Mesos

A Platform for Fine-Grained Resource Sharing in Data Centers

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Challenges in Hadoop Cluster Management

Isolation (both fault and resource)

- » E.g. if co-locating production and experimental jobs

Testing and deploying upgrades

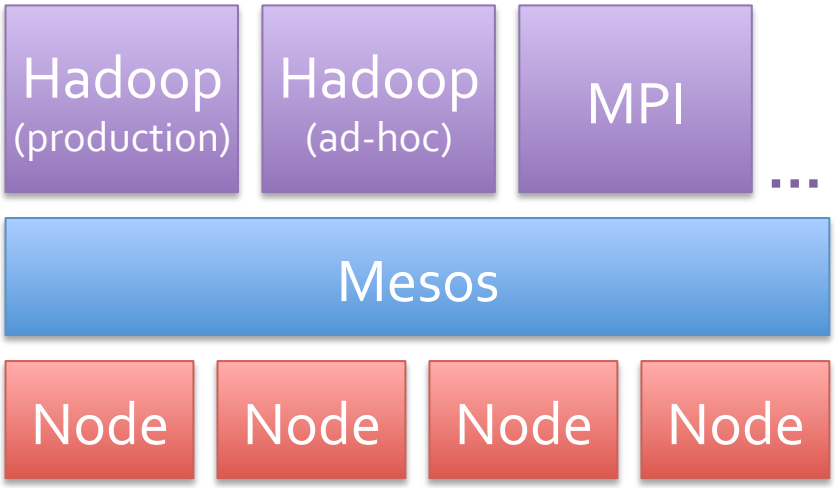
JobTracker scalability (in larger clusters)

Running non-Hadoop jobs

- » E.g. MPI, streaming MapReduce, etc

Mesos

Mesos is a cluster resource manager over which multiple instances of Hadoop and other distributed applications can run



What's Different About It?

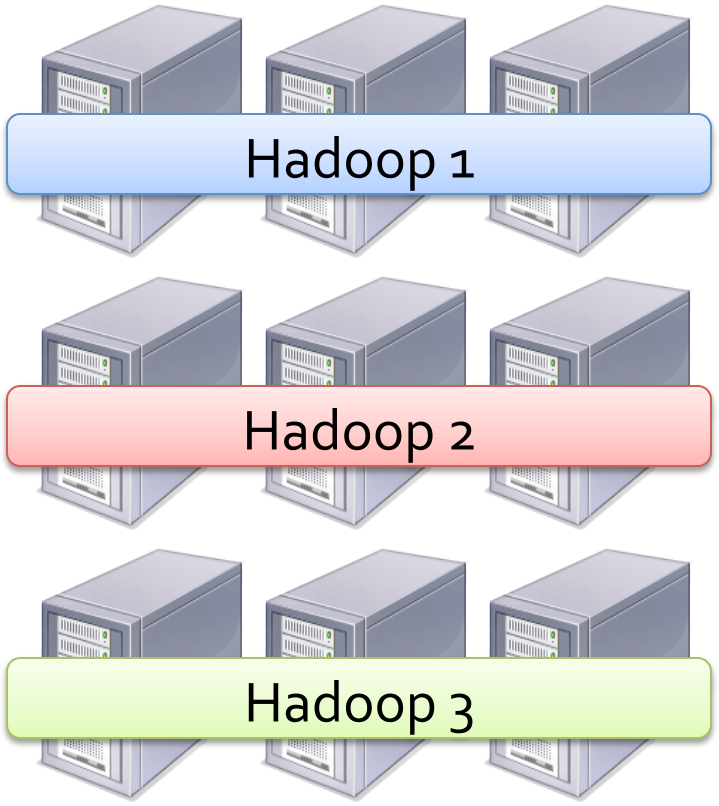
Other resource managers exist today, including
- » Hadoop on Demand
- » Batch schedulers (e.g. Torque)
- » VM schedulers (e.g. Eucalyptus)

However, have 2 problems with Hadoop-like workloads:
- » **Data locality** compromised due to static partitioning of nodes
- » **Utilization** hurt because jobs hold nodes for their full duration

Mesos addresses these through two features:
- » **Fine-grained sharing** at the level of tasks
- » **Two-level scheduling model** where jobs control placement

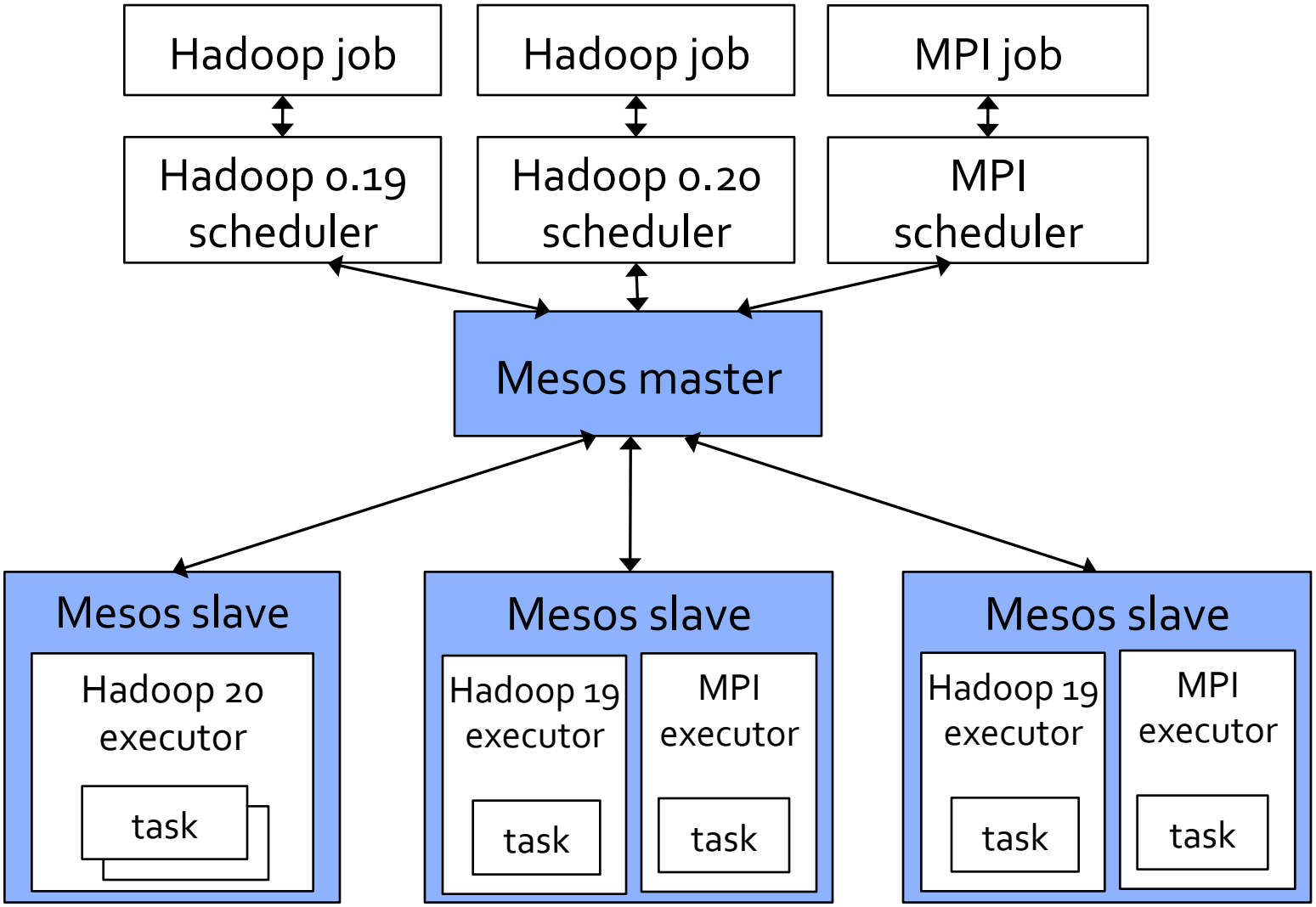
Fine-Grained Sharing

Coarse-Grained (HOD, etc)



Fine-Grained (Mesos)

Mesos Architecture



Design Goals

Scalability (to 10,000's of nodes)

Robustness (even to master failure)

Flexibility (support wide variety of frameworks)

Resulting design: simple, minimal core that pushes resource selection logic to frameworks

Other Features

Master fault tolerance using ZooKeeper

Resource isolation using Linux Containers

- » Isolate CPU and memory between tasks on each node
- » In newest kernels, can isolate network & disk IO too

Web UI for viewing cluster state

Deploy scripts for private clusters and EC2

Mesos Status

Prototype in 10000 lines of C++

Ported frameworks:

» Hadoop (0.20.2), MPI (MPICH2), Torque

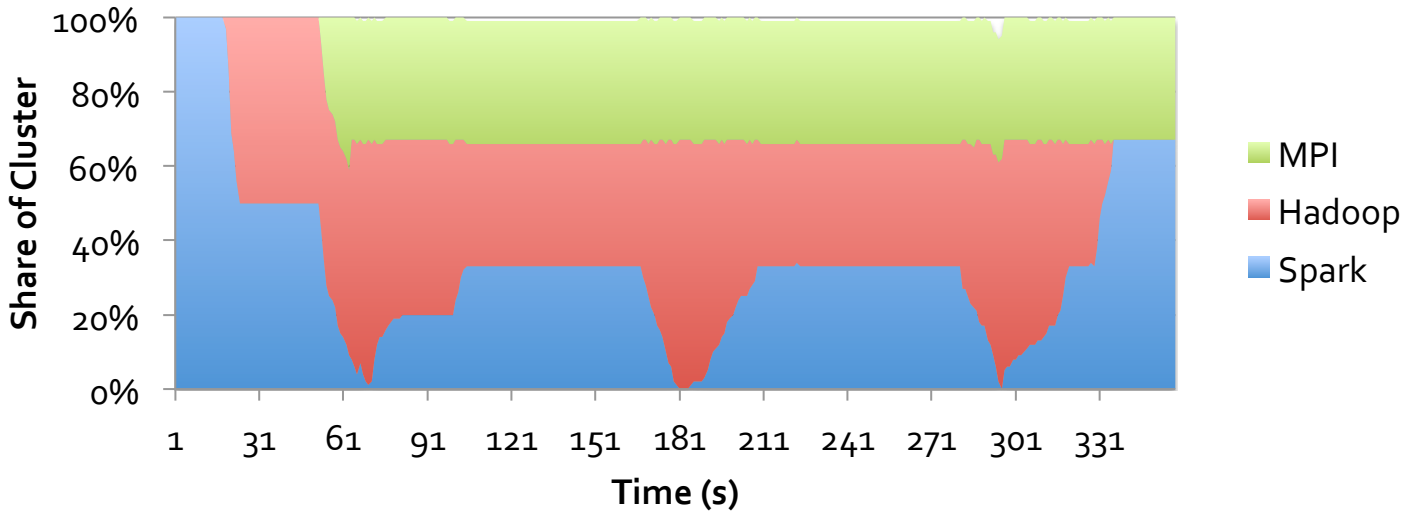
New frameworks:

» Spark, Scala framework for iterative & interactive jobs

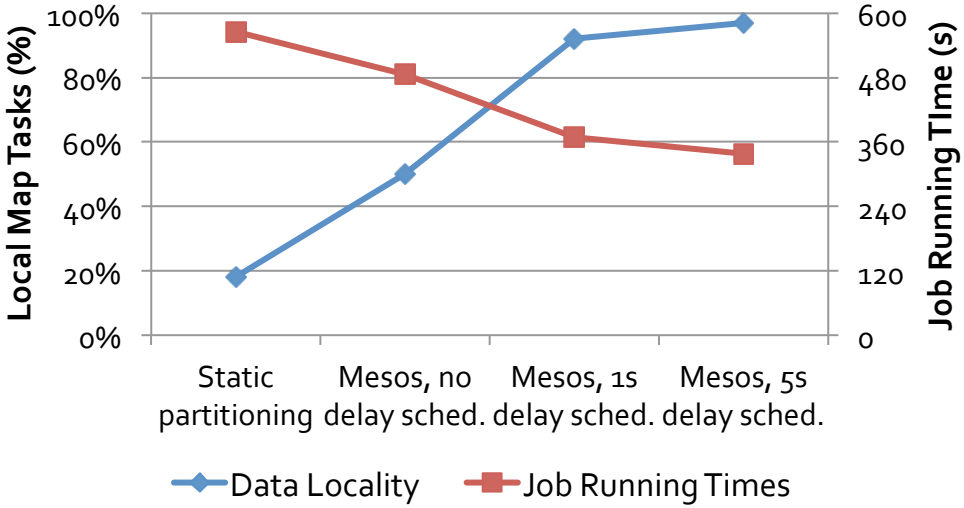
Test deployments at Twitter and Facebook

Results

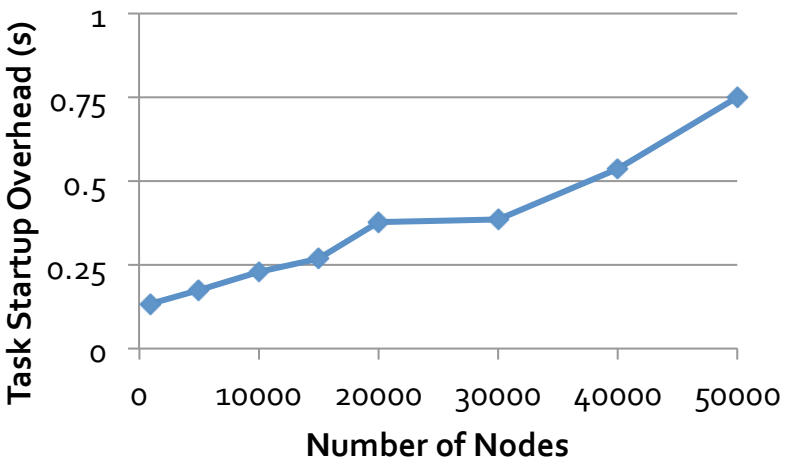
Dynamic Resource Sharing



Data Locality



Scalability



Spark

A framework for iterative and interactive cluster computing

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Spark Goals

Support iterative applications

- » Common in machine learning but problematic for MapReduce, Dryad, etc

Retain MapReduce's fault tolerance & scalability

Experiment with programmability

- » Integrate into Scala programming language
- » Support interactive use from Scala interpreter

Key Abstraction

Resilient Distributed Datasets (RDDs)

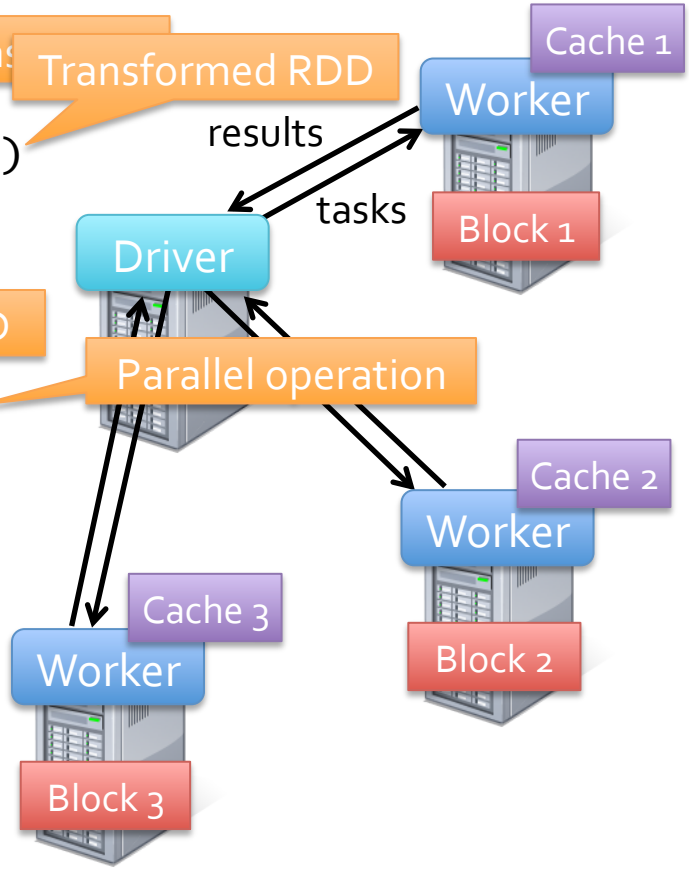
- » Collections of elements distributed across cluster that can persist across parallel operations
- » Can be stored in memory, on disk, etc
- » Can be transformed with map, filter, etc
- » Automatically rebuilt on failure

Example: Log Mining

Load error messages from a log into memory, then interactively search for various patterns

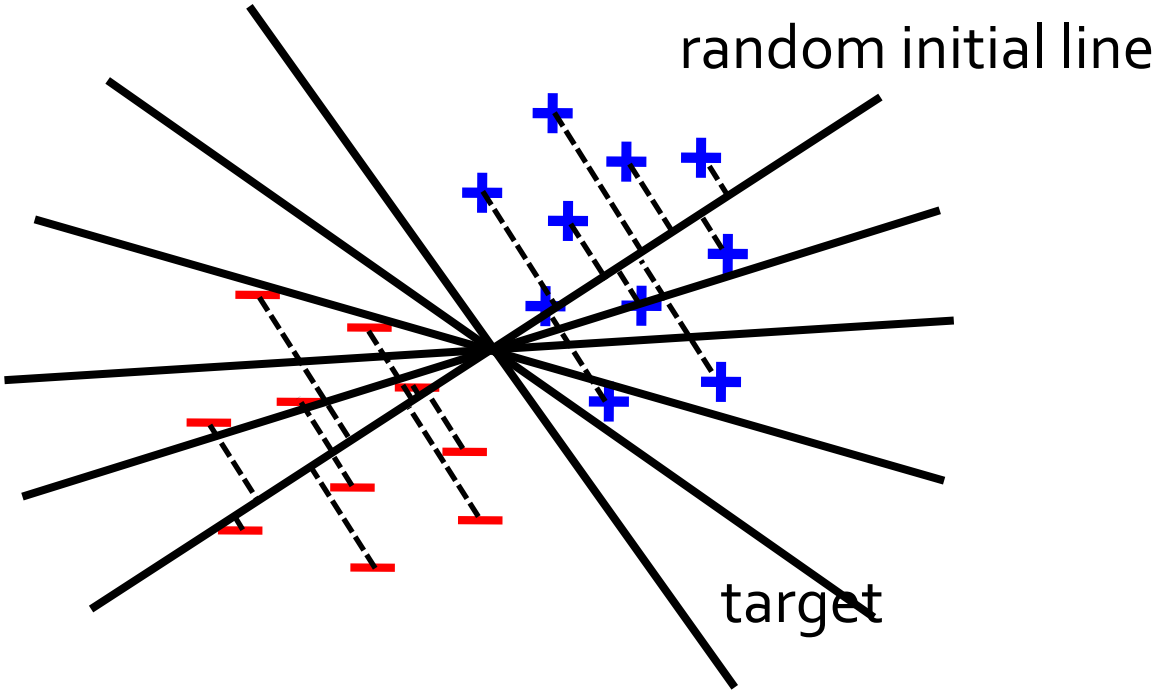
```
lines = spark.textFile("hdfs://...")
errors = lines.filter(_.startsWith("ERROR"))
messages = errors.map(_.split('\t')(2))
cachedMsgs = messages.cache()

cachedMsgs.filter(_.contains("foo")).count
cachedMsgs.filter(_.contains("bar")).count
. . .
```



Example: Logistic Regression

Goal: find best line separating two sets of points



Logistic Regression Code

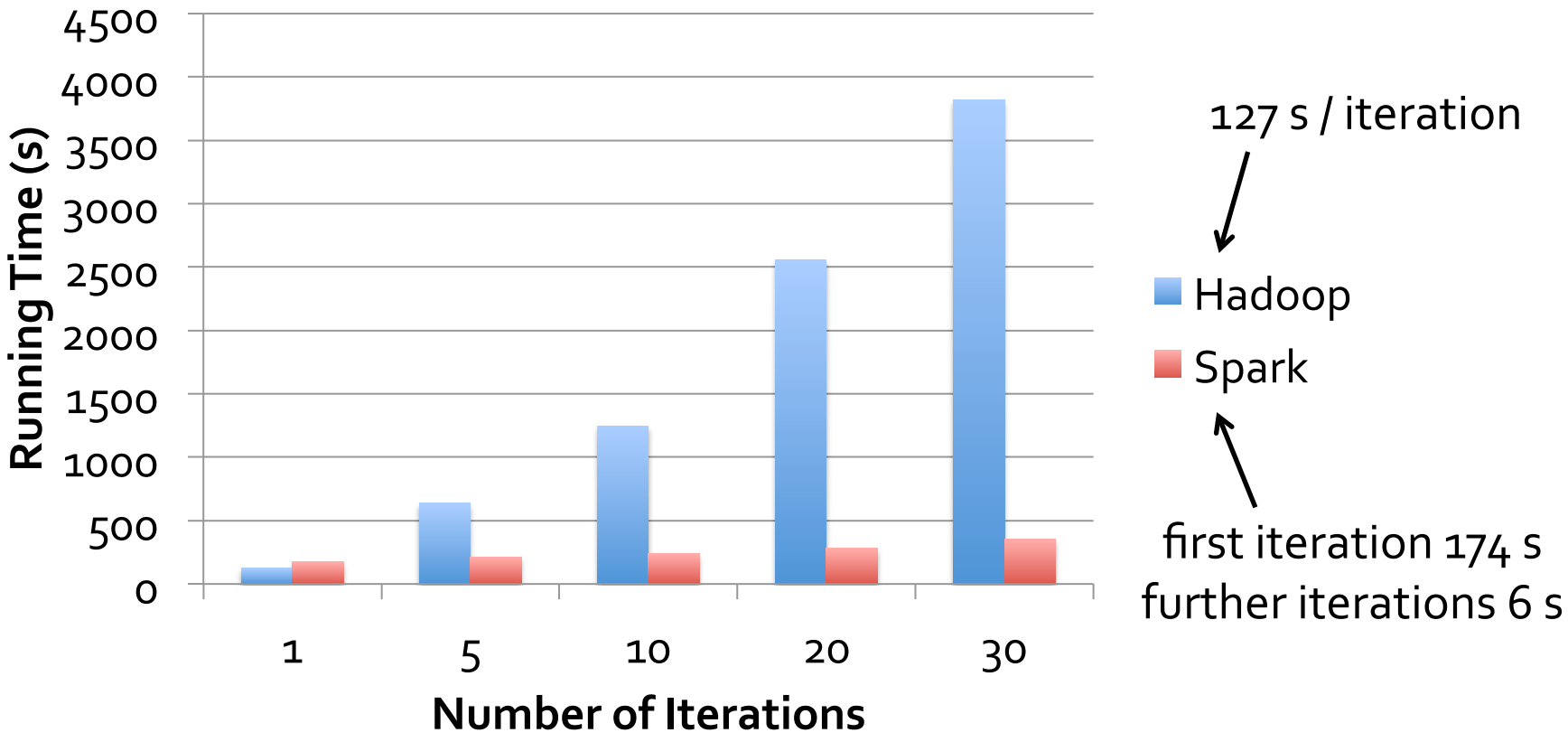
```
val data = spark.textFile(...).map(readPoint).cache()

var w = Vector.random(D)

for (i <- 1 to ITERATIONS) {
  val gradient = data.map(p => {
    val scale = (1/(1+exp(-p.y*(w dot p.x))) - 1) * p.y
    scale * p.x
  }).reduce(_ + _)
  w -= gradient
}

println("Final w: " + w)
```

Logistic Regression Performance



Spark Demo

Conclusion

Mesos provides a stable platform to multiplex resources among diverse cluster applications

Spark is a new cluster programming framework for iterative & interactive jobs enabled by Mesos

Both are open-source (but in very early alpha!)

http://github.com/mesos

http://mesos.berkeley.edu