

The Building Blocks of Hadoop - HDFS, MapReduce, and YARN

INTRODUCING HADOOP



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Overview

Understand the need for Distributed Computing

Understand the role of Hadoop in a distributed computing setup

Get introduced to core technologies which work on Hadoop

How Much Data Do These Organizations Deal With?

A solid purple square representing the Facebook logo.

Facebook

A solid teal square representing the NSA logo.

NSA

A solid lime green square representing the Google logo.

Google

Facebook

Current storage = 300 petabytes

Processed per day = 600 terabytes

Users per month = 1 billion

Likes per day = 2.7 billion

Photos uploaded per day = 300 million



NSA

Current storage = ~5 exabytes

Processed per day = 30 petabytes

NSA touches 1.6% of internet traffic per day

Web searches, websites visited, phone calls, credit/debit card transactions, financial and health information

The Google logo is displayed in white text on a solid green rectangular background.

Google

Current storage = 15 exabytes

Processed per day = 100 petabytes

Number of pages indexed = 60 trillion

Unique search users per month > 1 billion

Searches per second = 2.3 million

Huge Data Set

A solid purple square containing the word "Facebook" in white, bold, sans-serif font.

Facebook

A solid teal square containing the letters "NSA" in white, bold, sans-serif font.

NSA

A solid green square containing the word "Google" in white, bold, sans-serif font.

Google

Huge Data Set



Huge Data Set



Cannot meet big data requirements

Big Data System Requirements

Raw data

**Store massive
amounts of data**

Big Data System Requirements

Store

**Extract useful
information**

Store massive
amounts of data

**Process it in a
timely manner**

Big Data System Requirements

Store

Store massive
amounts of data

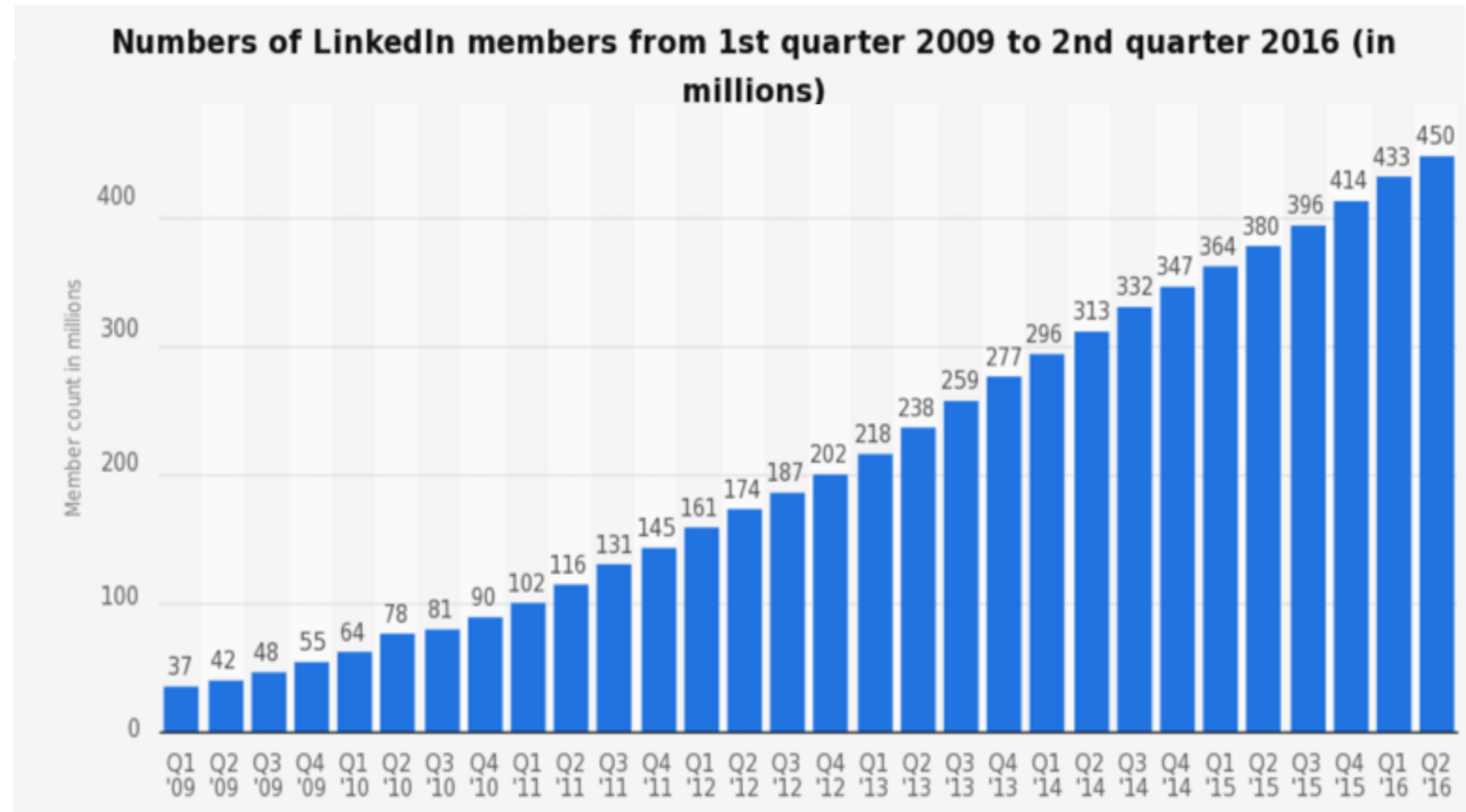
Process

Process it in a
timely manner

?

Store
Process
?

Growing size of data



**Store
Process
?**

The infrastructure needs
to keep up with the
growing size of data

Big Data System Requirements

Store

Store massive
amounts of data

Process

Process it in a
timely manner

**Accommodate
changing needs**

**Scale easily as
data grows**

Big Data System Requirements

Store

Store massive
amounts of data

Process

Process it in a
timely manner

Scale

Scale easily as
data grows

Big Data System Requirements



**Traditional data
technologies don't
cut it anymore**

Store

Process

Scale

Distributed Computing Frameworks

like Hadoop were developed for
exactly this

Two Ways to Build a System



Monolithic

Distributed

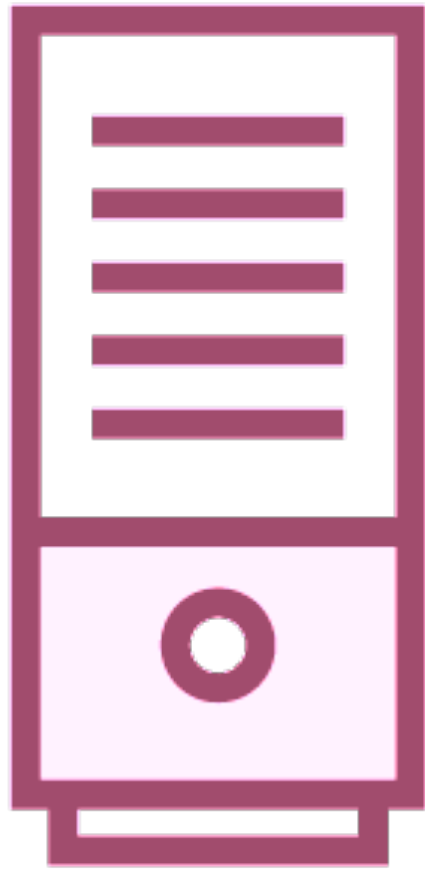
Two Ways to Build a Team



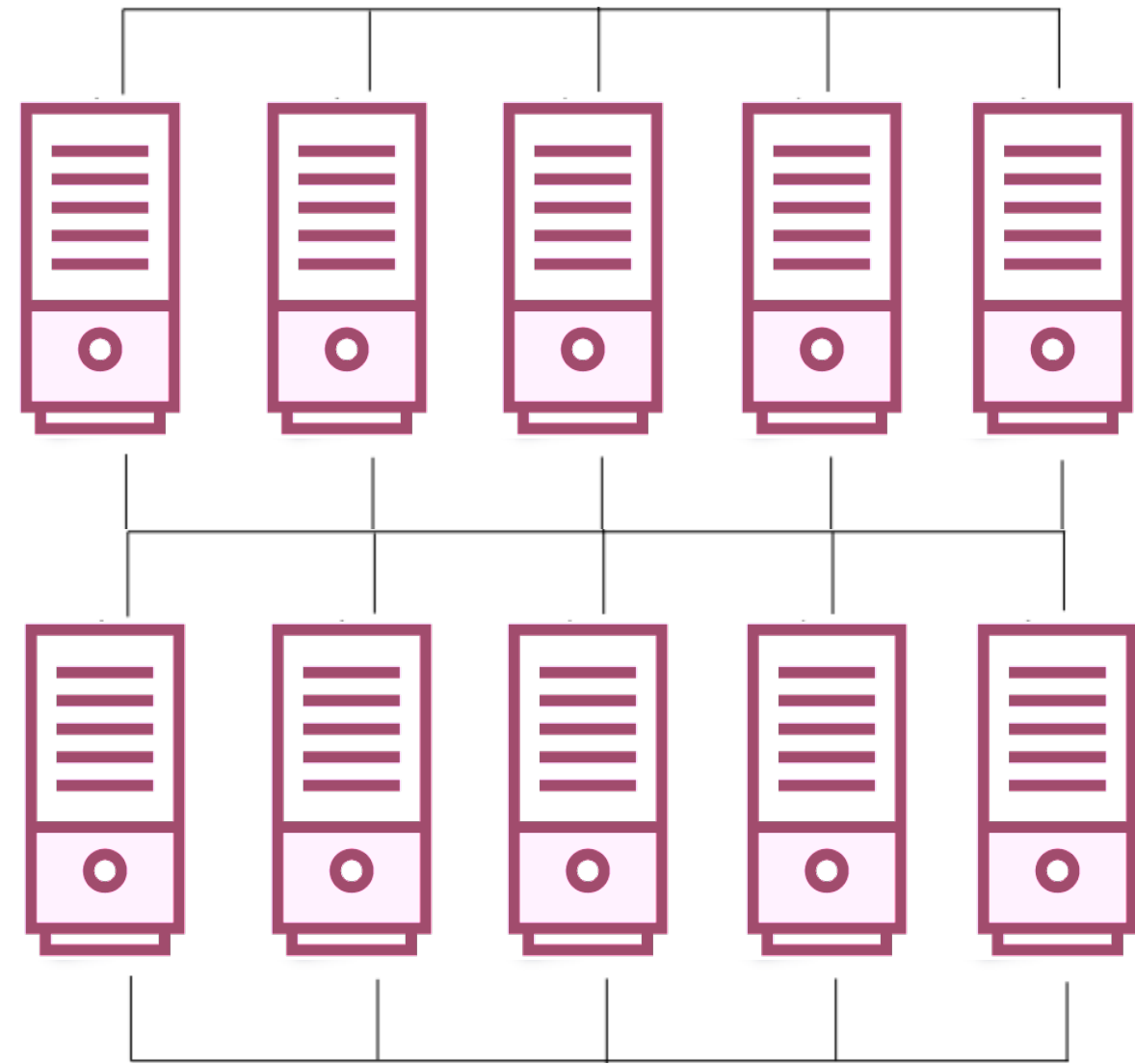
A star who dribbles and shoots



A team of good players who
know how to pass



A supercomputer



**A cluster of decent machines
that know how to parallelize**

Two Ways to Build a System



Monolithic

Distributed

Monolithic



One star player

Monolithic



**A single
powerful server**

2x Expense

< 2x

Performance

Two Ways to Build a System



Monolithic

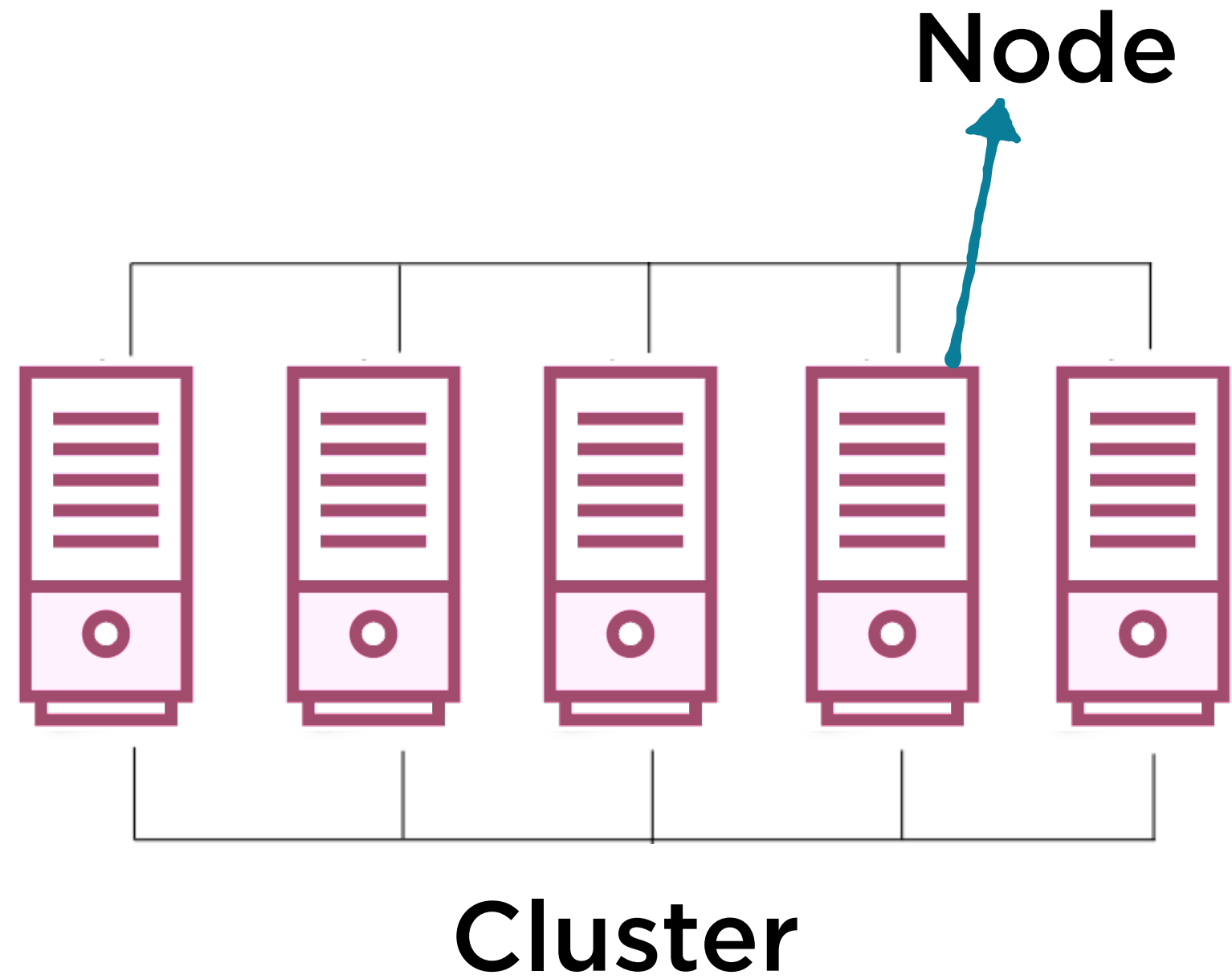
Distributed

Distributed

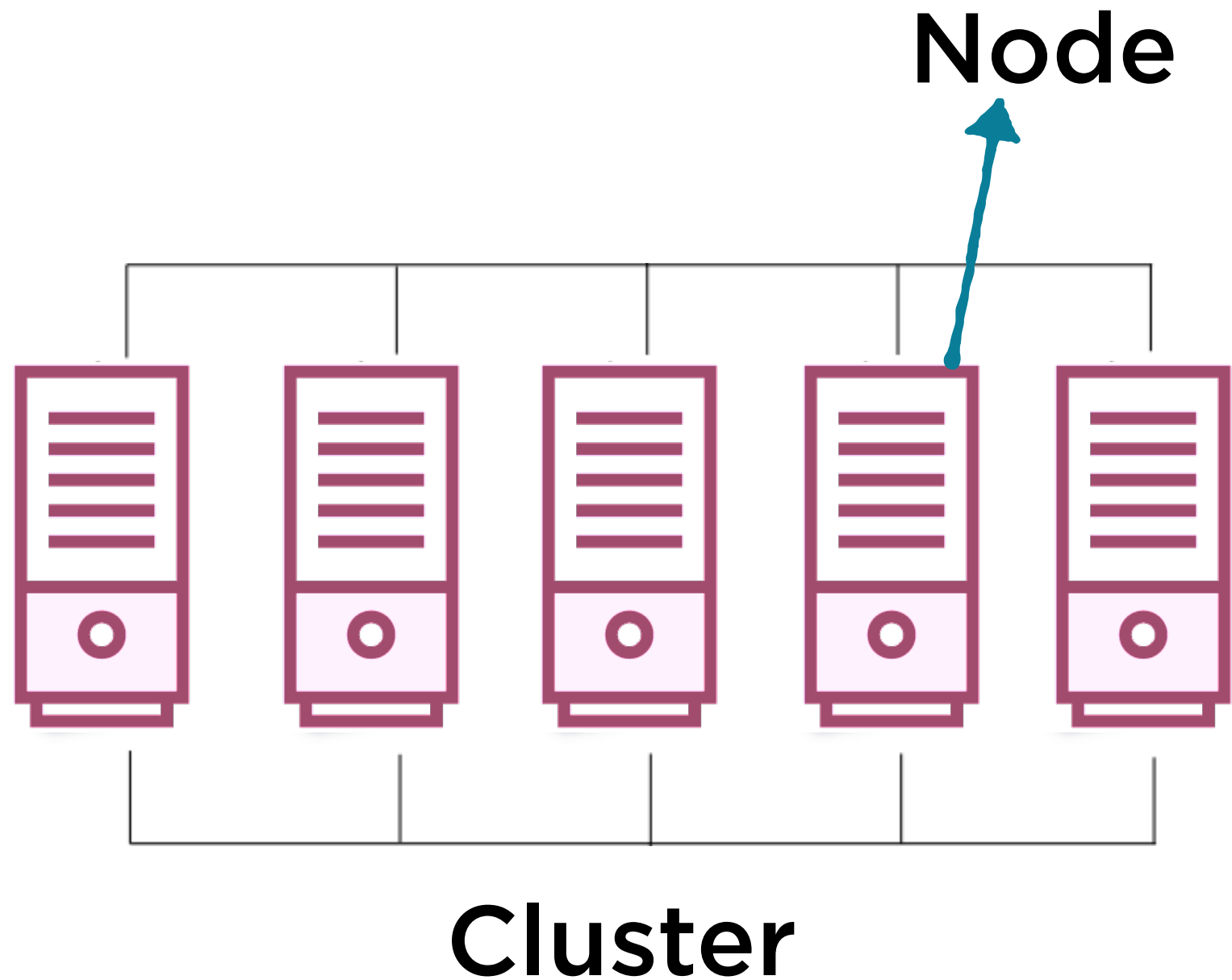


A team of good players who
know how to pass

Distributed



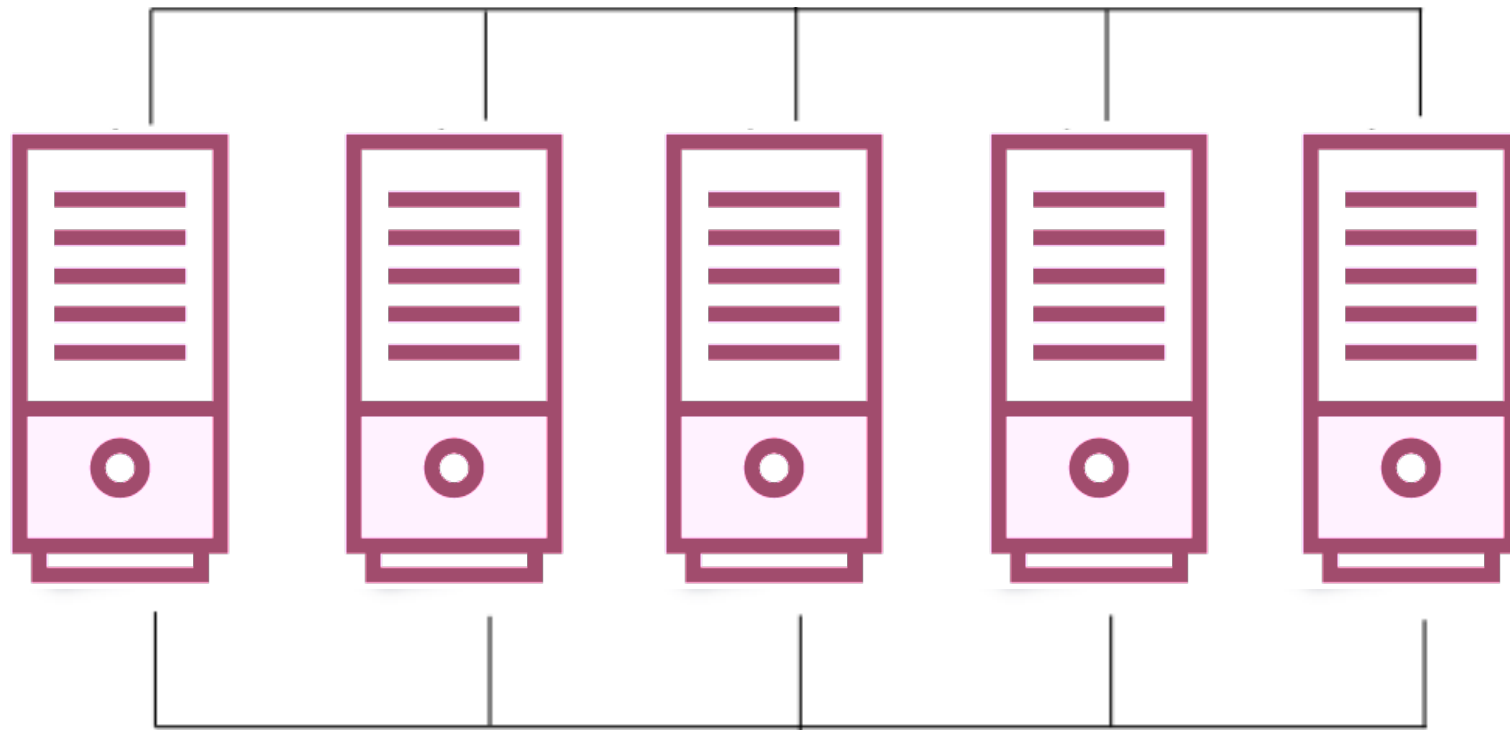
Distributed System



**Many small and
cheap computers
come together...**

**...to act as a
single entity**

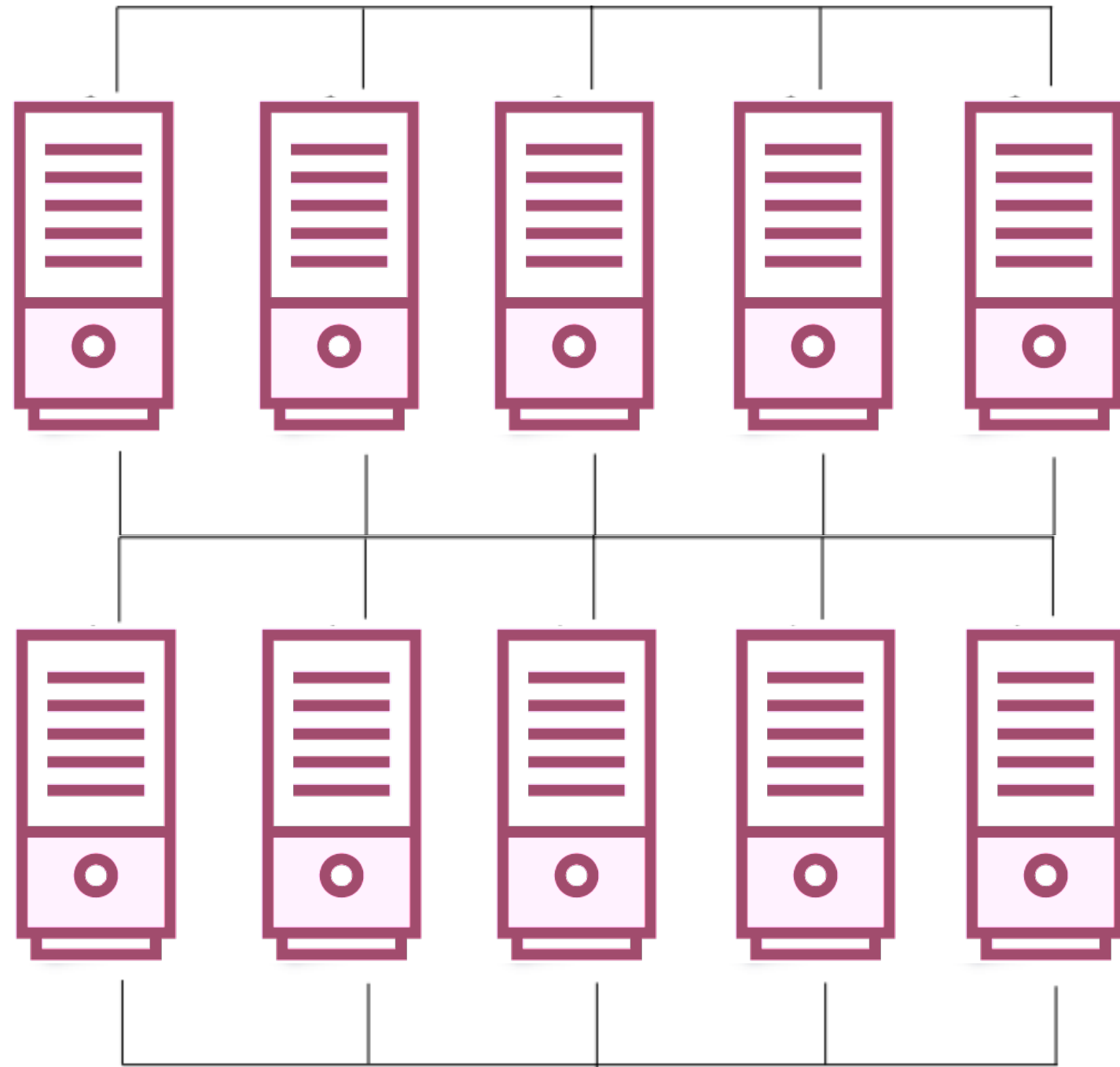
Distributed System



Cluster

**Such a system
can scale linearly**

Distributed System



2x Nodes

2x Storage

~ 2x Speed

Server Farms



**Companies like
Facebook, Google,
Amazon are building
vast server farms**

Server Farms



**These farms have
100s of 1000s of
servers working in
tandem to process
complex data**

Server Farms



All of these servers need to be co-ordinated by a single piece of software

Single Co-ordinating Software



- Partition data
- Co-ordinate computing tasks
- Handle fault tolerance and recovery
- Allocate capacity to processes

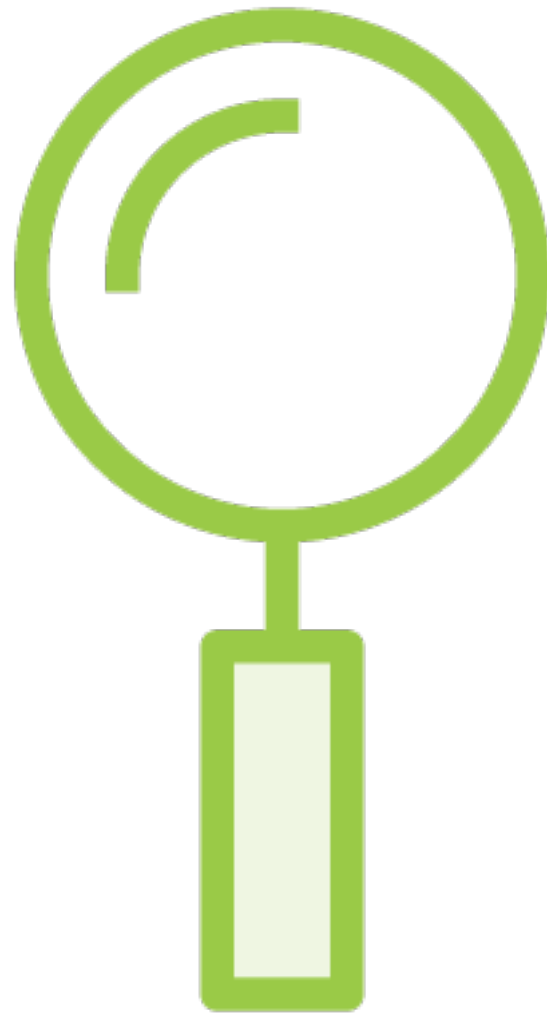
Store

Process

Scale

Distributed Computing makes for a
lot of complexity

Single Co-ordinating Software



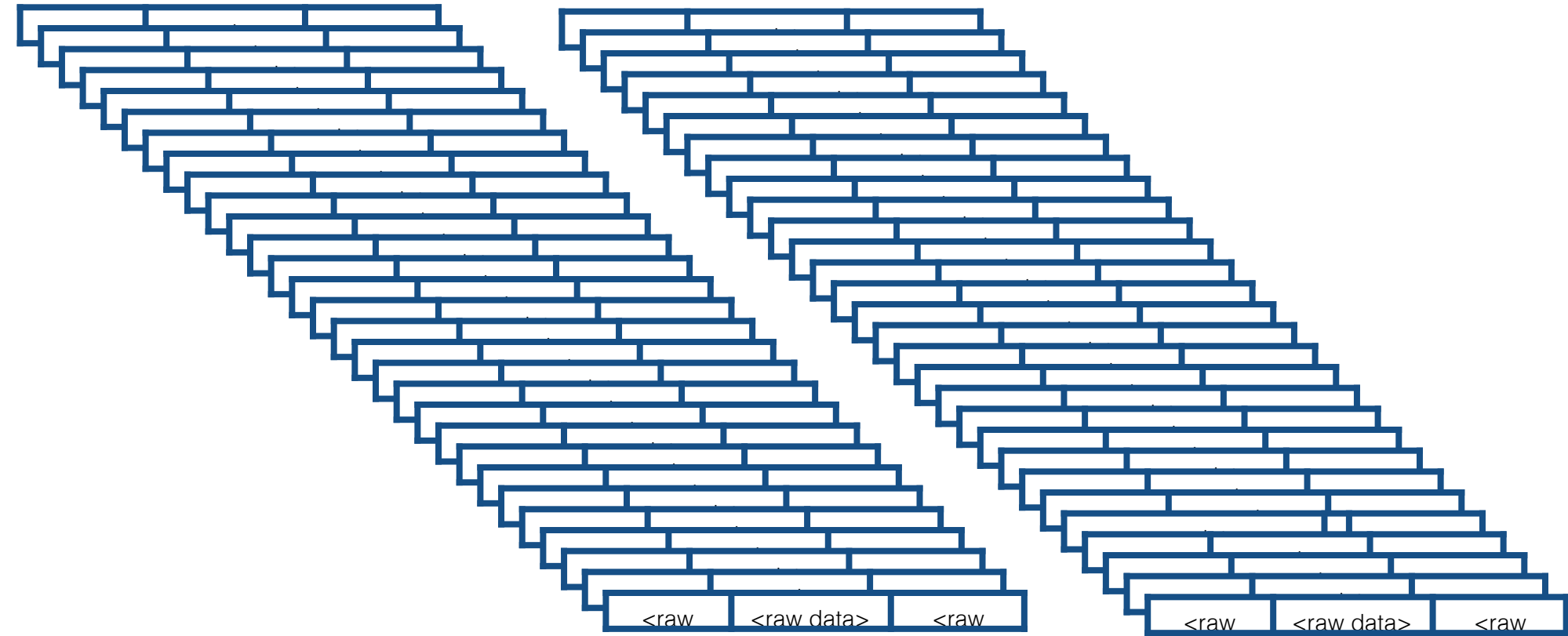
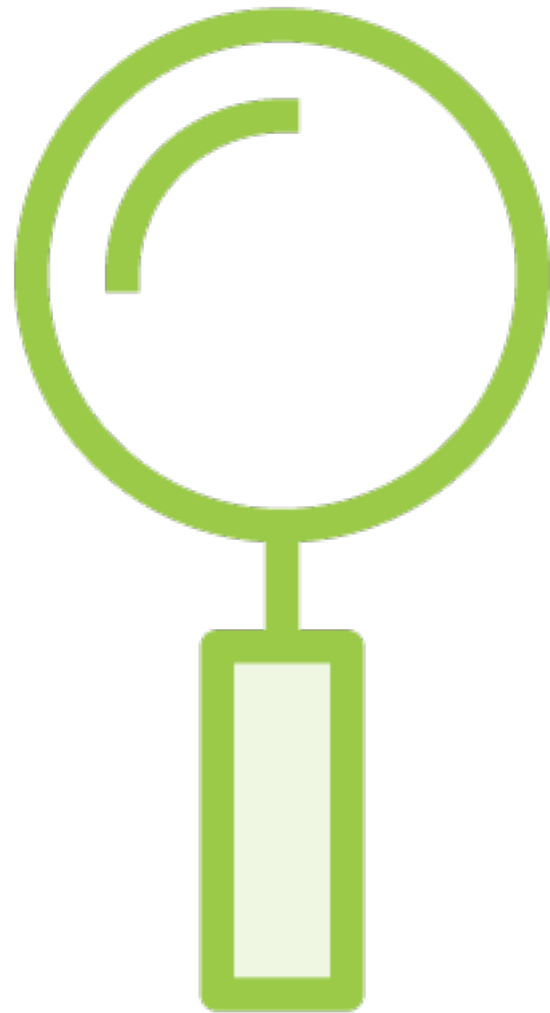
**Back in the early 2000s
Google realized that web
search requires something
completely new**

Single Co-ordinating Software



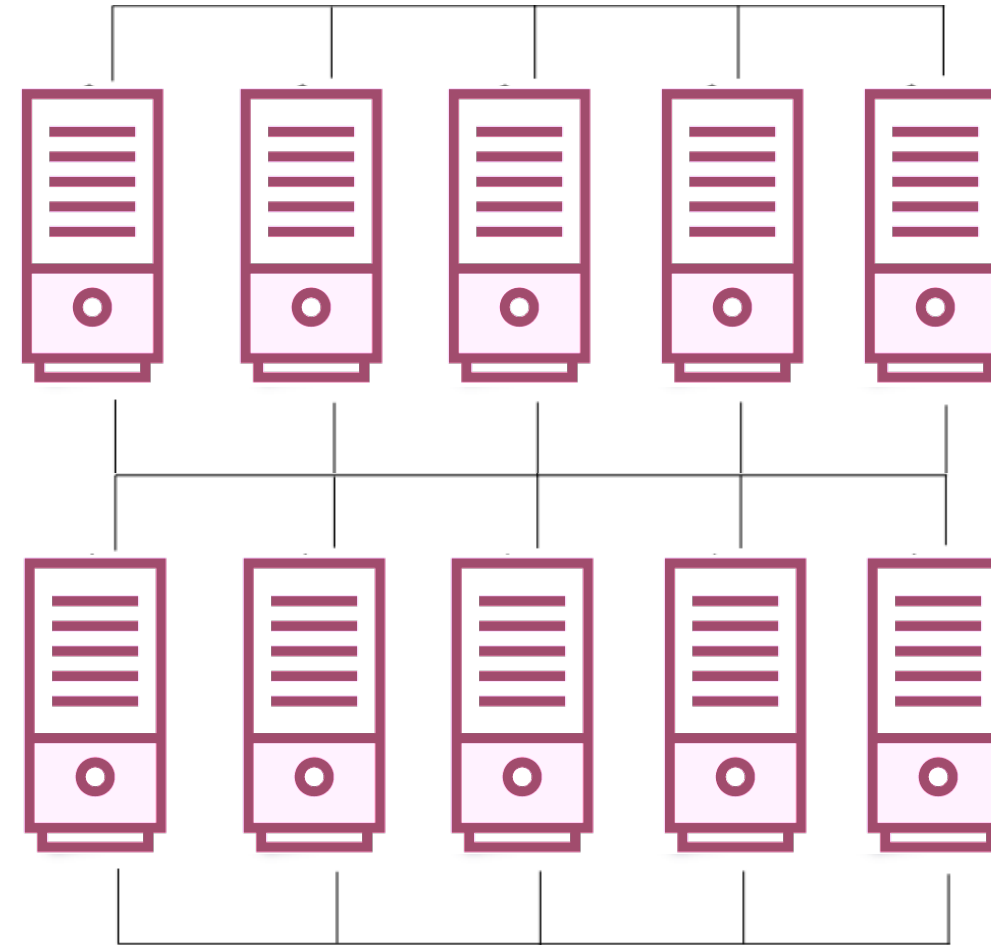
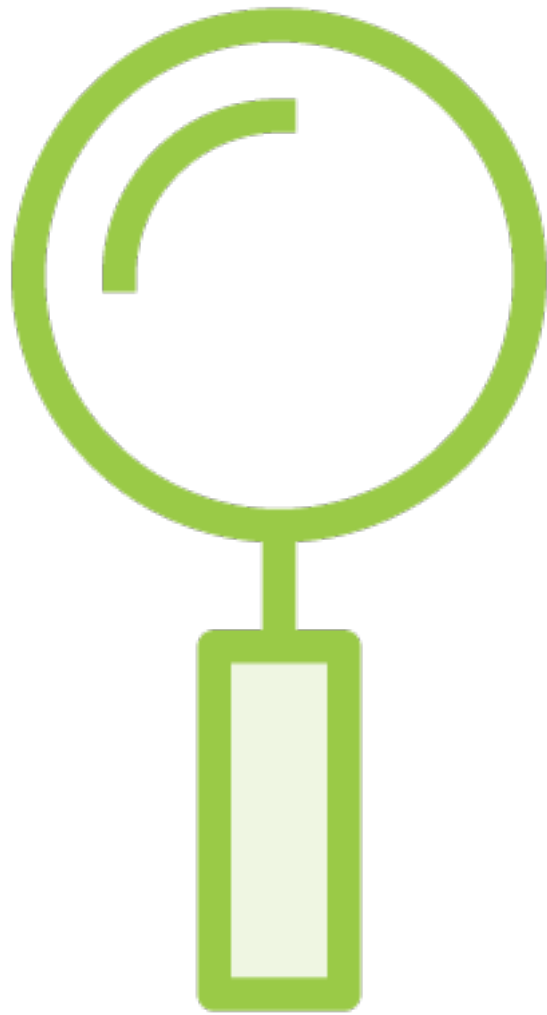
**Google developed
proprietary software
to run on these
distributed systems**

Single Co-ordinating Software



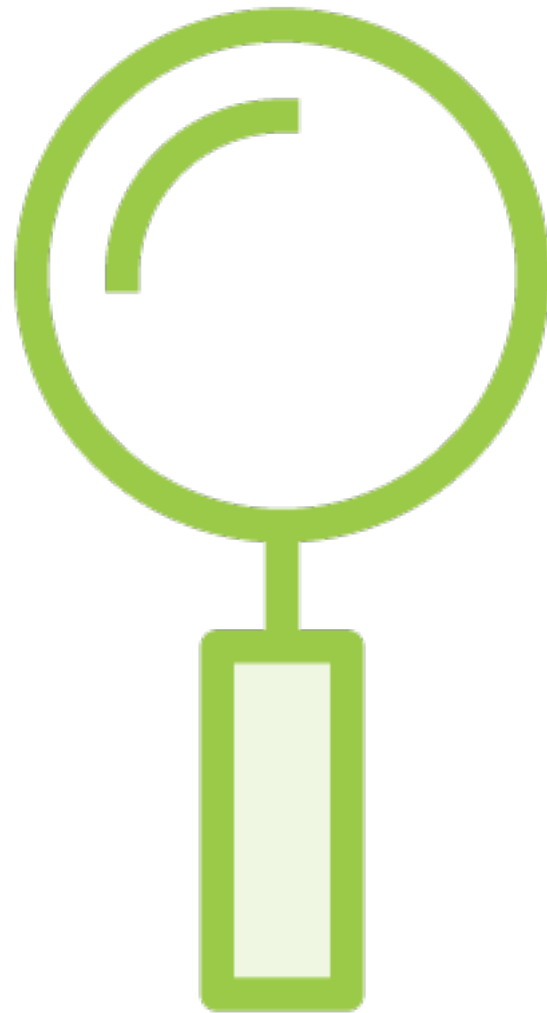
First: store millions of records on multiple machines

Single Co-ordinating Software



Second: run processes on all these machines to crunch data

Single Co-ordinating Software



Google File System

To solve
distributed
storage

MapReduce

To solve
distributed
computing

Single Co-ordinating Software

Google File System

MapReduce

**Apache developed
open source versions
of these technologies**

Single Co-ordinating Software

Google File System



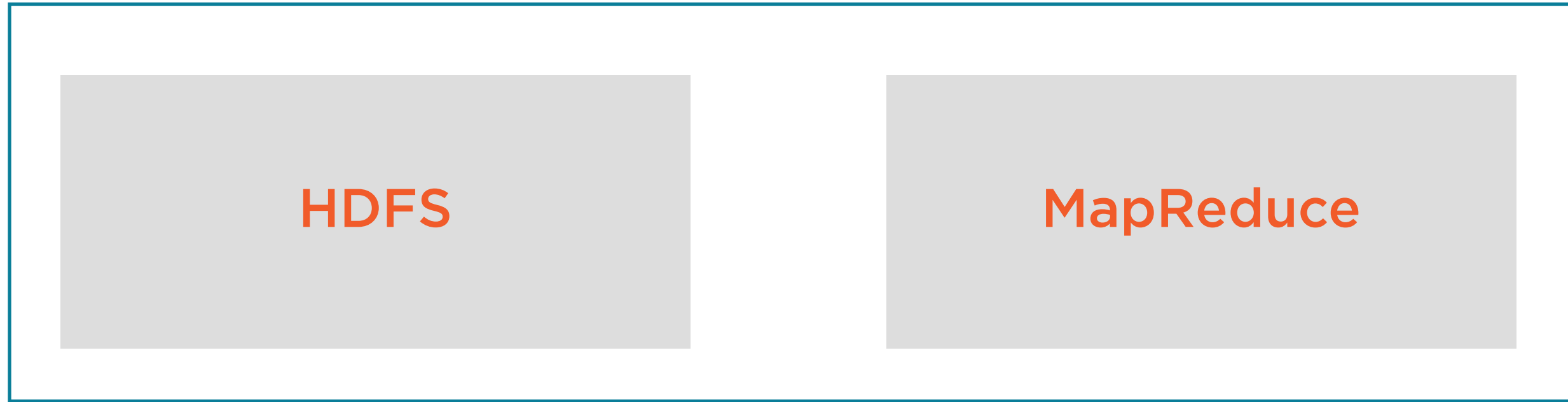
HDFS

MapReduce



MapReduce

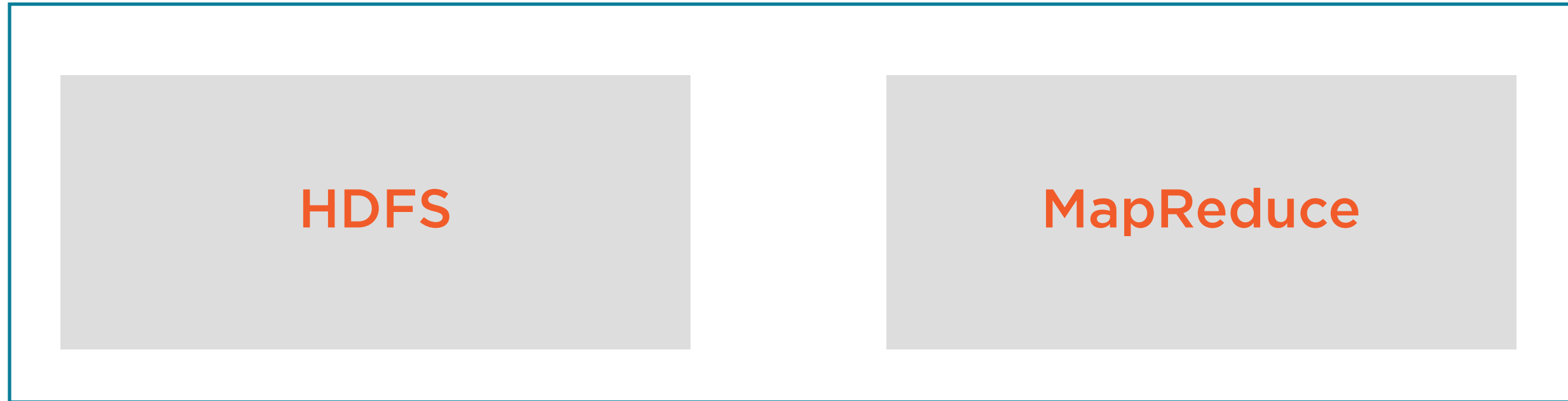
Hadoop



**A file system
to manage the
storage of data**

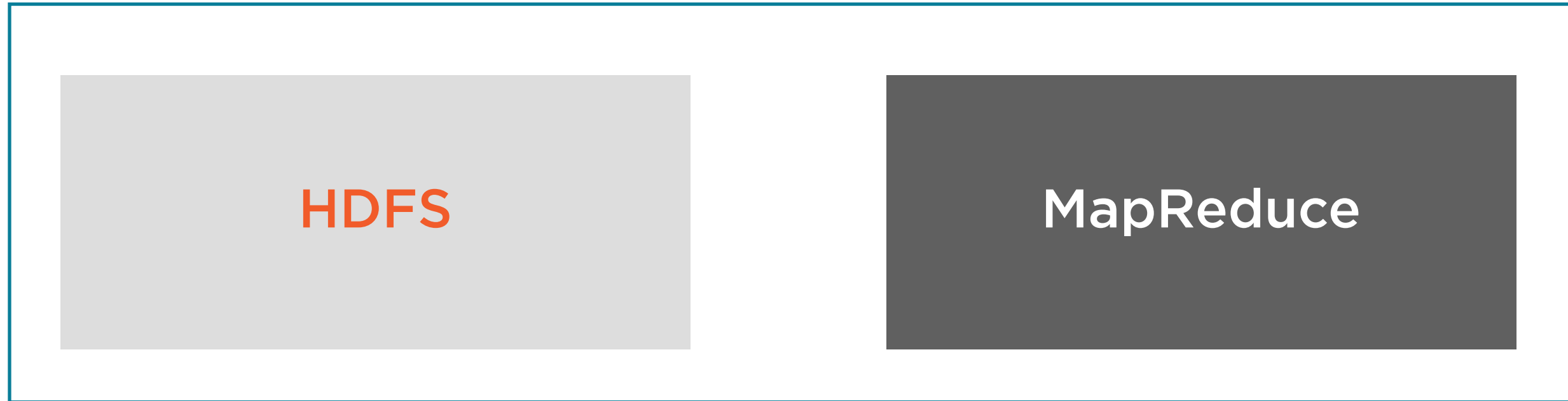
**A framework to
process data across
multiple servers**

Hadoop



**In 2013, Apache
released Hadoop 2.0**

Hadoop



**MapReduce was broken
into two separate parts**

Hadoop



The diagram shows the Hadoop ecosystem components. At the top is the word 'Hadoop'. Below it is a large blue-bordered rectangle containing three gray boxes. The first box on the left is labeled 'HDFS' in orange. The middle box is labeled 'MapReduce' in orange. The third box on the right is labeled 'YARN' in orange. Below the 'MapReduce' and 'YARN' boxes are two columns of text describing their functions.

HDFS

MapReduce

YARN

**A framework to
define a data
processing task**

**A framework to
run the data
processing task**

Hadoop



The diagram consists of a large light blue rectangle with a thin blue border. Inside this rectangle, there are three smaller, light gray rectangles arranged horizontally. Each gray rectangle contains a component name in orange text. From left to right, the components are HDFS, MapReduce, and YARN.

HDFS

MapReduce

YARN

**Each of these components have
corresponding configuration files**

Co-ordination Between Hadoop Blocks

MapReduce



**User defines map and
reduce tasks using
the MapReduce API**

YARN

HDFS

Co-ordination Between Hadoop Blocks

MapReduce



YARN

HDFS

**A job is
triggered on the
cluster**

Co-ordination Between Hadoop Blocks

MapReduce

YARN



HDFS

YARN figures out where and how to run the job, and stores the result in HDFS

Hadoop Ecosystem



**An ecosystem of tools have sprung up
around this core piece of software**

Hadoop Ecosystem

Hive

HBase

Pig

Hadoop

Flume/Sqoop

Spark

Oozie

Hadoop Ecosystem

Hive

HBase

Pig

Flume/Sqoop

Spark

Oozie

A solid orange rectangle with the word "Hive" centered inside it in white text.

Hive

**Provides an SQL interface to
Hadoop**

**The bridge to Hadoop for folks
who don't have exposure to OOP
in Java**



HBase

**A database management system
on top of Hadoop**

**Integrates with your application
just like a traditional database**



Pig

A data manipulation language

**Transforms unstructured data into
a structured format**

**Query this structured data using
interfaces like Hive**



Spark

A distributed computing engine
used along with Hadoop

Interactive shell to quickly
process datasets

Has a bunch of built in libraries
for machine learning, stream
processing, graph processing etc.

Oozie

**A tool to schedule workflows on
all the Hadoop ecosystem
technologies**

Flume/Sqoop

**Tools to transfer data between
other systems and Hadoop**

Summary

Understood the need for Distributed Computing

Understood the role of Hadoop in a distributed computing setup

Overview of basic technologies which exist in the Hadoop eco-system