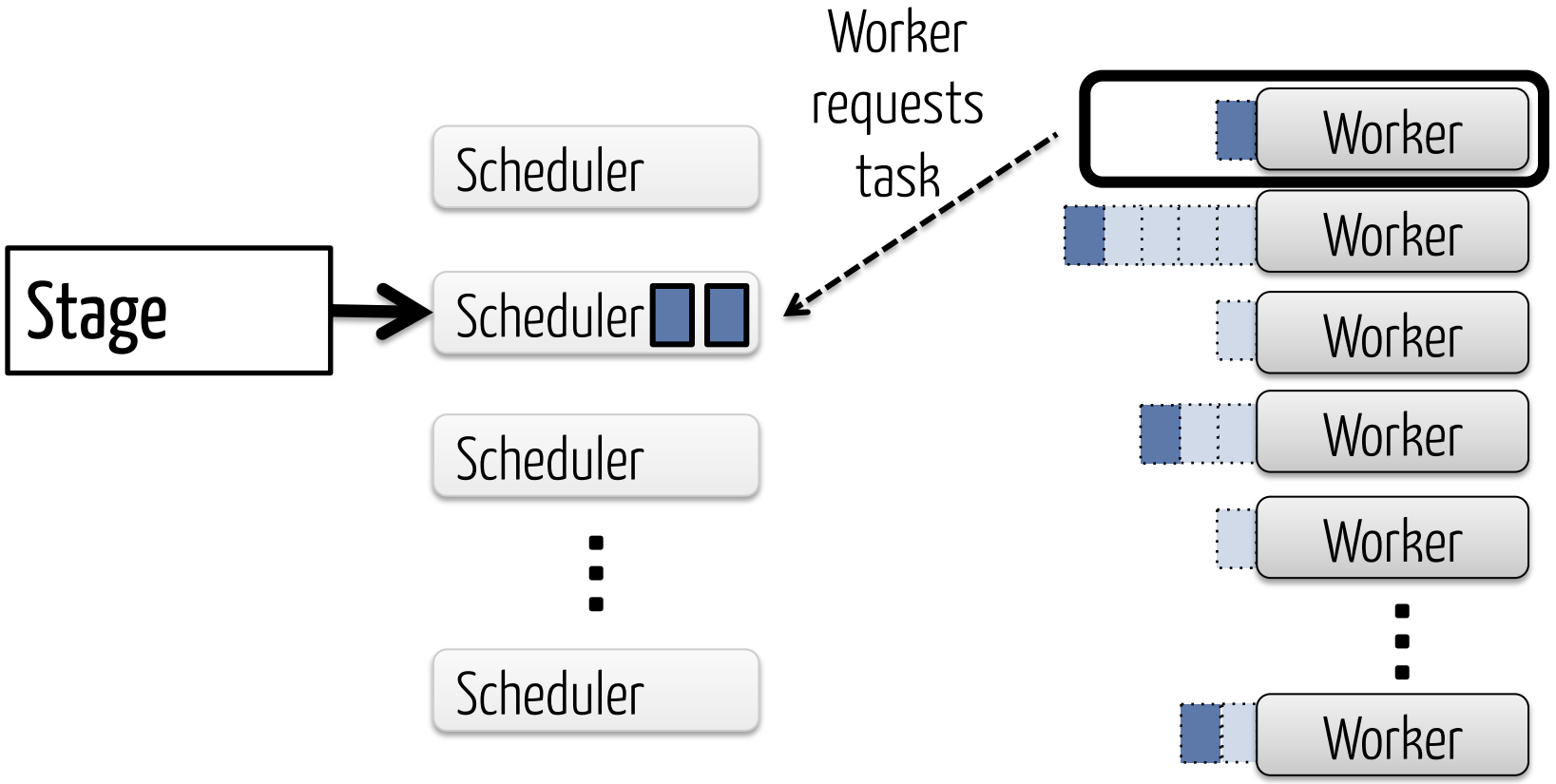
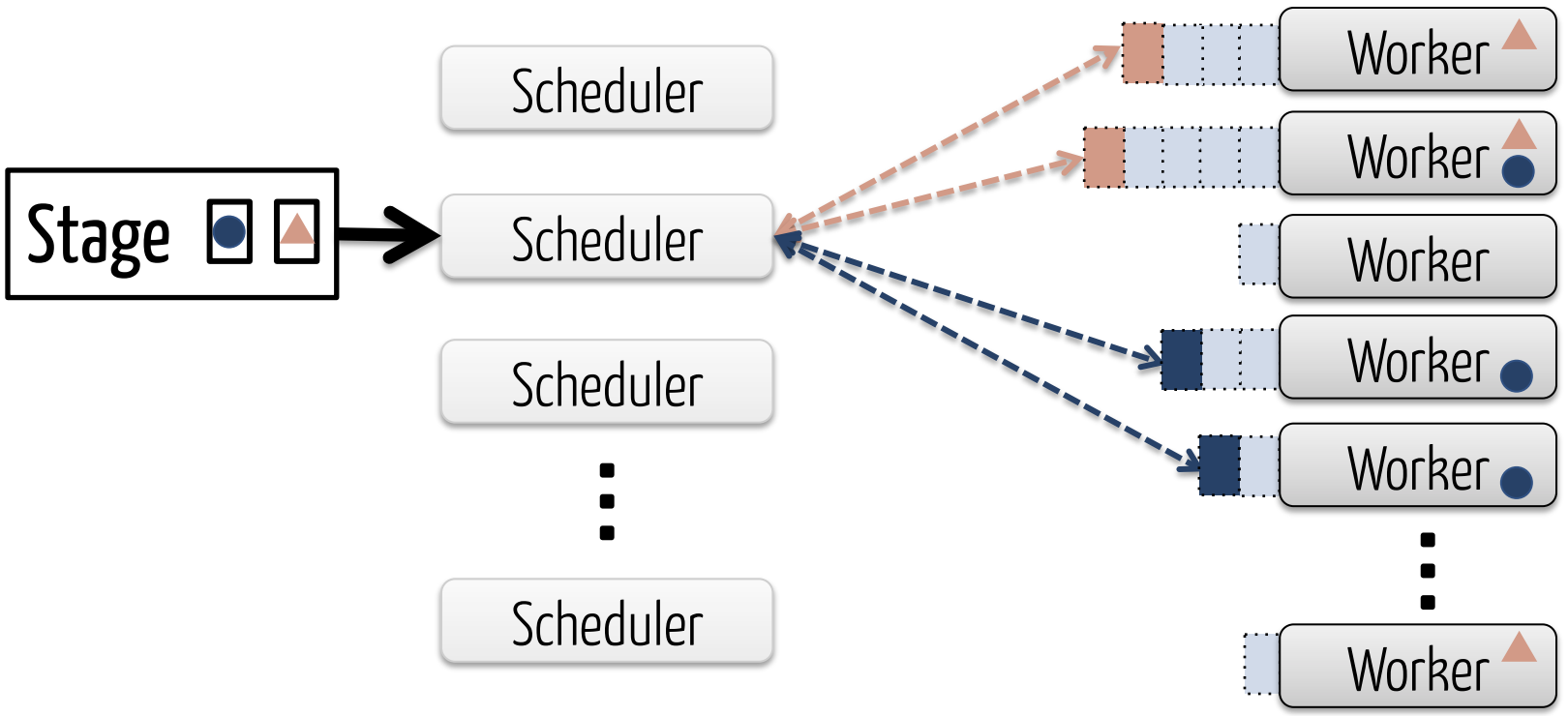


Place m tasks on the least loaded of $d \bullet m$ workers

What about constraints?

Per-Task Constraints



Probe separately for each task

Technique Recap

Batch sampling

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Late binding

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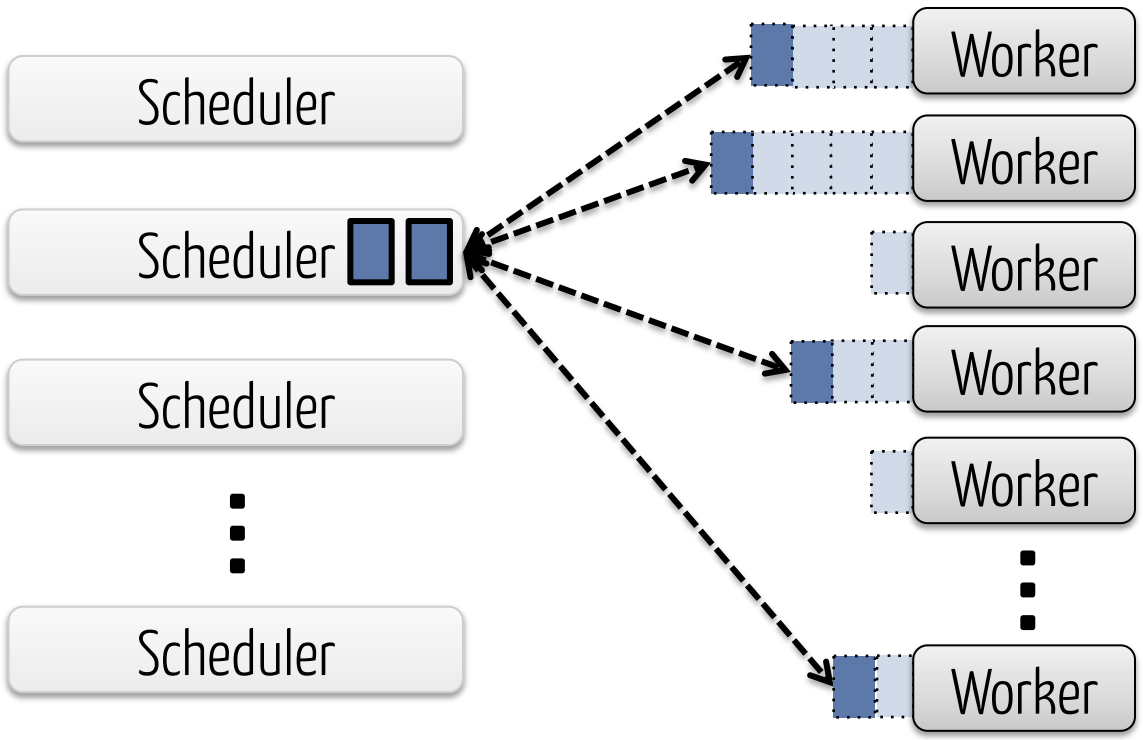
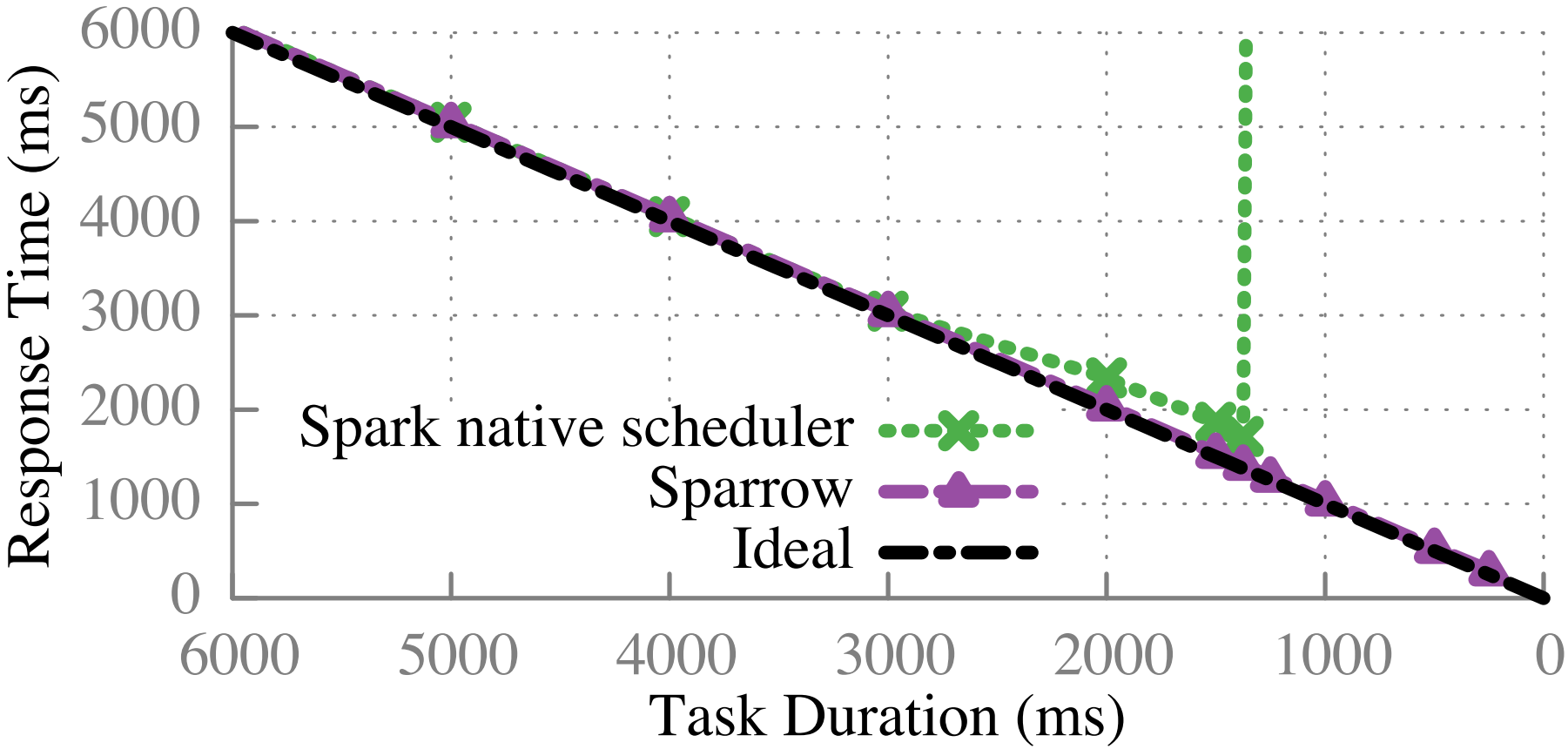
Constraints



How well does Sparrow perform?

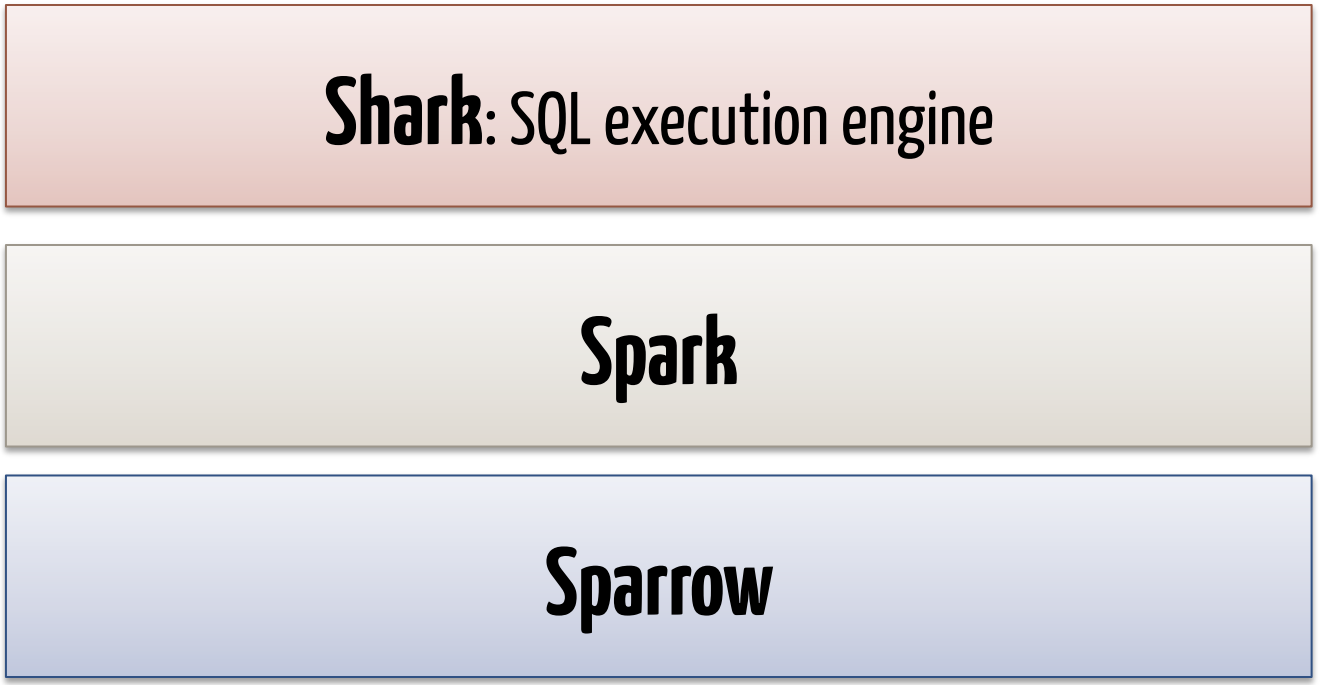
How does Sparrow compare to Spark's native scheduler?



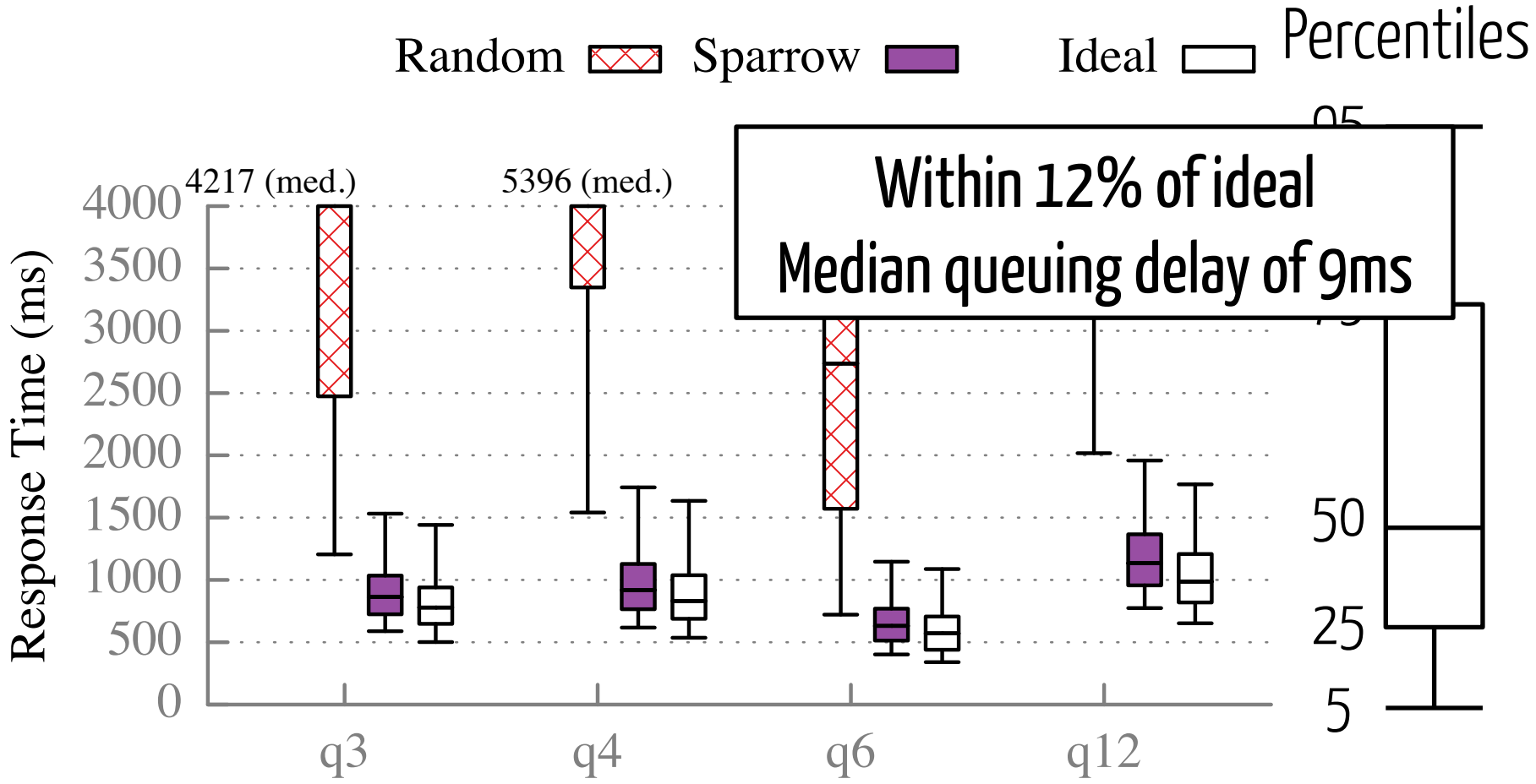
100 16-core EC2 nodes, 10 tasks/job, 10 schedulers, 80% load

TPC-H Queries: Background

TPC-H: Common benchmark for analytics workloads



TPC-H Queries

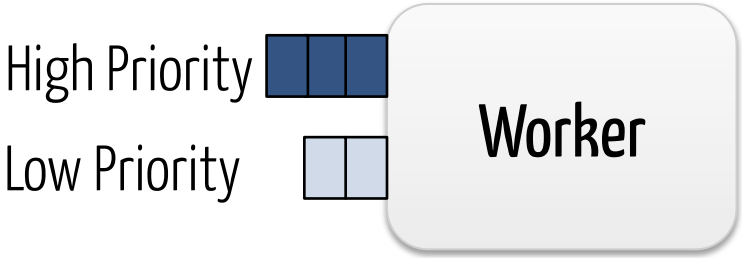


100 16-core EC2 nodes, 10 schedulers, 80% load

Policy Enforcement

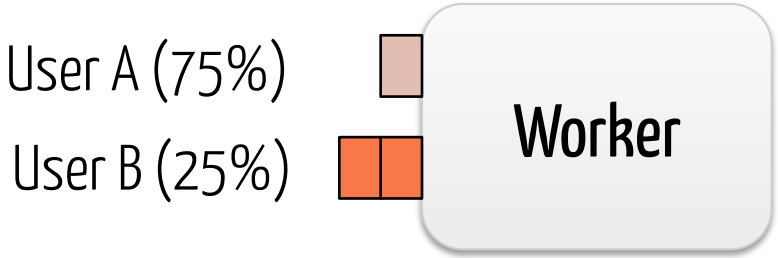
Priorities

Serve queues based on strict priorities

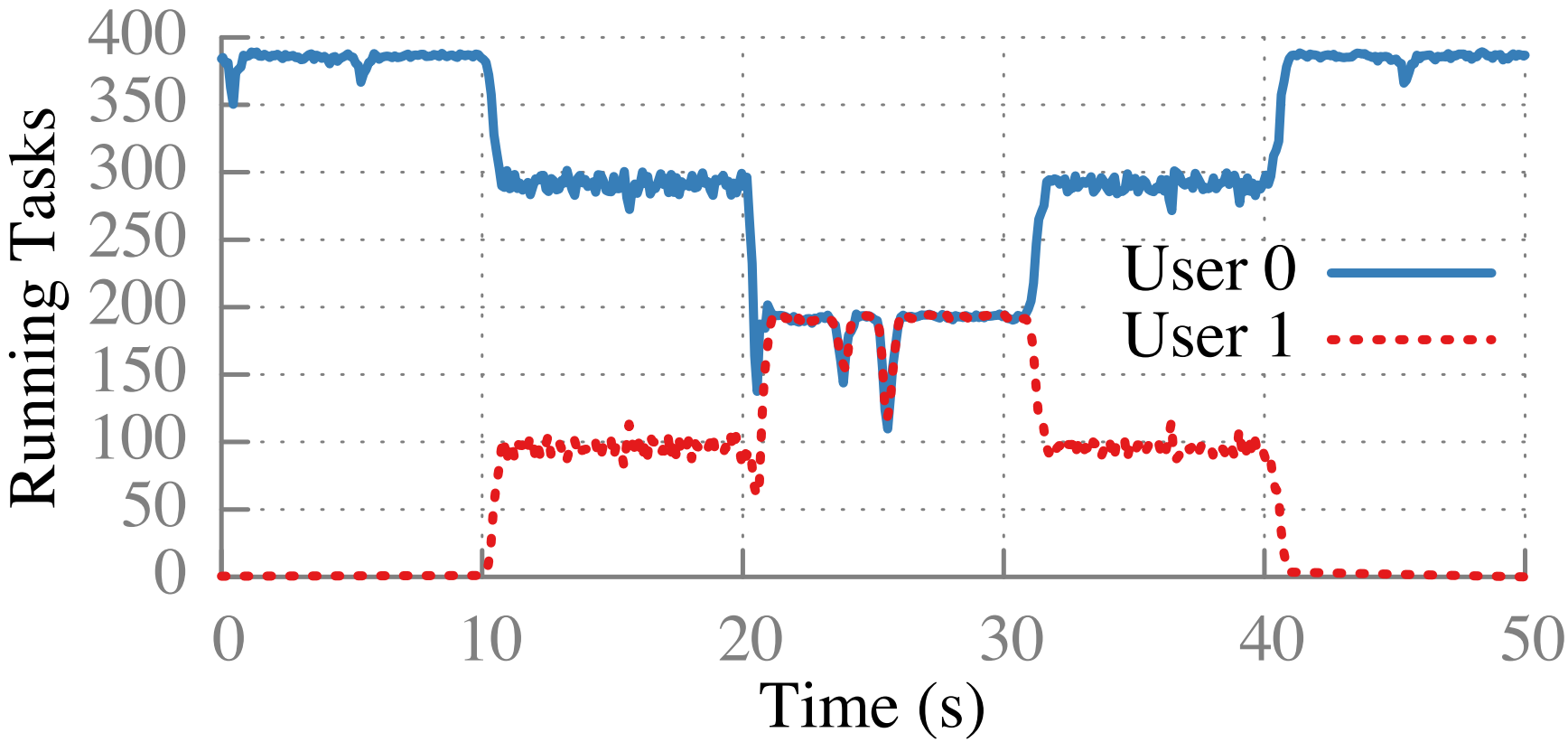


Fair Shares

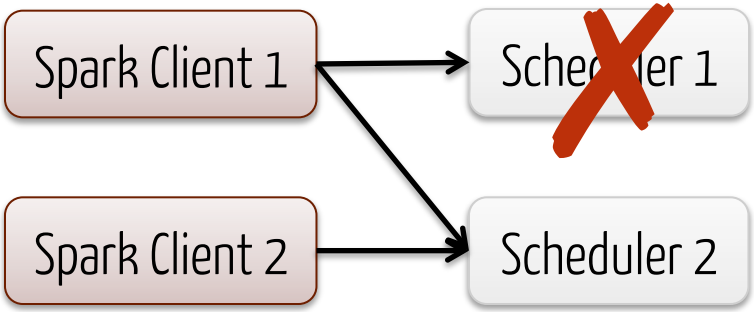
Serve queues using weighted fair queuing

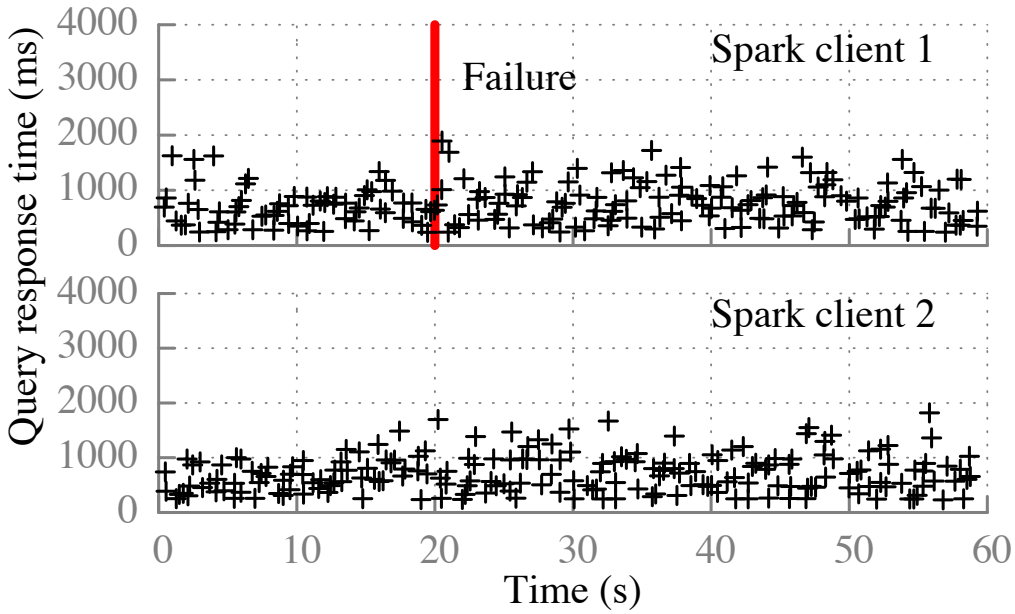


Weighted Fair Sharing



Fault Tolerance





Timeout: 100ms

Failover: 5ms

Re-launch queries: 15ms

Making Sparrow feature-complete

Interfacing with UI

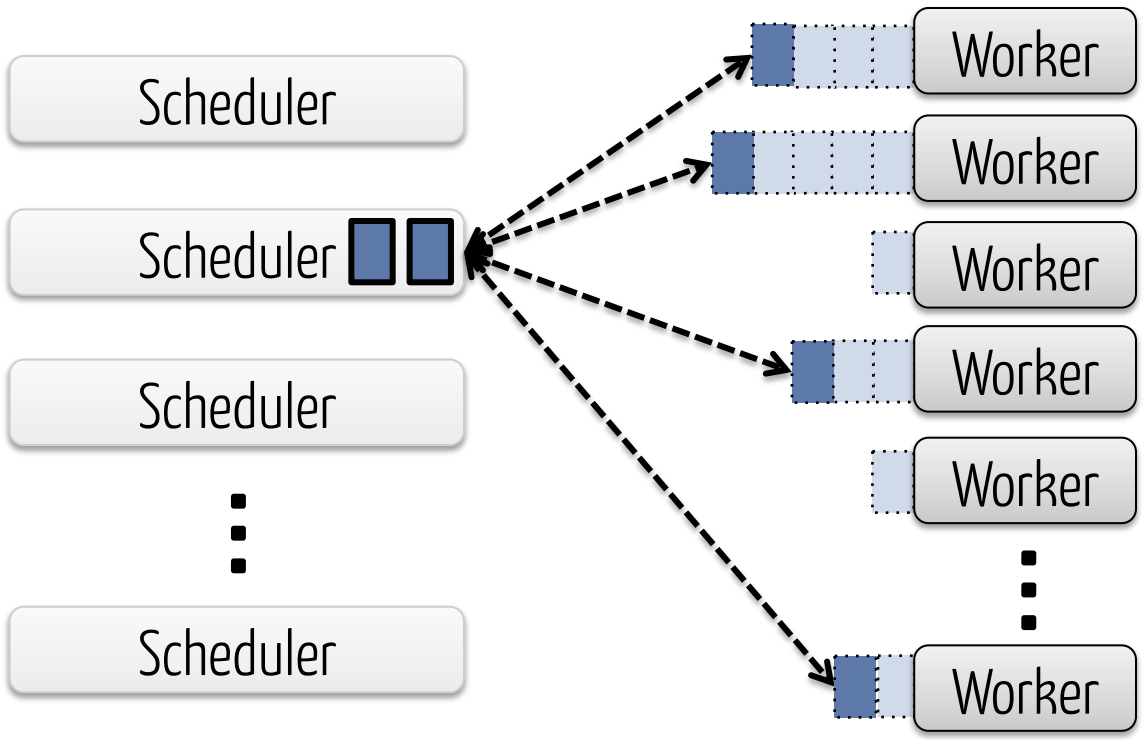
Delay scheduling

Speculation

(1) Diagnosing a Spark scheduling bottleneck

Metric	Min	25th percentile	Median	75th percen
Duration	1 ms	1 ms	1 ms	1 ms
Time spent fetching task results	0 ms	0 ms	0 ms	0 ms
Scheduler delay	30 ms	81 ms	91 ms	95 ms

(2) Distributed, fault-tolerant scheduling with Sparrow



www.github.com/radlab/sparrow