Hadoop & Spark – Using Amazon EMR

Michael Hanisch, AWS Solutions Architecture

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Agenda

Why did we build Amazon EMR?

What is Amazon EMR?

How do I get started using Amazon EMR?

Q&A

Why did we build Amazon EMR?

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Ingest

Amazon Mobile Analytics

AWS Import/ Export

Store

Amazon RDS

Amazon Kinesis

Amazon DynamoDB

Amazon CloudSearch

Amazon S3

Amazon Glacier

Process

Amazon EMR

Amazon Machine Learning

Amazon Redshift

AWS Data Pipeline

Amazon Lambda

Amazon EC2

Visualize

Hadoop: The Framework for Big Data Processing

Can process huge amounts of data

Scalable and fault tolerant

Respects multiple data formats

Supports an ecosystem of tools with a robust community

Executes batch and real-time analytics

Common Customer Challenges

Must purchase, provision, deploy and manage the infrastructure for Hadoop

Deploying, configuring and administering the Hadoop clusters can be difficult, expensive and time-consuming

What is Amazon Elastic MapReduce?

Amazon EMR Benefits

Simplifies Big Data Processing on a Managed Hadoop Framework

Low Cost

Pay an hourly rate for every instance hour you use

Reliable

Spend less time tuning and monitoring your cluster

Elastic

Easily add or remove capacity

Secure

Managed firewall settings

Easy to use

Launch a cluster in minutes

Flexible

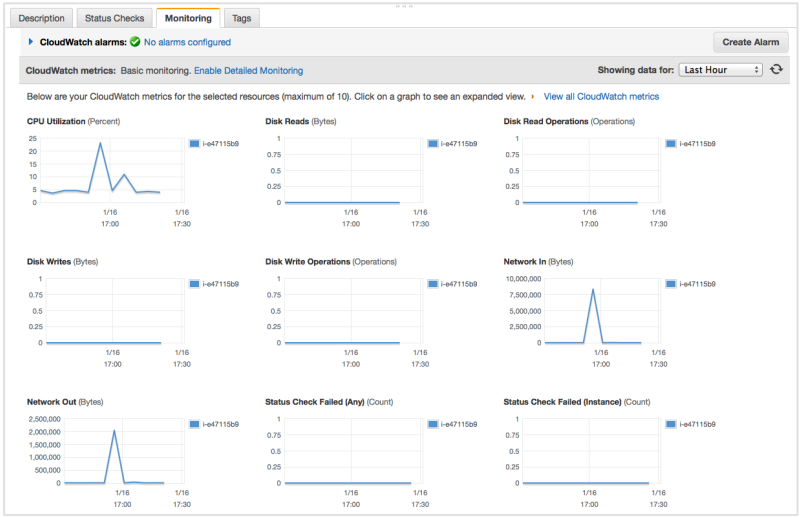
You control every cluster

Amazon EMR is Elastic

Dynamically change number of compute resources

Provision one or thousands of instances to Process Data at any scale

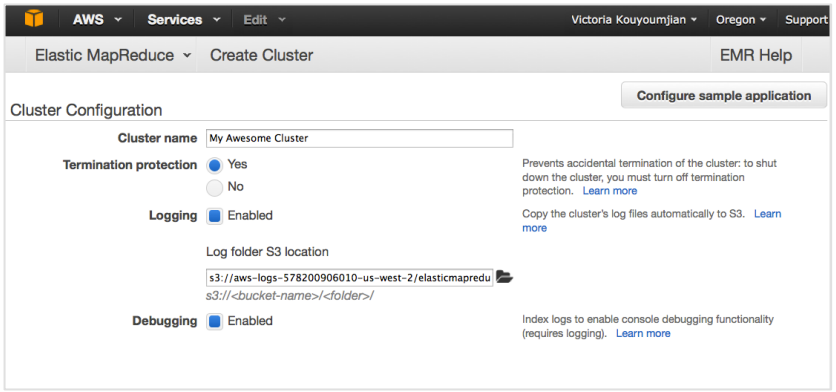
Use CloudWatch to alert for scaling needs



Easy to Use

Launch a cluster in minutes through console

EMR sets up your cluster, provisions nodes, and configures Hadoop so you can focus on your analysis



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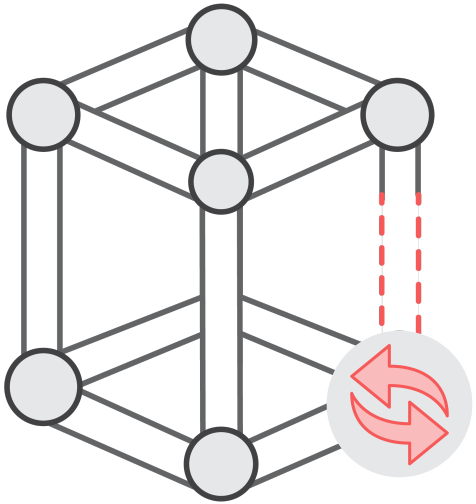
Low Cost

Low Hourly Pricing for On-demand Instance Hours

Name your Price with Amazon EC2 Spot Instance Integration

Use EC2 Reserved Instances to reserve capacity and further lower your costs

Reliable



Monitors cluster health

Retries failed tasks

Automatically replaces under-performing instances

Secure

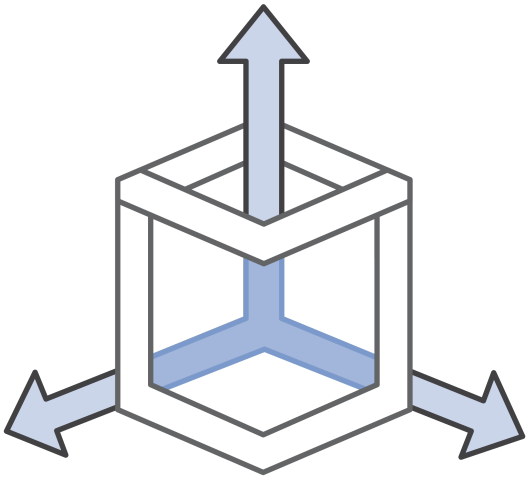
Automatically configures firewall settings to control network access

Managed security groups for instances or specify your own

Launch in the Amazon Virtual Private Cloud (VPC)

Support for server-side & client-side encryption

Flexible



Completely control your cluster including customizations

Use data sources from Amazon S3, HDFS, Redshift, RDS, Kinesis and DynamoDB

Supports Apache & MapR Hadoop distributions

Runs popular Hadoop tools and frameworks (Hive, Hbase, Pig, Mahout, Spark, Presto)

How do I get started using Amazon EMR?

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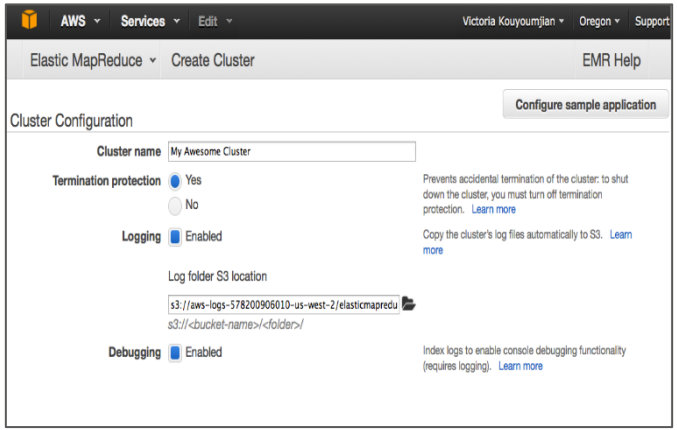
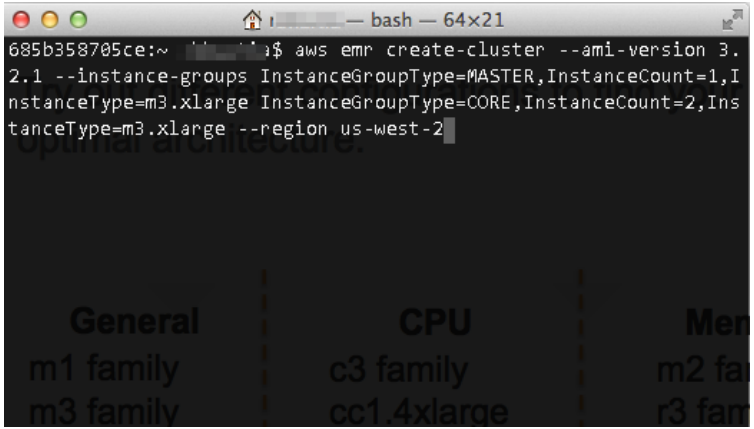
Easy to start

AWS Management Console



Command Line



Or use the Amazon EMR API with your favorite SDK.

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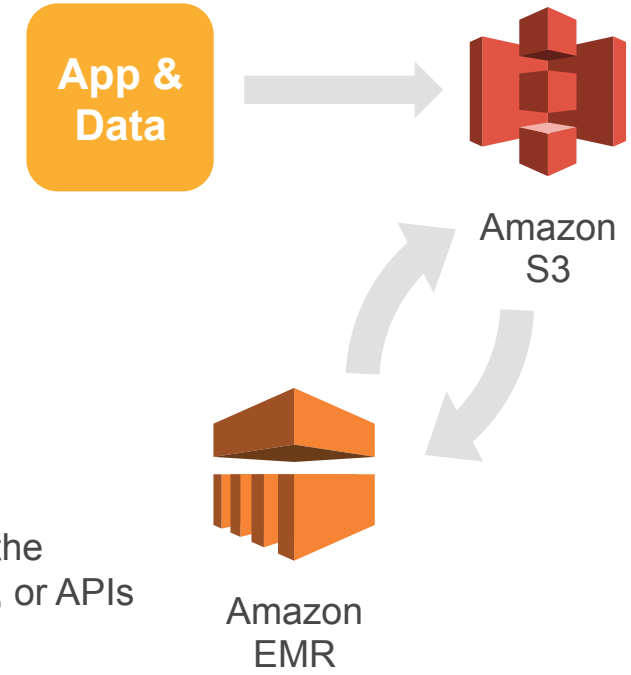
How to use Amazon EMR

1. Upload
your application and data to S3



2. Configure
your cluster: Choose Hadoop distribution, number and type of nodes, applications (Hive/ Pig/Hbase)

3. Launch
your cluster using the console, CLI, SDK, or APIs

4. Retrieve
your output results from S3

Configuration & Customization

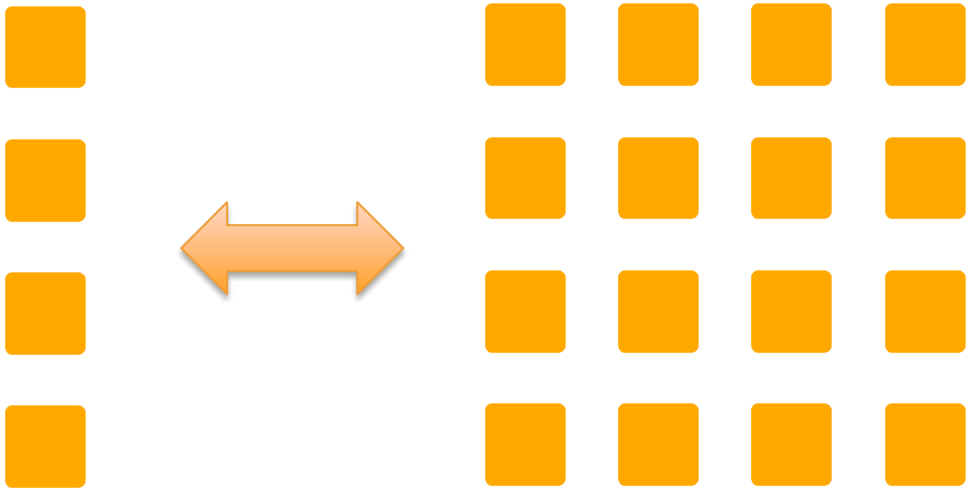
Choose your instance types

Try different configurations to find your optimal architecture.

General	CPU	Memory	Disk/IO
m1 family m3 family	c3 family cc1.4xlarge cc2.8xlarge	m2 family r3 family	d2 family i2 family
Batch process	**Machine learning**	**Spark and interactive**	**Large HDFS**

Resizable clusters

Easy to add and remove compute capacity on your cluster.

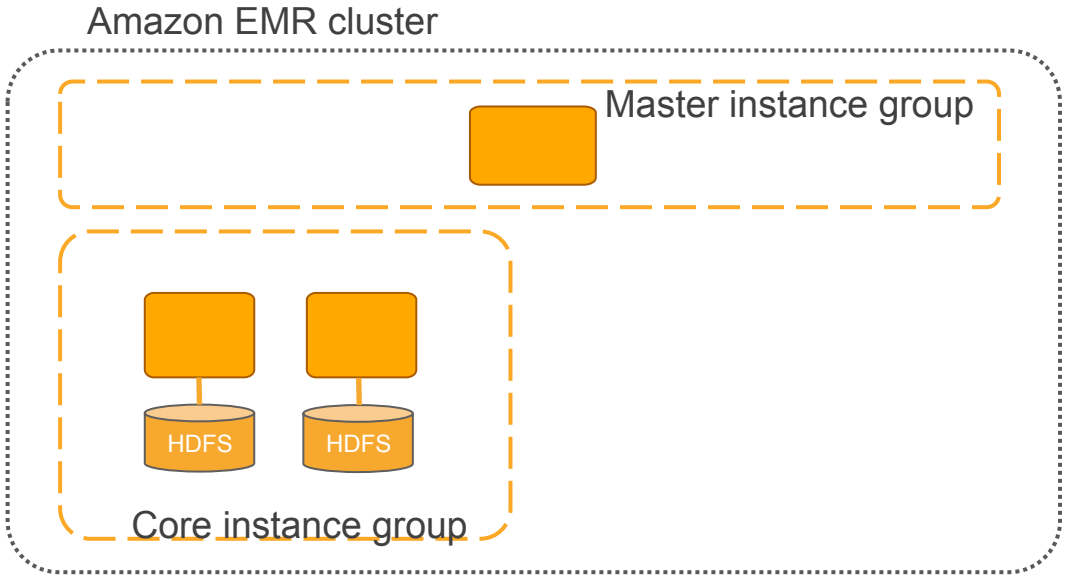


Match compute demands with cluster sizing.

Core Nodes

Run TaskTrackers (Compute)

Run DataNode (HDFS)

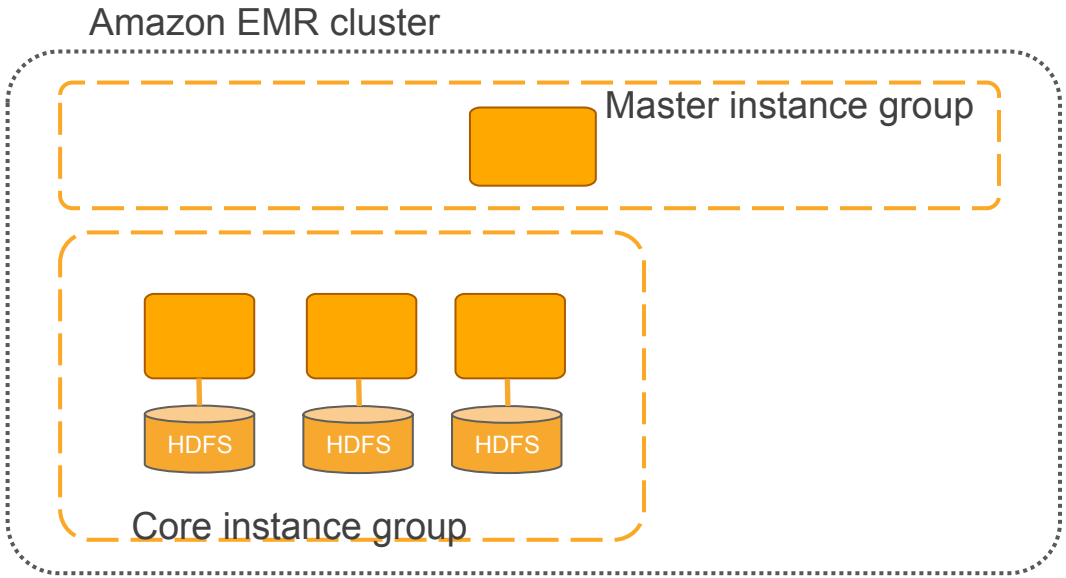


Core Nodes

Can add core nodes

More HDFS space

More CPU/mem

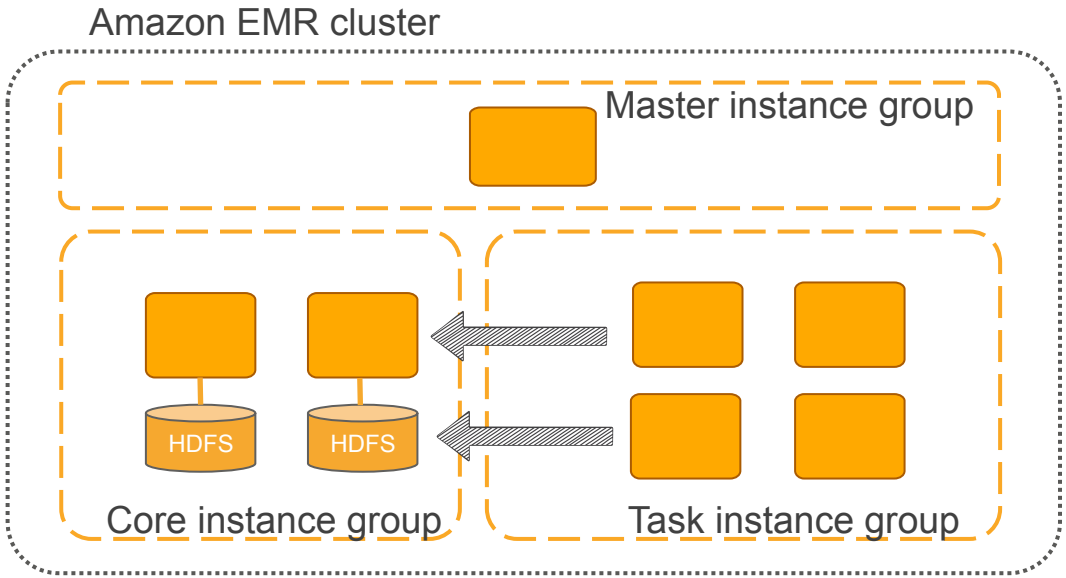


Amazon EMR Task Nodes

Run TaskTrackers

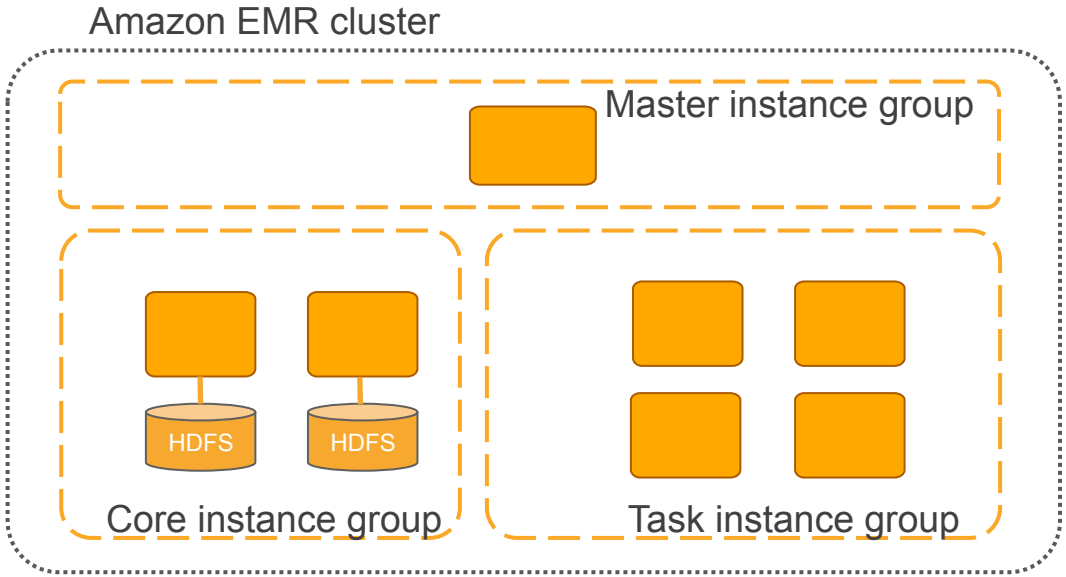
No HDFS

Reads from core node HDFS



Amazon EMR Task Nodes

Can Add Task Nodes

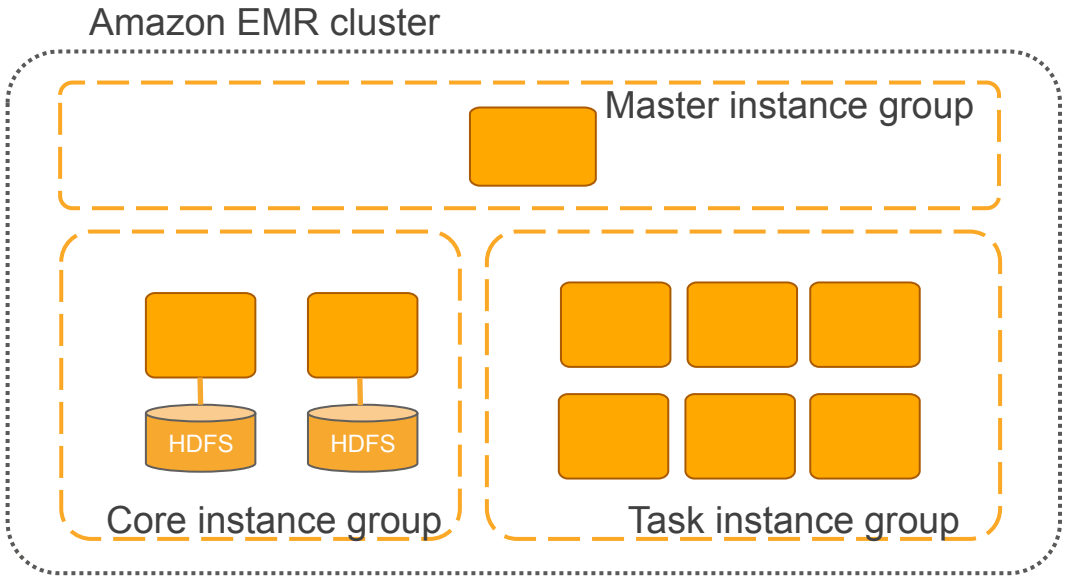


Amazon EMR Task Nodes

More CPU power

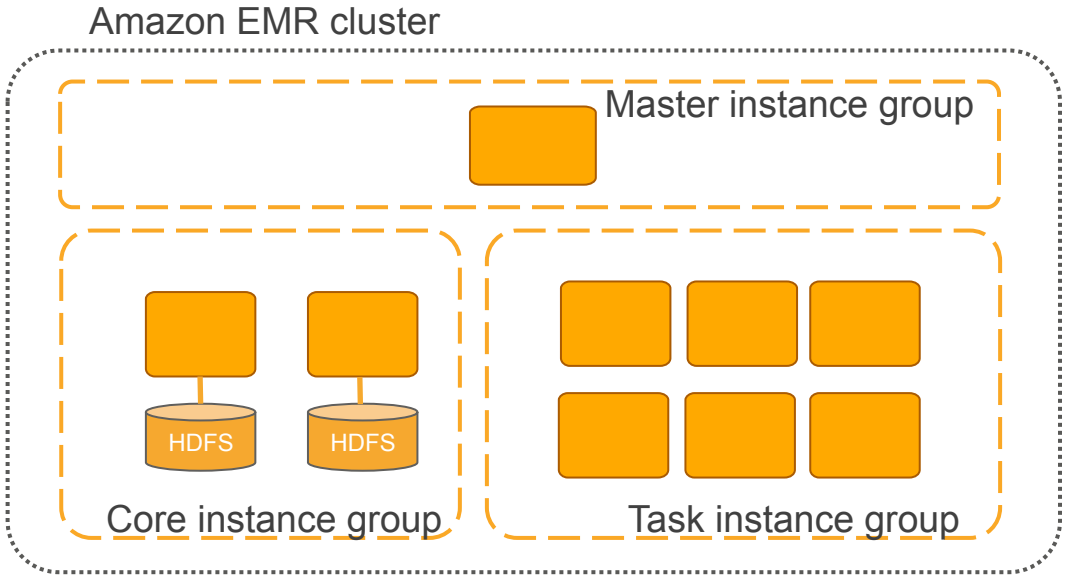
More memory

More network throughput



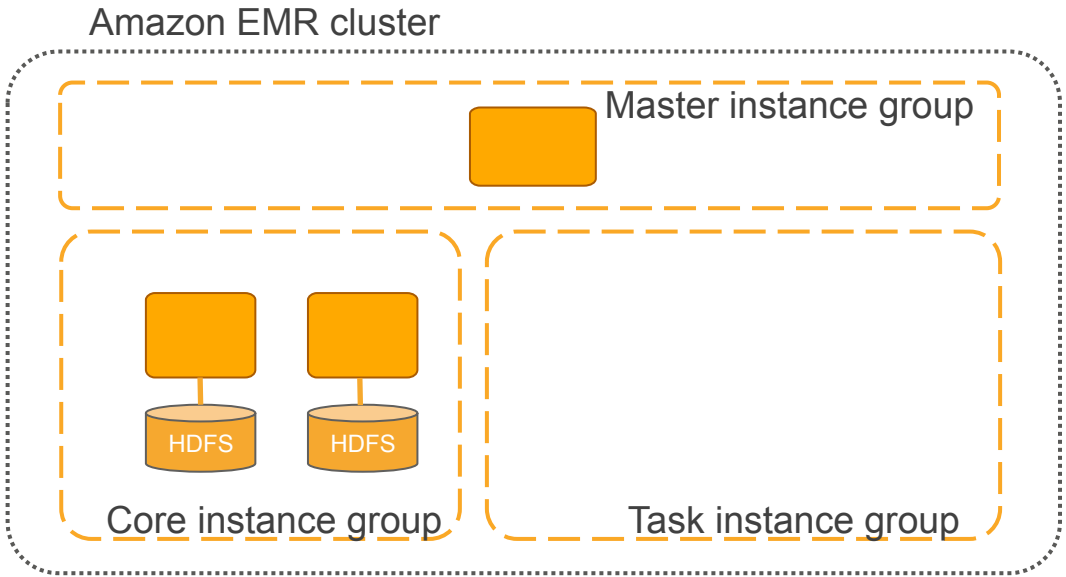
Amazon EMR Task Nodes

You can remove Task Nodes



Amazon EMR Task Nodes

Save Cost when Processing power is not required



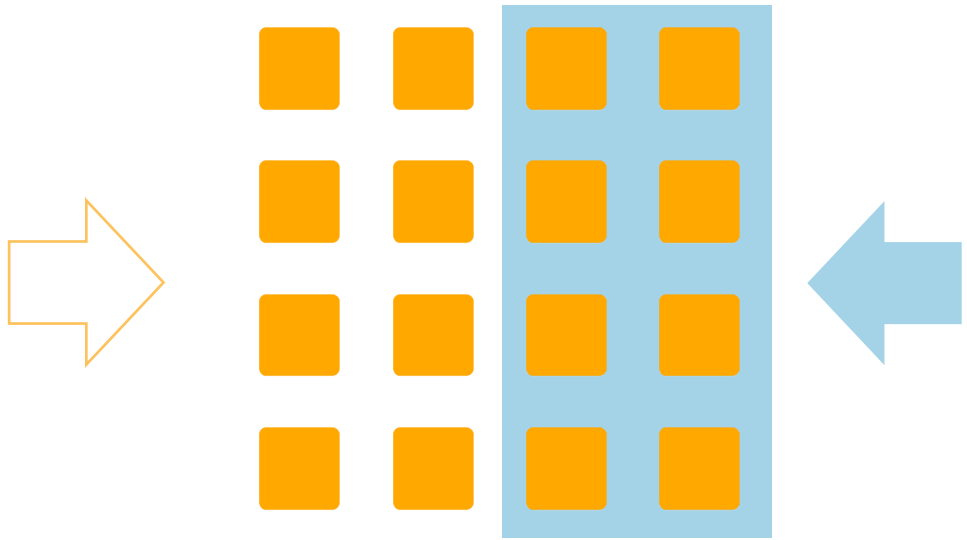
Easy to use Spot Instances

Meet SLA at predictable cost

Exceed SLA at lower cost

On-demand for core nodes

Standard Amazon EC2 pricing for on-demand capacity



Spot Instances for task nodes

Up to 86% lower on average off on-demand pricing

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Serial Processing

COST: 4h x $2.1 = **$8.4**
RENDERING TIME: **4h**

1 Machine for 10 Hours
≈
10 Machines for 1 Hour

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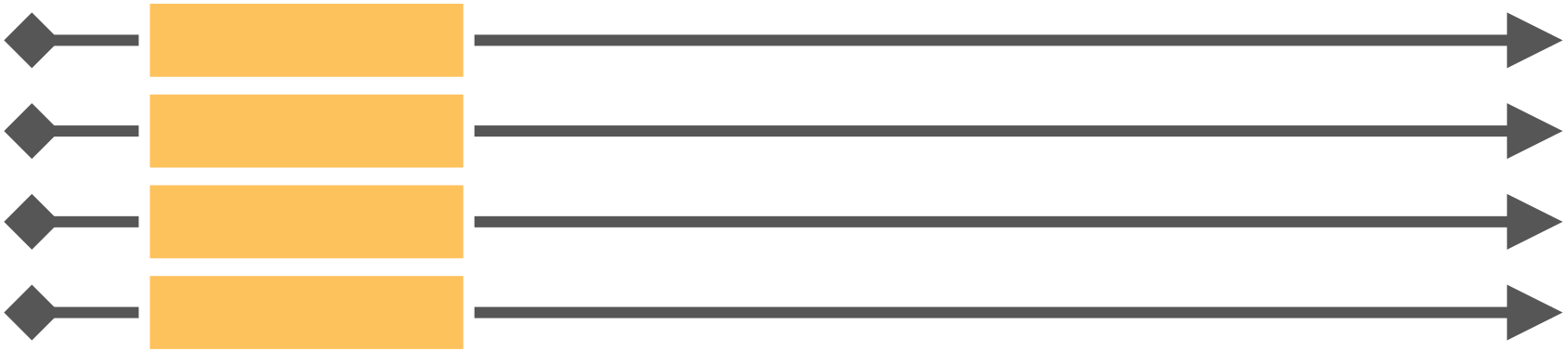
Parallel Processing

COST: 2 x 2h x $2.1 = **$8.4**
RENDERING TIME: **2h**

Embarrassingly Parallel Processing



COST: 4 x 1h x $2.1 = **$8.4**
RENDERING TIME: **1h**

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Pick the right version

Pick your Hadoop Version & Applications

EMR < 4.x:

- AMI version had fixed Hadoop version, Hive version etc.
- Additional applications via **Bootstrap Actions**
  - Lots of different ones available from EMR & on github
- Configuration via Bootstrap Actions

https://github.com/awslabs/emr-bootstrap-actions

Pick your Hadoop Version & Applications

Starting with EMR **4.x**:

- Release tags are independent of AMIs
- Pick from supported applications directly
  - Based on Apache BigTop
- Configuration objects
  - unified JSON syntax, mapped to configuration files

Recommendation: Use EMR 4.x by default!

Transient or persistent cluster?

Transient or persistent cluster?

Storing data on Amazon S3 give you more flexibility to run & shutdown Hadoop clusters when you need to.

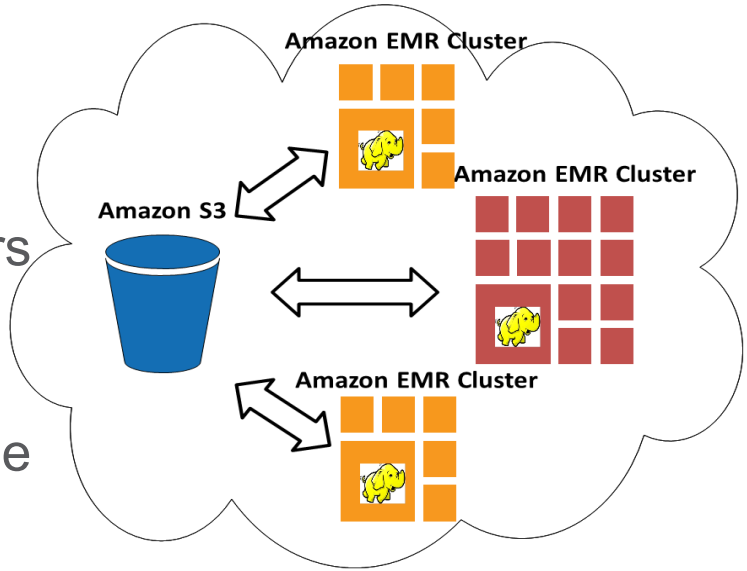
Amazon S3 as your persistent data store

Amazon S3

- Designed for 99.999999999% durability
- Separate compute and storage

Resize and shut down Amazon EMR clusters with no data loss

Point multiple Amazon EMR clusters at same data in Amazon S3



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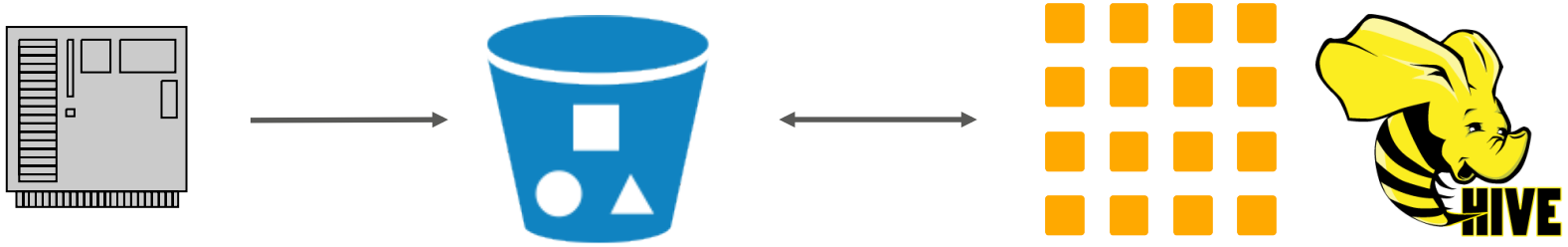
Amazon EMR example #1: Batch processing



GBs of logs pushed to Amazon S3 hourly

Input and output stored in Amazon S3

Daily Amazon EMR cluster using Hive to process data

250 Amazon EMR jobs per day, processing 30 TB of data

http://aws.amazon.com/solutions/case-studies/yelp/

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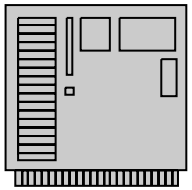
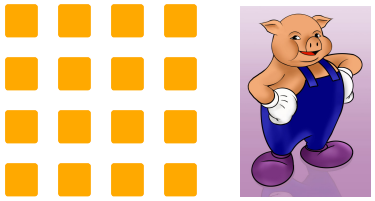
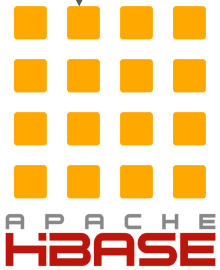
Amazon EMR example #2: Long-running cluster



Data pushed to Amazon S3



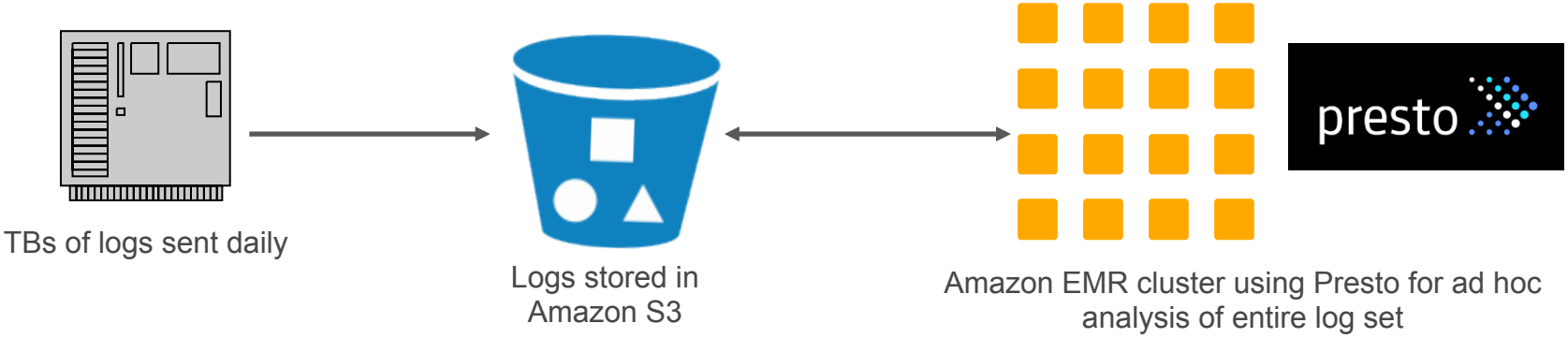
Daily Amazon EMR cluster Extract, Transform, and Load (ETL) data into database



24/7 Amazon EMR cluster running HBase holds last 2 years' worth of data

Front-end service uses HBase cluster to power dashboard with high concurrency

Amazon EMR example #3: Interactive query



NETFLIX

Interactive query using Presto on multipetabyte warehouse

http://techblog.netflix.com/2014/10/using-presto-in-our-big-data-platform.html

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Steps & Clusters

Applications

Vibrant Ecosystem

TACHYON

APACHE PHOENIX

APACHE HBASE

mahout

Apache Ambari

accumulo™

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MR job

APACHE HBASE

MapReduce

HDFS

Amazon S3

Local filesystem

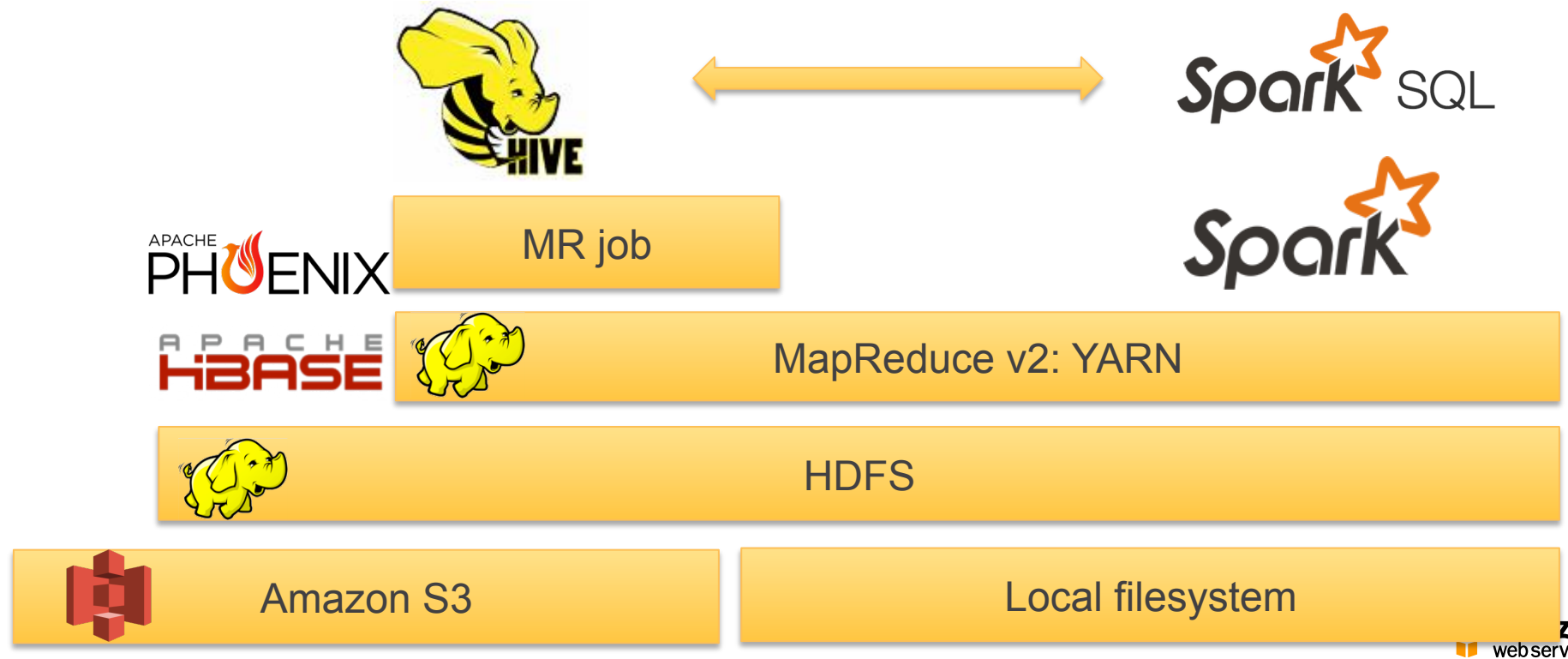
MR job

MapReduce v2: YARN

HDFS

Amazon S3

Local filesystem


HIVE
Spark SQL
APACHE PHOENIX
MR job
Spark
APACHE HBASE
MapReduce v2: YARN
HDFS
Amazon S3
Local filesystem

Cloudera Impala

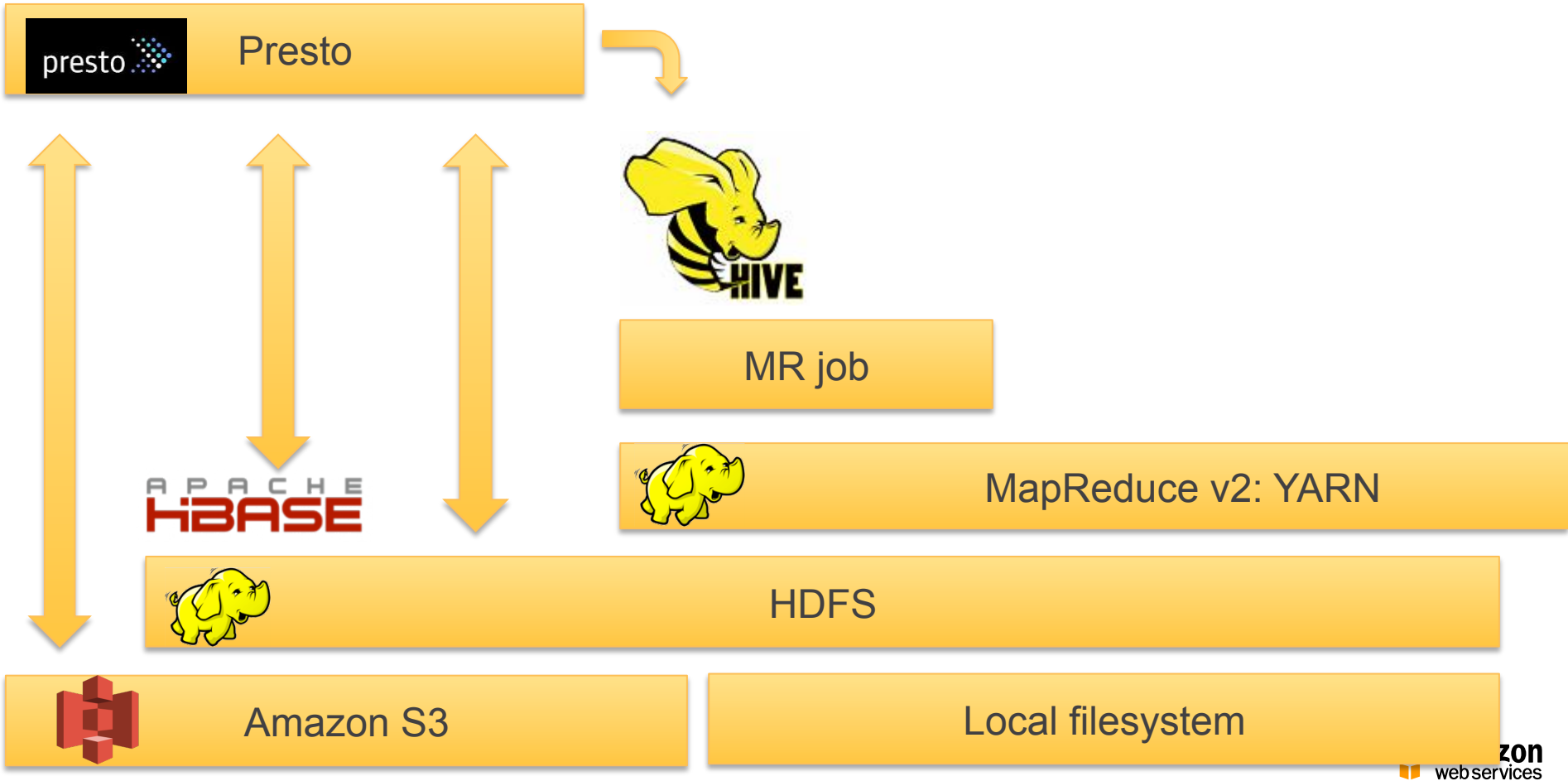
MR job

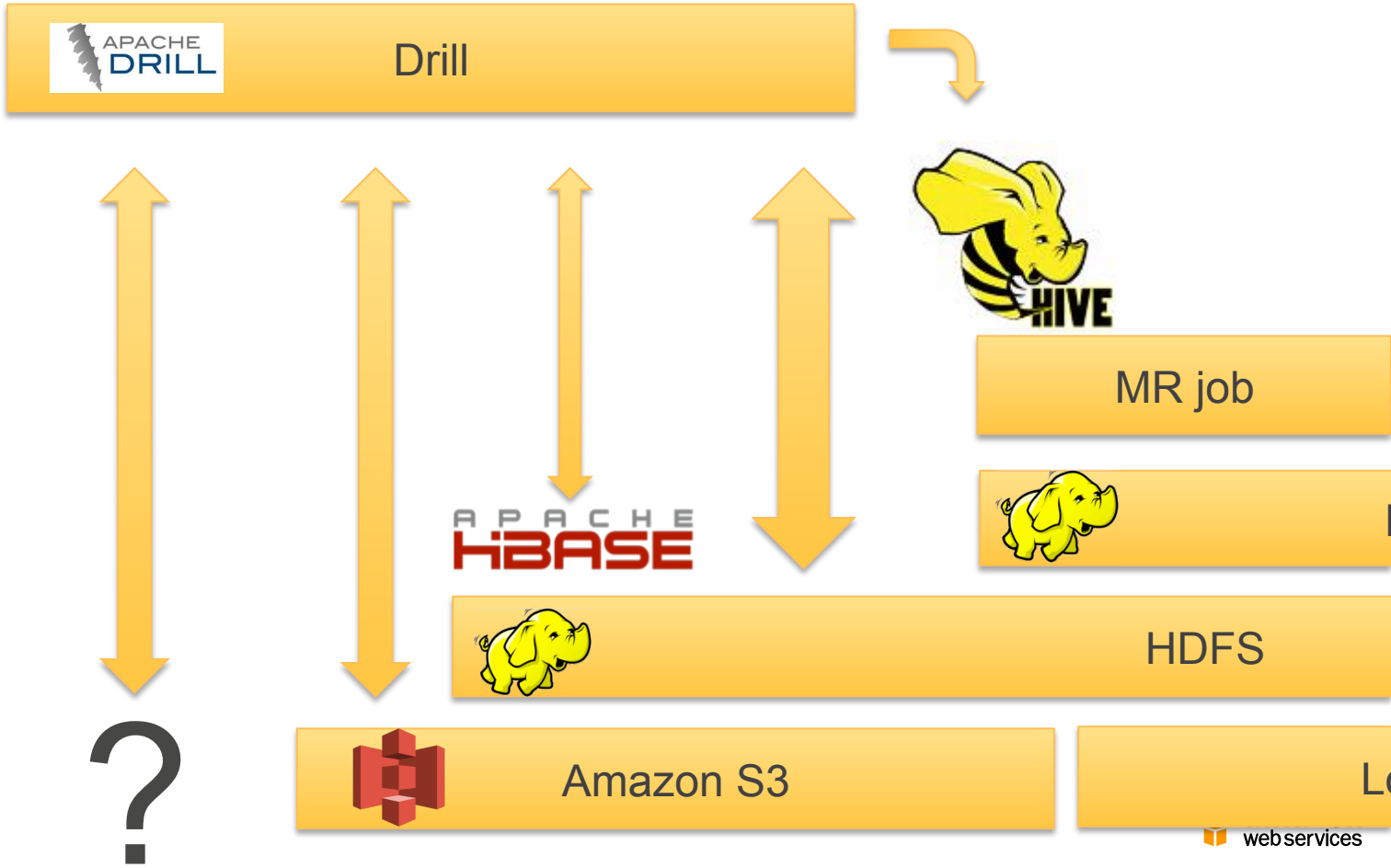
MapReduce v2: YARN

HDFS

Amazon S3

Local filesystem


presto
Presto
HIVE
MR job
APACHE HBASE
MapReduce v2: YARN
HDFS
Amazon S3
Local filesystem


APACHE DRILL
Drill
HIVE
MR job
APACHE HBASE
HDFS
?
Amazon S3
web services

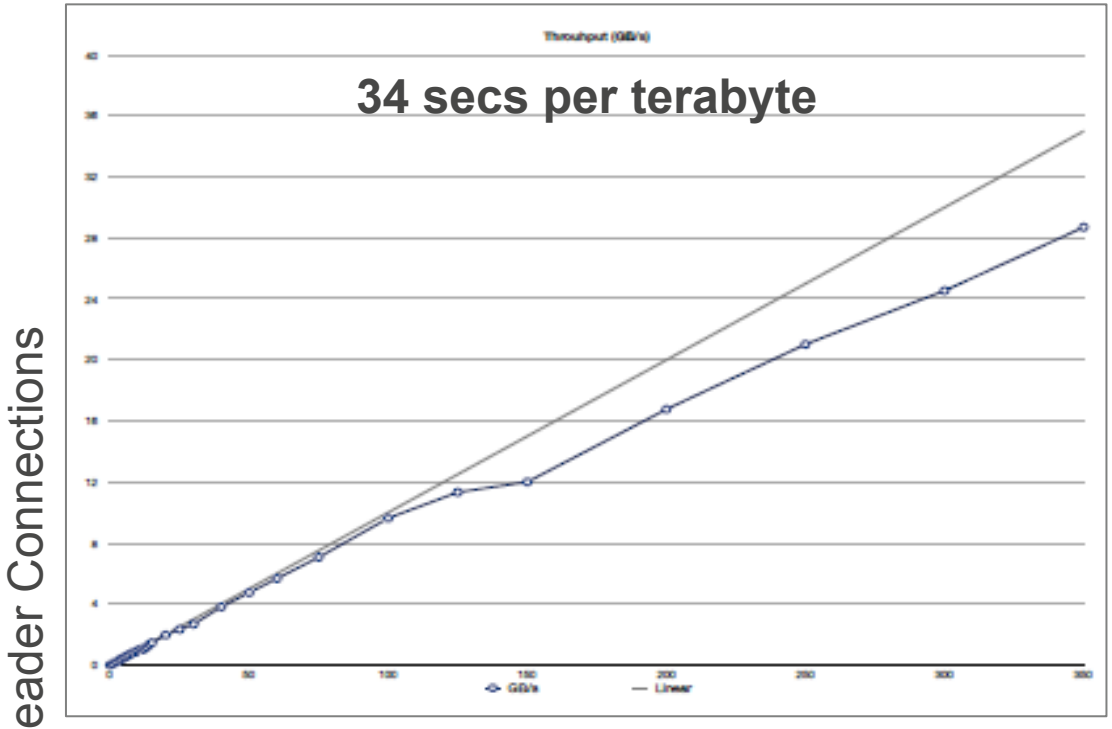
Amazon S3 and HDFS

Amazon S3 has near linear scalability

S3 Streaming Performance

100 VMs; 9.6GB/s; $26/hr

350 VMs; 28.7GB/s; $90/hr



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EMRFS makes it easier to leverage Amazon S3

Better performance and error handling options

Transparent to applications – just read/write to “s3://”

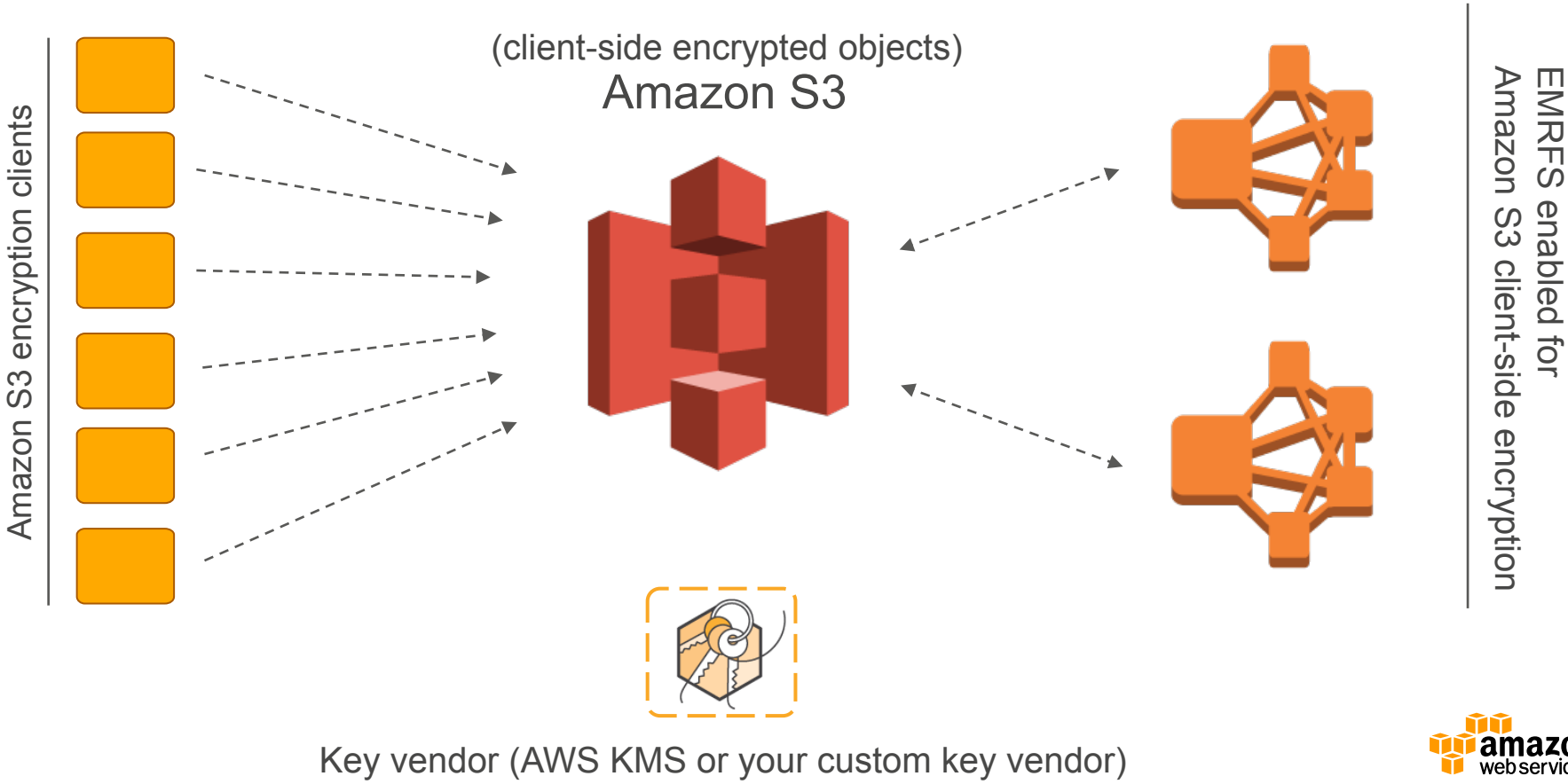
Consistent view

- For consistent list and read-after-write for new puts

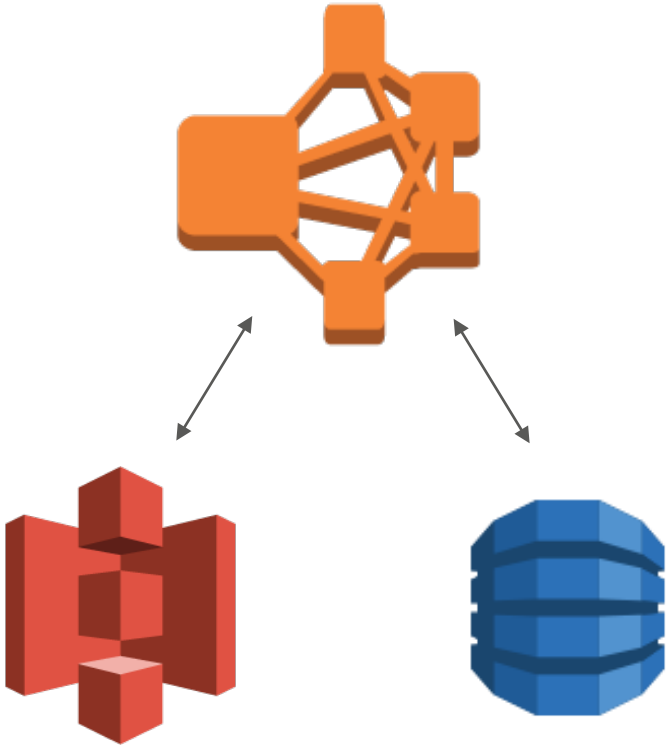
Support for Amazon S3 server-side and client-side encryption

Faster listing using EMRFS metadata

EMRFS support for Amazon S3 client-side encryption



Fast listing of Amazon S3 objects using EMRFS metadata



- List and read-after-write consistency
- Faster list operations

Number of objects	Without Consistent Views	With Consistent Views
1,000,000	147.72	29.70
100,000	12.70	3.69

*Tested using a single node cluster with a m3.xlarge instance.

Optimize to leverage HDFS

Iterative workloads

- If you're processing the same dataset more than once

Disk I/O intensive workloads

Persist data on Amazon S3 and use S3DistCp to copy to HDFS for processing.

Running Spark on Amazon EMR

Launch the latest Spark version

July 15 – Spark 1.4.1 GA release

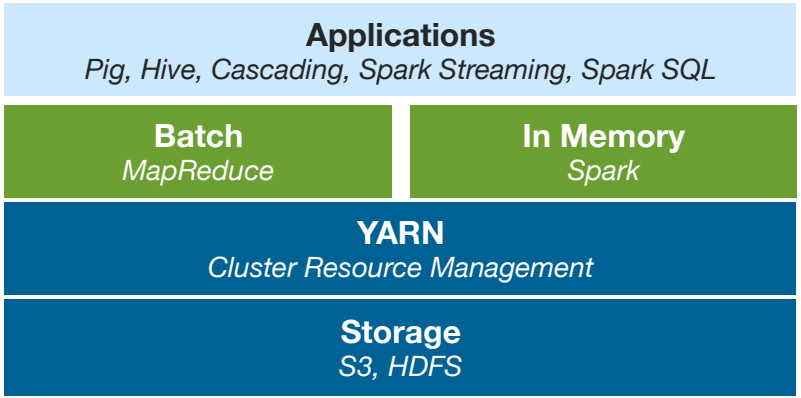
July 24 – Spark 1.4.1 available on Amazon EMR

September 9 – Spark 1.5.0 GA release

September 30 – Spark 1.5.0 available on Amazon EMR

< 3 week cadence with latest open source release

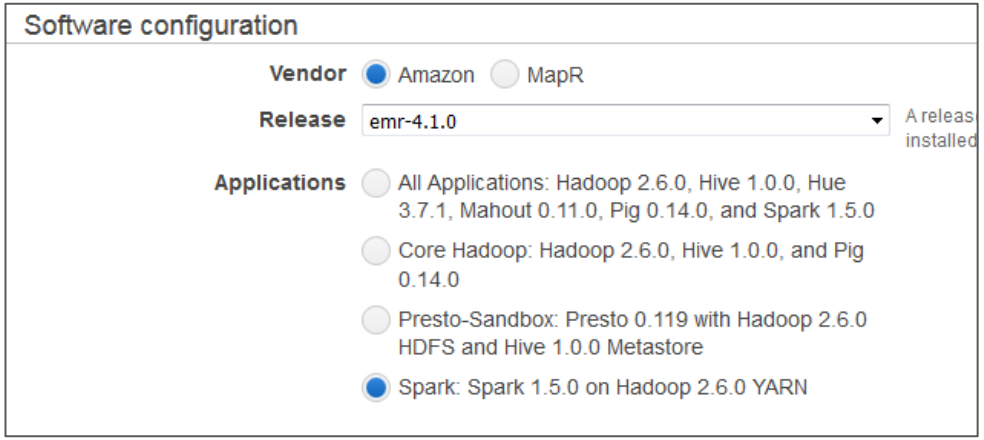
Amazon EMR runs Spark on YARN



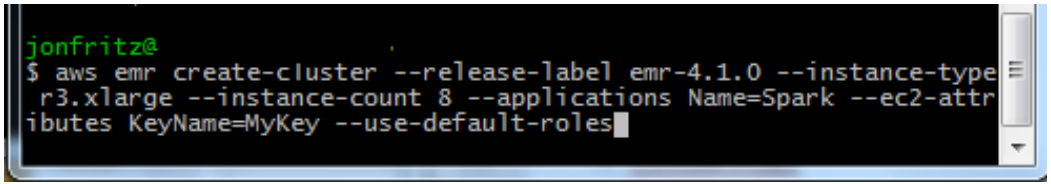
- Dynamically share and centrally configure the same pool of cluster resources across engines
- Schedulers for categorizing, isolating, and prioritizing workloads
- Choose the number of executors to use, or allow YARN to choose (dynamic allocation)
- Kerberos authentication

Create a fully configured cluster in minutes

AWS Management Console



AWS Command Line Interface (CLI)



Or use an AWS SDK directly with the Amazon EMR API

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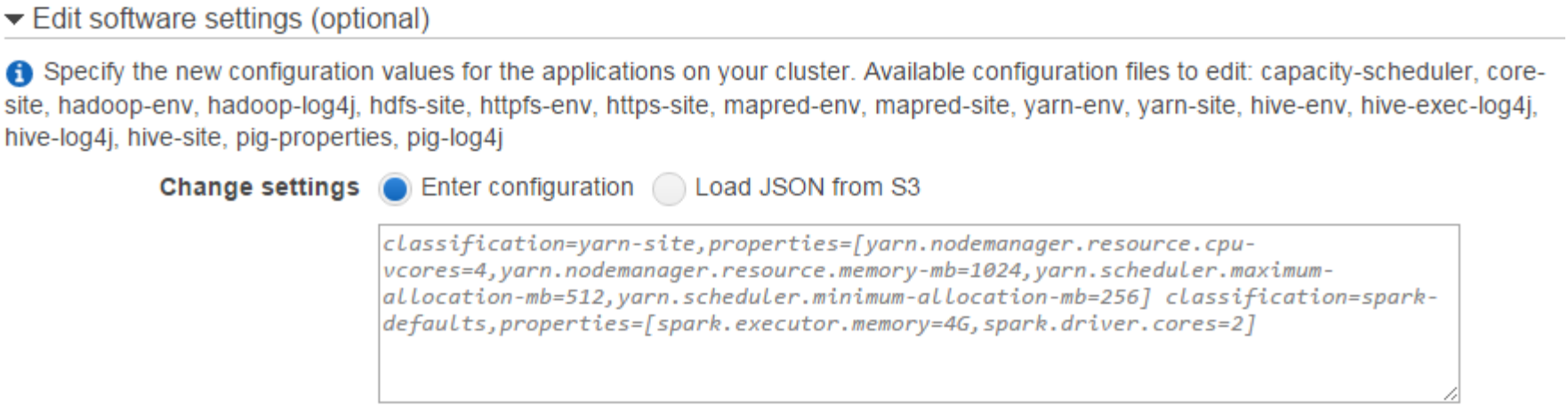
Or easily change your settings



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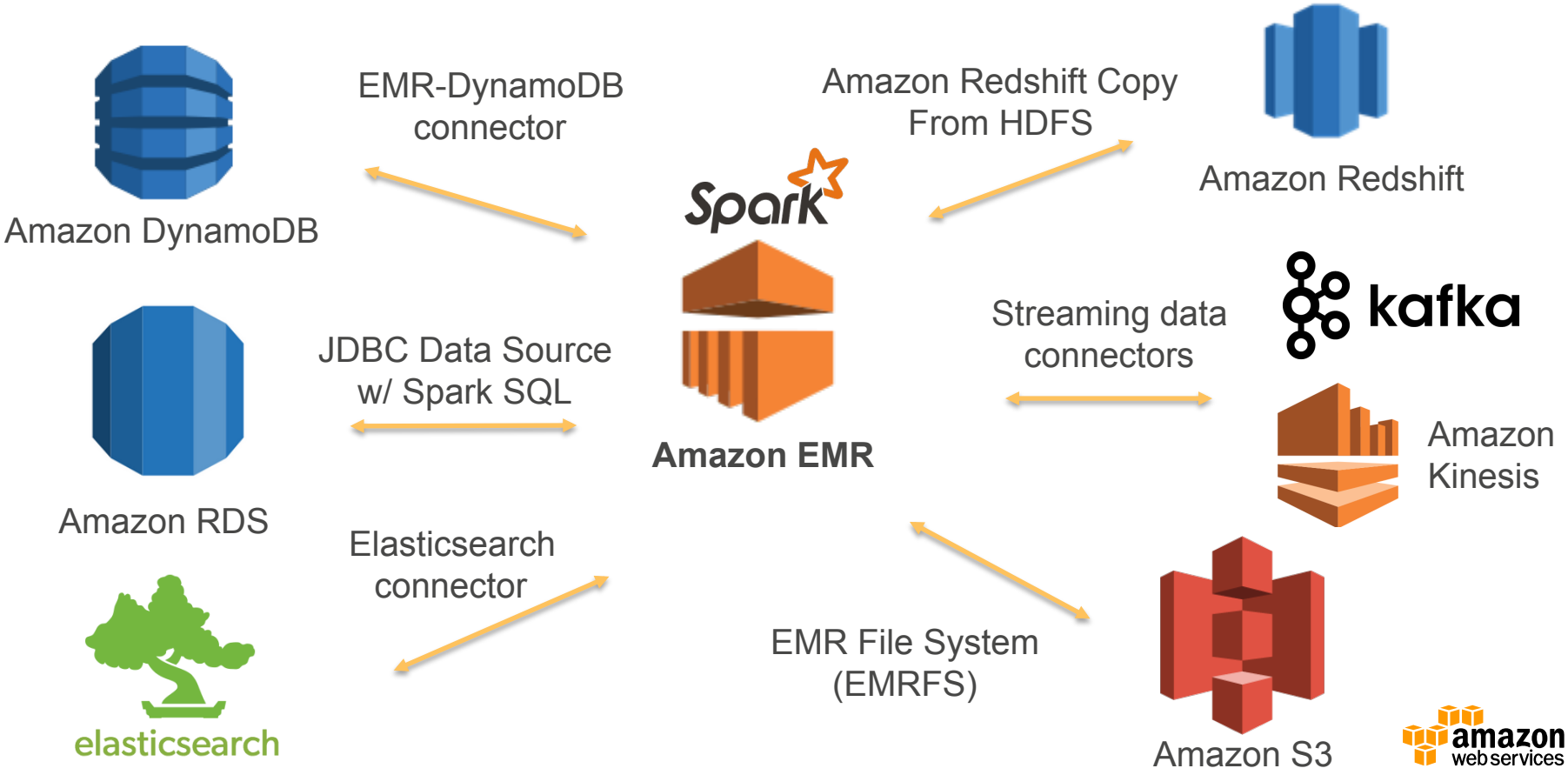
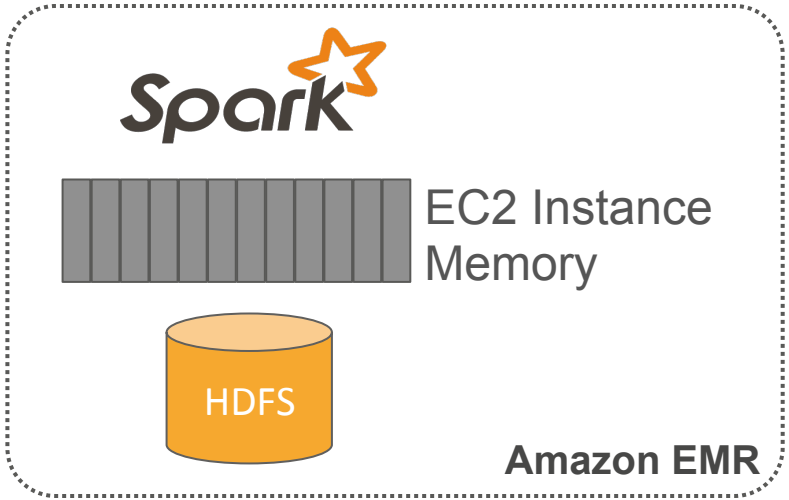
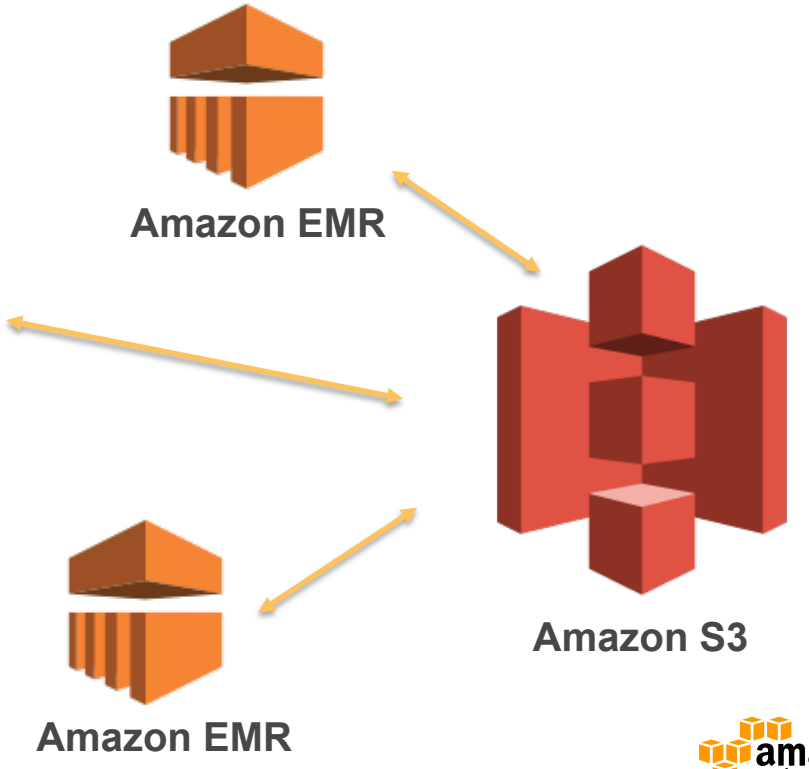
Many storage layers to choose from



Decouple compute and storage by using S3 as your data layer





S3 is designed for 11 9's of durability and is massively scalable

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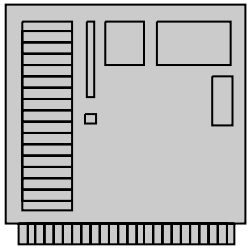
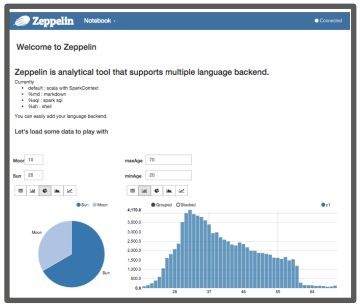
Easy to run your Spark workloads

Submit a Spark application



Amazon EMR Step API

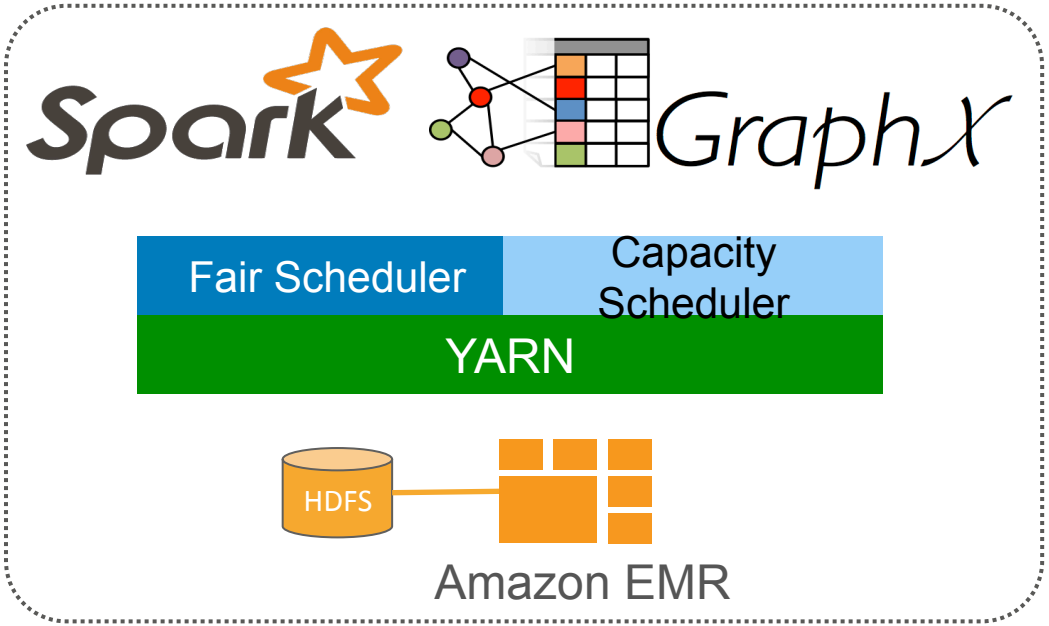
Amazon EMR



SSH to master node (Spark Shell)

amazon web services

Spark on YARN



YARN is Hadoop 2's Cluster Manager

Spark Standalone Cluster Manager is FIFO, 100% Core Allocation

- Not ideal for multi-tenancy

YARN Default is 'Capacity Scheduler'

- Focus on Throughput
- Configure Queues

'Fair Scheduler' also available

- Focus on even distribution

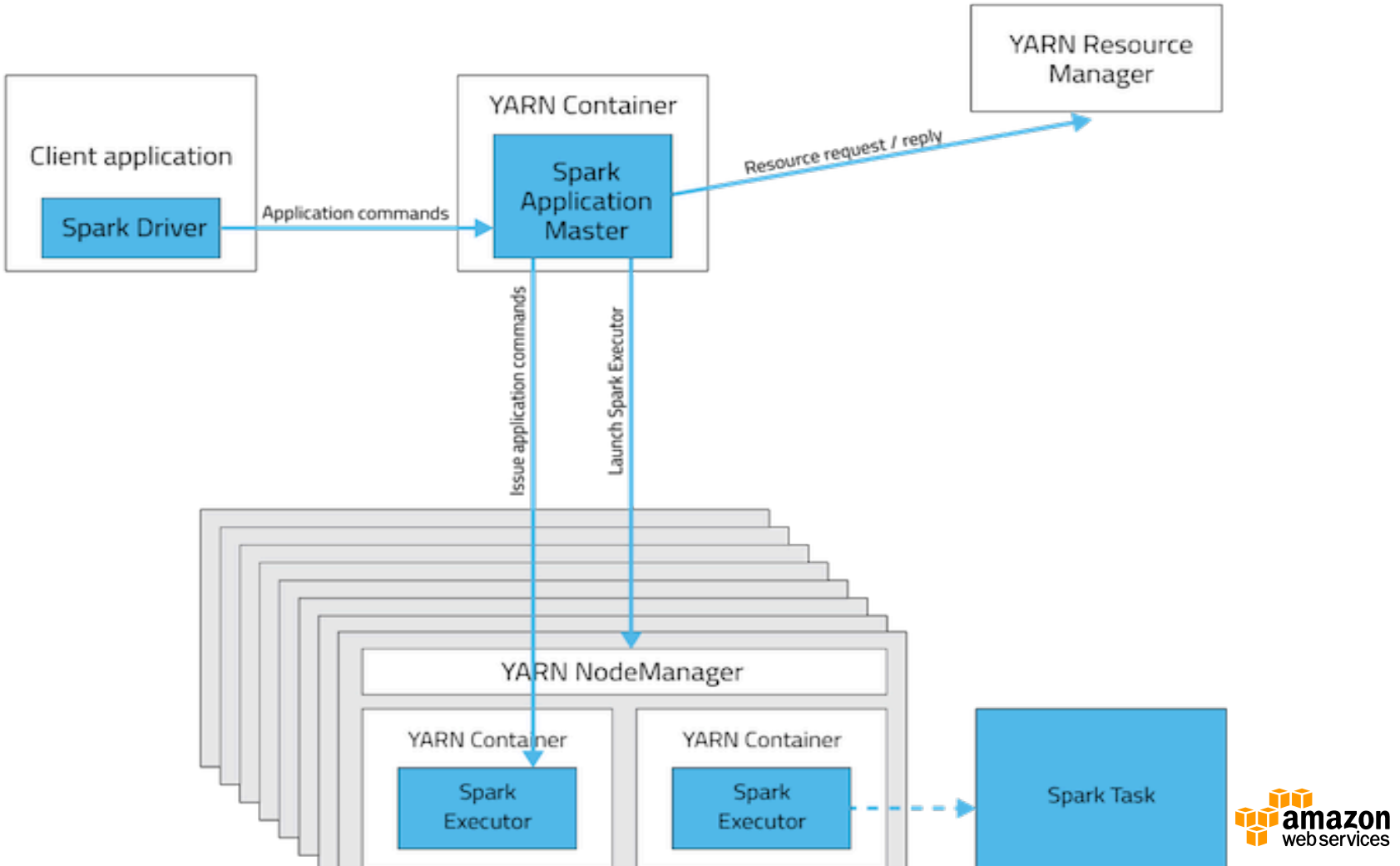
Why run Spark on YARN?

- YARN allows you to dynamically share and centrally configure the same pool of cluster resources between all frameworks that run on YARN. You can throw your entire cluster at a MapReduce job, then use some of it on an Impala query and the rest on Spark application, without any changes in configuration.

- You can take advantage of all the features of YARN schedulers for categorizing, isolating, and prioritizing workloads.

- Spark standalone mode requires each application to run an executor on every node in the cluster, whereas with YARN you choose the number of executors to use.

- YARN is the only cluster manager for Spark that supports security. With YARN, Spark can run against Kerberized Hadoop clusters and uses secure


YARN Resource Manager
Client application
Spark Driver
Application commands
YARN Container
Spark Application Master
Resource request / reply
Issue application commands
Launch Spark Executor
YARN NodeManager
YARN Container
Spark Executor
YARN Container
Spark Executor
Spark Task

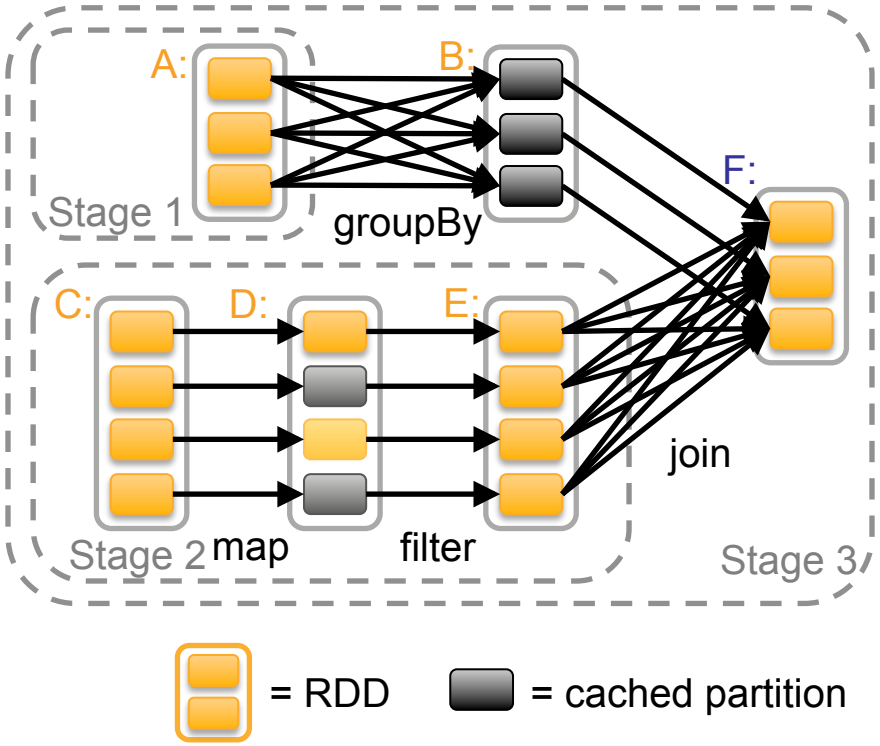
Task Scheduler

Supports general task graphs

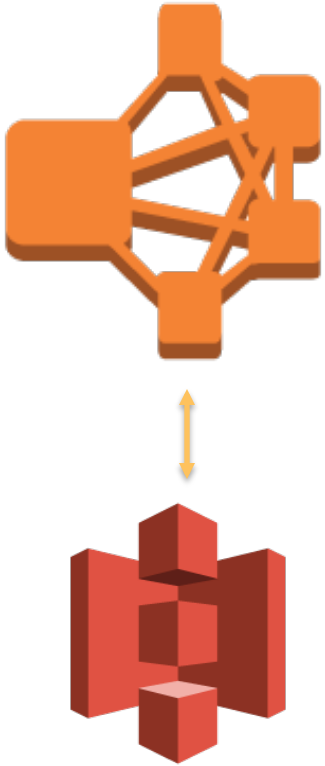
Pipelines functions where possible

Cache-aware data reuse & locality

Partitioning-aware to avoid shuffles



Secure Spark clusters – encryption at rest

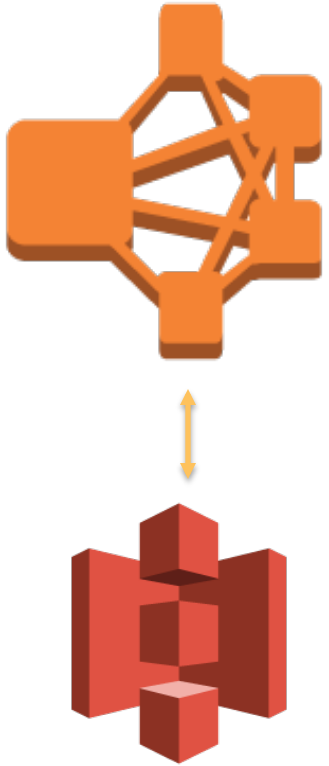


On-Cluster
HDFS transparent encryption (AES 256)
[new on release emr-4.1.0]

Local disk encryption for temporary files using LUKS encryption via bootstrap action

Amazon S3
EMRFS support for Amazon S3 client-side and server-side encryption (AES 256)

Secure Spark clusters – encryption in flight



Internode communication on-cluster
Blocks are encrypted in-transit in HDFS when using transparent encryption

Spark's Broadcast and FileServer services can use SSL. BlockTransferService (for shuffle) can't use SSL (SPARK-5682).

S3 to Amazon EMR cluster
Secure communication with SSL

Objects encrypted over the wire if using client-side encryption

Secure Spark clusters – additional features

Permissions:

- **Cluster level**: IAM roles for the Amazon EMR service and the cluster
- **Application level**: Kerberos (Spark on YARN only)
- **Amazon EMR service level**: IAM users

Access: VPC, security groups

Auditing: AWS CloudTrail

Thank you!