Hadoop for .NET Developers

INTRODUCING HADOOP

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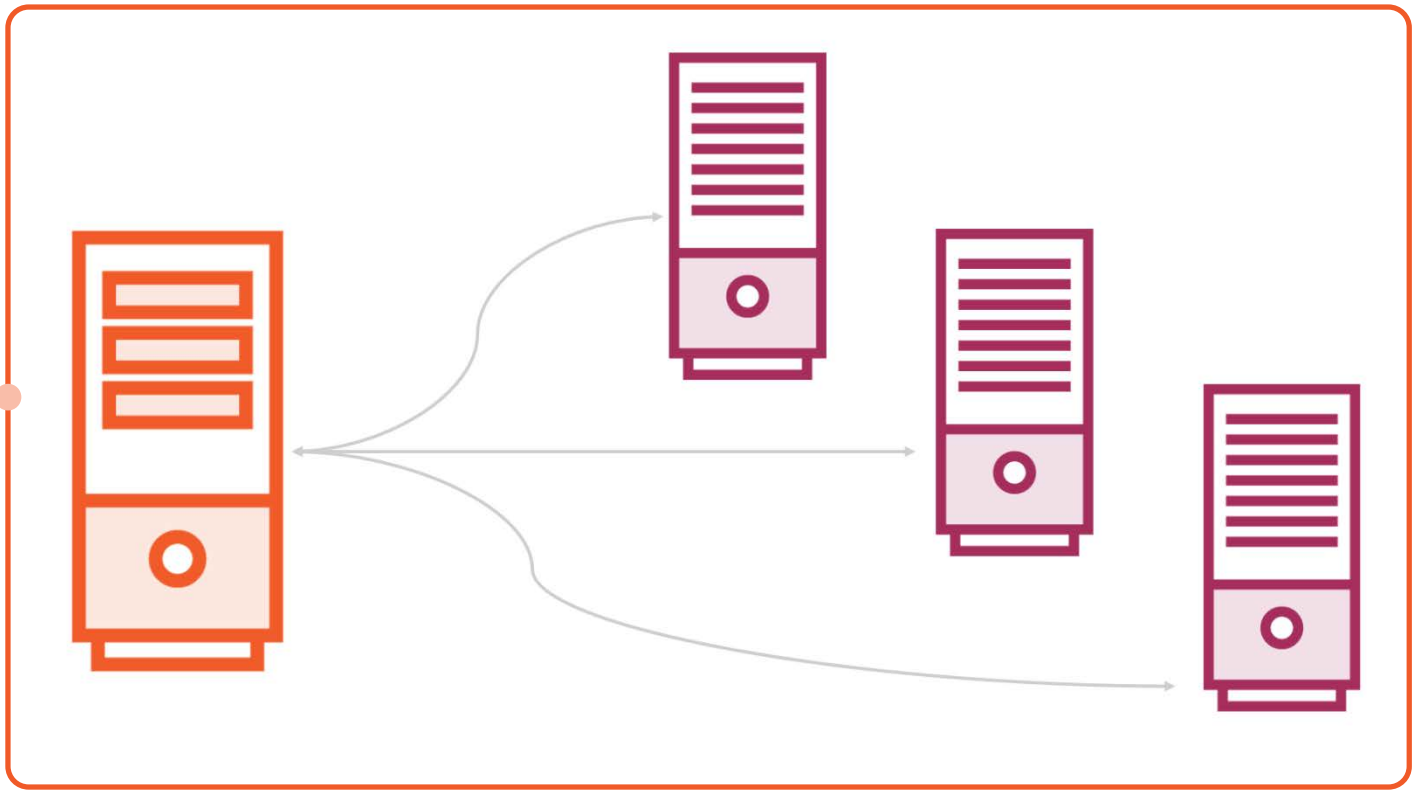
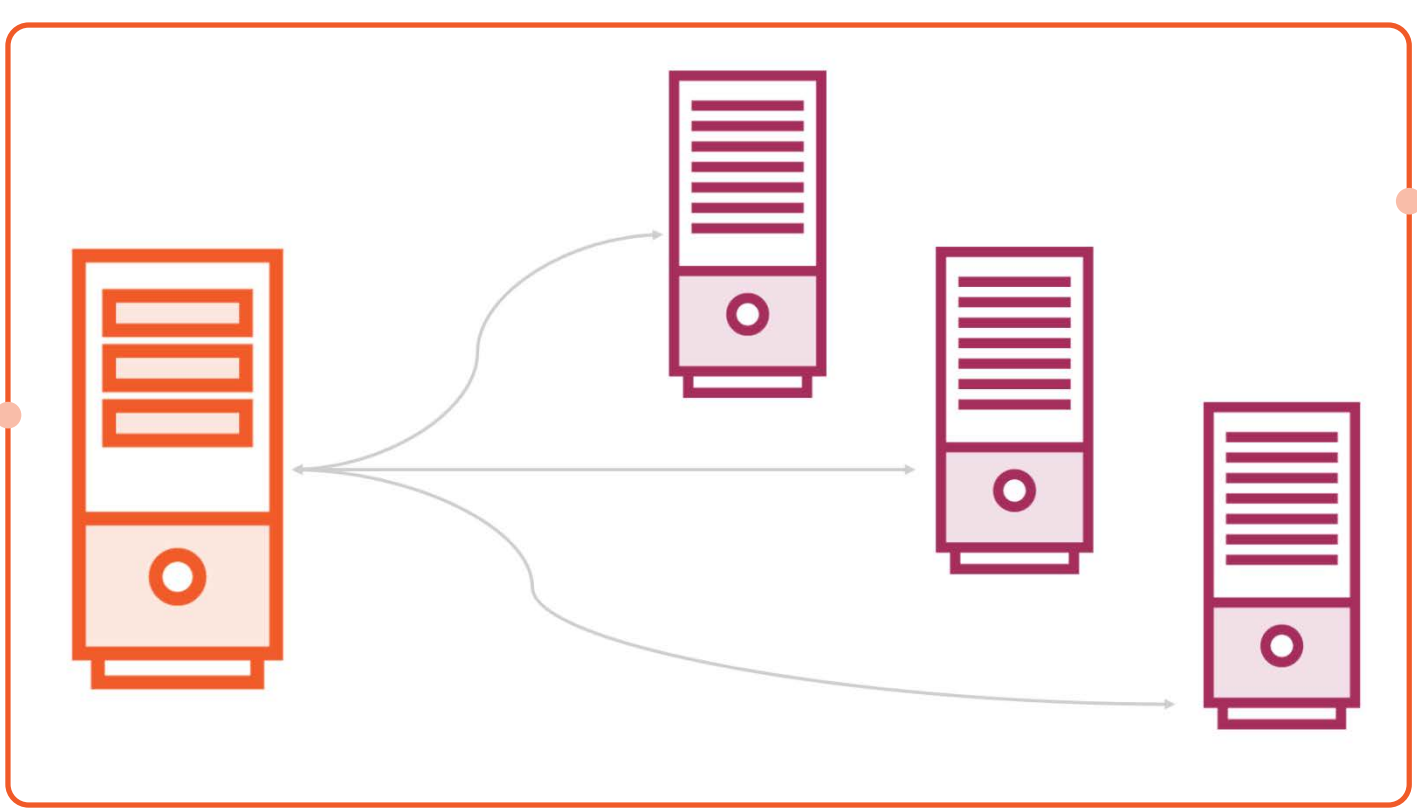
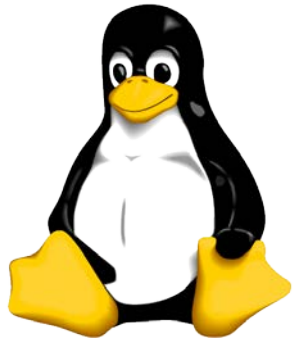
hadoop



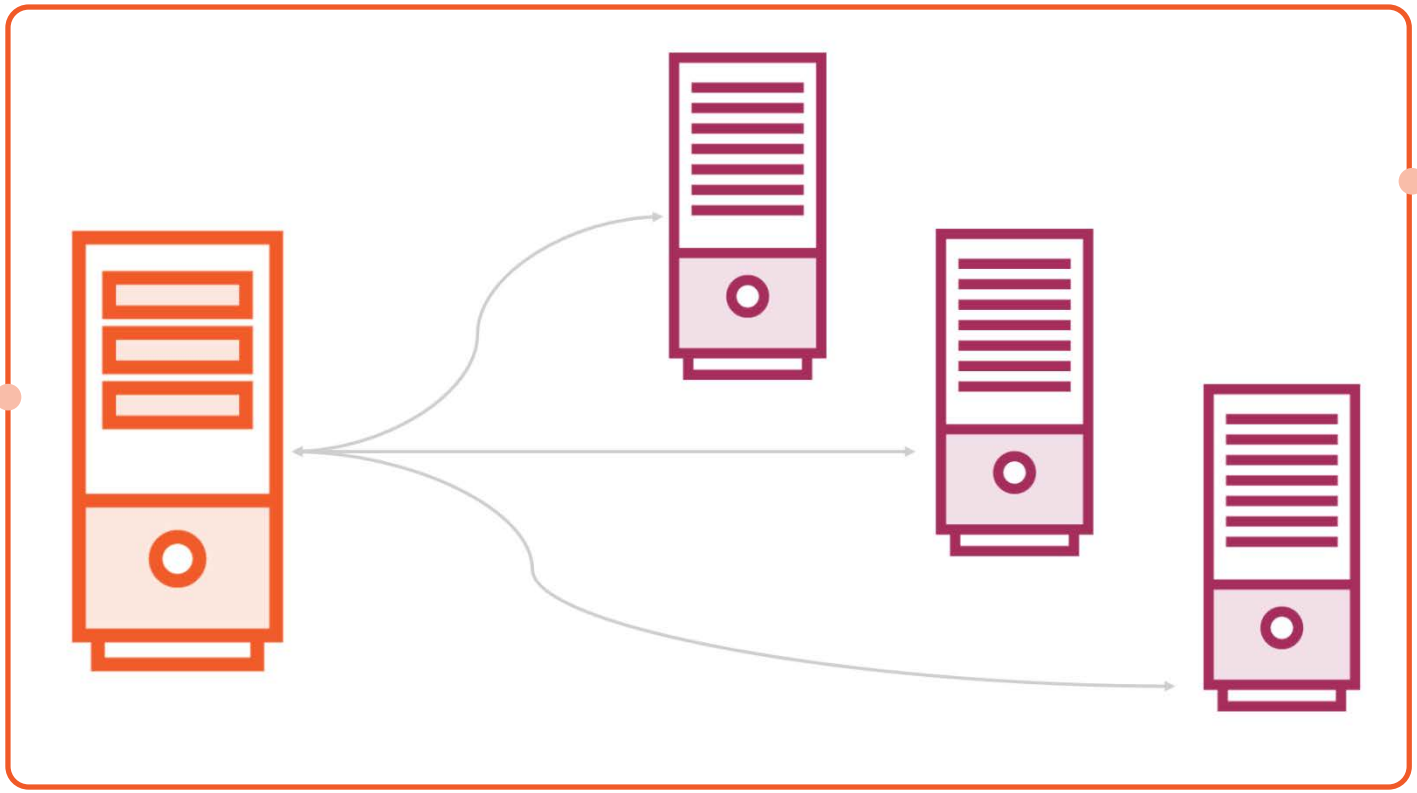

hadoop





Java

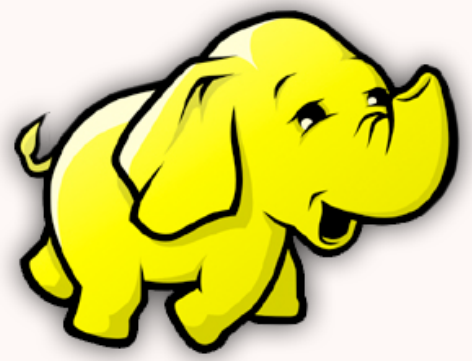
hadoop



Microsoft®
.NET

hadoop

Introducing Hadoop



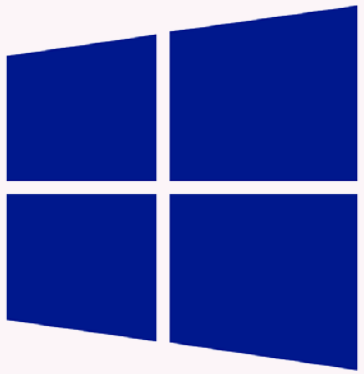
The Storage Platform

- Hadoop Distributed File System
- HDFS

The Compute Platform

- Yet Another Resource Negotiator
- YARN

Running Hadoop on Windows



Docker

- Master and Worker Images

Distributed Packages

- Hortonworks
- Syncfusion

The Cloud

- Azure HDInsight

Hadoop and .NET

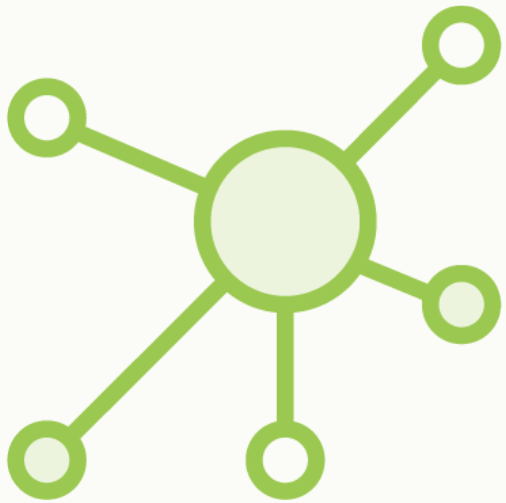
MapReduce

- Scalable Queries

Hadoop Streaming

- MapReduce with .NET

Querying Data with MapReduce



MapReduce Patterns

- Combiners and Multiple Reducers

Progress Tracking

- Hadoop Counters

Reliability

- Failure handling

The Hadoop Ecosystem

Hive

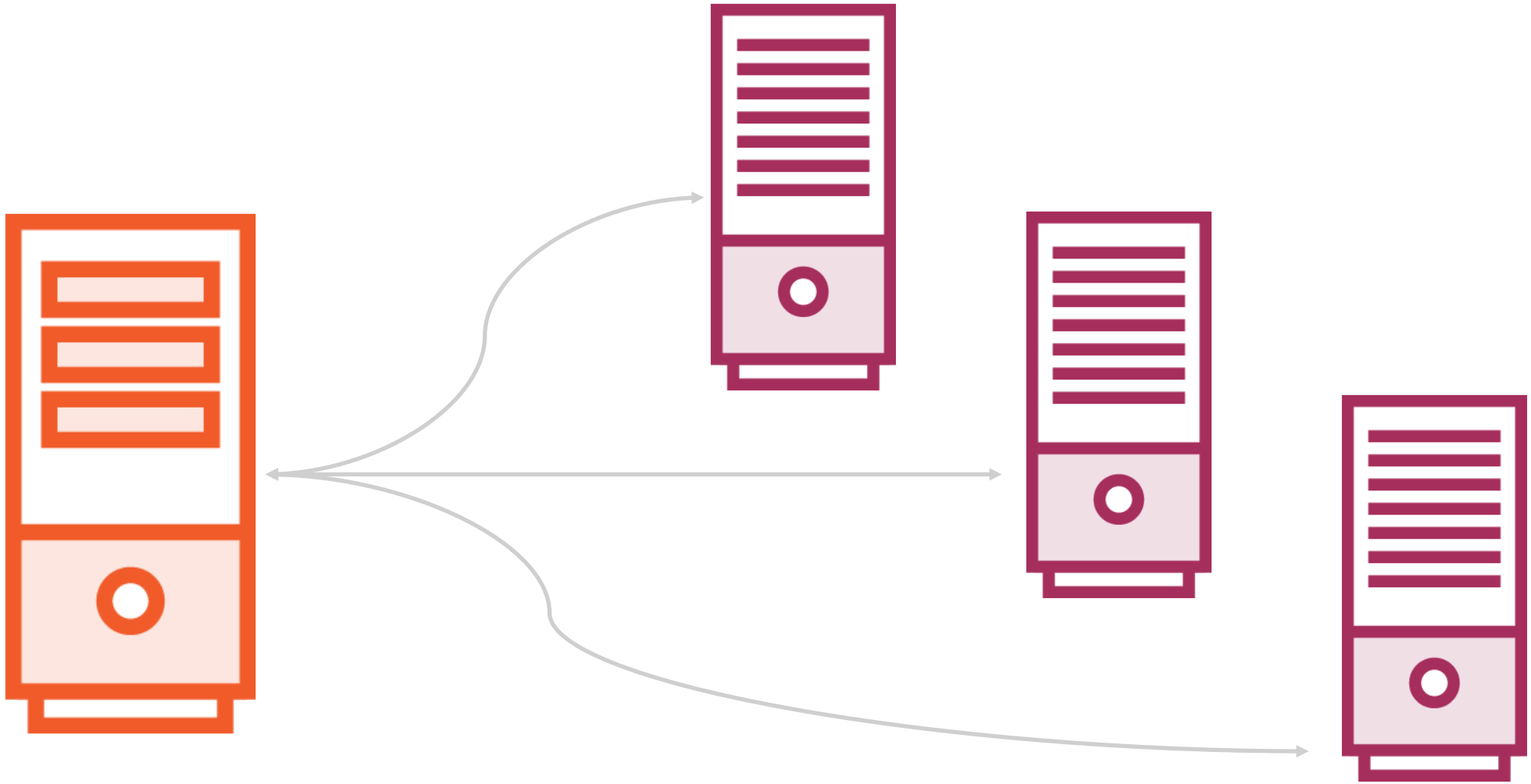
- Query Hadoop with SQL

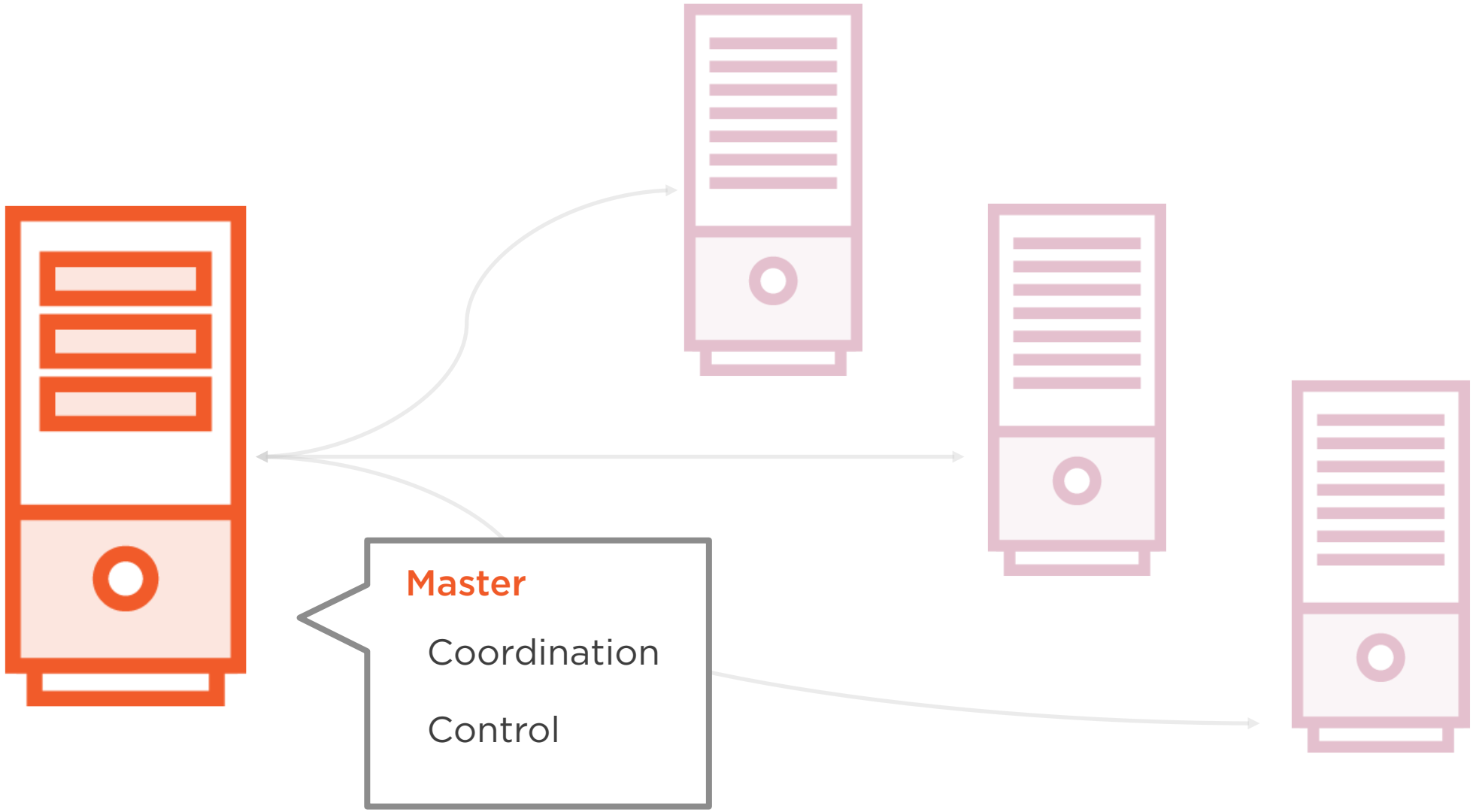
HBase

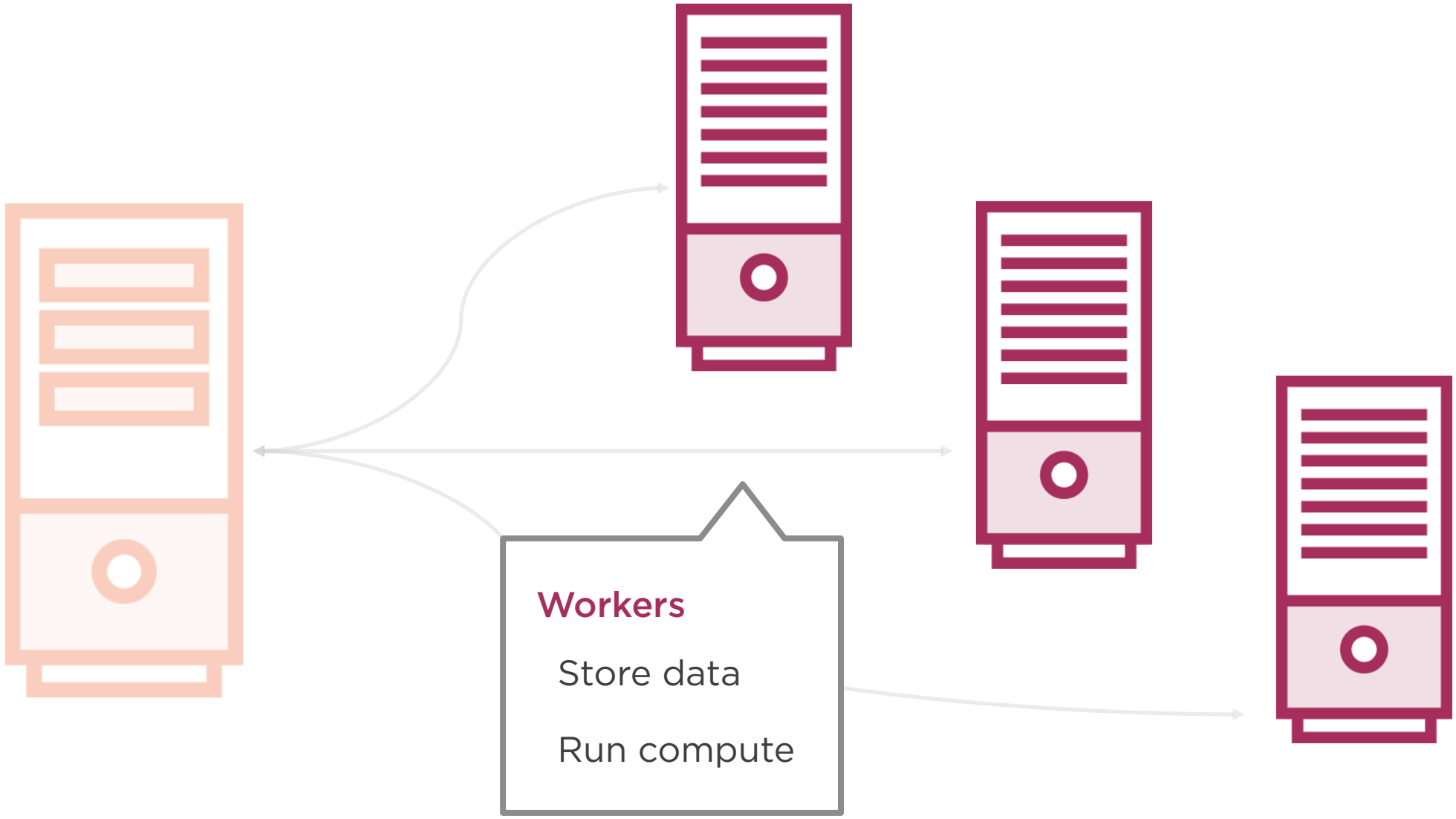
- Real-time Big Data

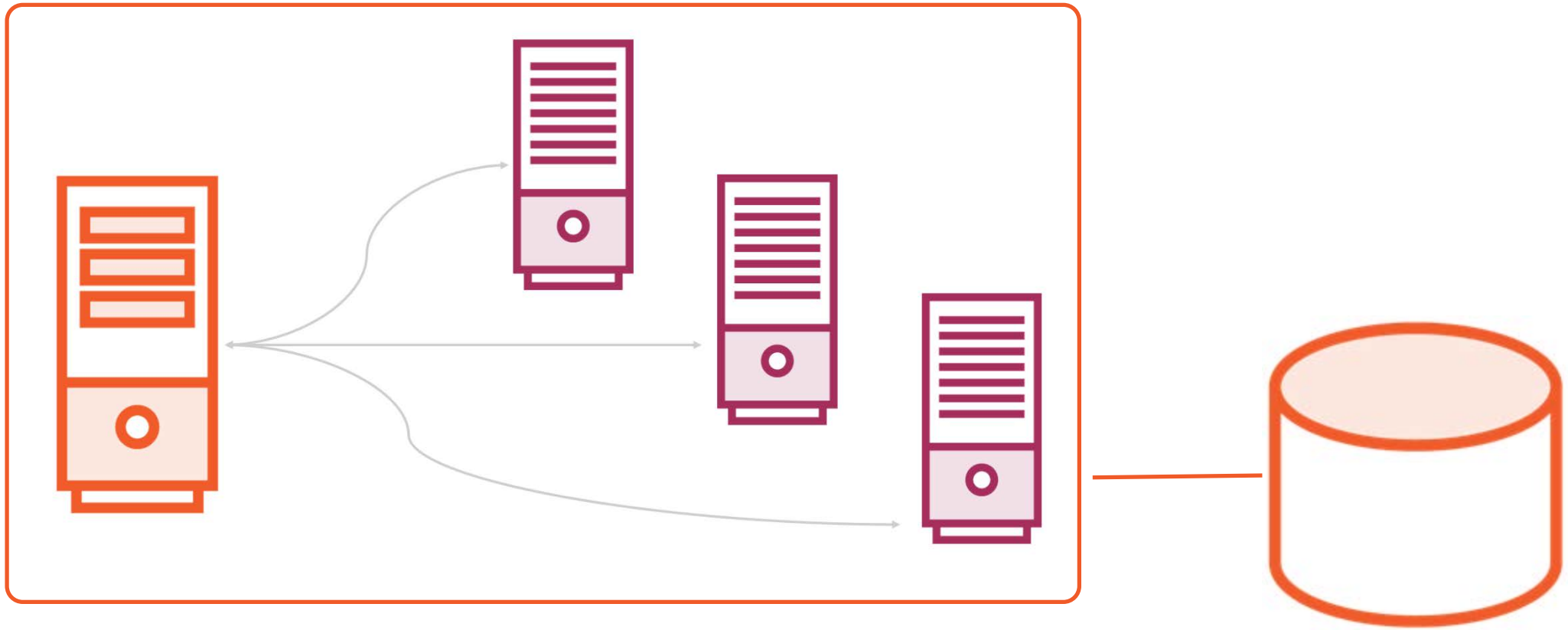
Spark

- In-Memory Analytics




Master
Coordination
Control


Workers
Store data
Run compute

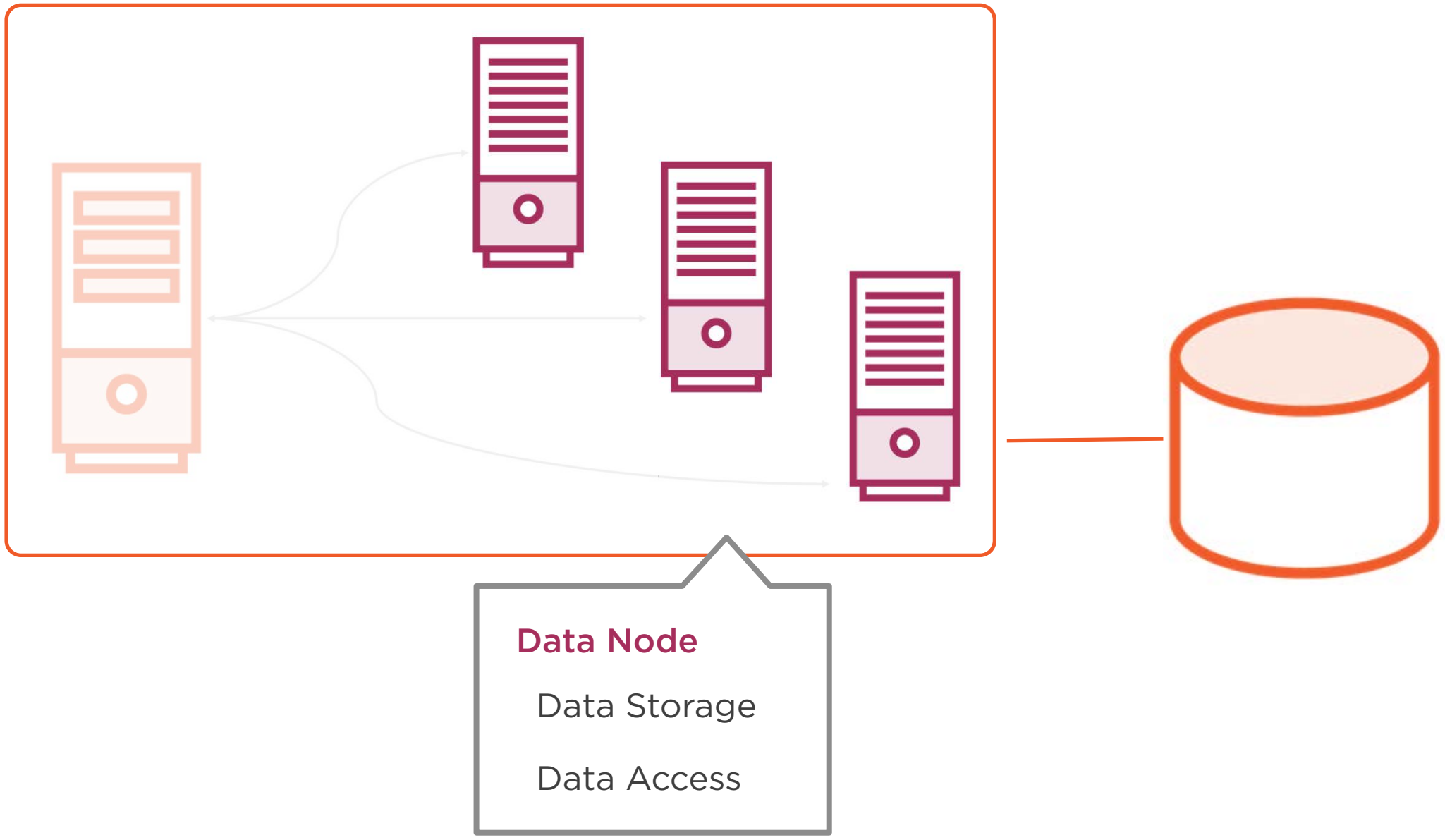


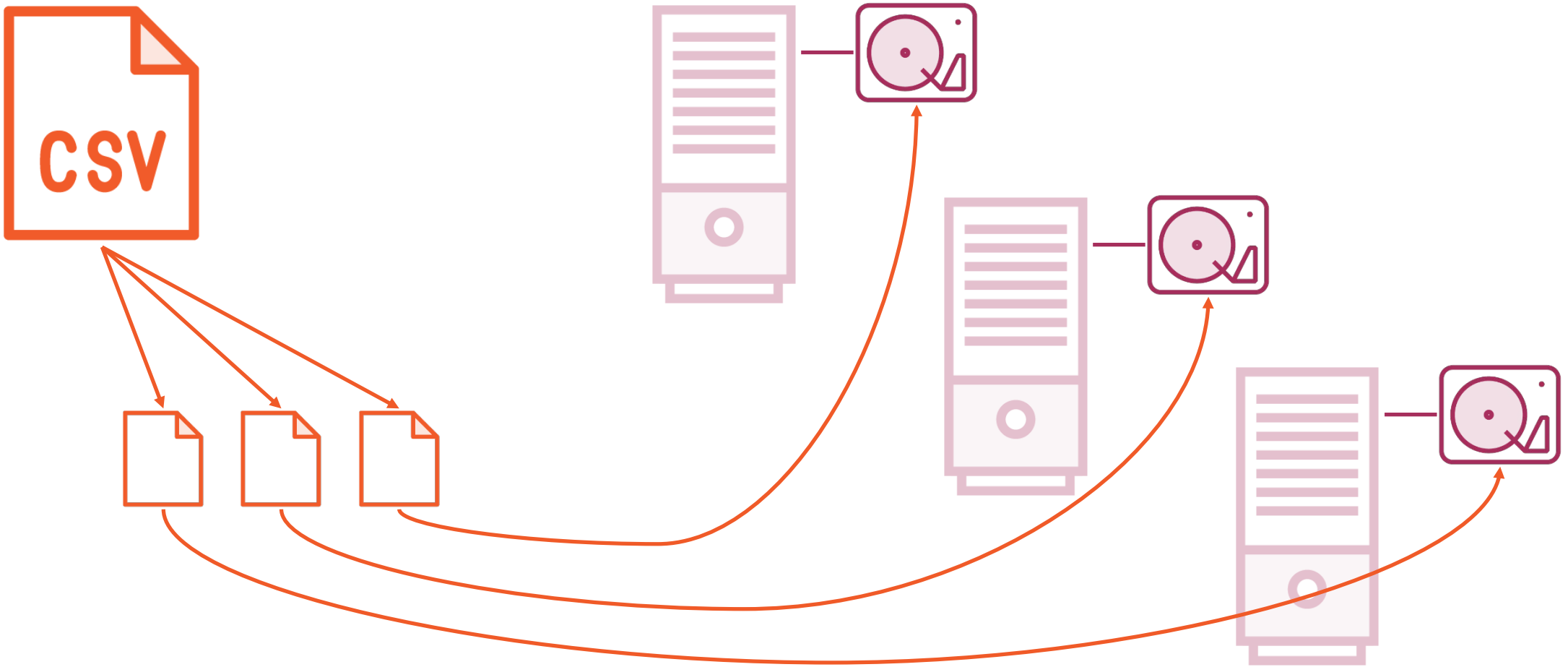
Hadoop Distributed File System

Name Node

Directory

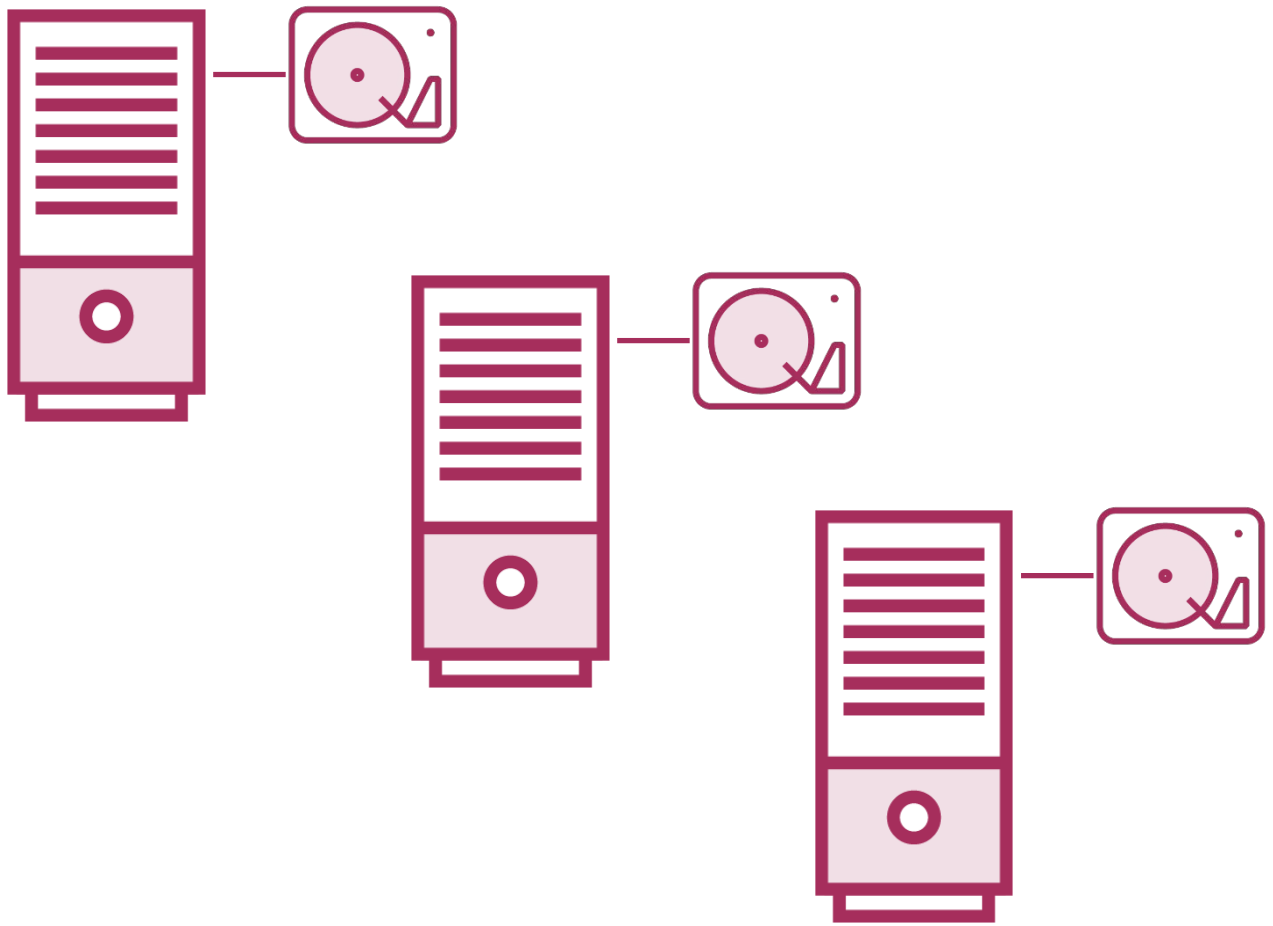
Client Interface

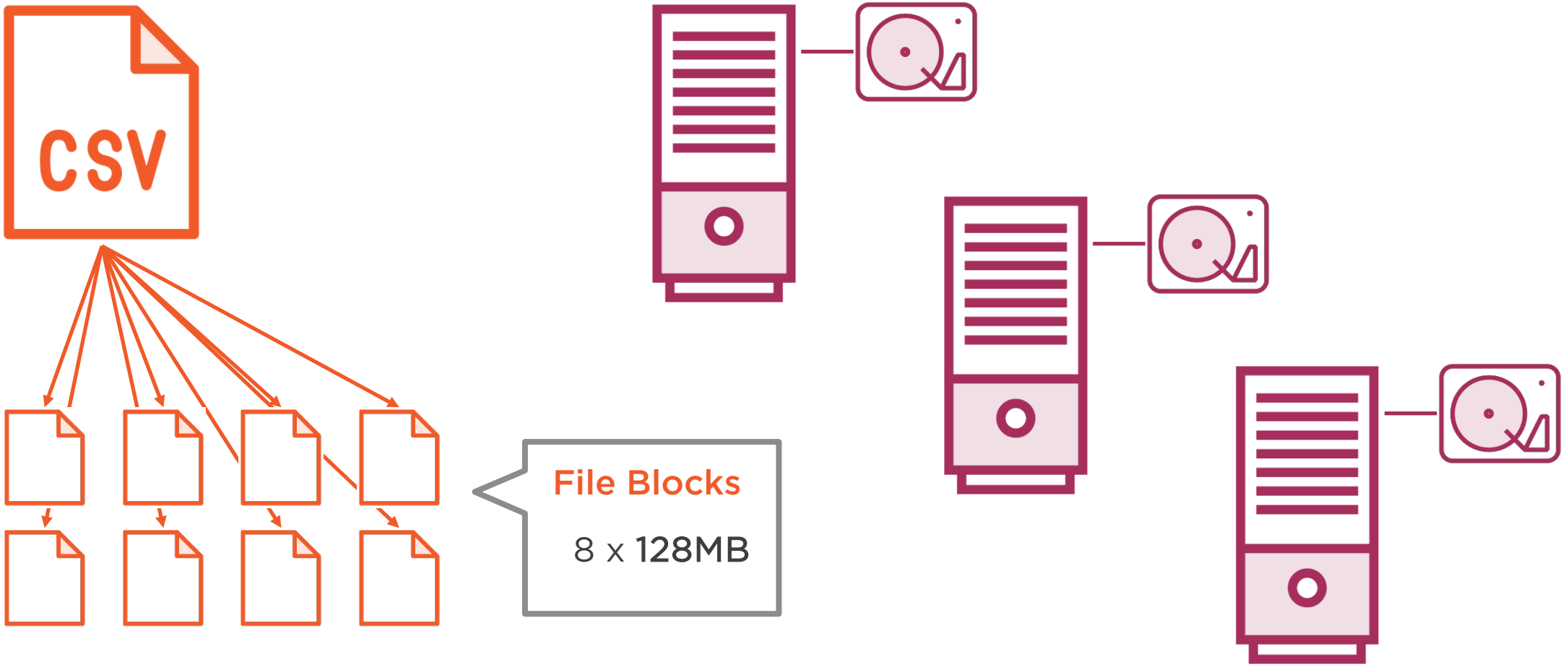

Data Node
Data Storage
Data Access

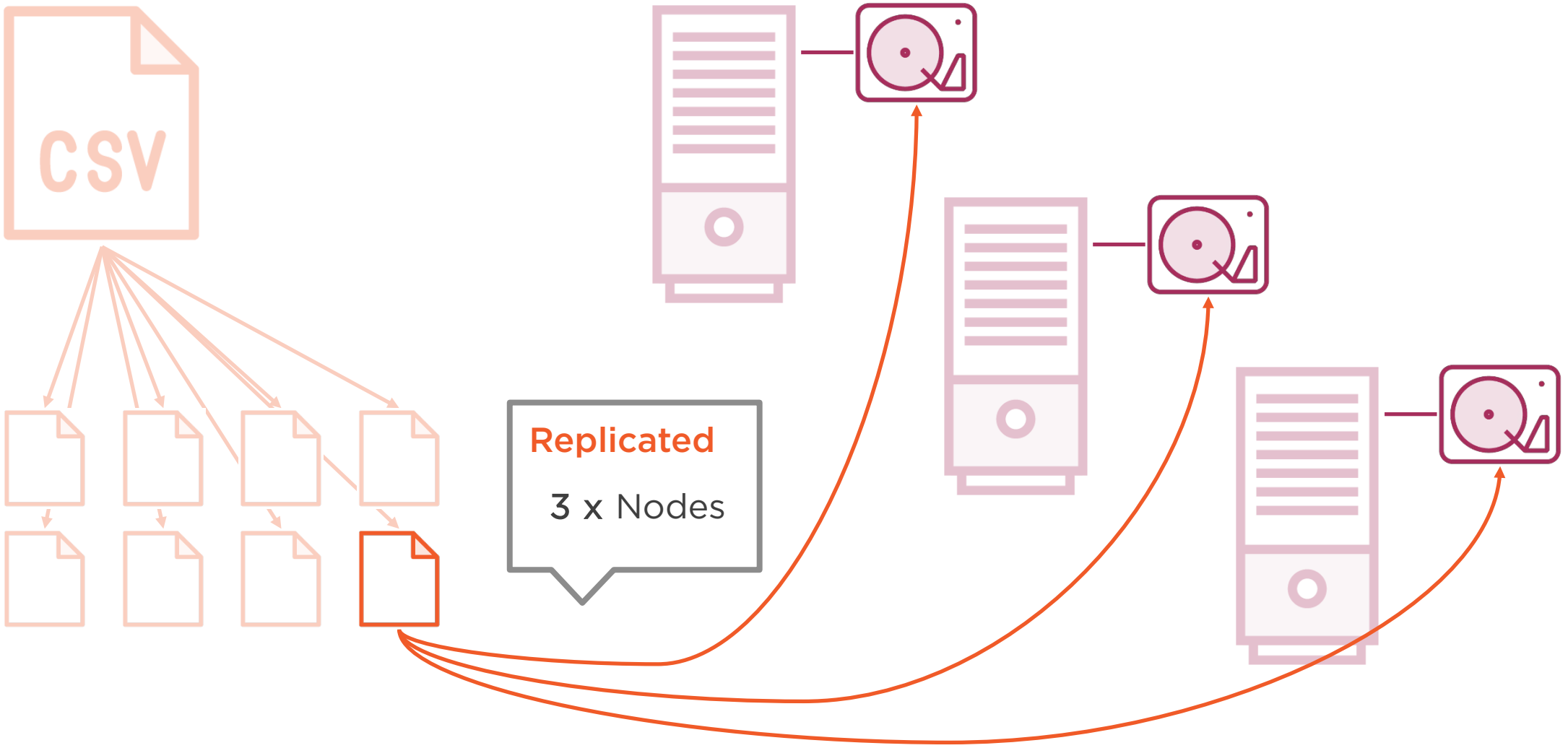

CSV

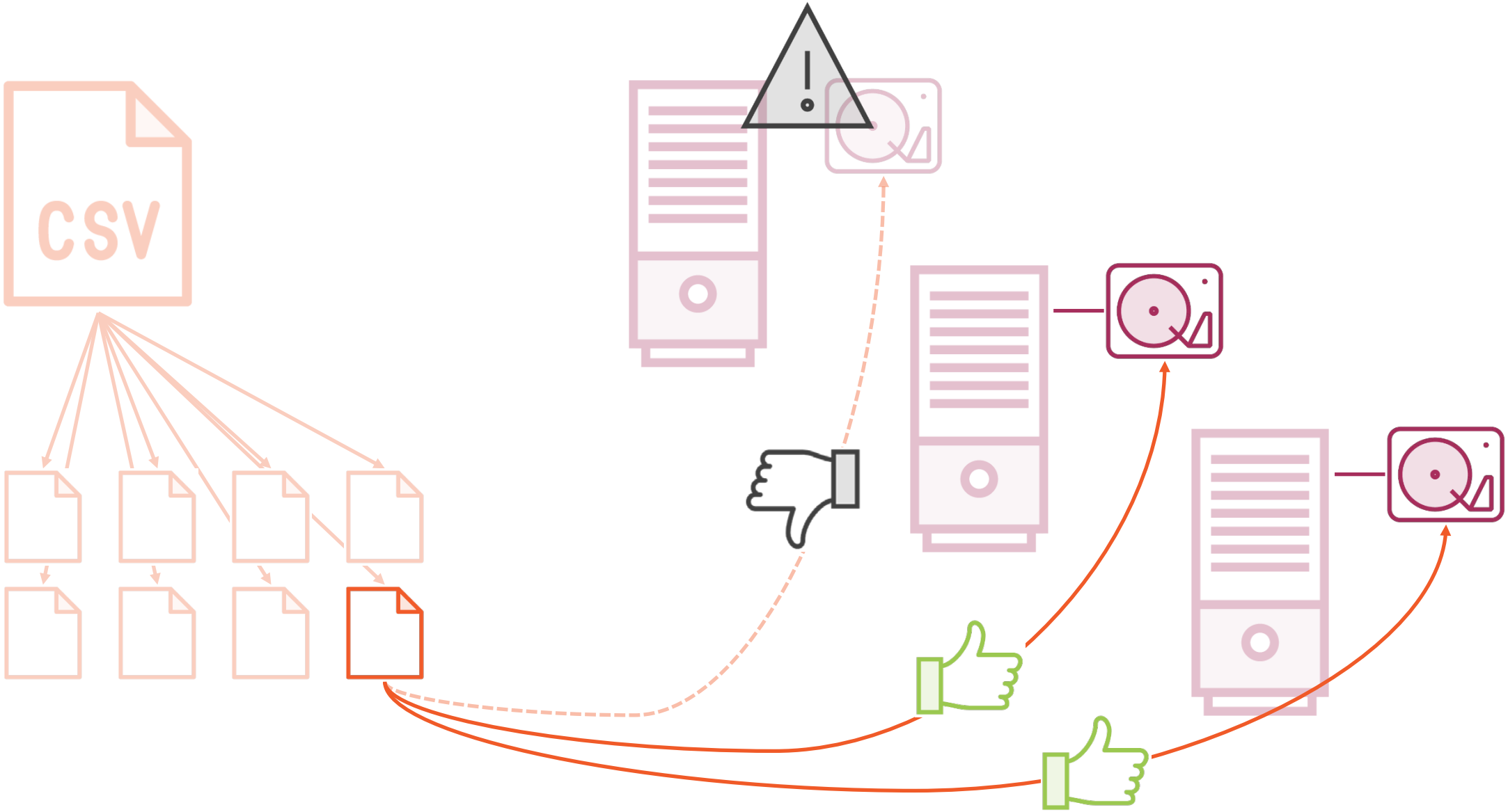
Source File

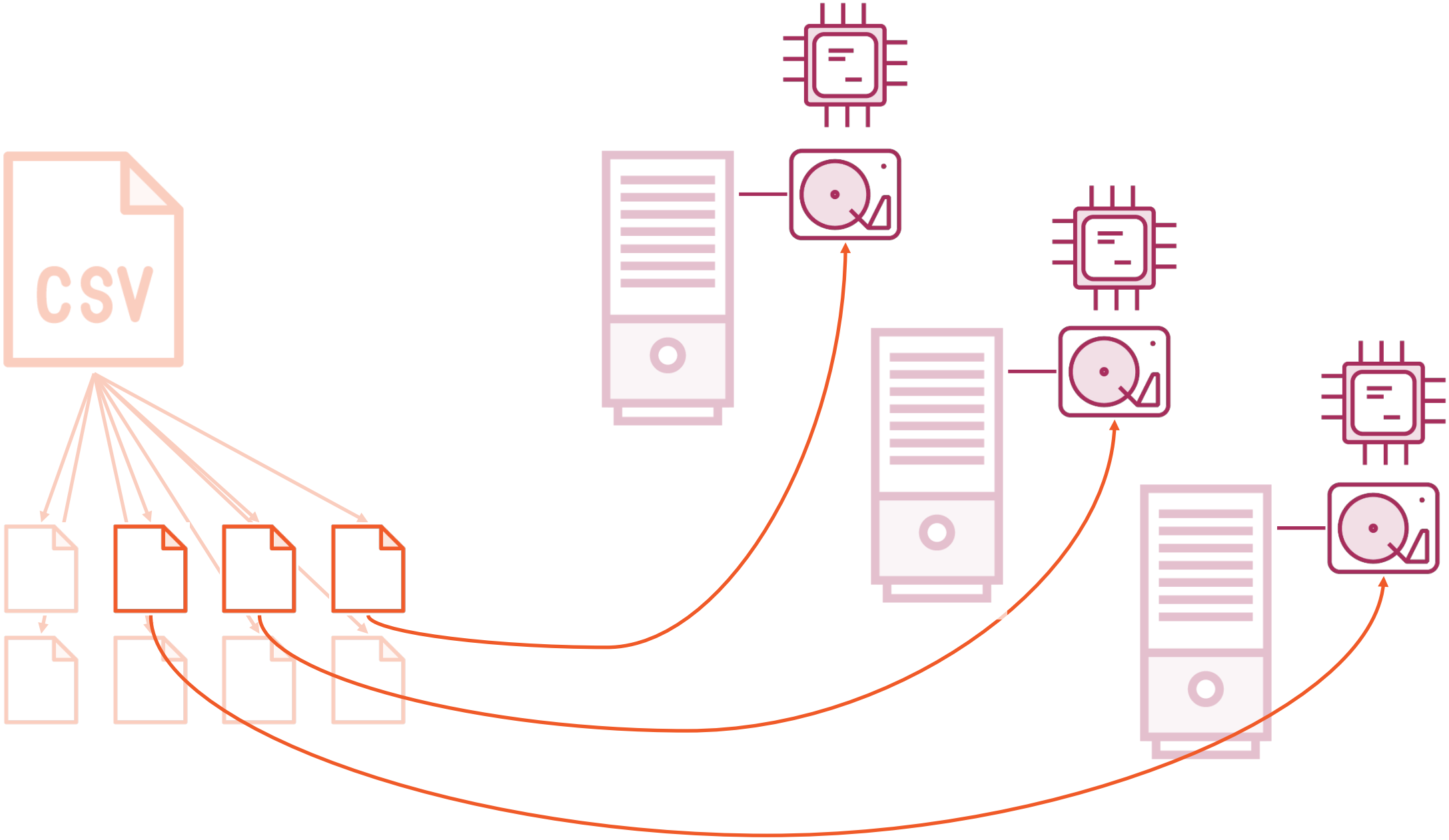
1GB (1024MB)

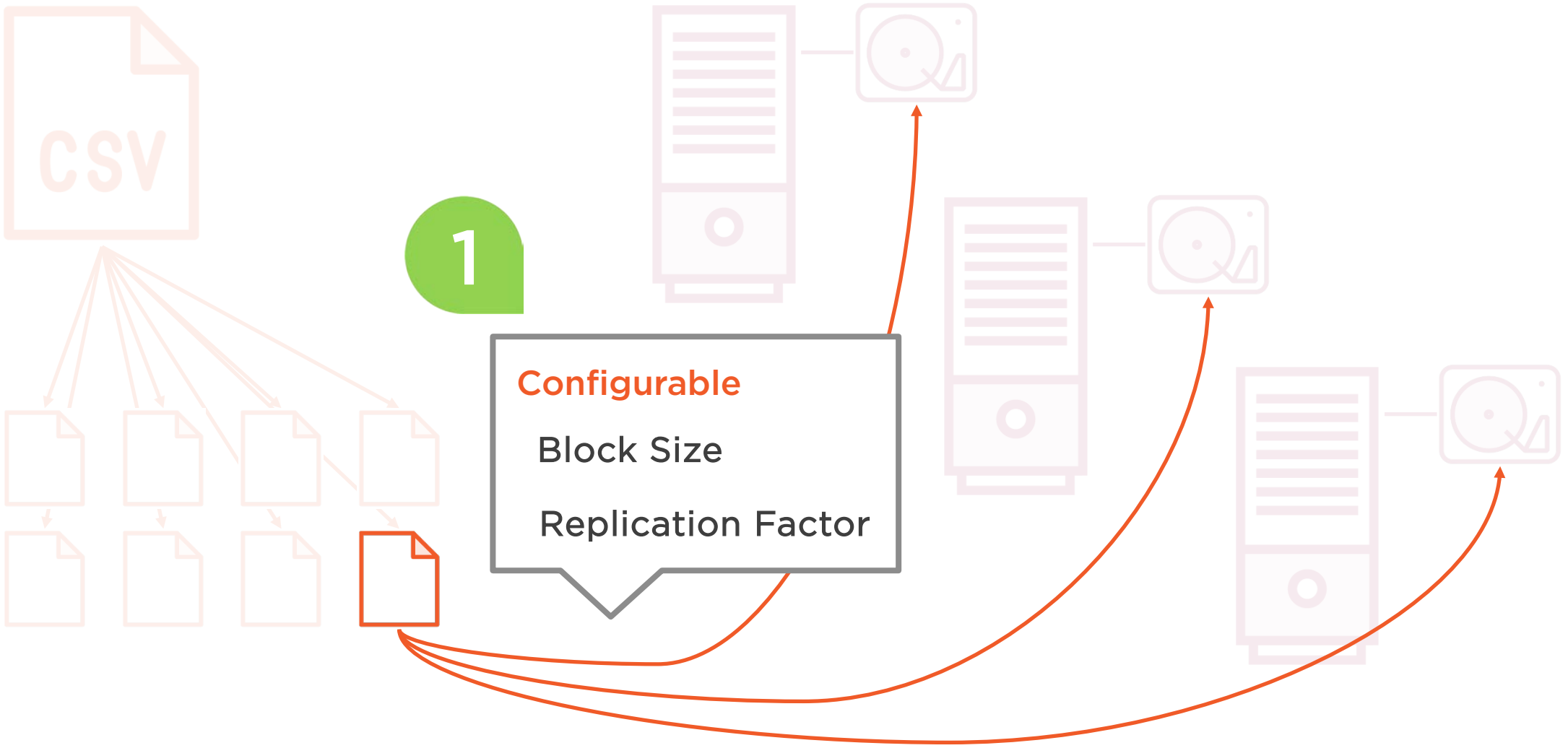


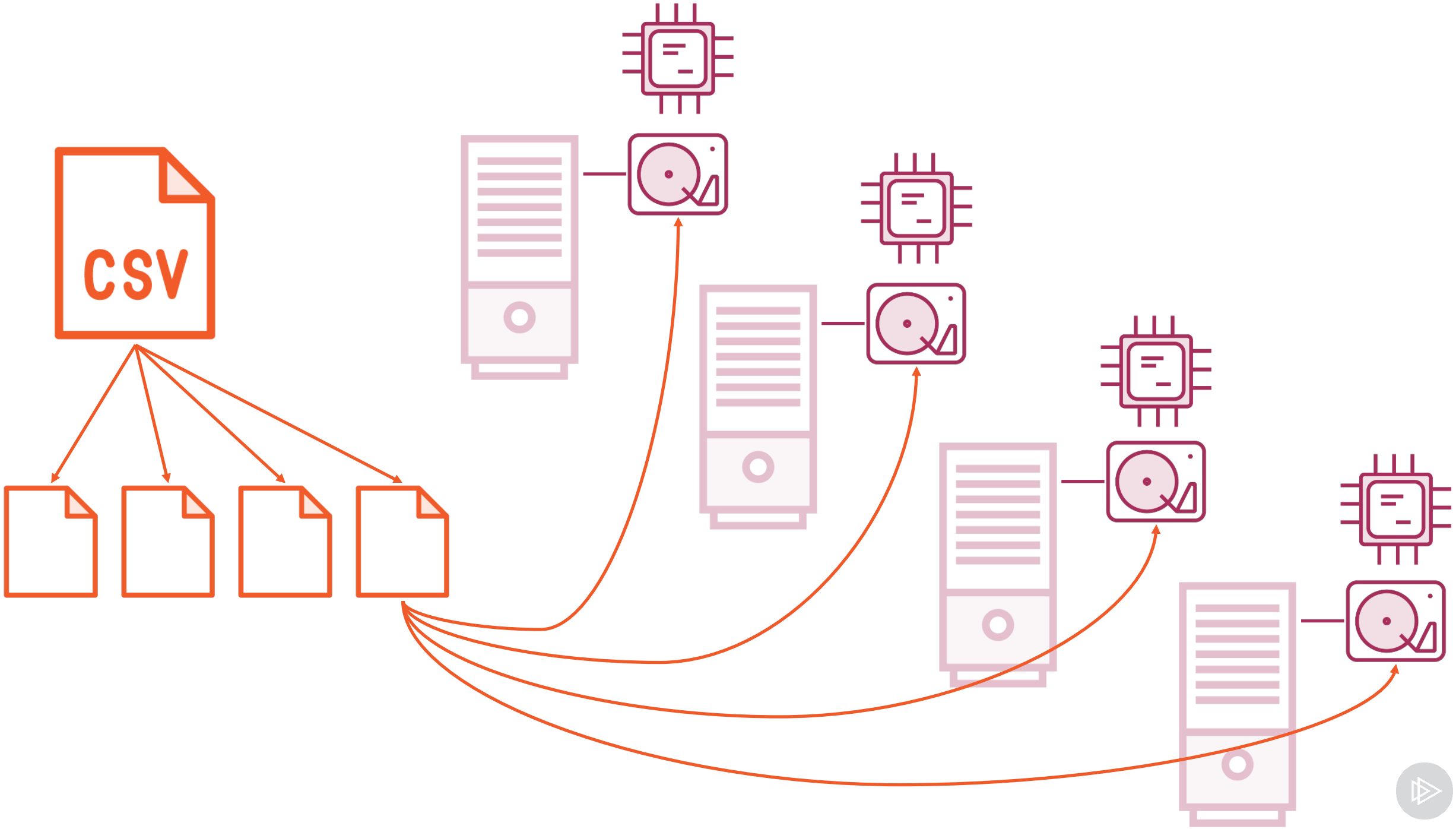

CSV
File Blocks
8 x 128MB


CSV
Replicated
3 x Nodes

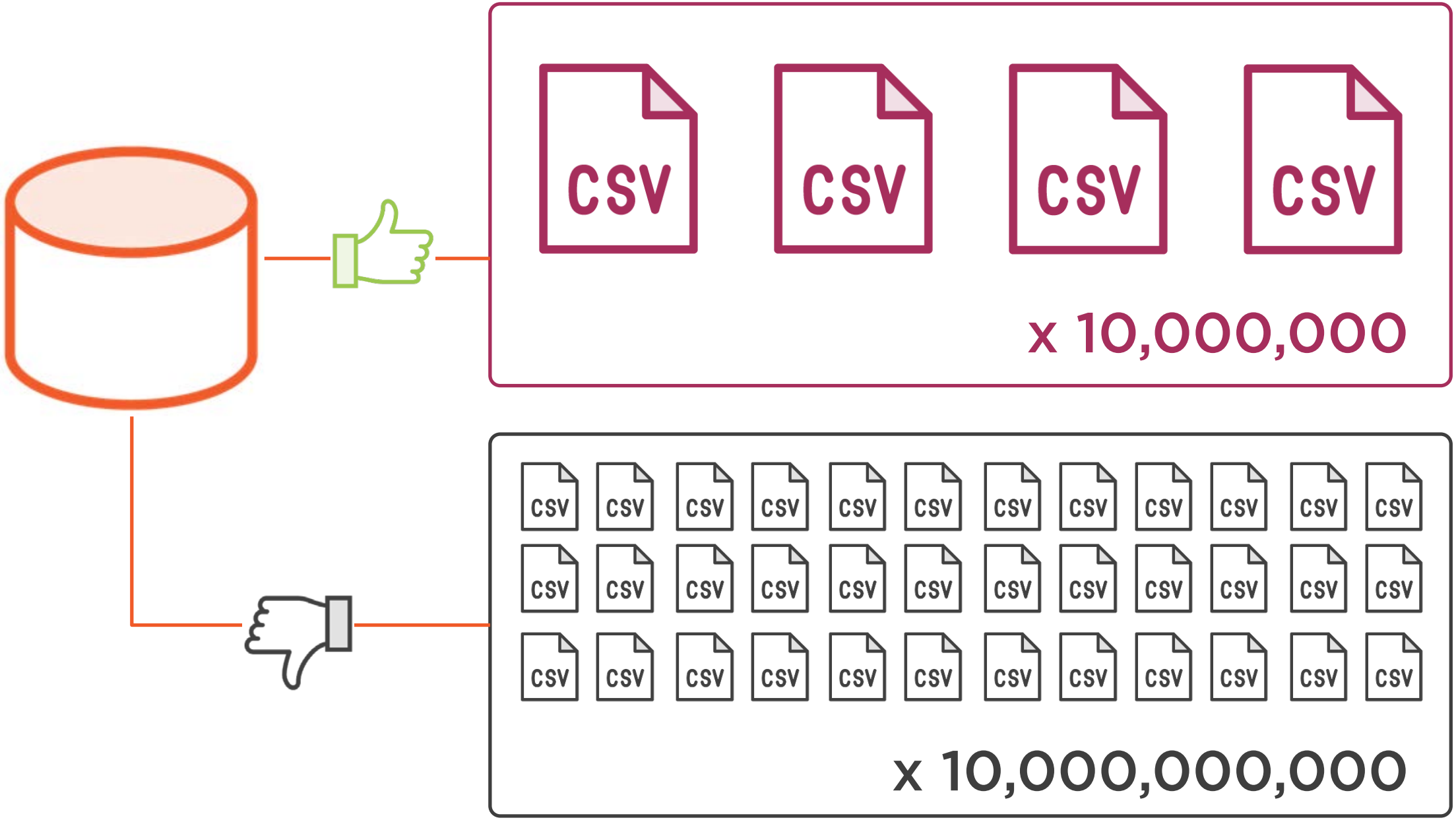

CSV


CSV

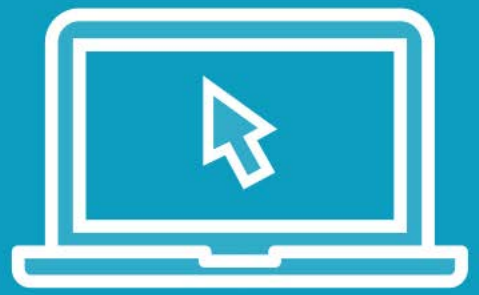

CSV
1
Configurable
Block Size
Replication Factor


CSV


Name Node
Directory
In-memory
2

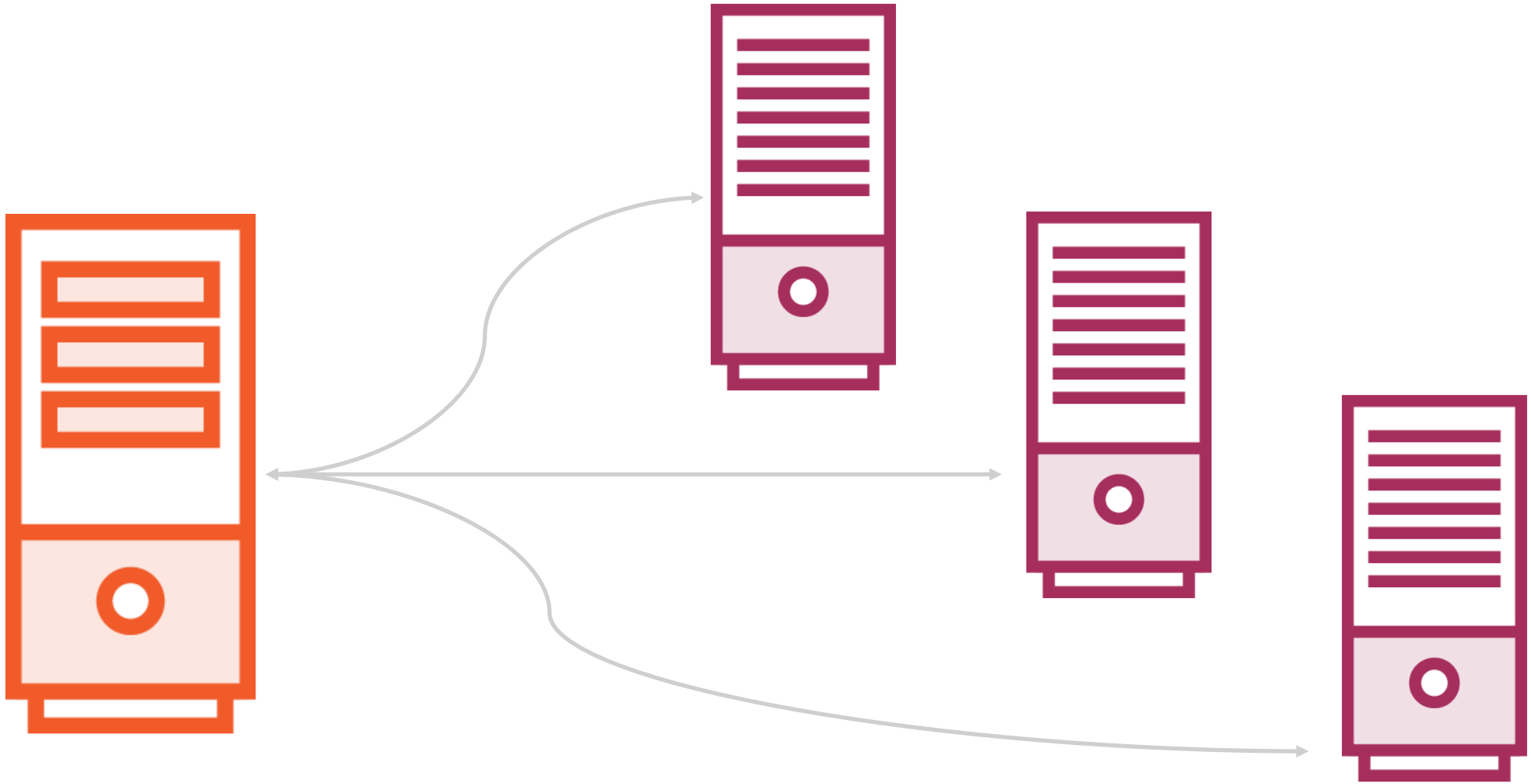

CSV
CSV
CSV
CSV
x 10,000,000
x 10,000,000,000

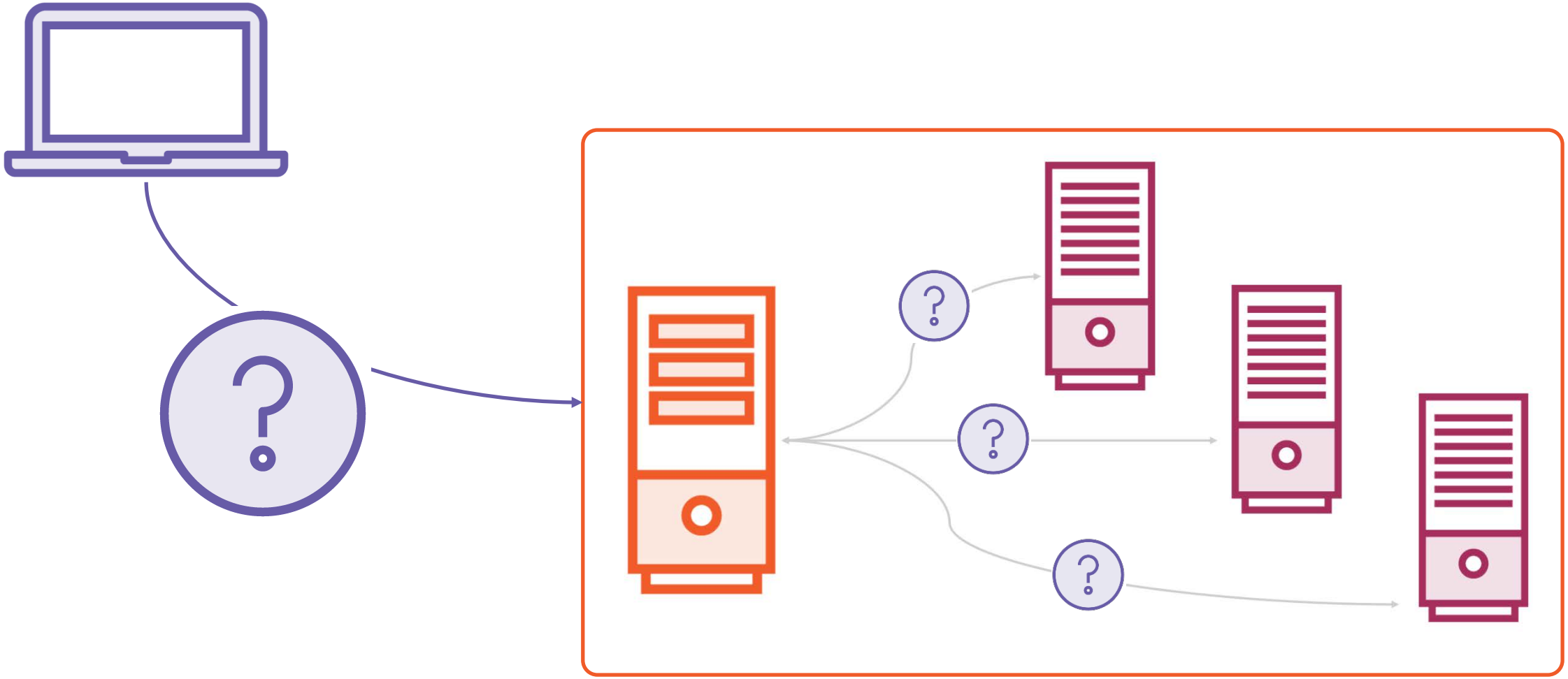
Demo

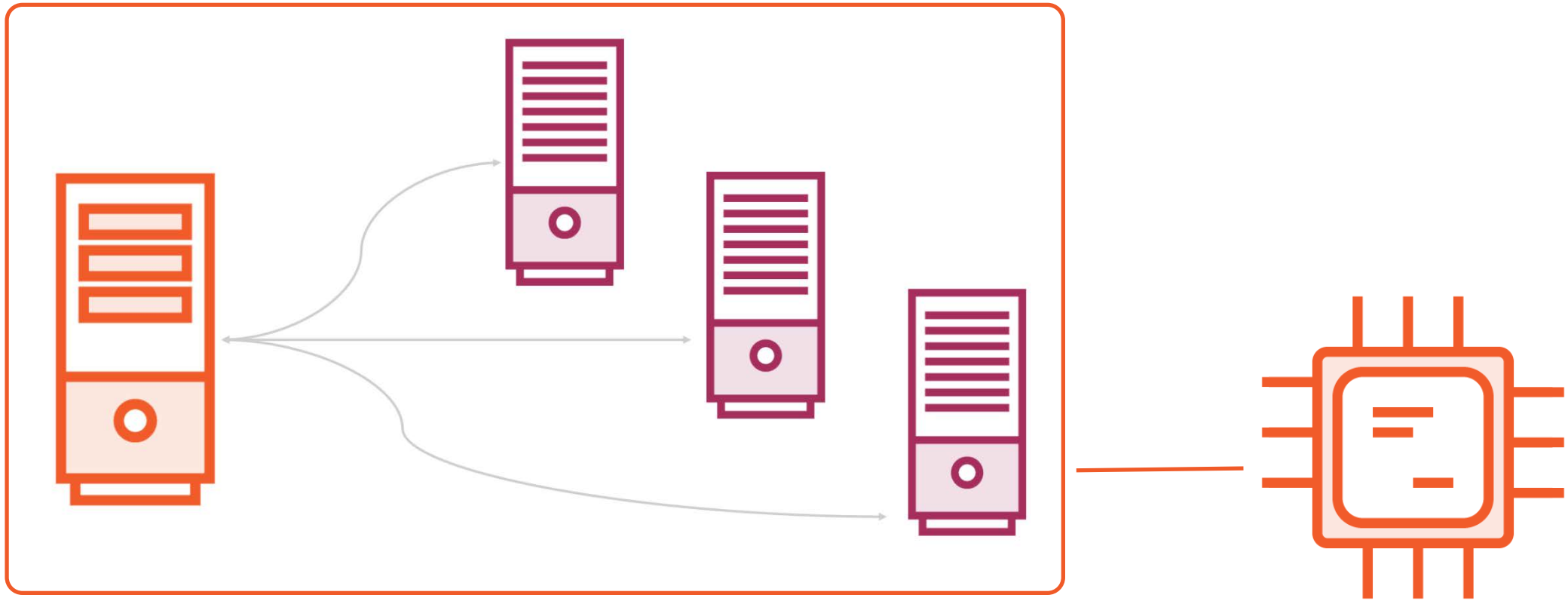


Working with HDFS

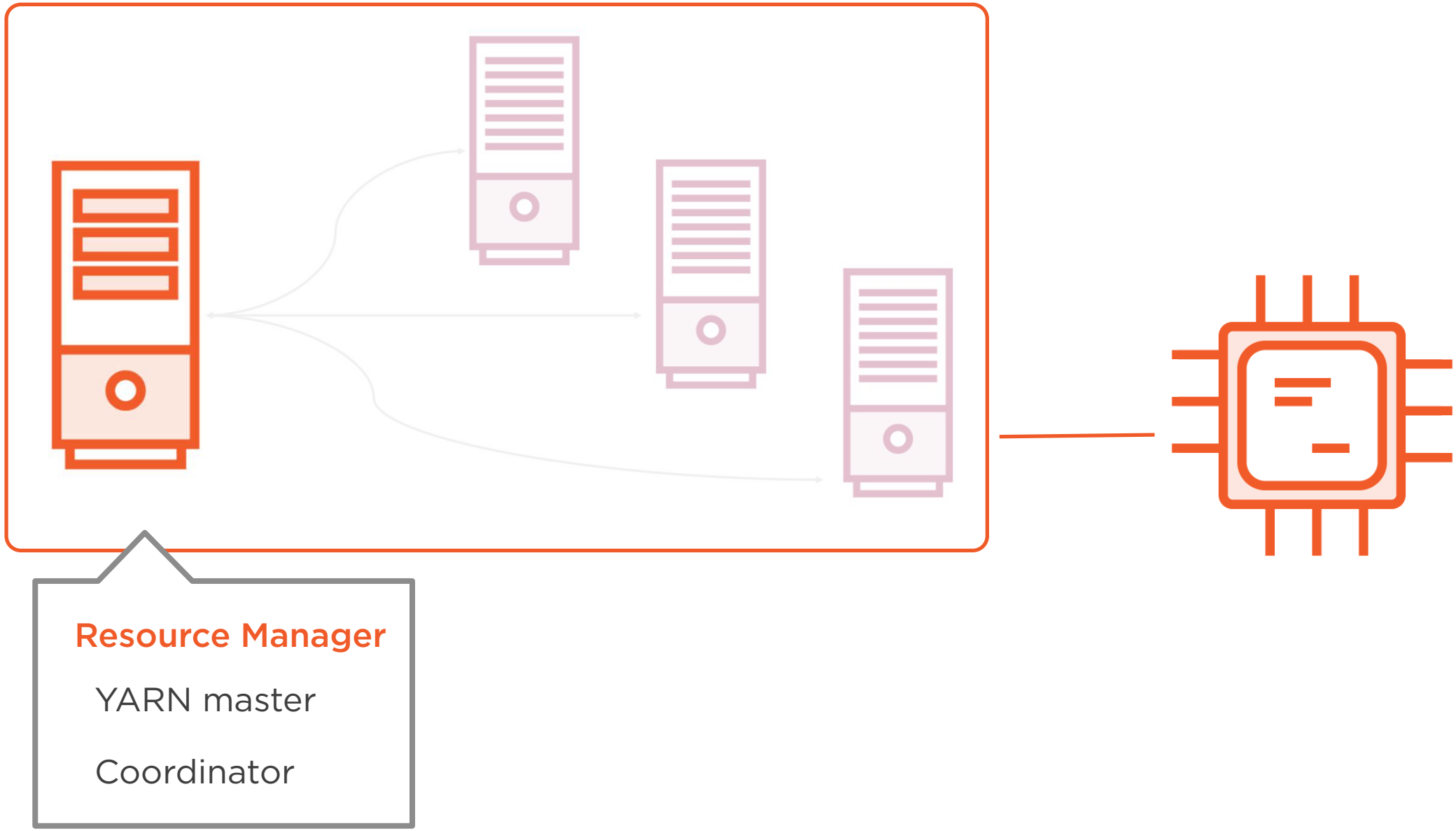
- The Hadoop command
- Storing and reading files
- Listing file blocks







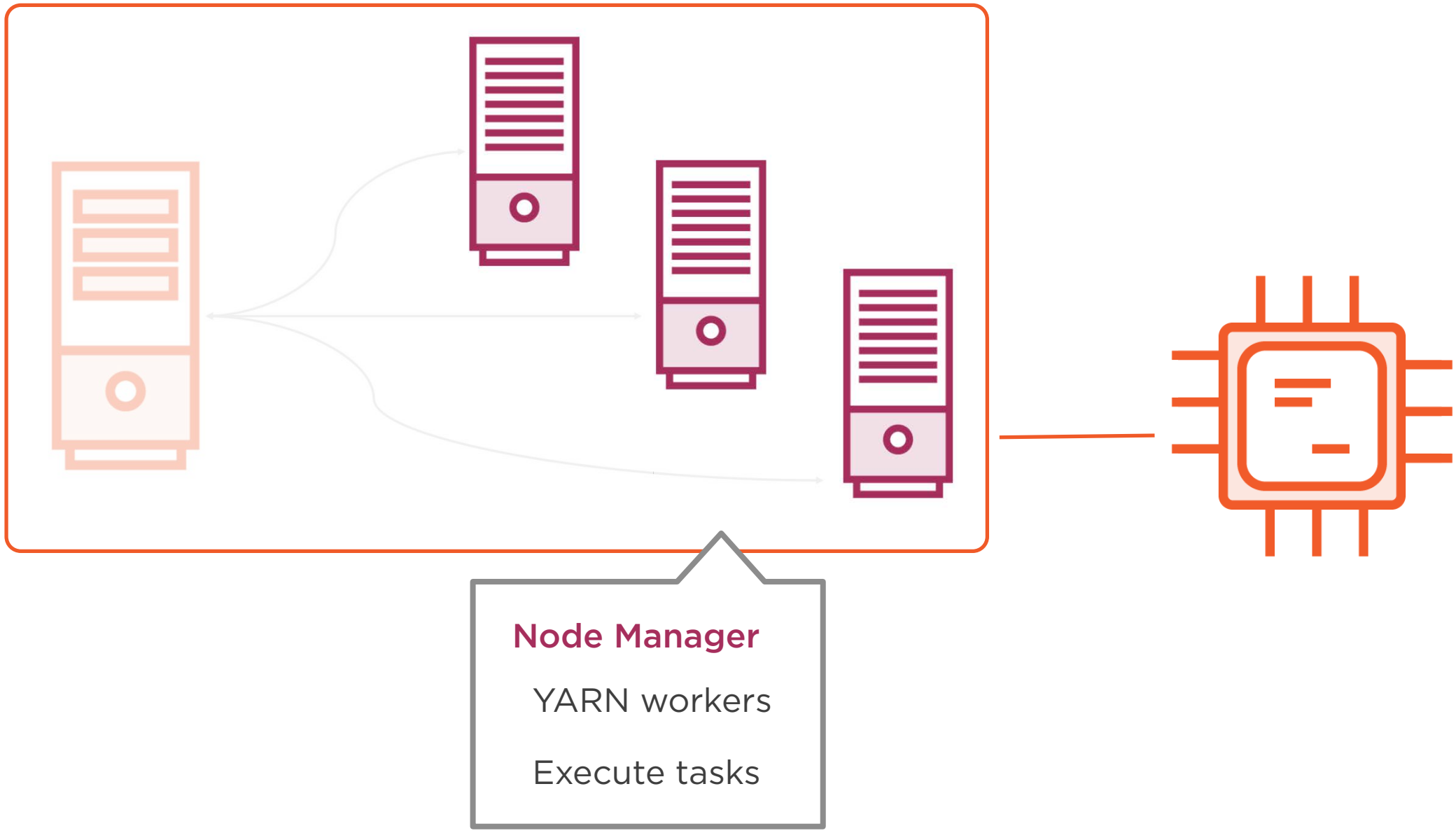
Yet Another Resource Negotiator

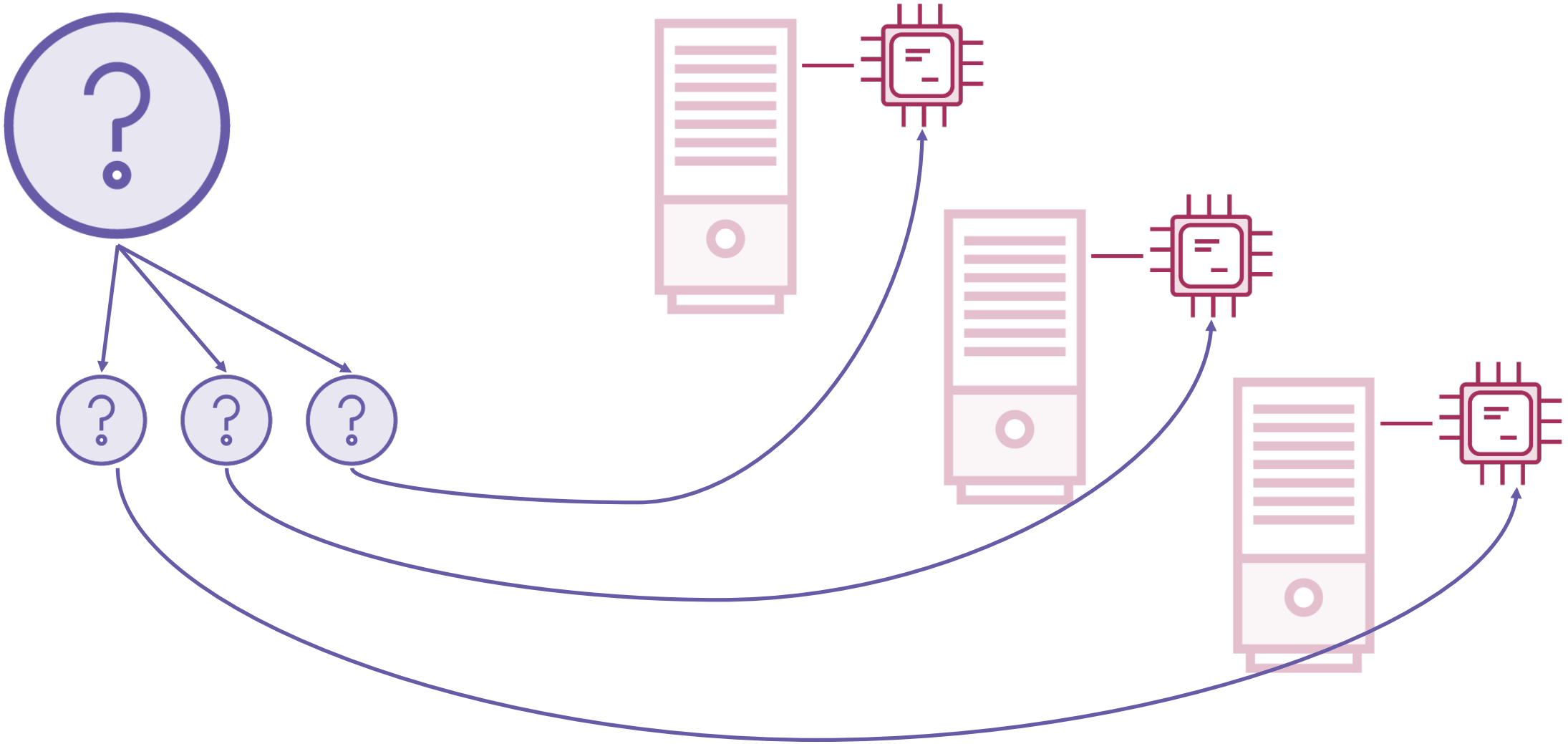


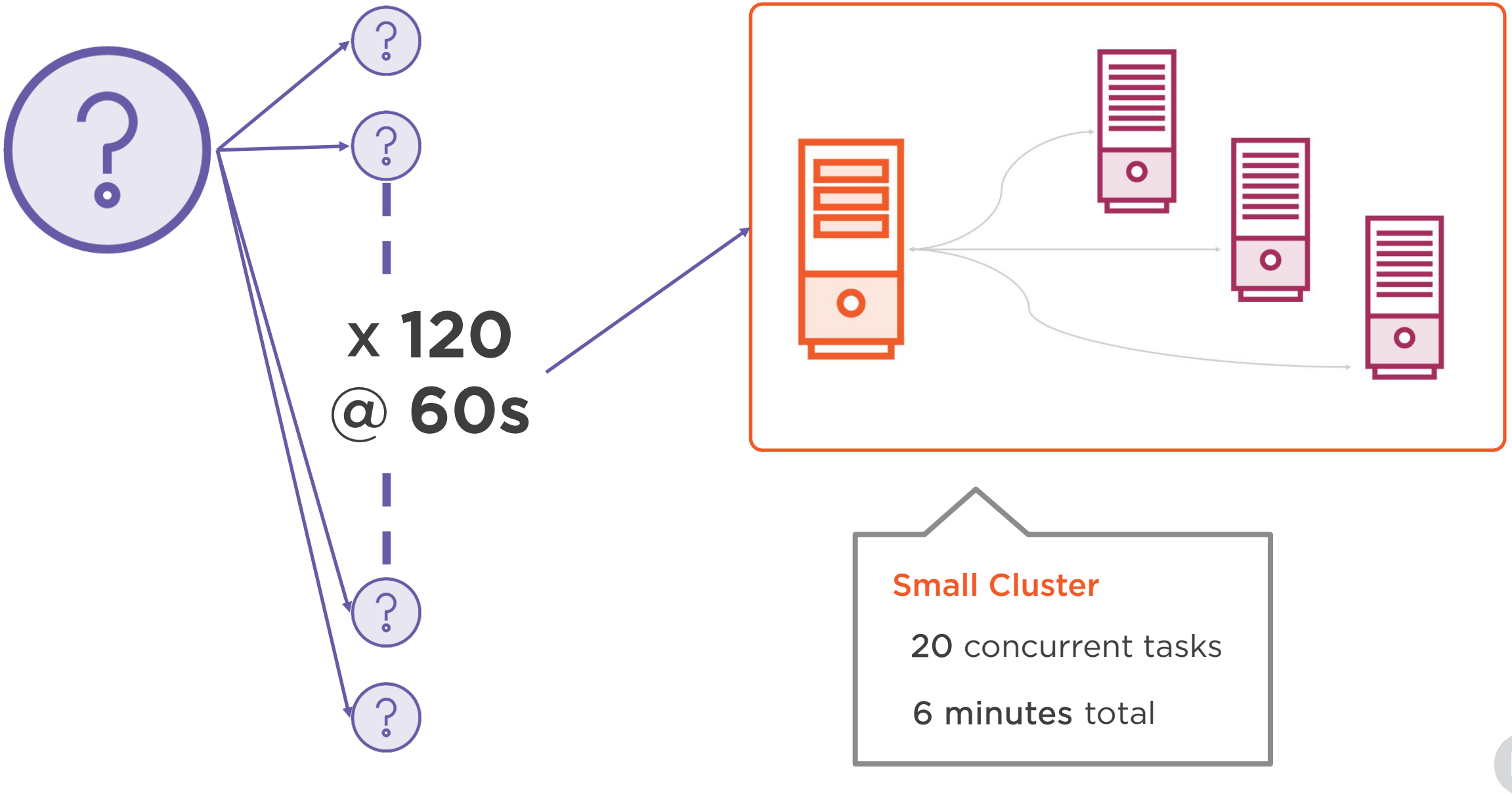
Resource Manager

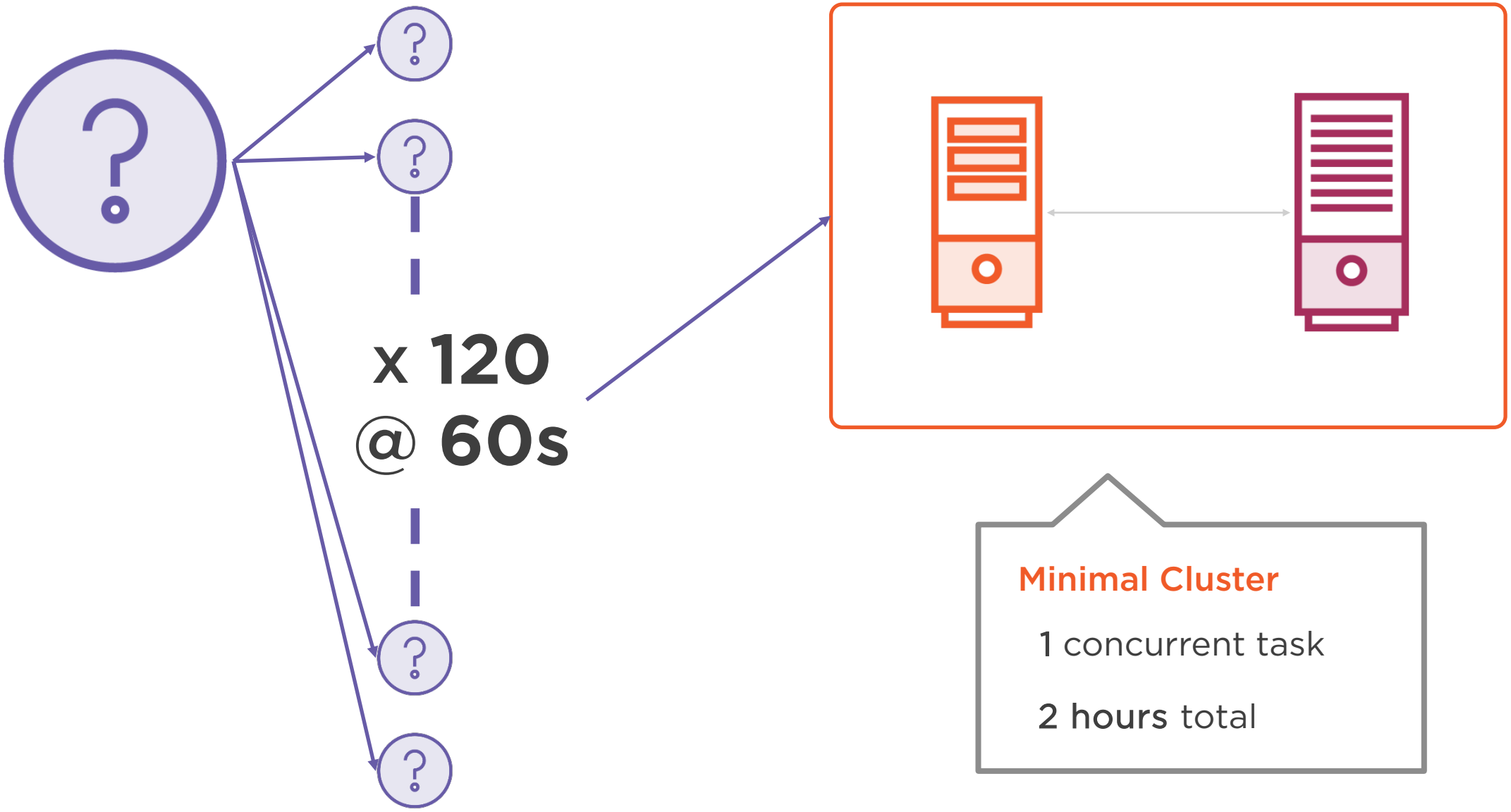
YARN master

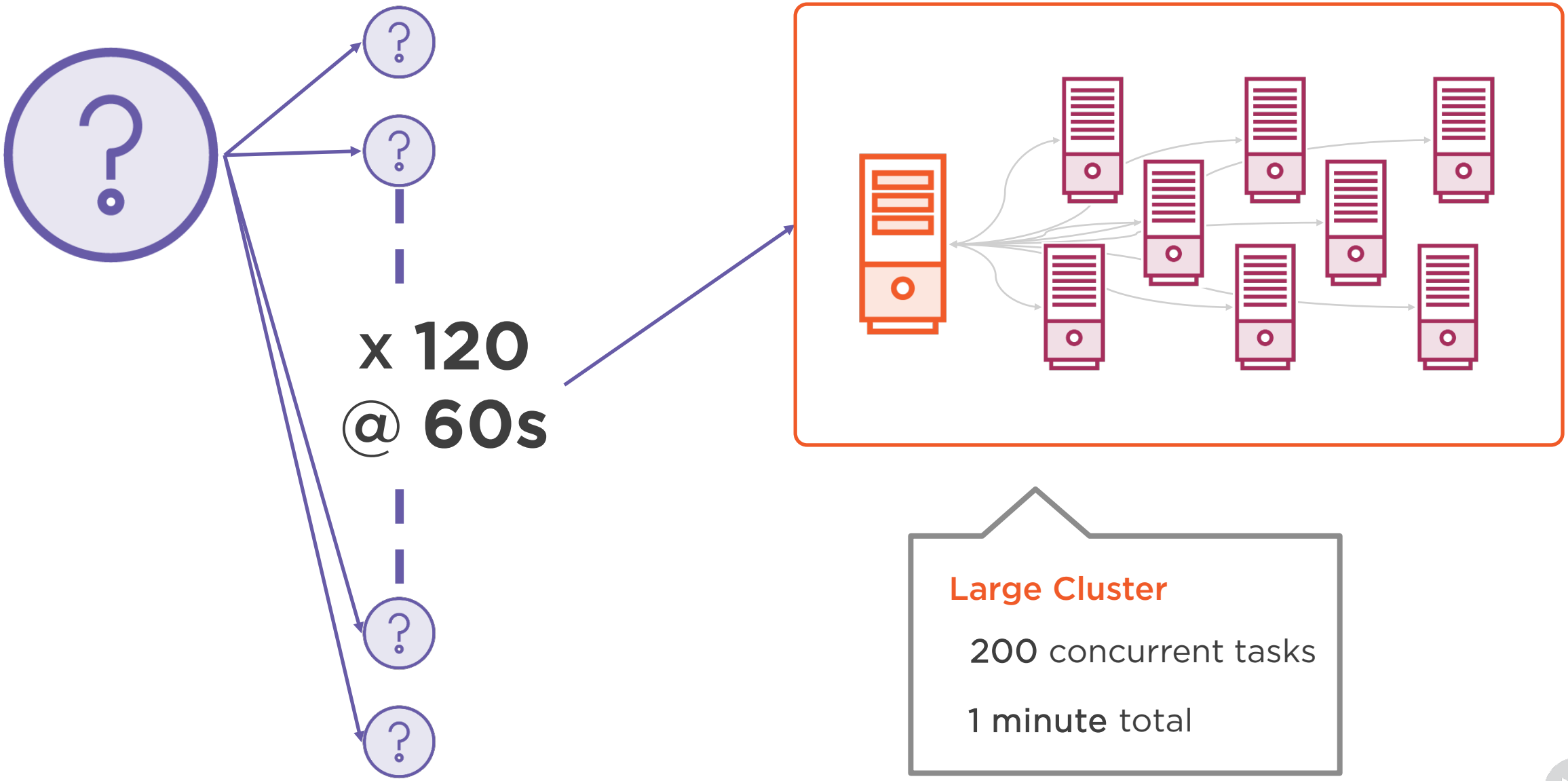
Coordinator

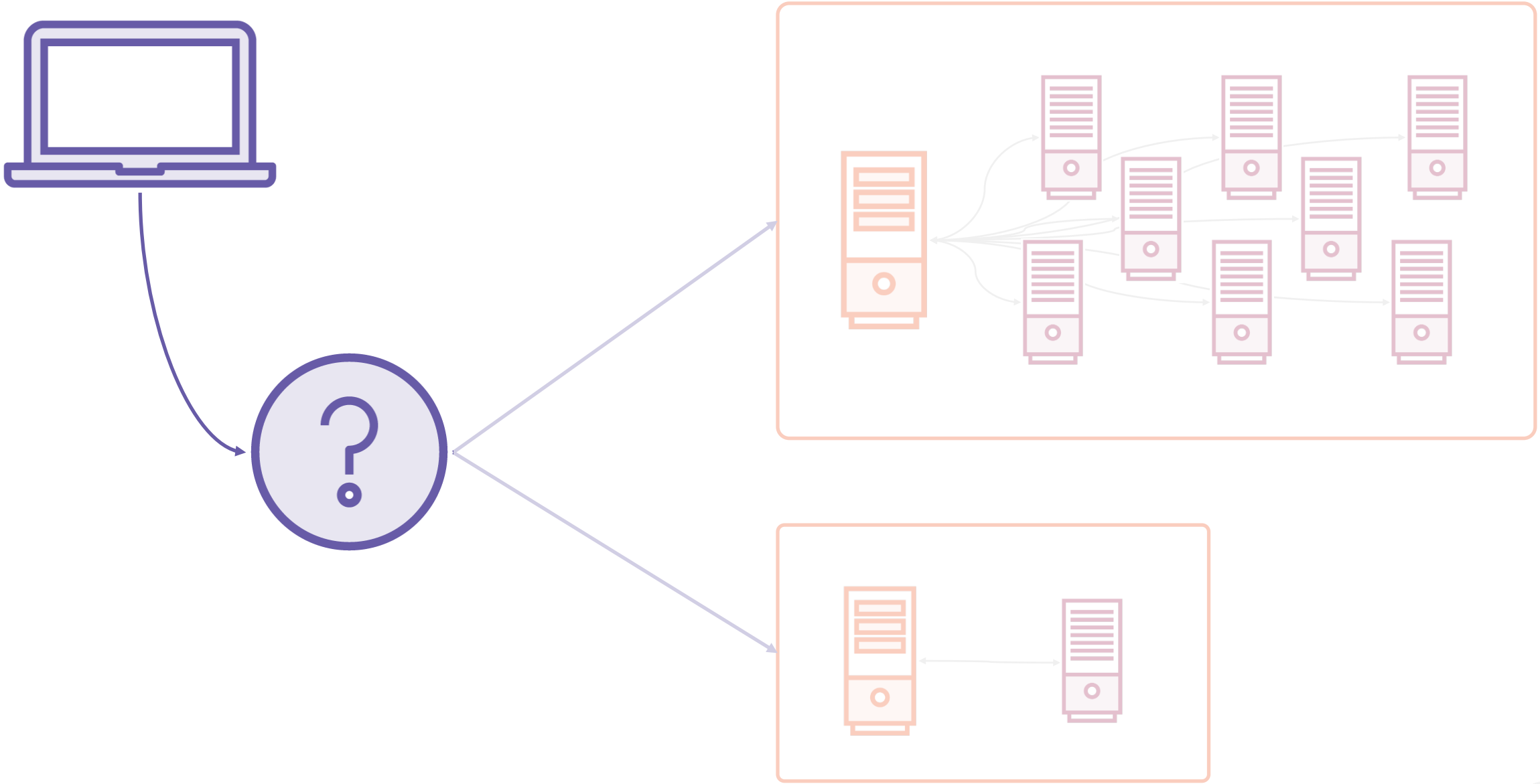

Node Manager
YARN workers
Execute tasks

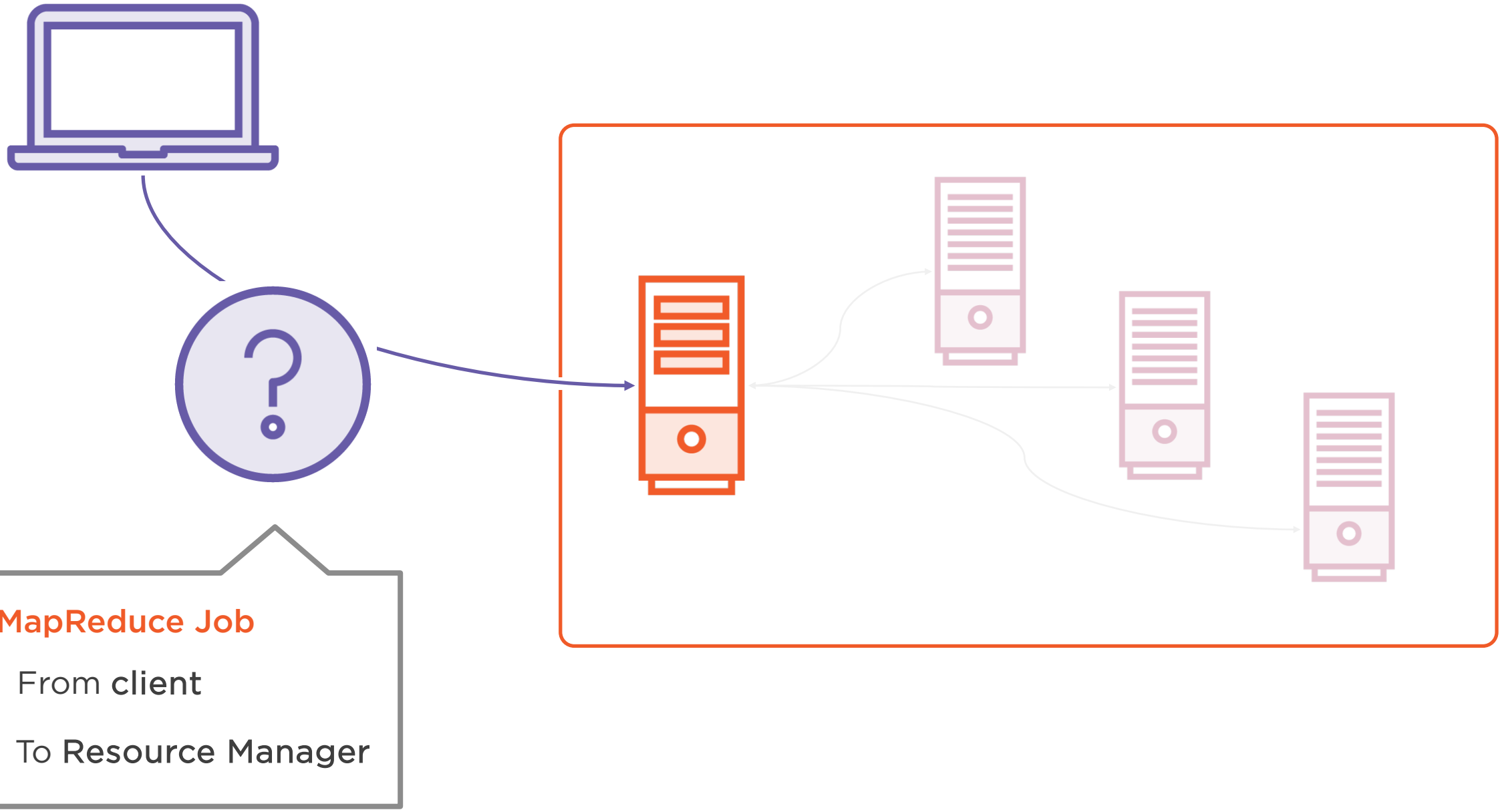


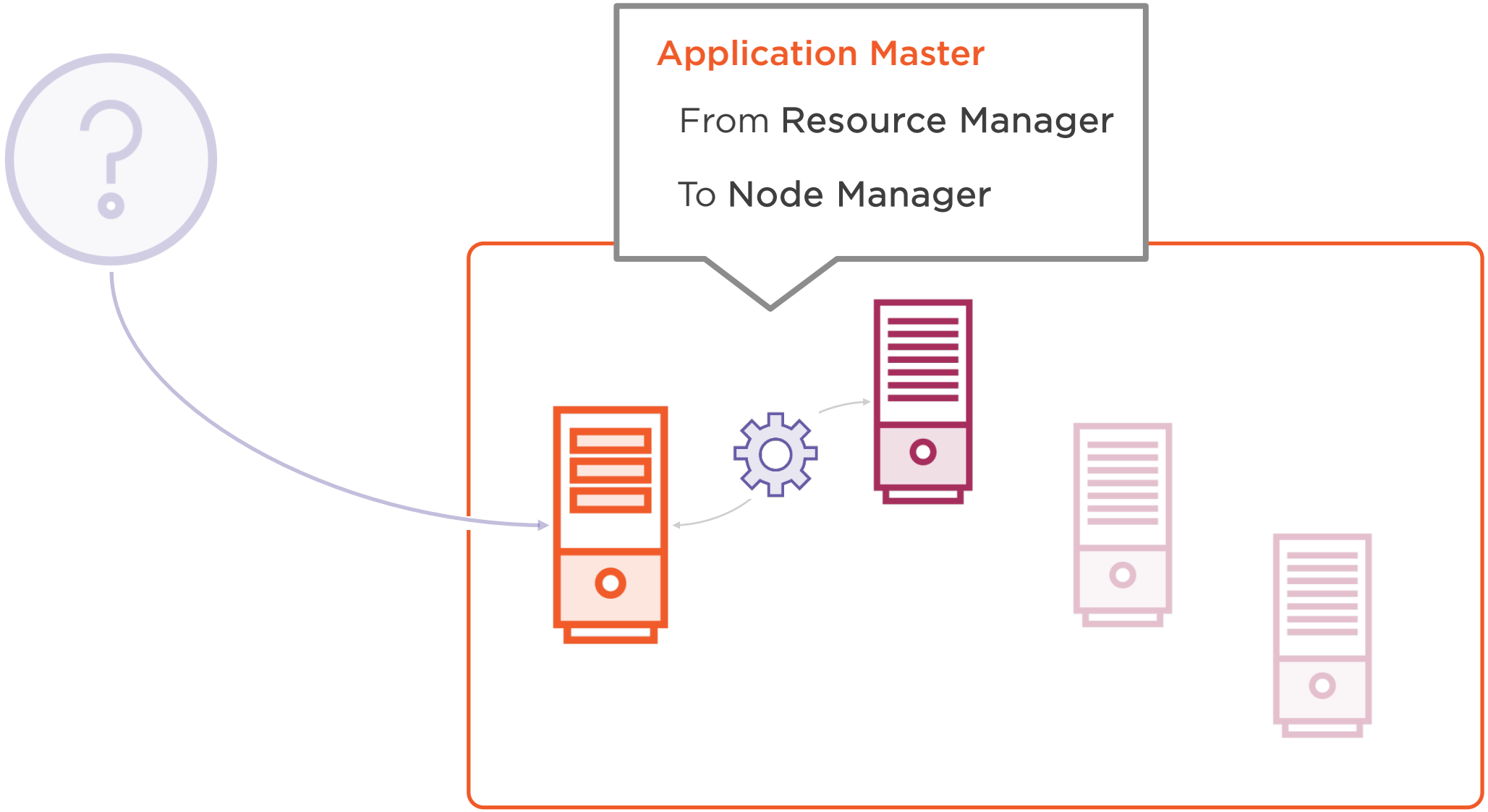

x 120
@ 60s
Small Cluster
20 concurrent tasks
6 minutes total

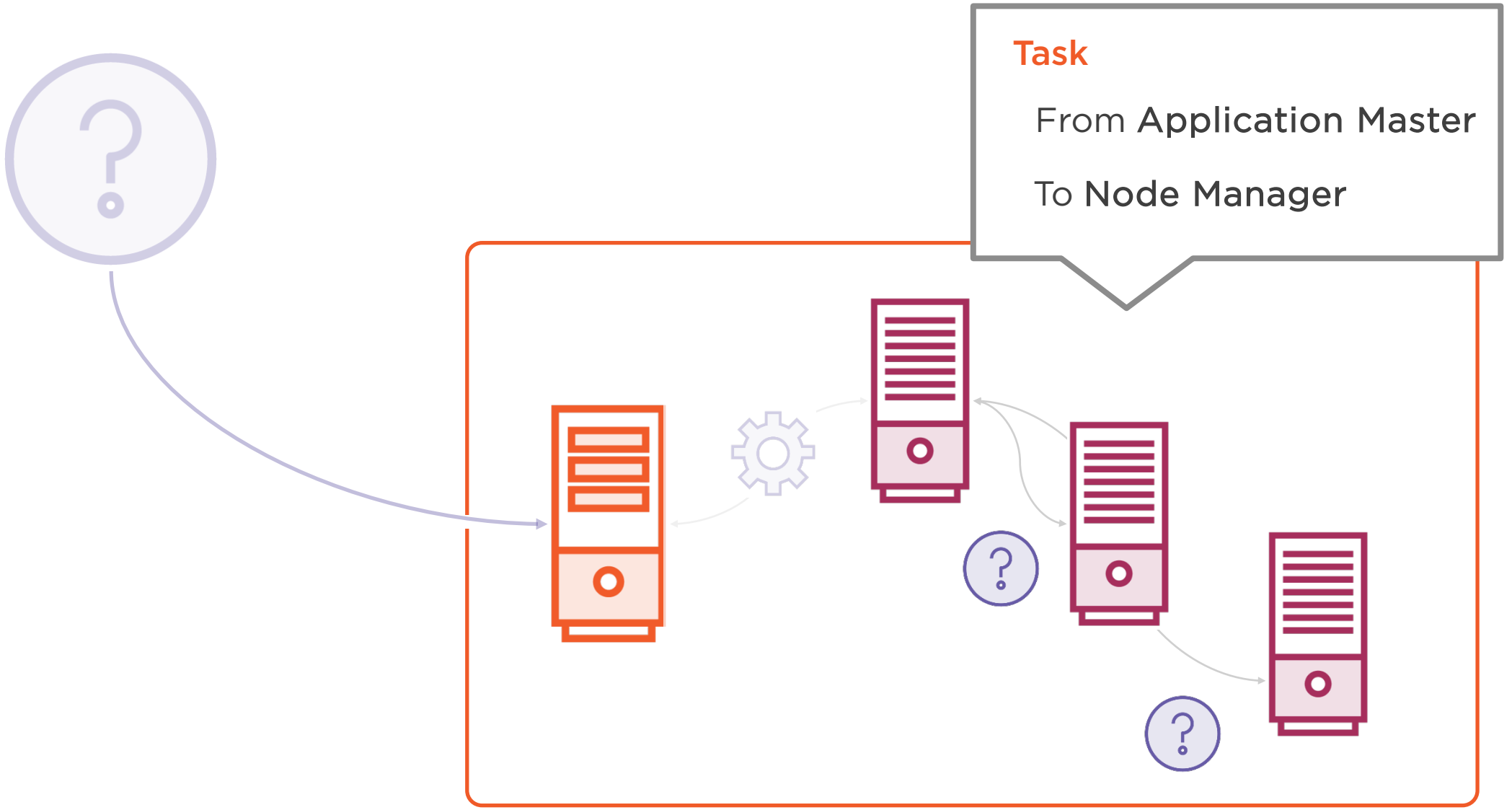

x 120
@ 60s
Minimal Cluster
1 concurrent task
2 hours total

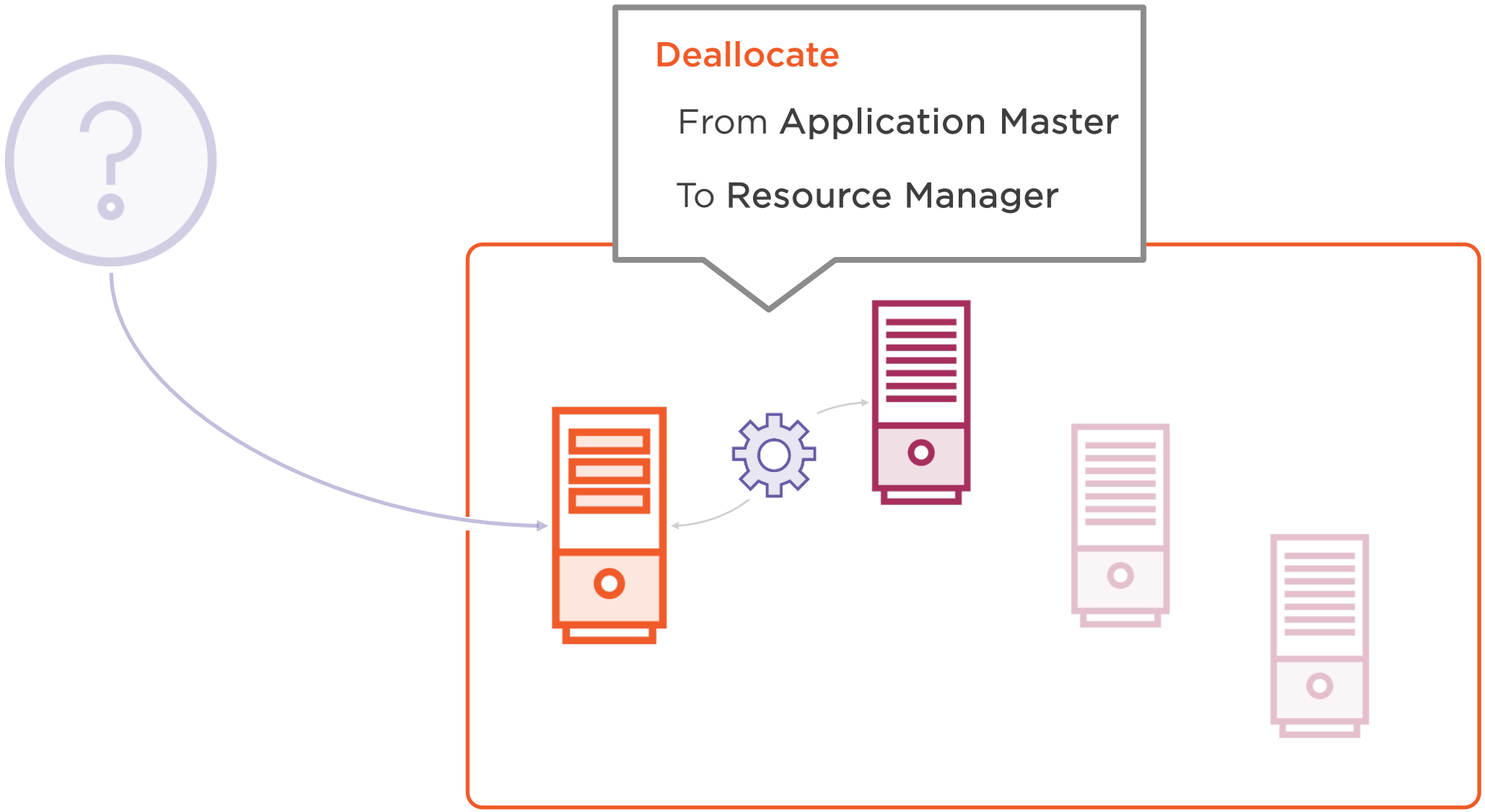

x 120
@ 60s
Large Cluster
200 concurrent tasks
1 minute total

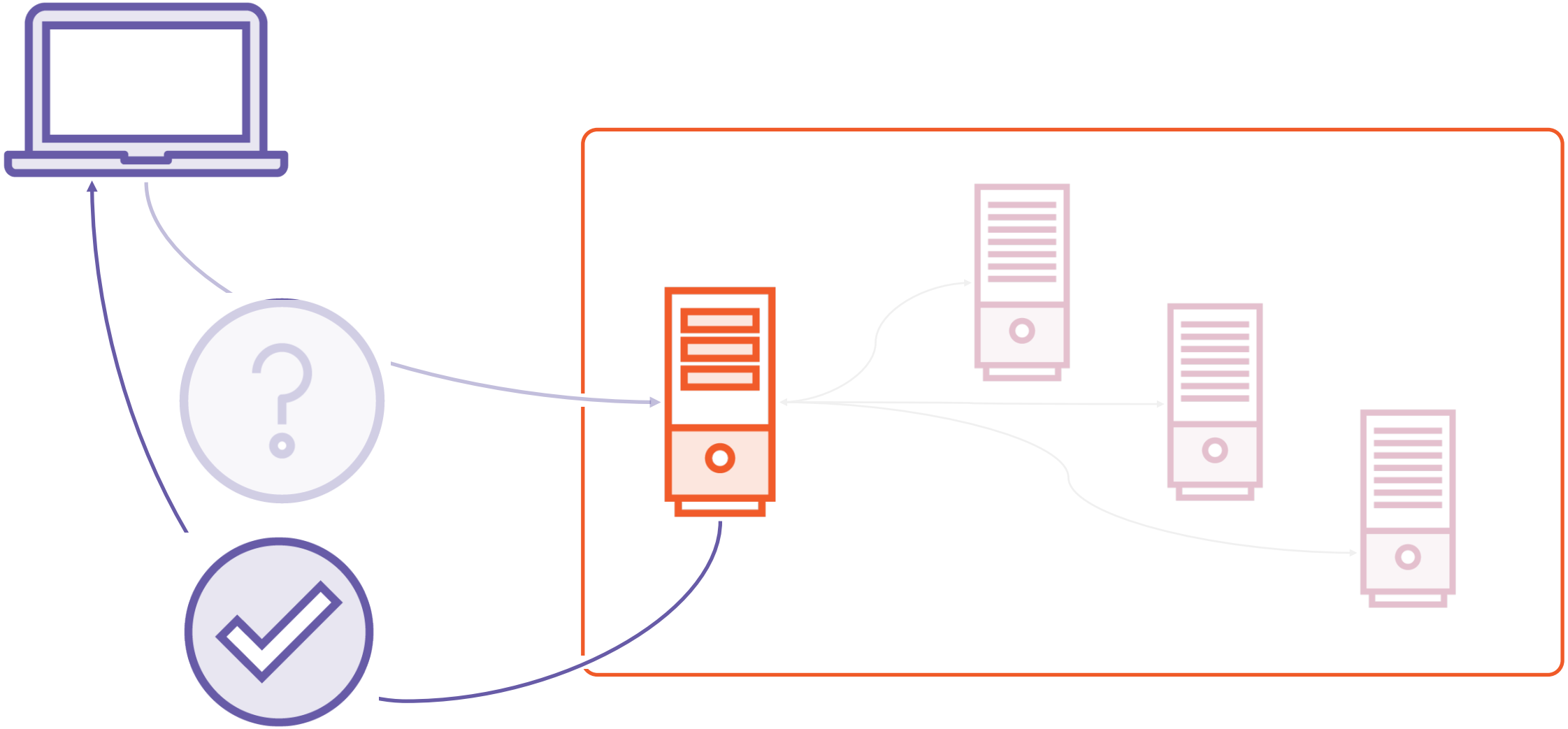



MapReduce Job
From client
To Resource Manager

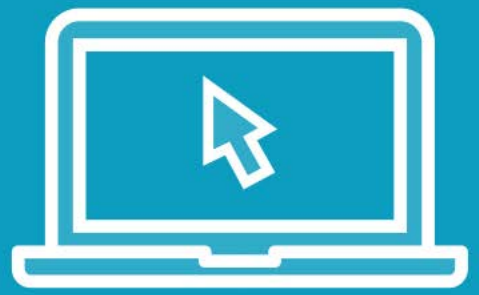

Application Master
From Resource Manager
To Node Manager


Task
From Application Master
To Node Manager


Deallocate
From Application Master
To Resource Manager

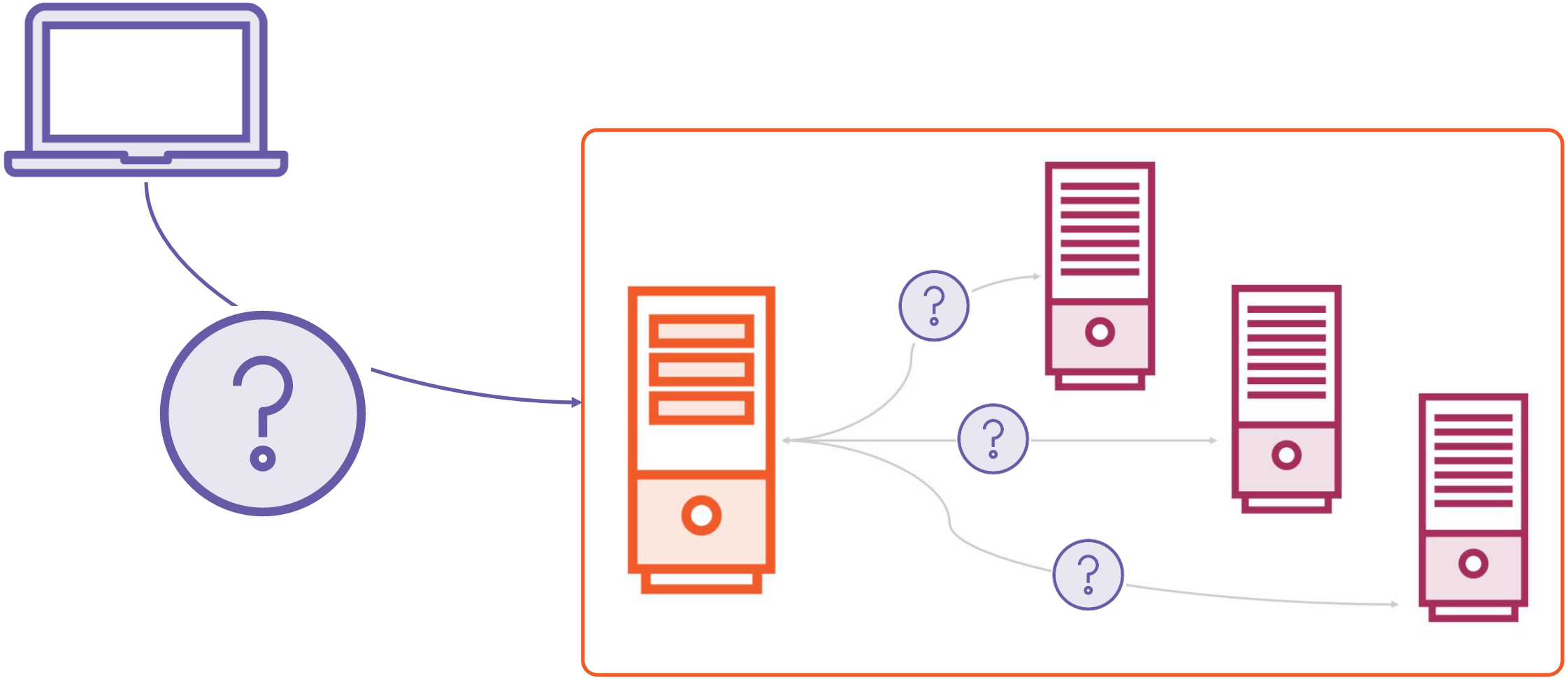


Demo



Running Jobs with YARN

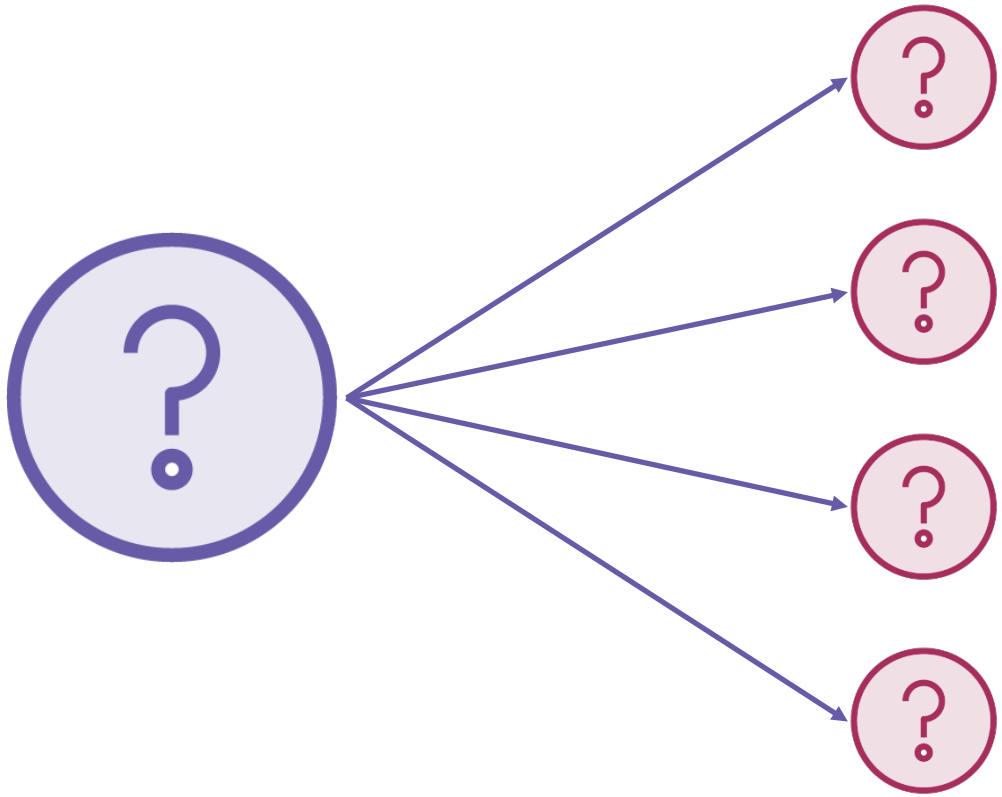
- Submitting MapReduce jobs
- Monitoring the Application Master
- Monitoring tasks



MapReduce Job

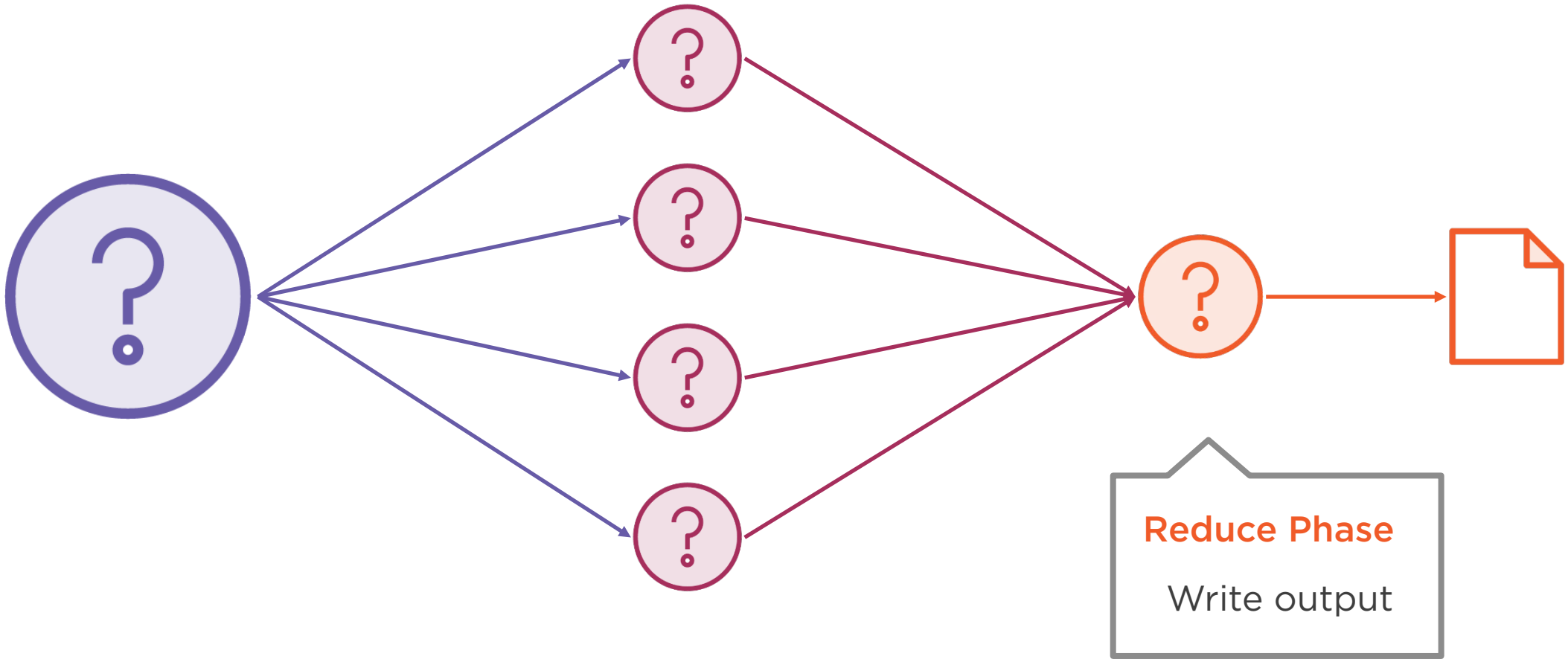
API known to YARN

Fixed structure



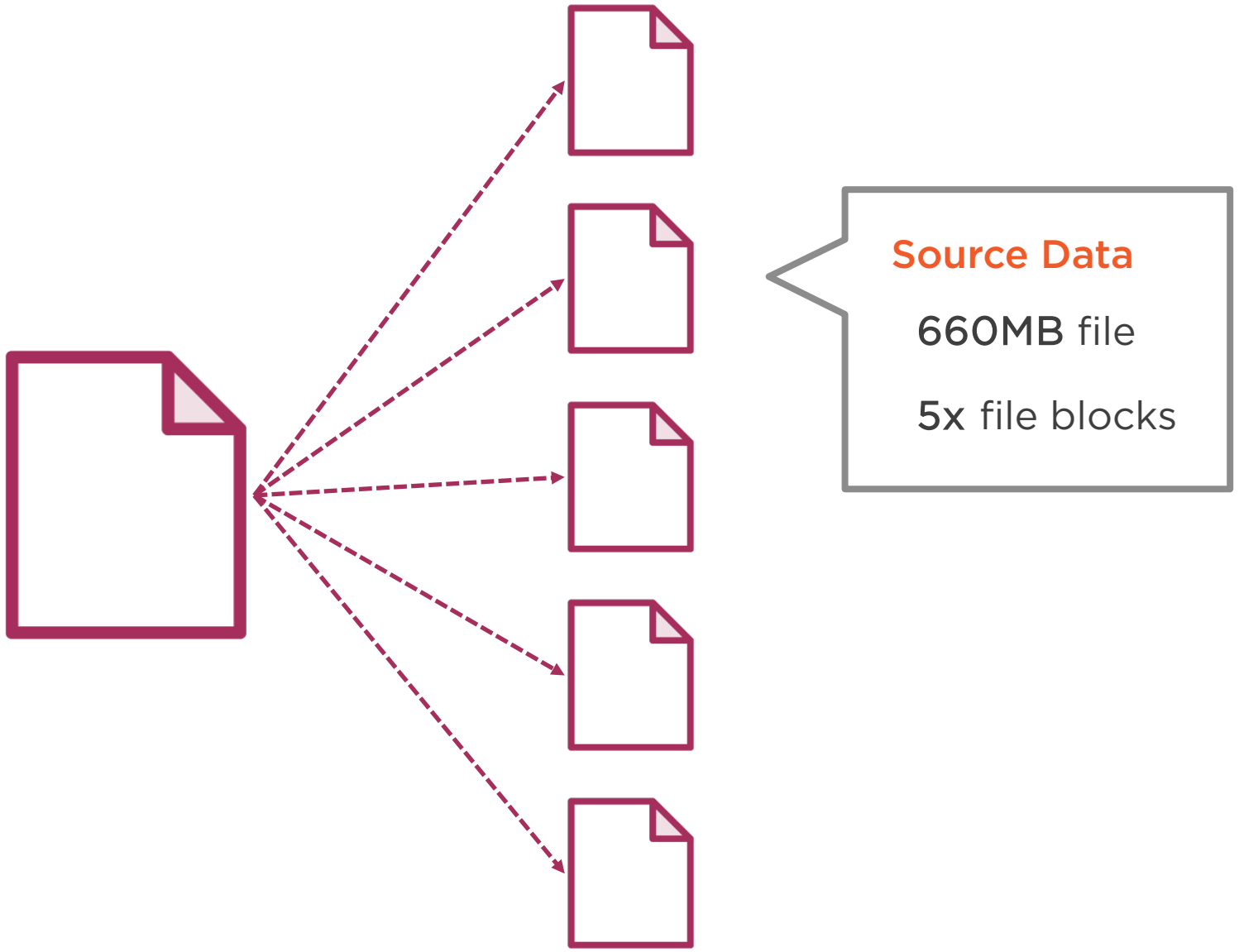
Map Phase

Read input


Reduce Phase
Write output

Mapper

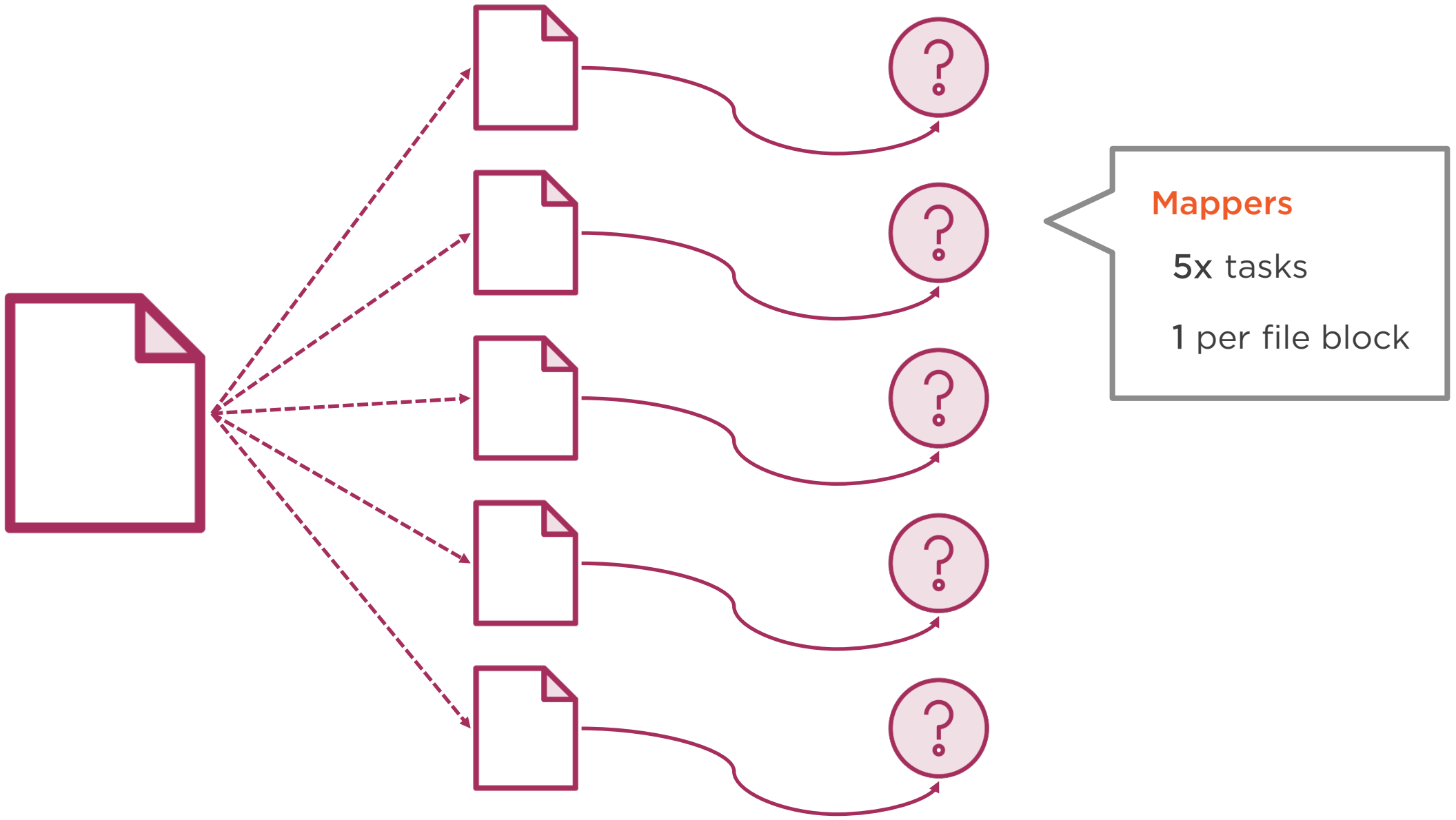
Custom component

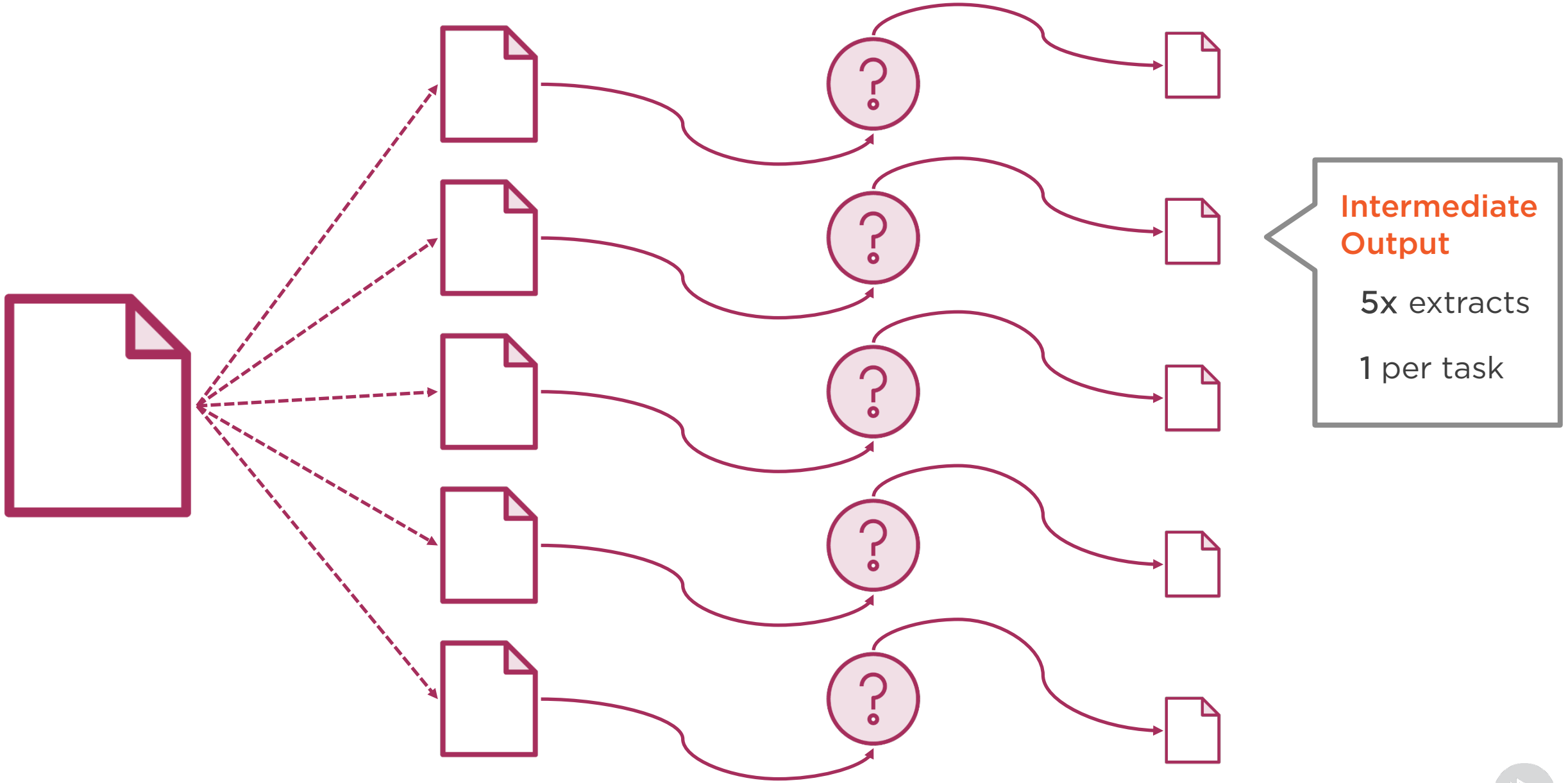


Source Data

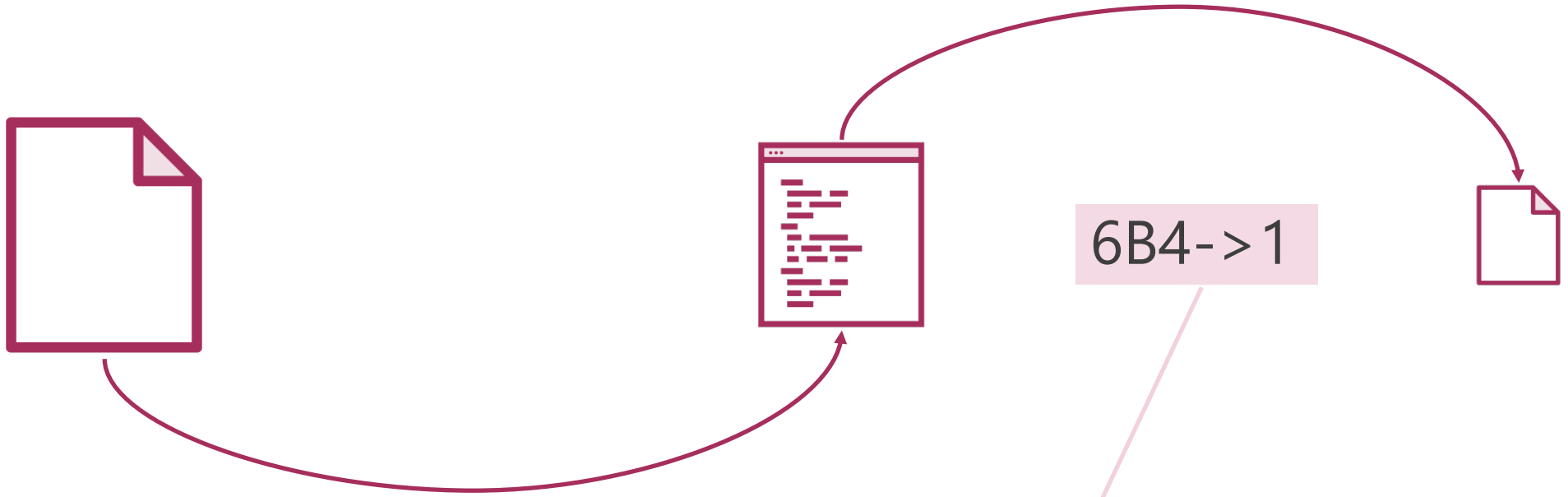
660MB file

5x file blocks


Mappers
5x tasks
1 per file block

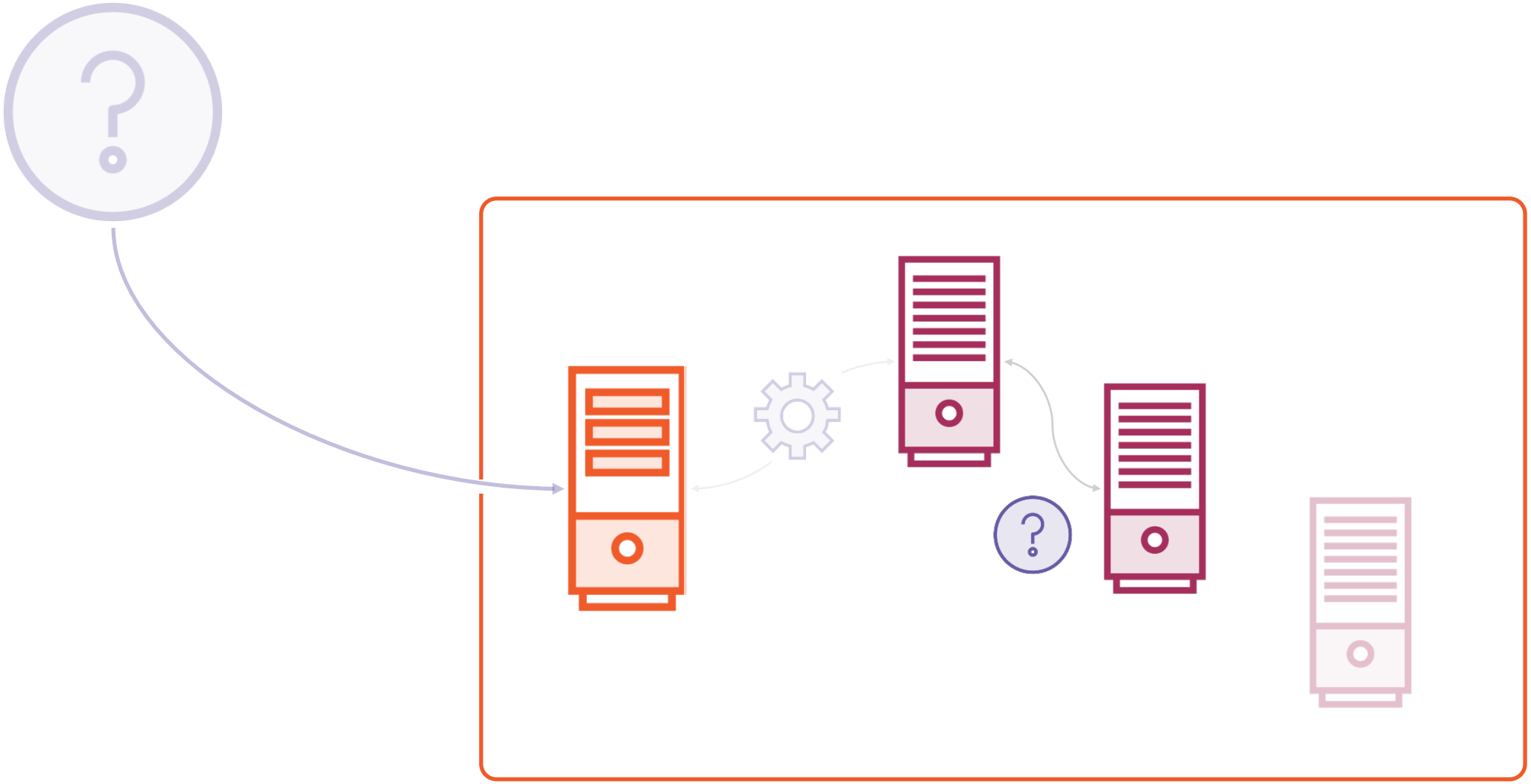

Intermediate Output
5x extracts
1 per task

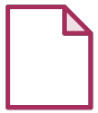
TF4 3SN,TF4 3SN,TF4 3SN,10-1985,0,368702,305526,1,E99999999,,E06000020,Telford and Wrekin,E05009972,,E92000001,England,E12000005,West Midlands,E14000989,Telford,E15000005,West Midlands,E16000071,Telford and Wrekin,E01014123,Telford and Wrekin 019E,E02002946,Telford and Wrekin 019,6B4,Older workers and retirement,-2.46402,52.64656,Postcode Level,22/02/2016,"(52.64656, -2.46402)",1537688



TF4 3SN,TF4 3SN,TF4 3SN,10-1985,0,368702,305526,1,E99999999,,E06000020,Telford and Wrekin,E05009972,,E92000001,England,E12000005,West Midlands,E14000989,Telford,E15000005,West Midlands,E16000071,Telford and Wrekin,E01014123,Telford and Wrekin 019E,E02002946,Telford and Wrekin 019,6B4,Older workers and retirement,-2.46402,52.64656,Postcode Level,22/02/2016,"(52.64656, -2.46402)",1537688

6B4



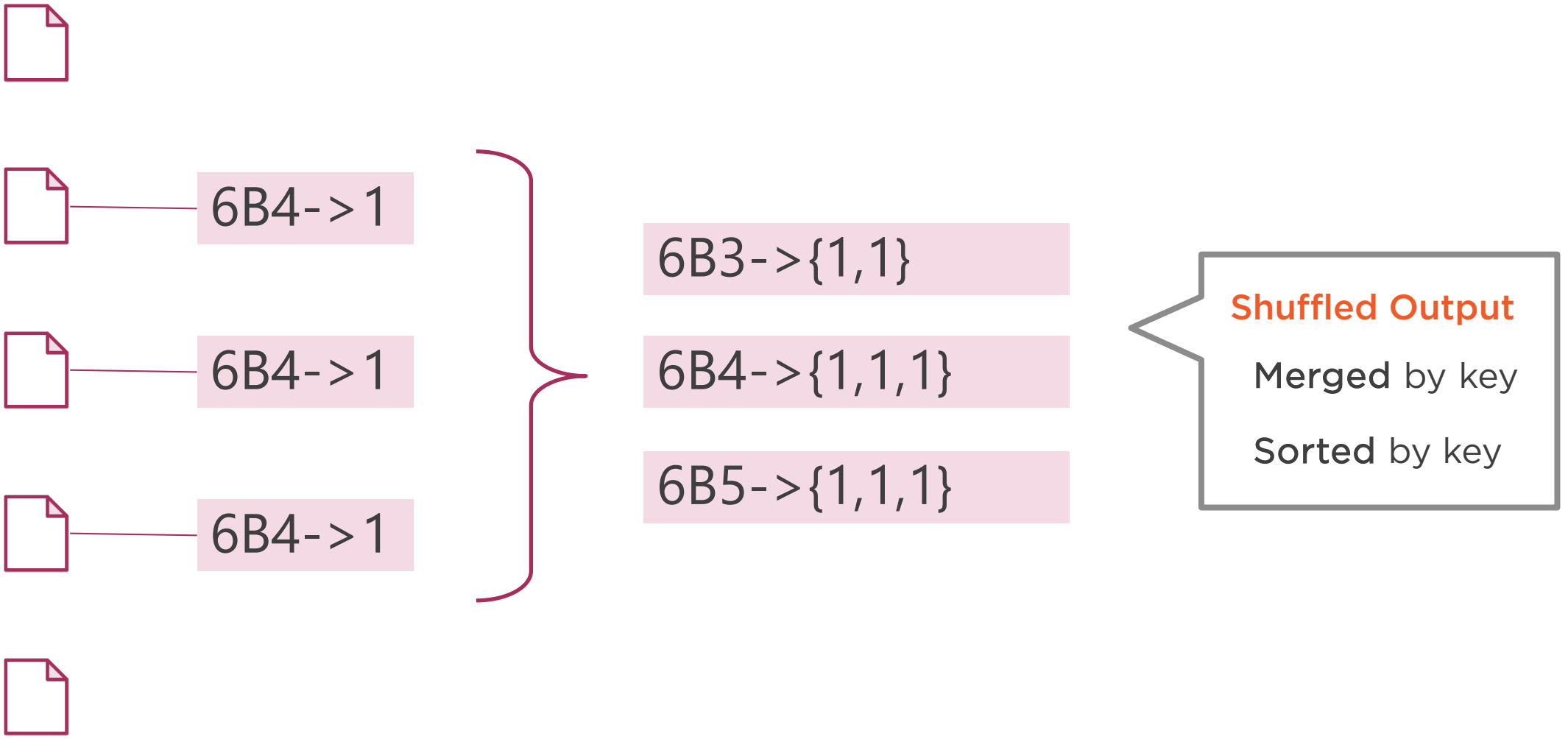




Intermediate Output

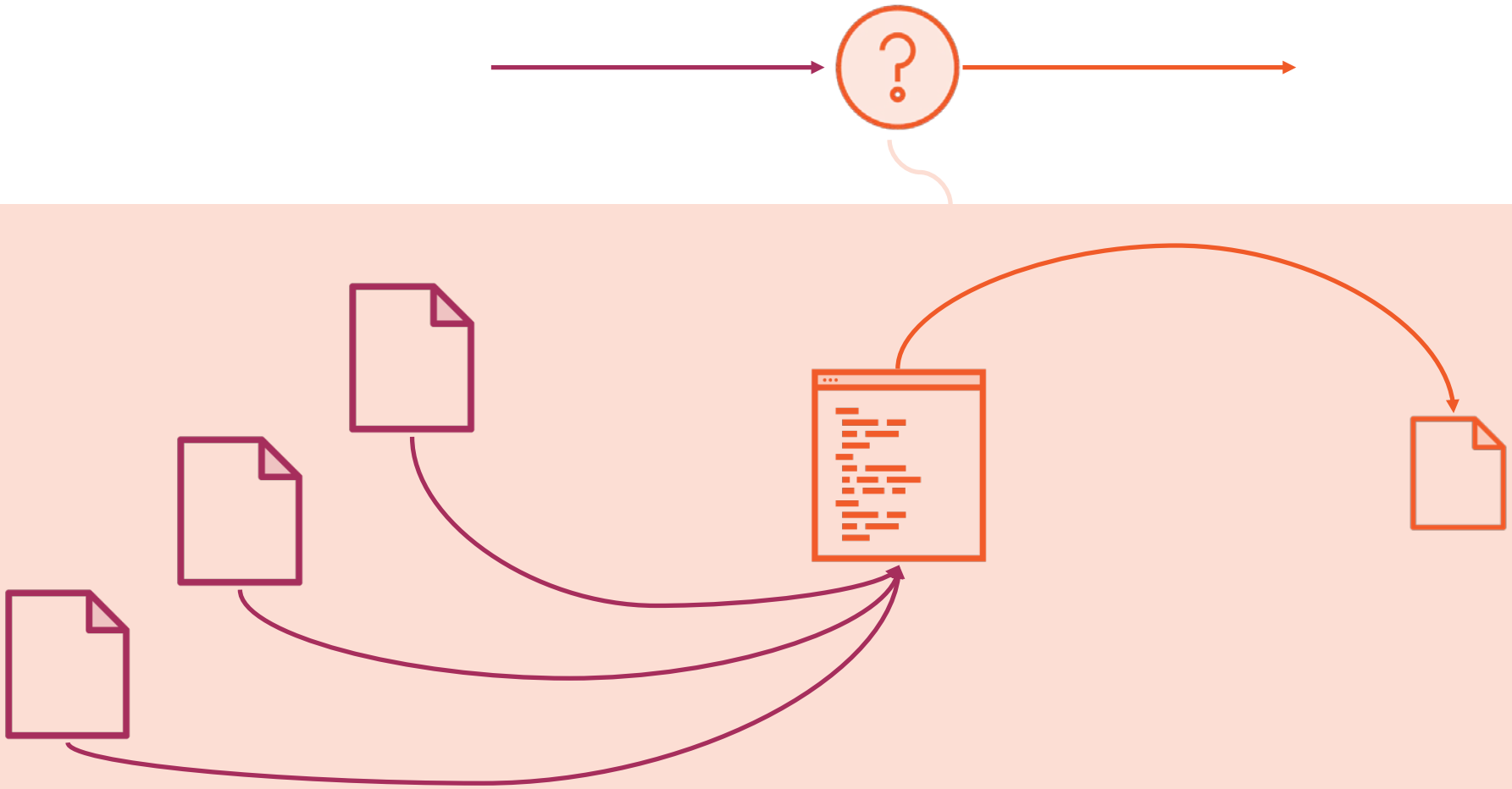
5x extracts

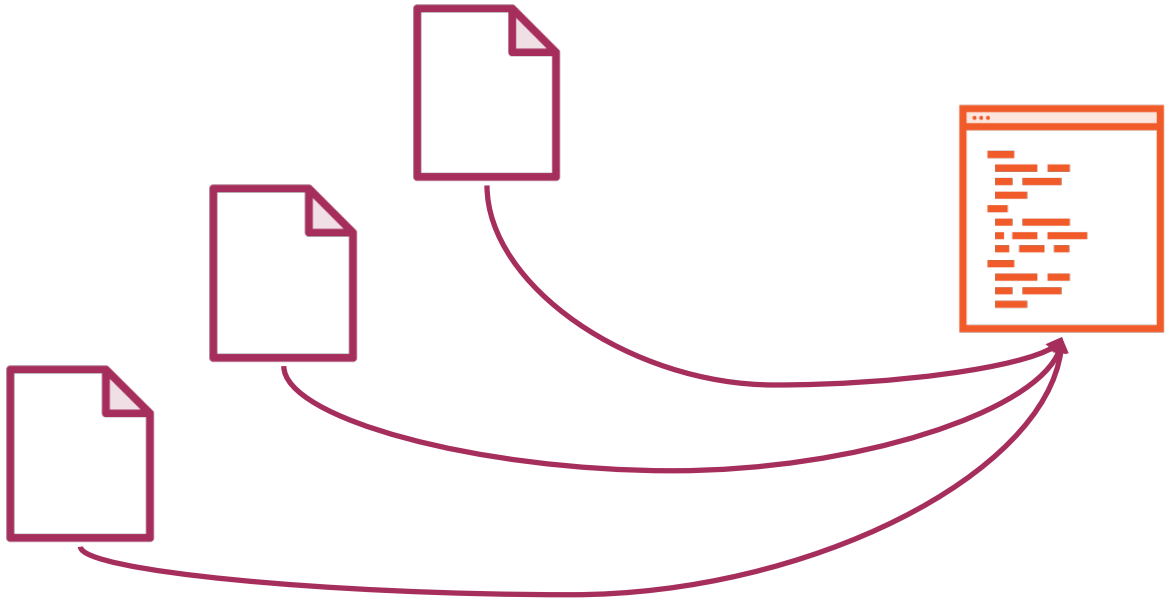
1 per task


6B4->1
6B4->1
6B4->1
6B3->{1,1}
6B4->{1,1,1}
6B5->{1,1,1}
Shuffled Output
Merged by key
Sorted by key

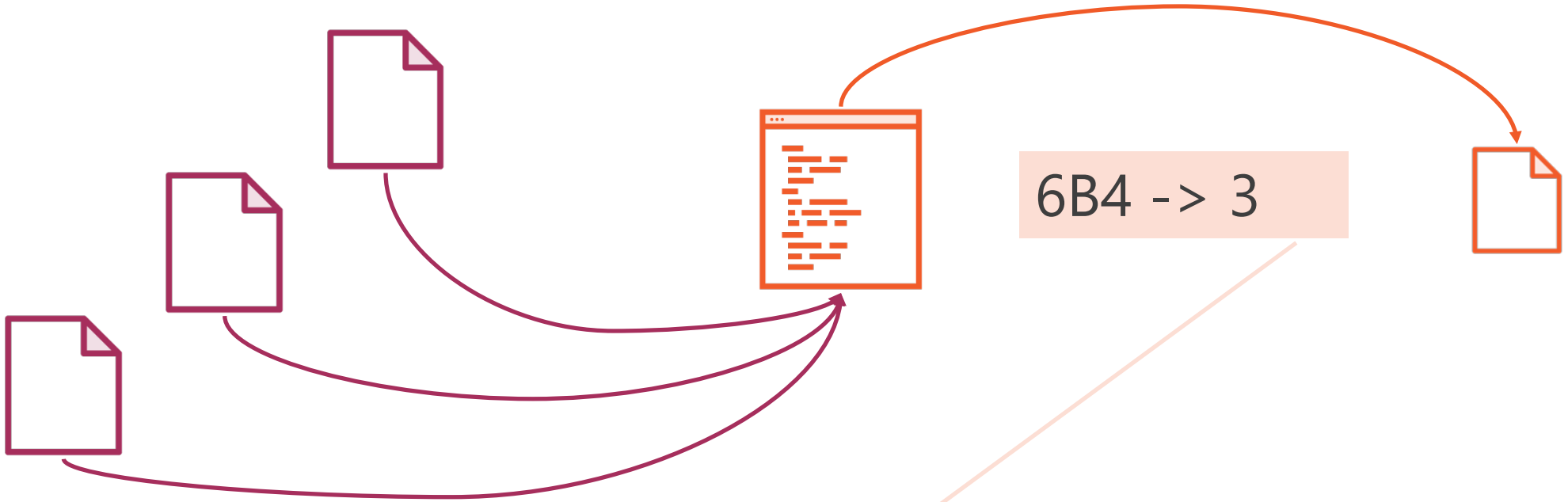
Reducer

Custom component

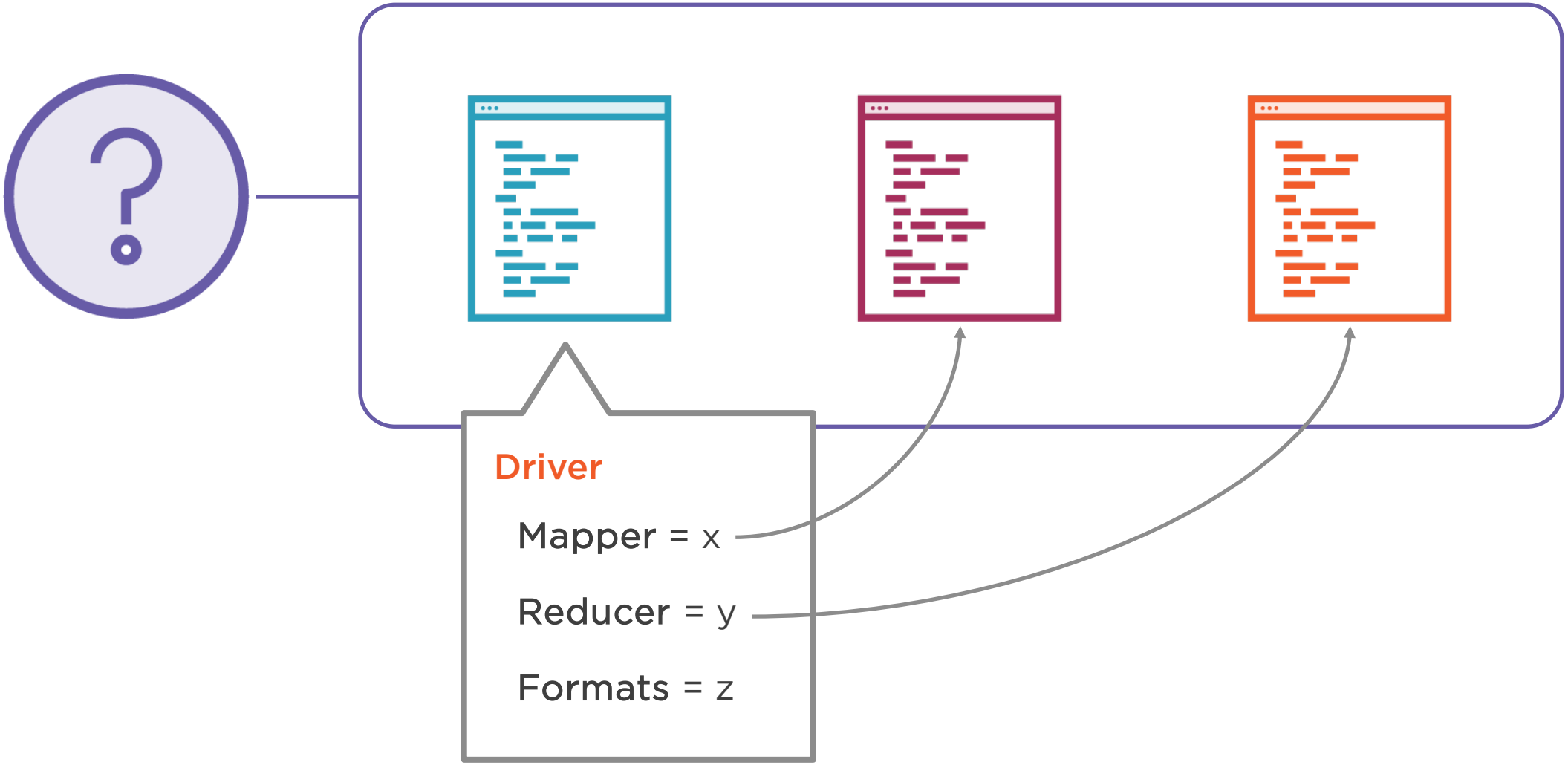




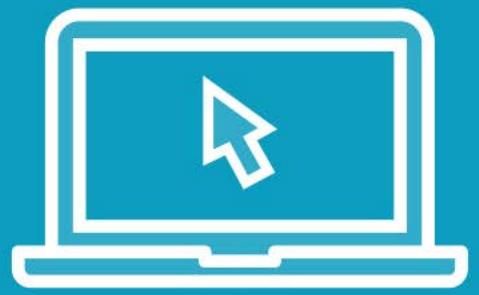
```
6B4 -> {1,1}
6B4 -> {1,1,1}
6B5 -> {1,1,1}
```



6B4 -> {1,1}
6B4 -> {1,1,1}
6B5 -> {1,1,1}


Driver
Mapper = x
Reducer = y
Formats = z

Demo

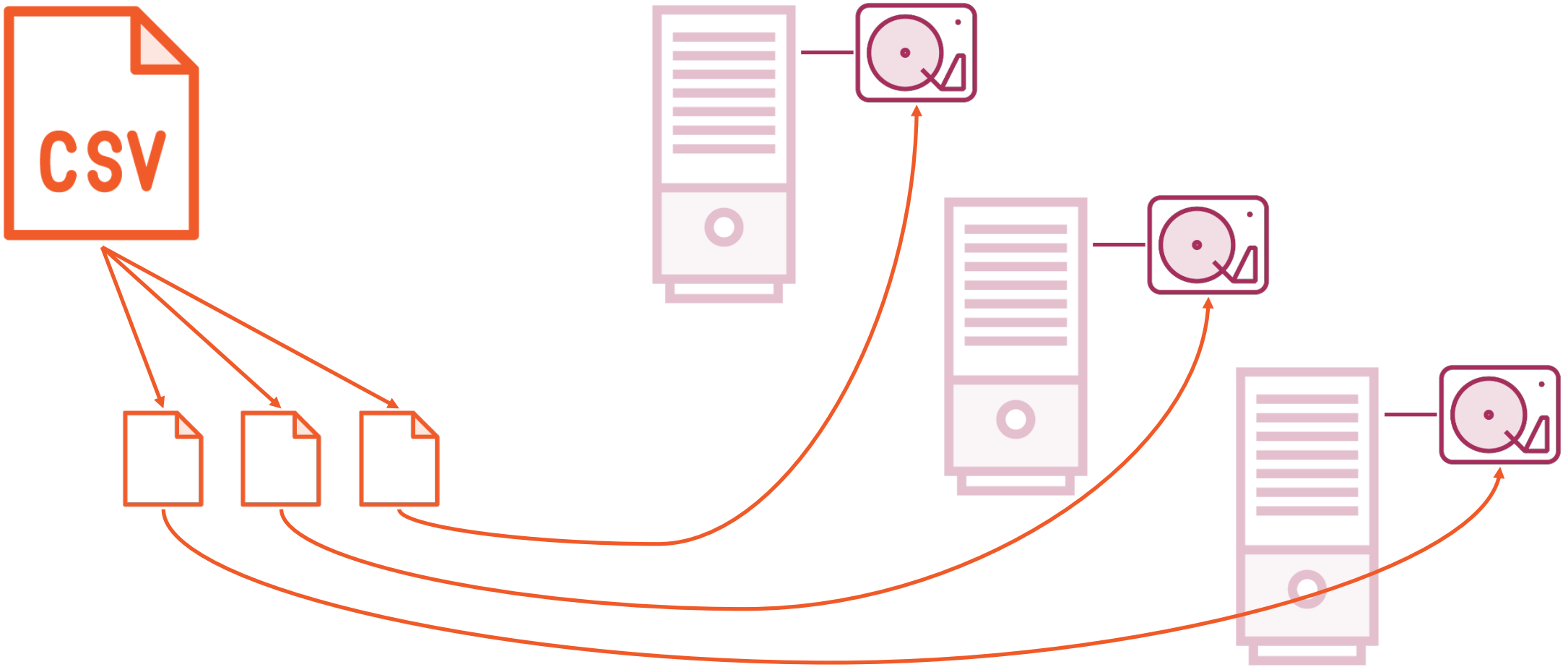


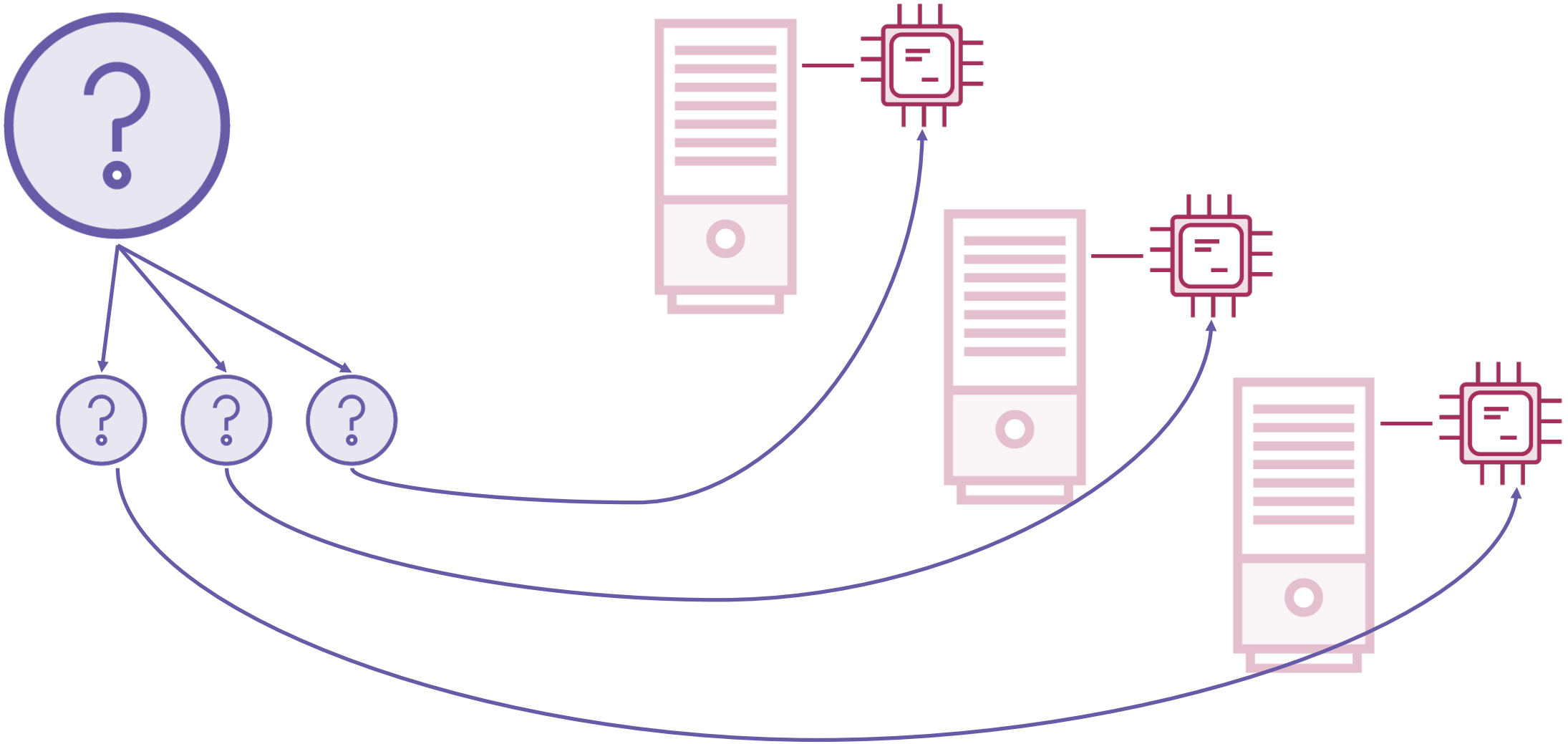
MapReduce in Java

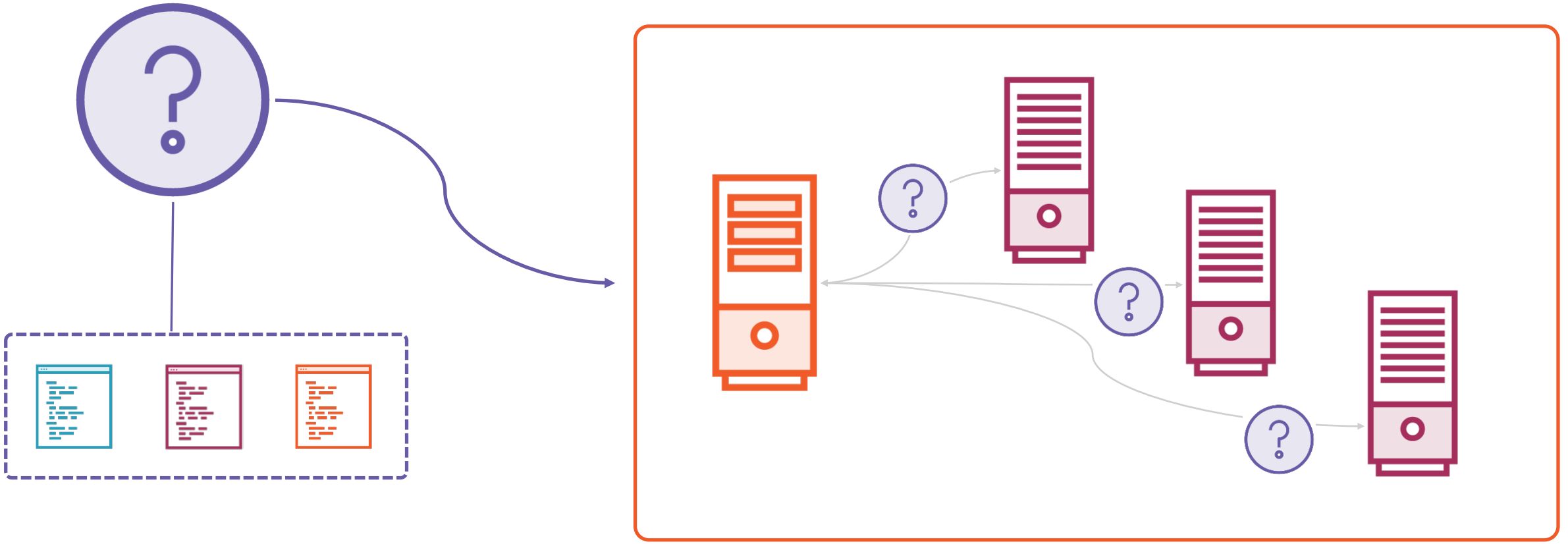
- Extracting data in the Mapper
- Aggregating in the Reducer
- Configuration in the Driver

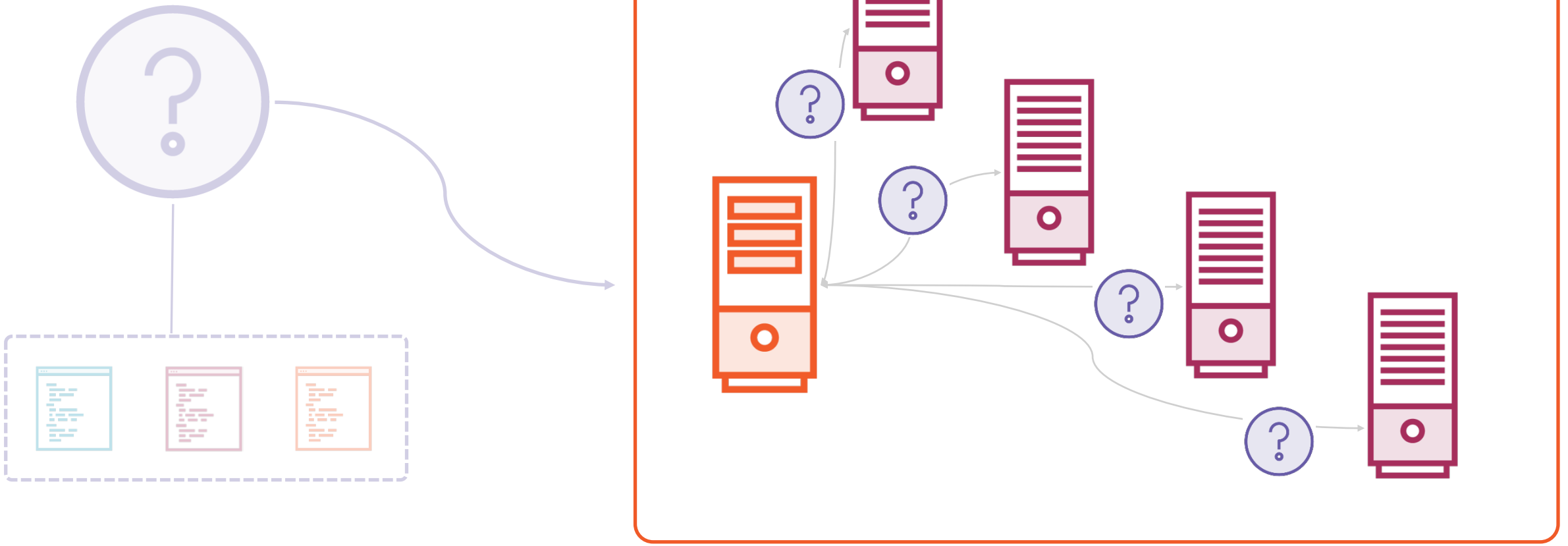
```
hadoop jar

job-with-dependencies.jar

/input

/output
```

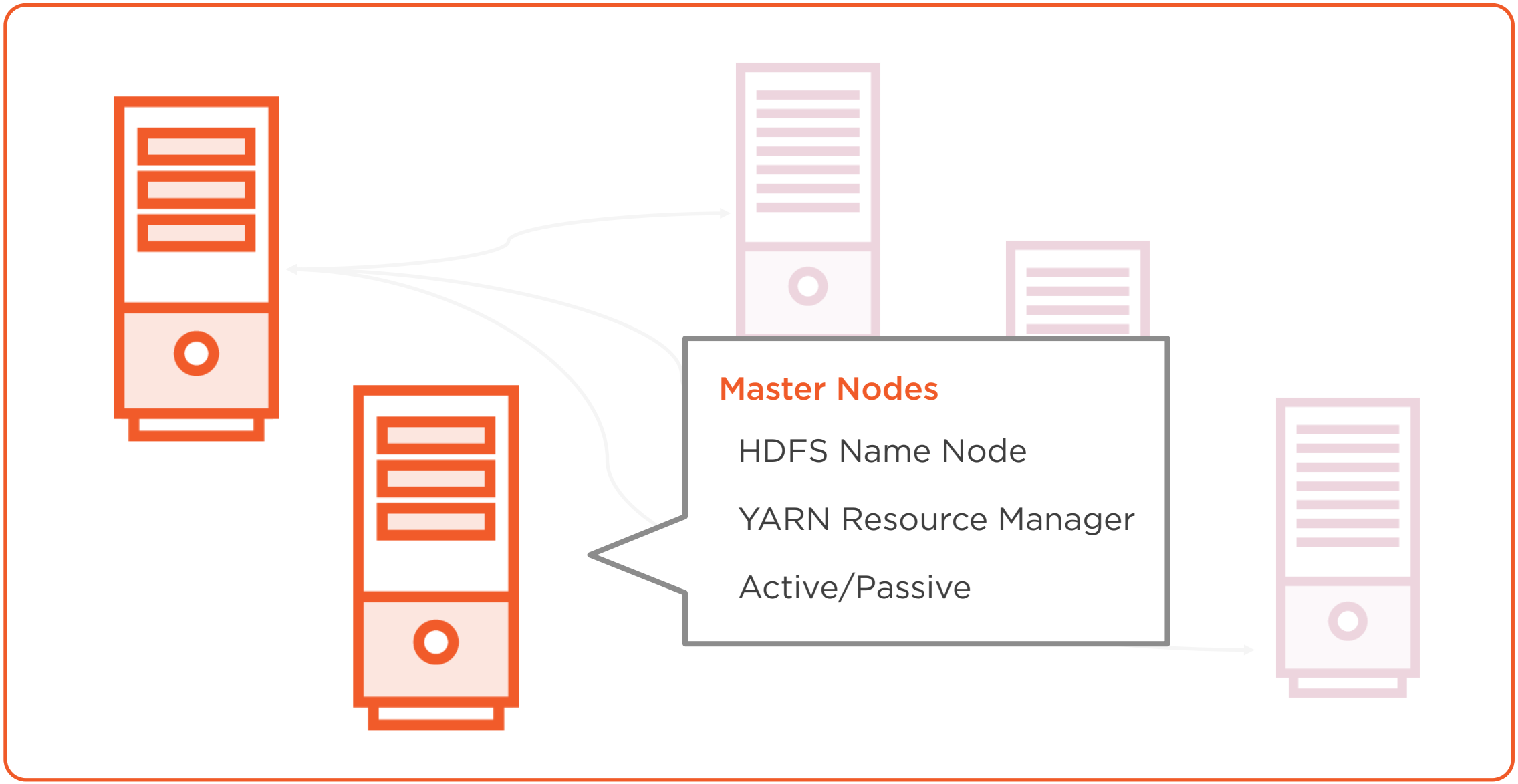
- Submit a job
- JAR file to run
- Input directory
- Output directory

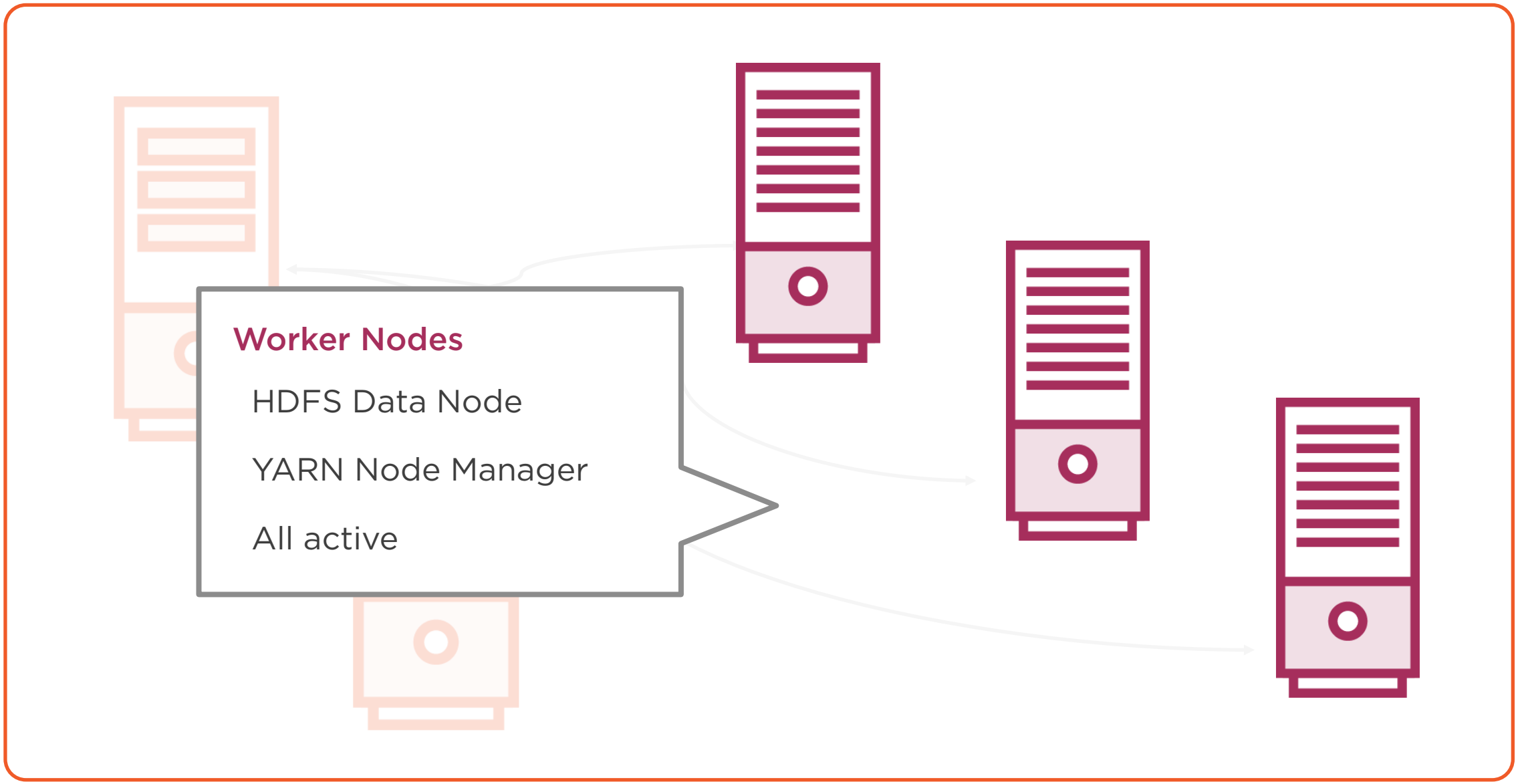

CSV

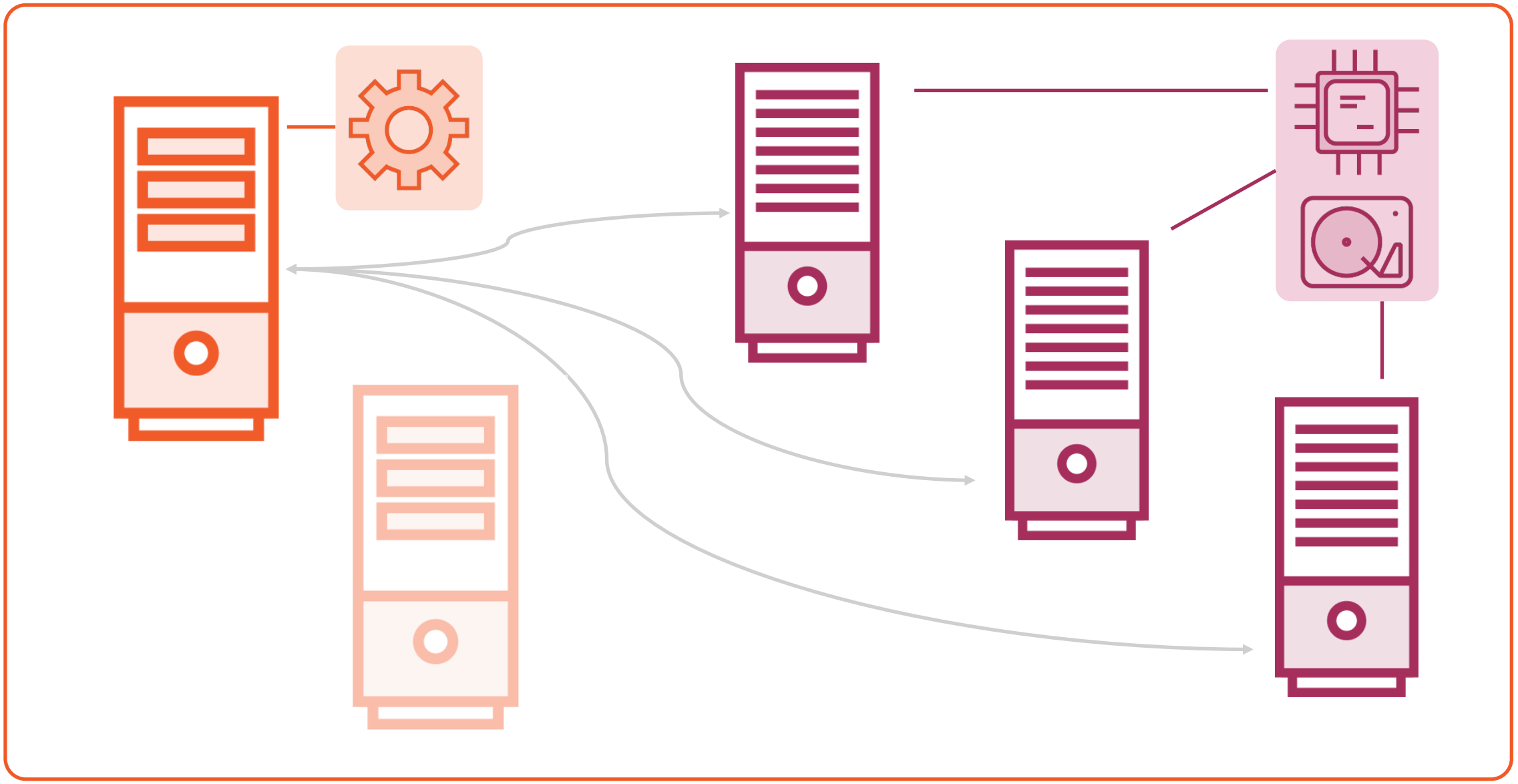


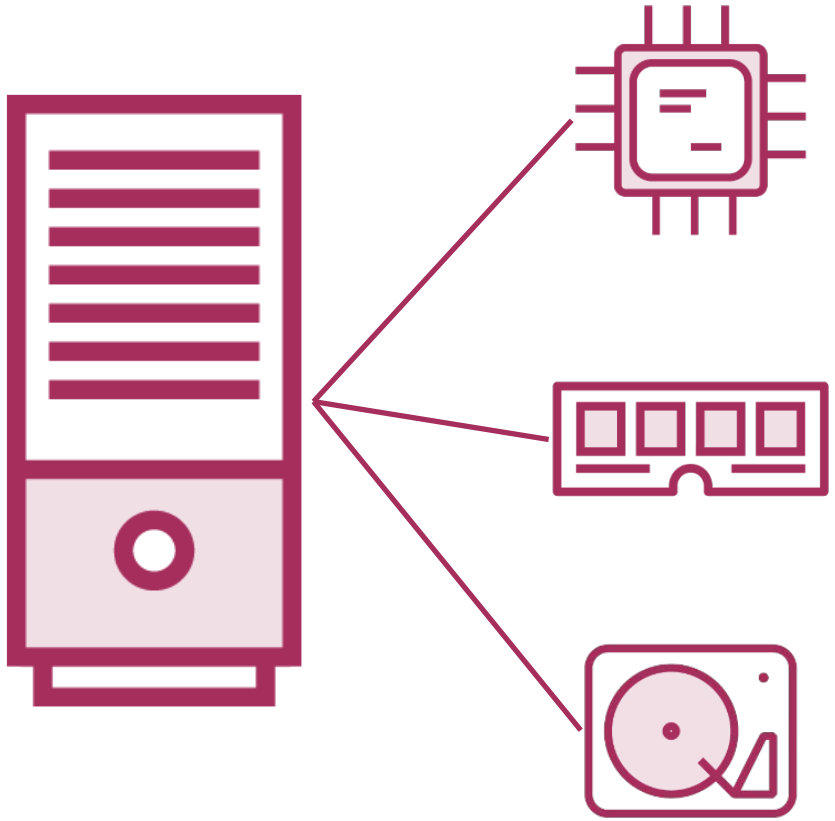





Master Nodes
HDFS Name Node
YARN Resource Manager
Active/Passive


Worker Nodes
HDFS Data Node
YARN Node Manager
All active

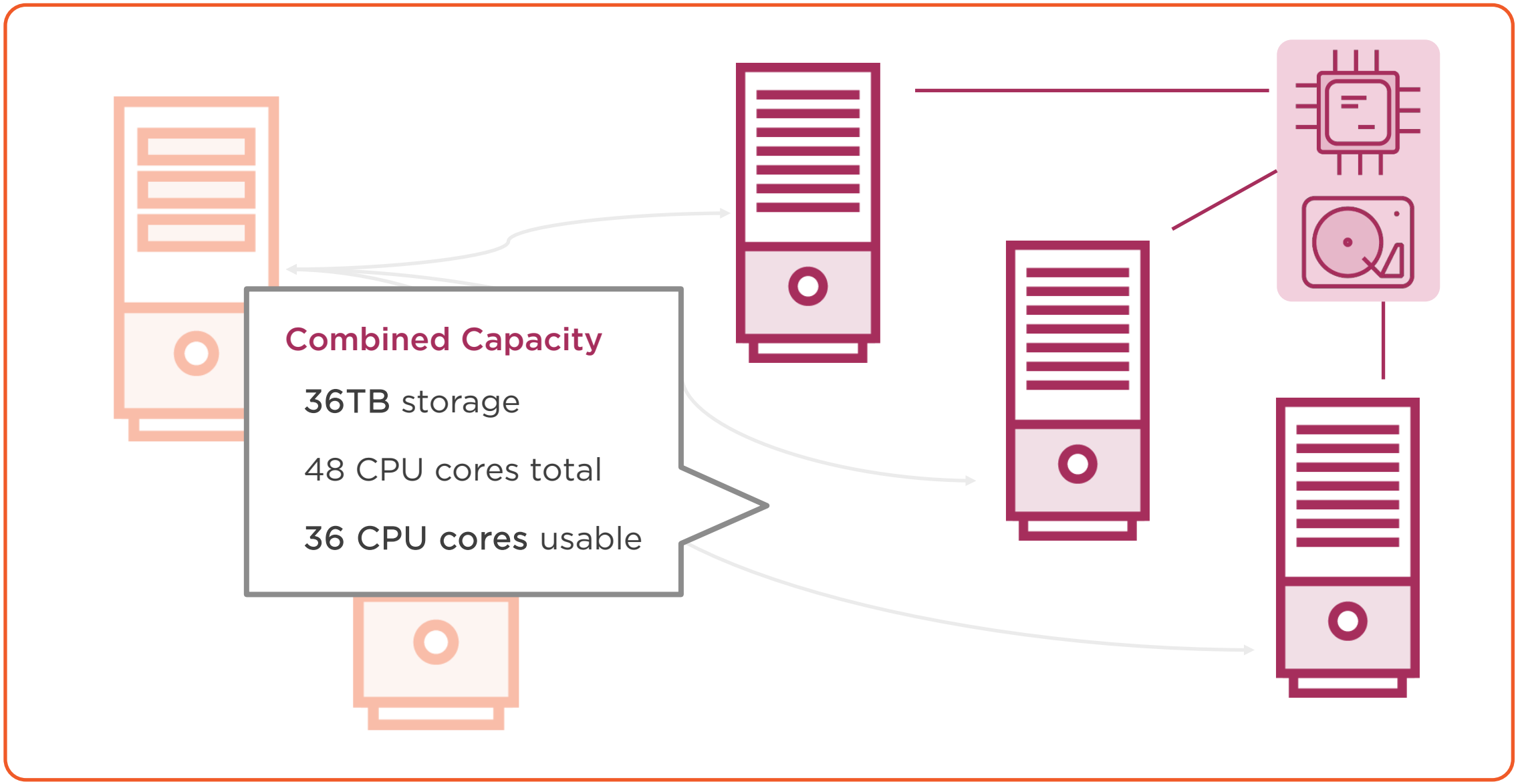


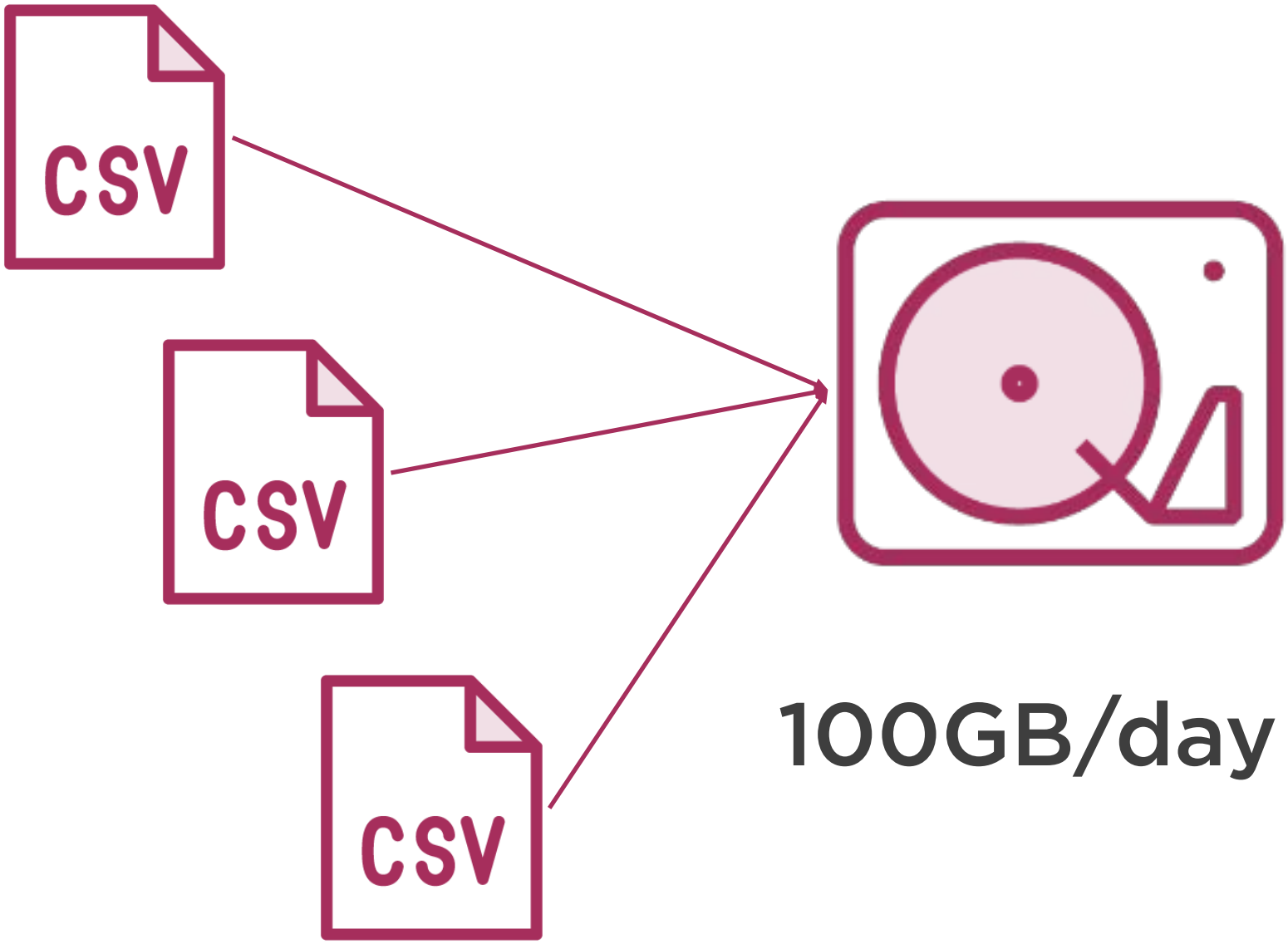


4x CPU = **16x Cores**

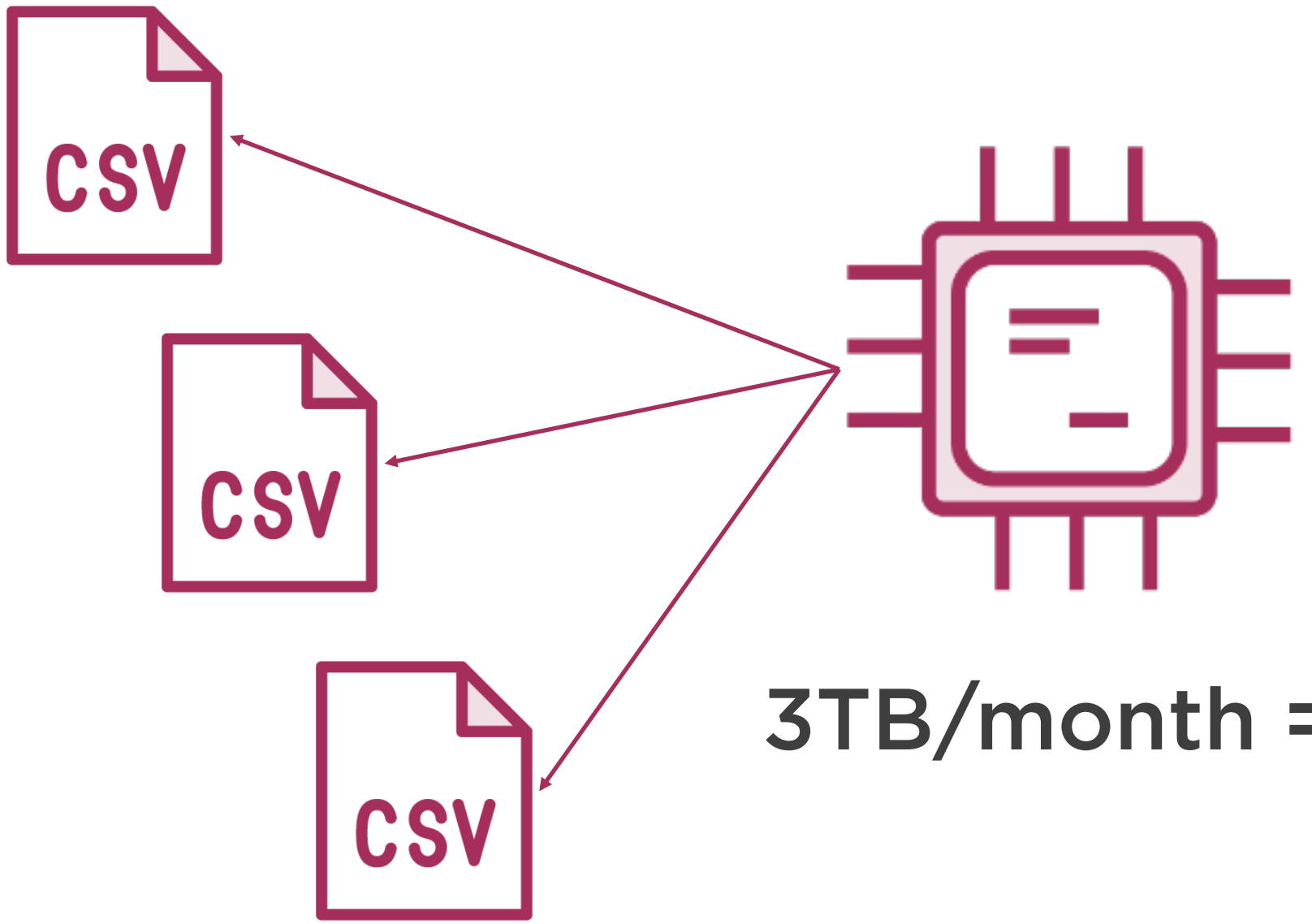
6x 8GB = **48GB RAM**

12x HDD = **36TB Storage**

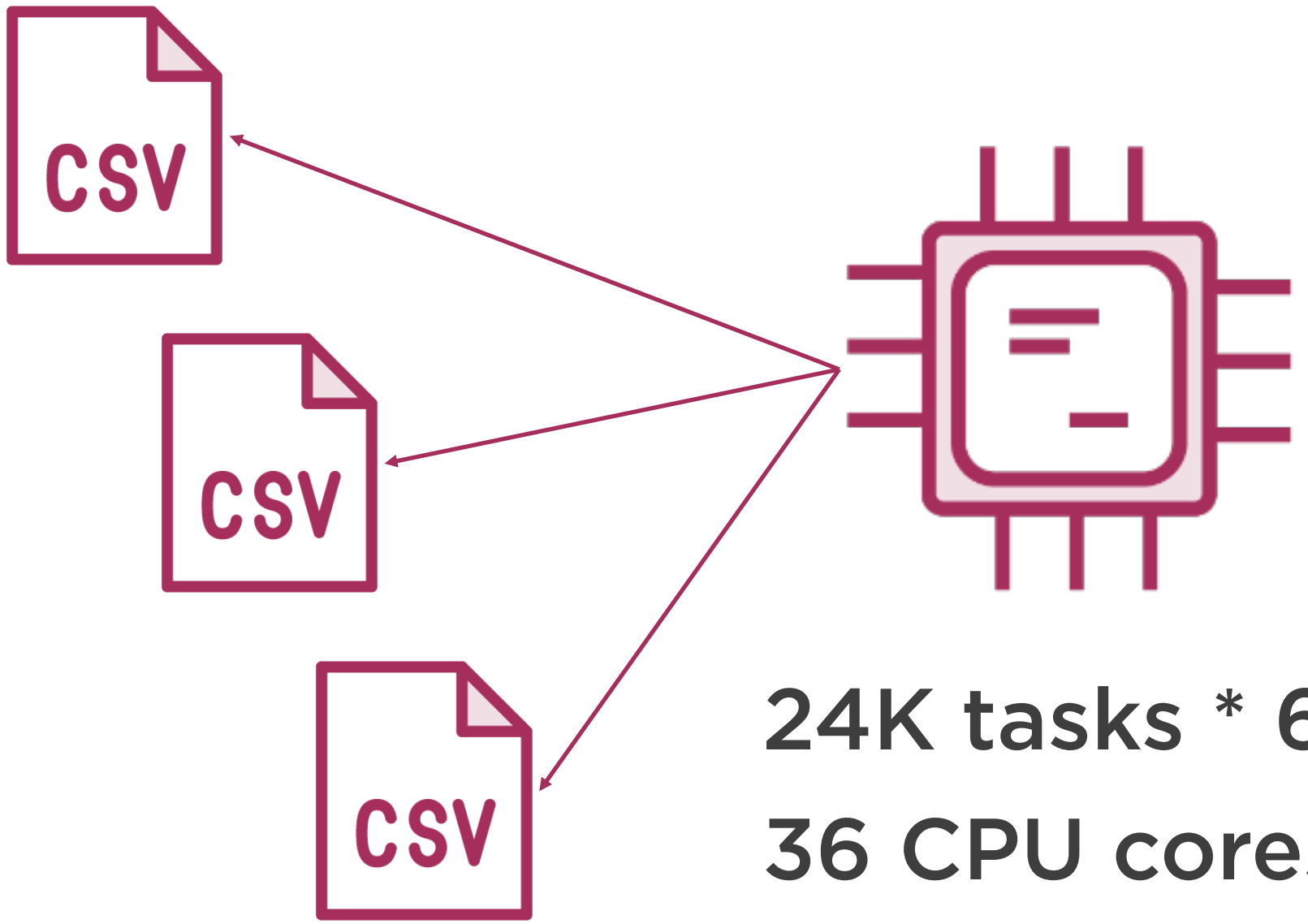

Combined Capacity
36TB storage
48 CPU cores total
36 CPU cores usable



100GB/day = **36TB/year**

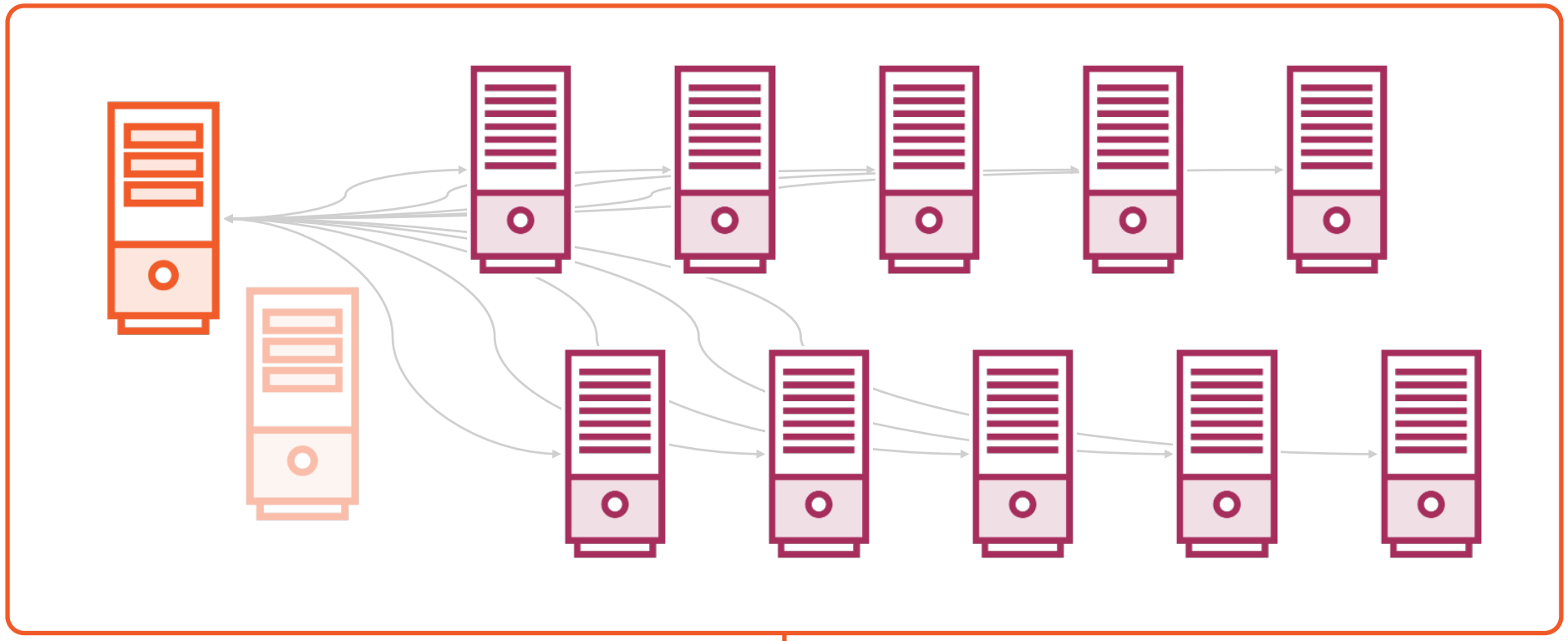


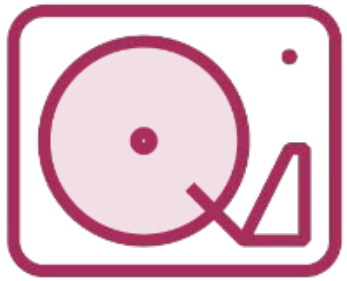
3TB/month = **24K blocks**



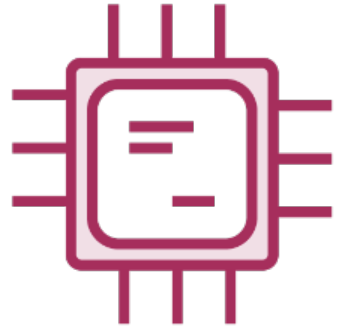
24K tasks * 60 seconds ÷

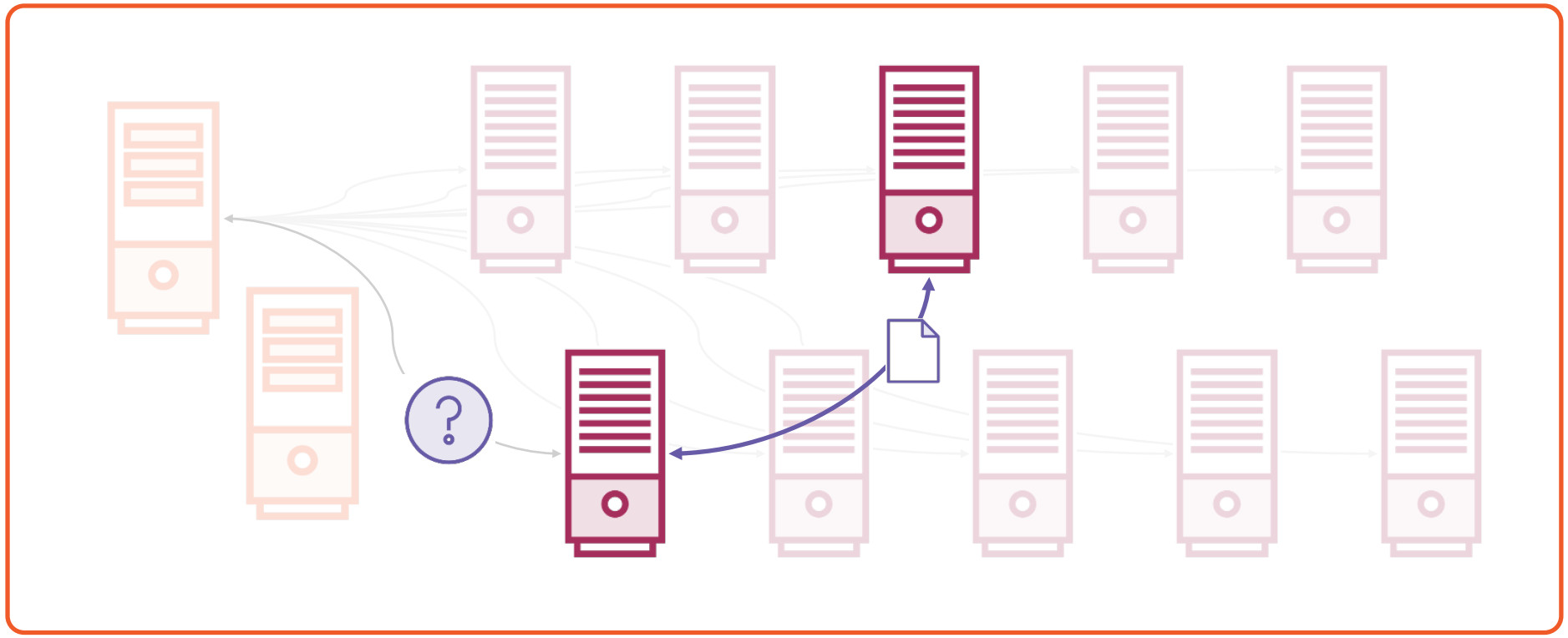
36 CPU cores = **11 hours**

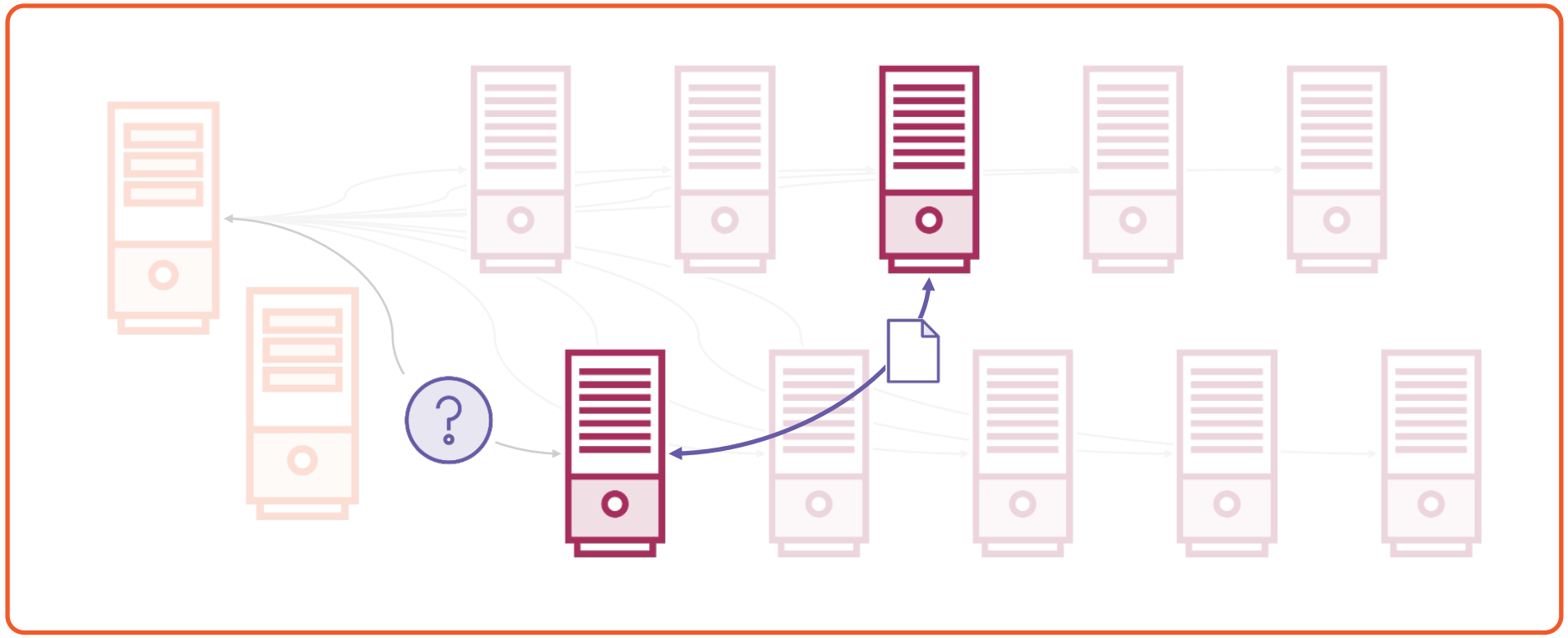




120TB & 120 Cores

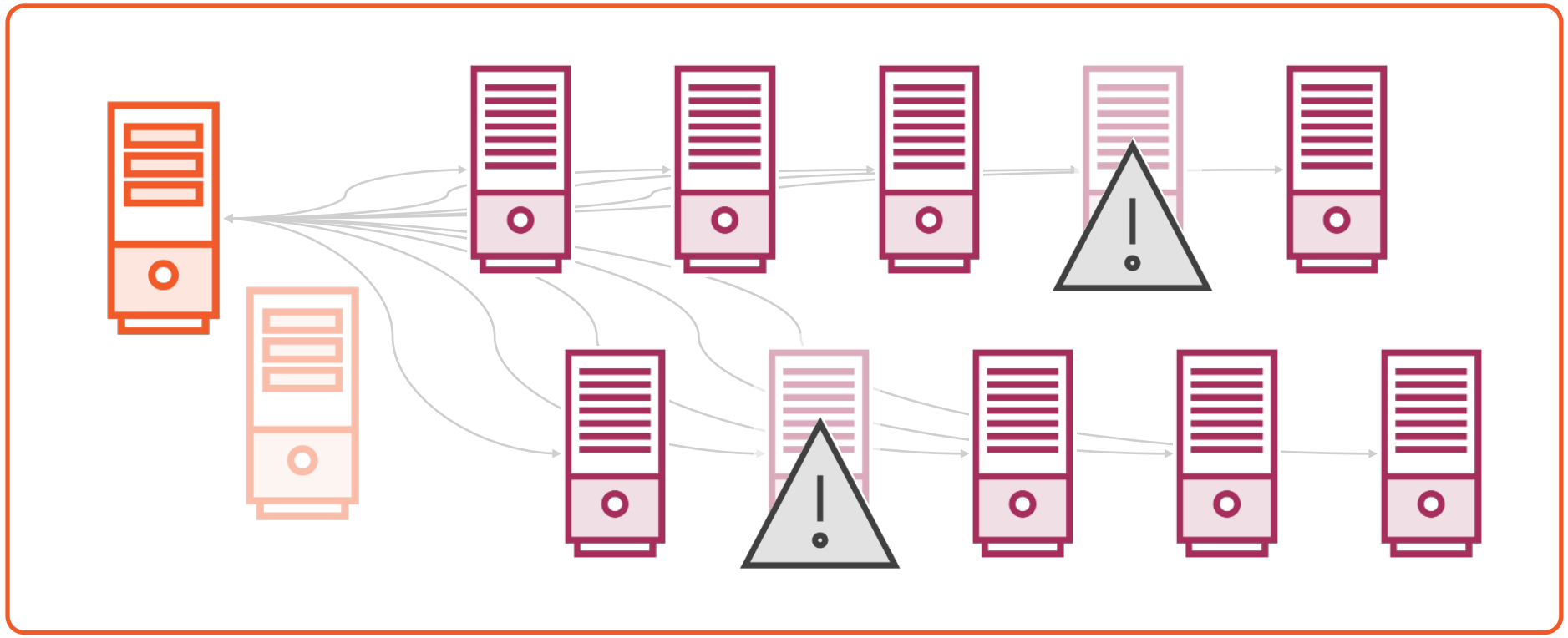


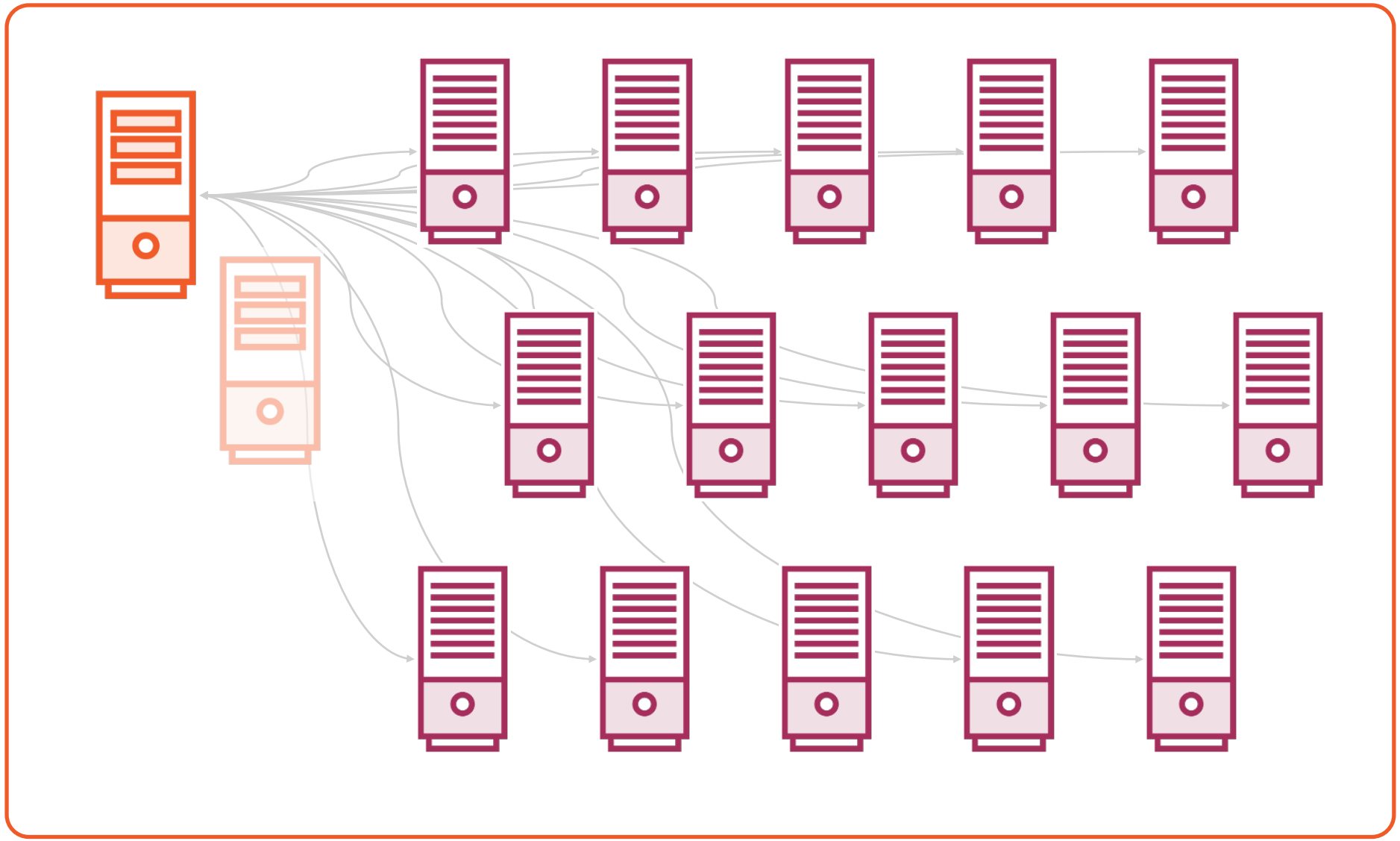


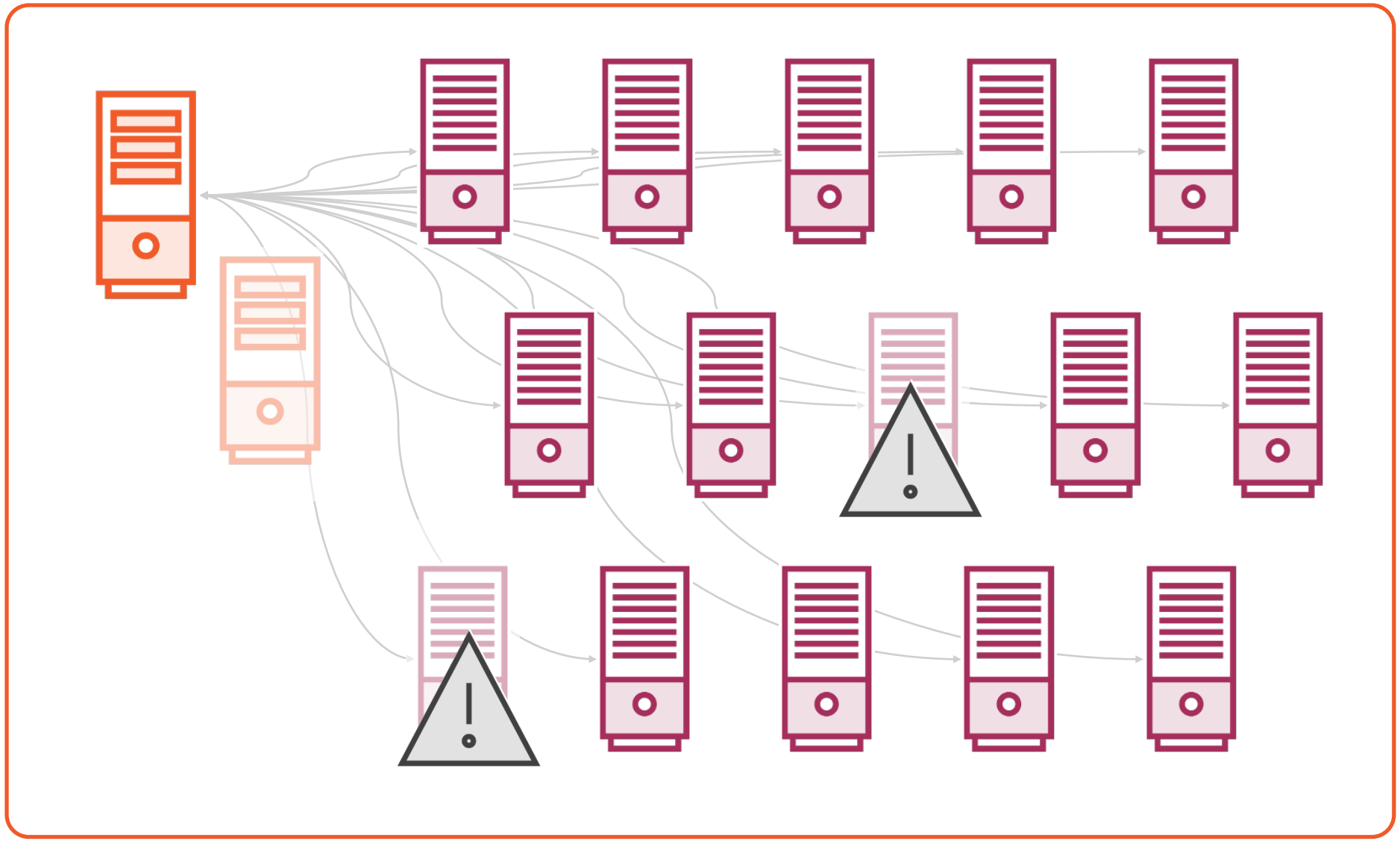


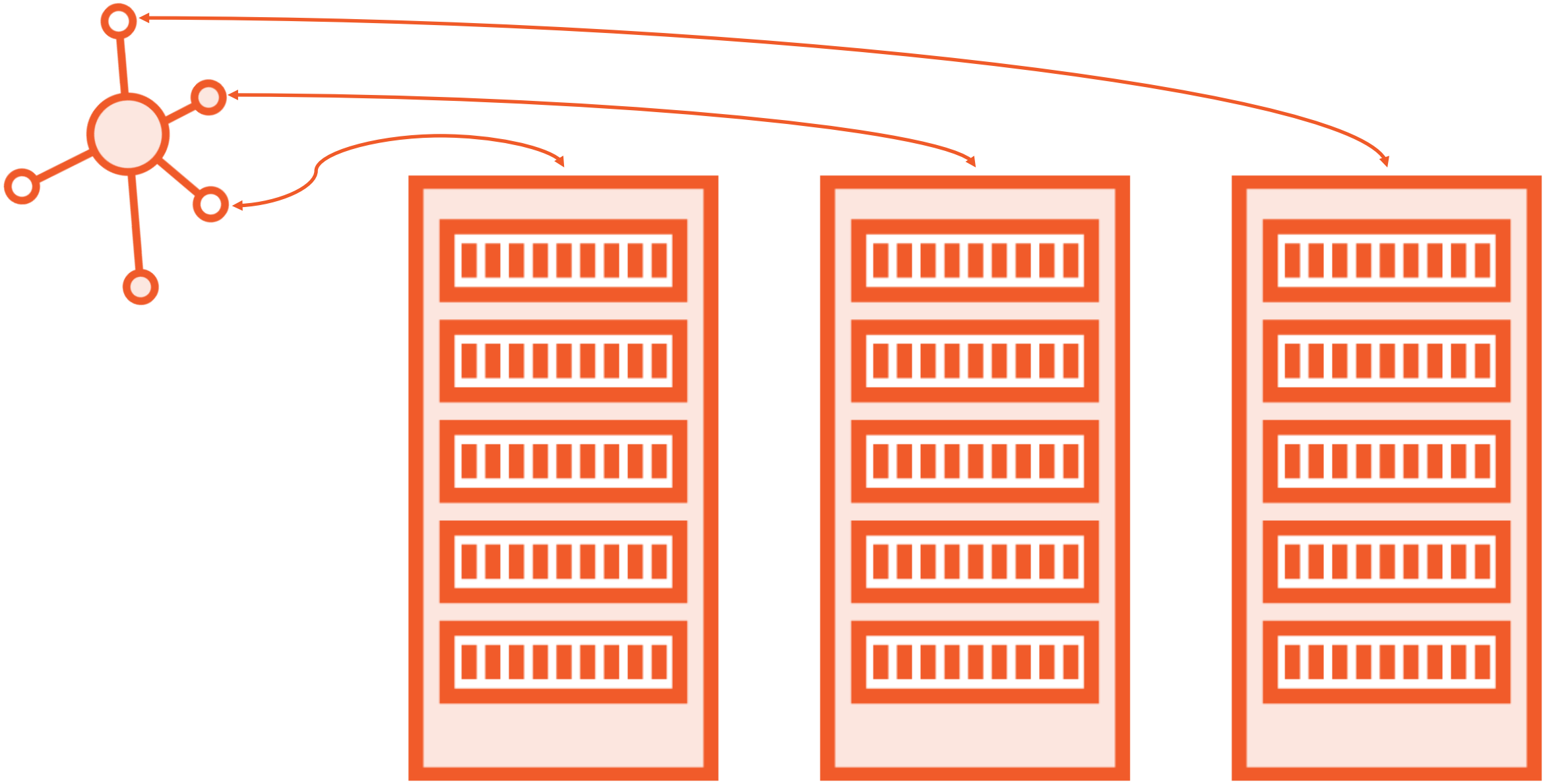
24K tasks * 75 seconds ÷

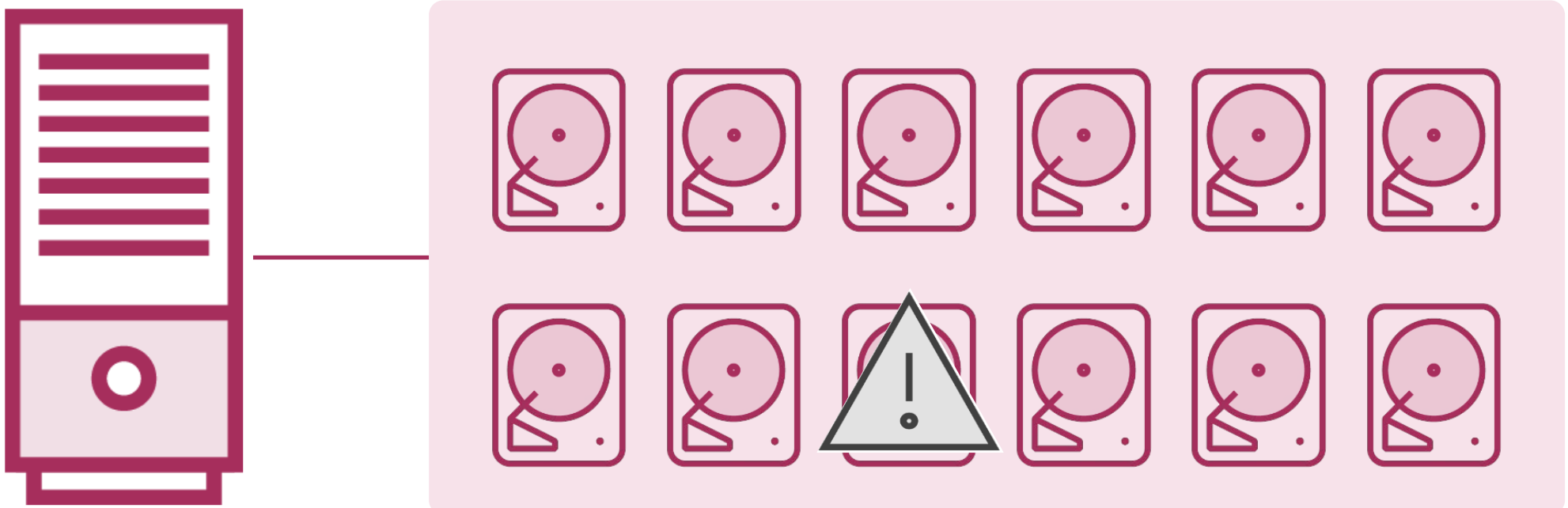
120 CPU cores = **4 hours**

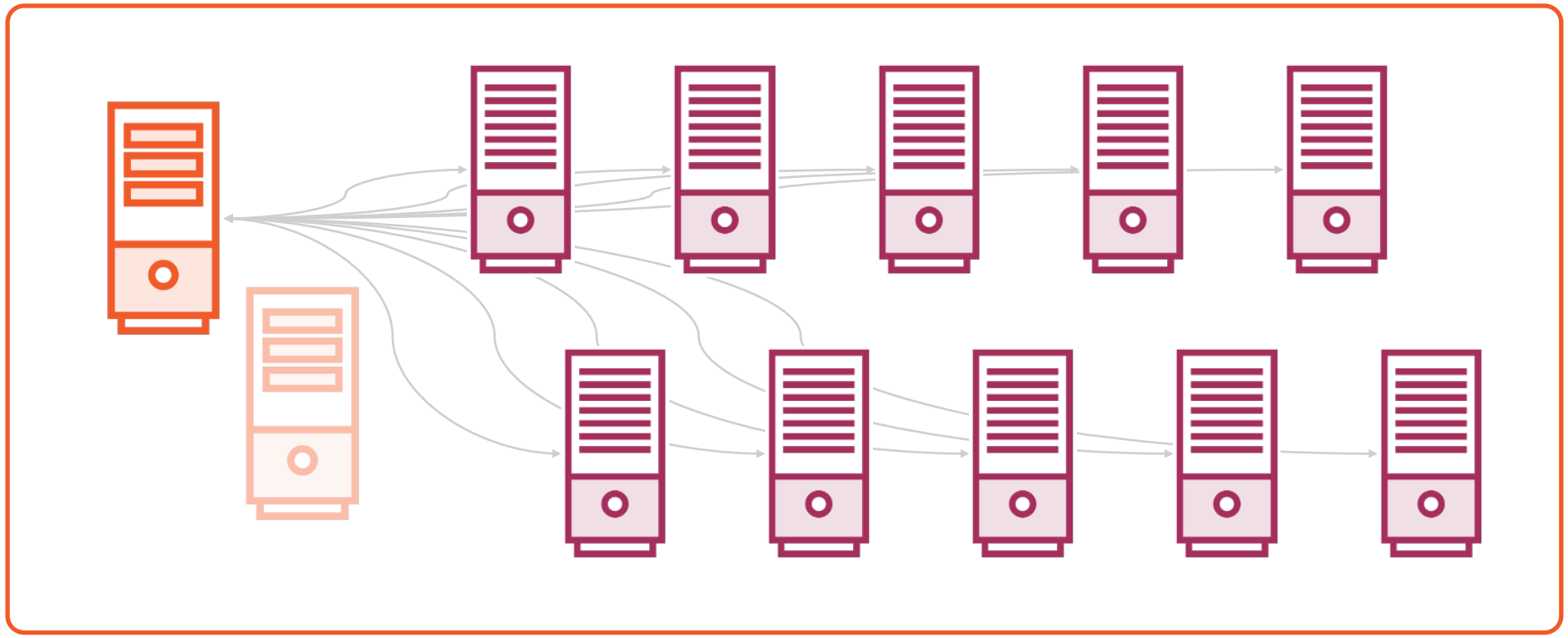








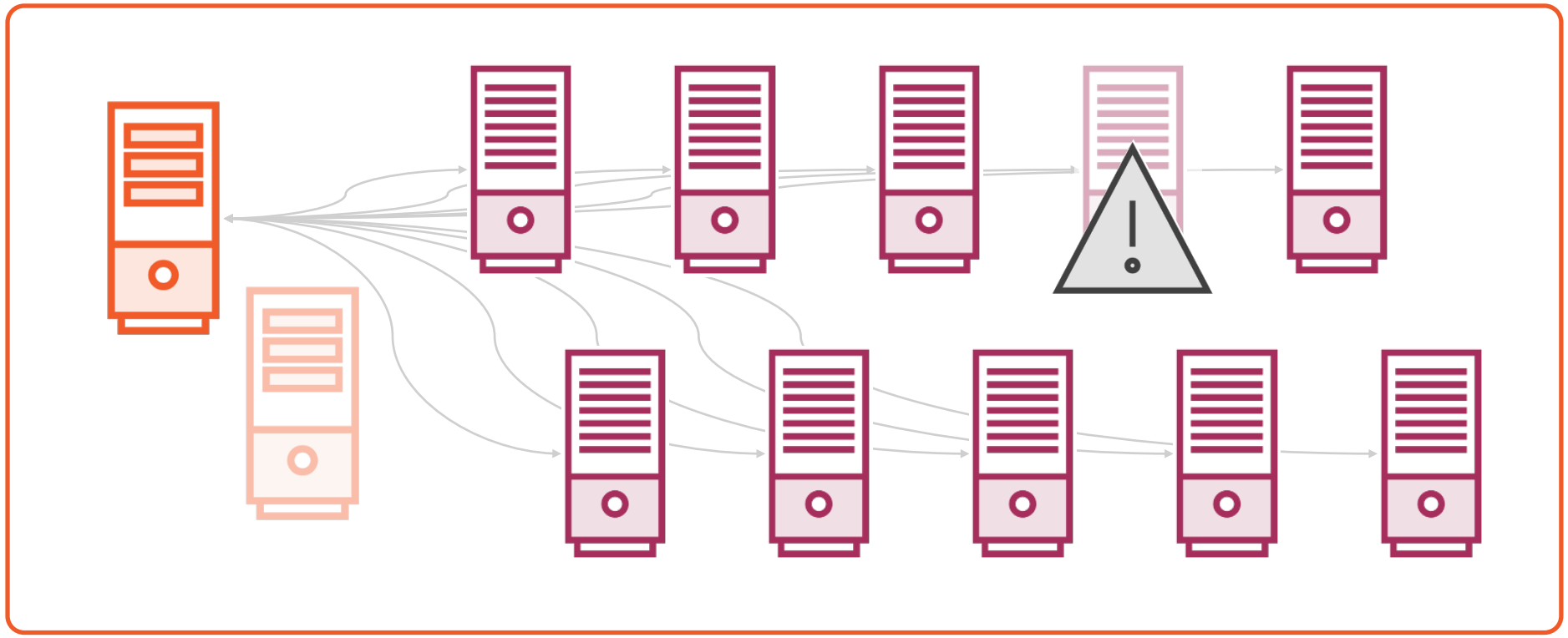




Cluster Health: 100%

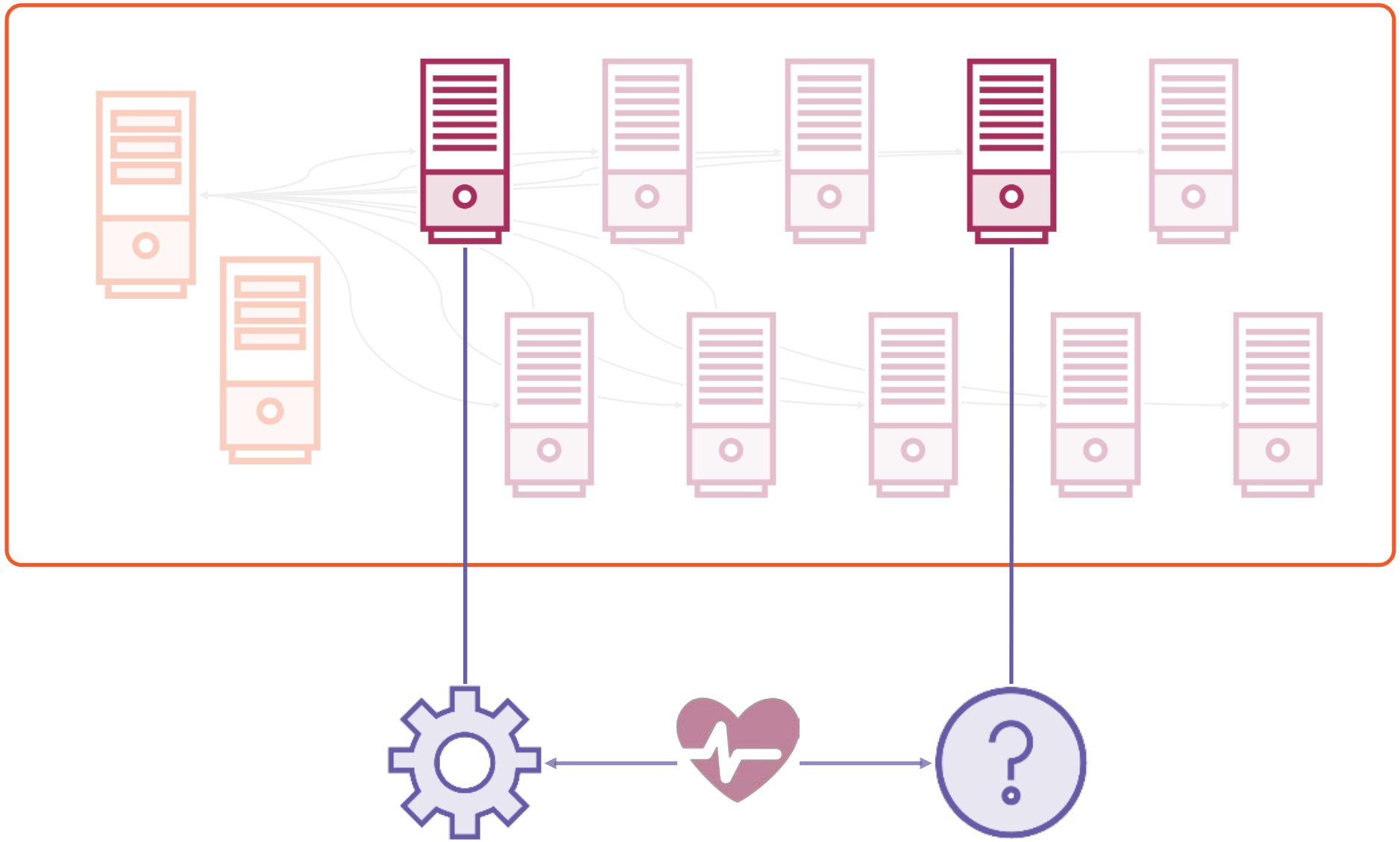
Storage: **Normal**

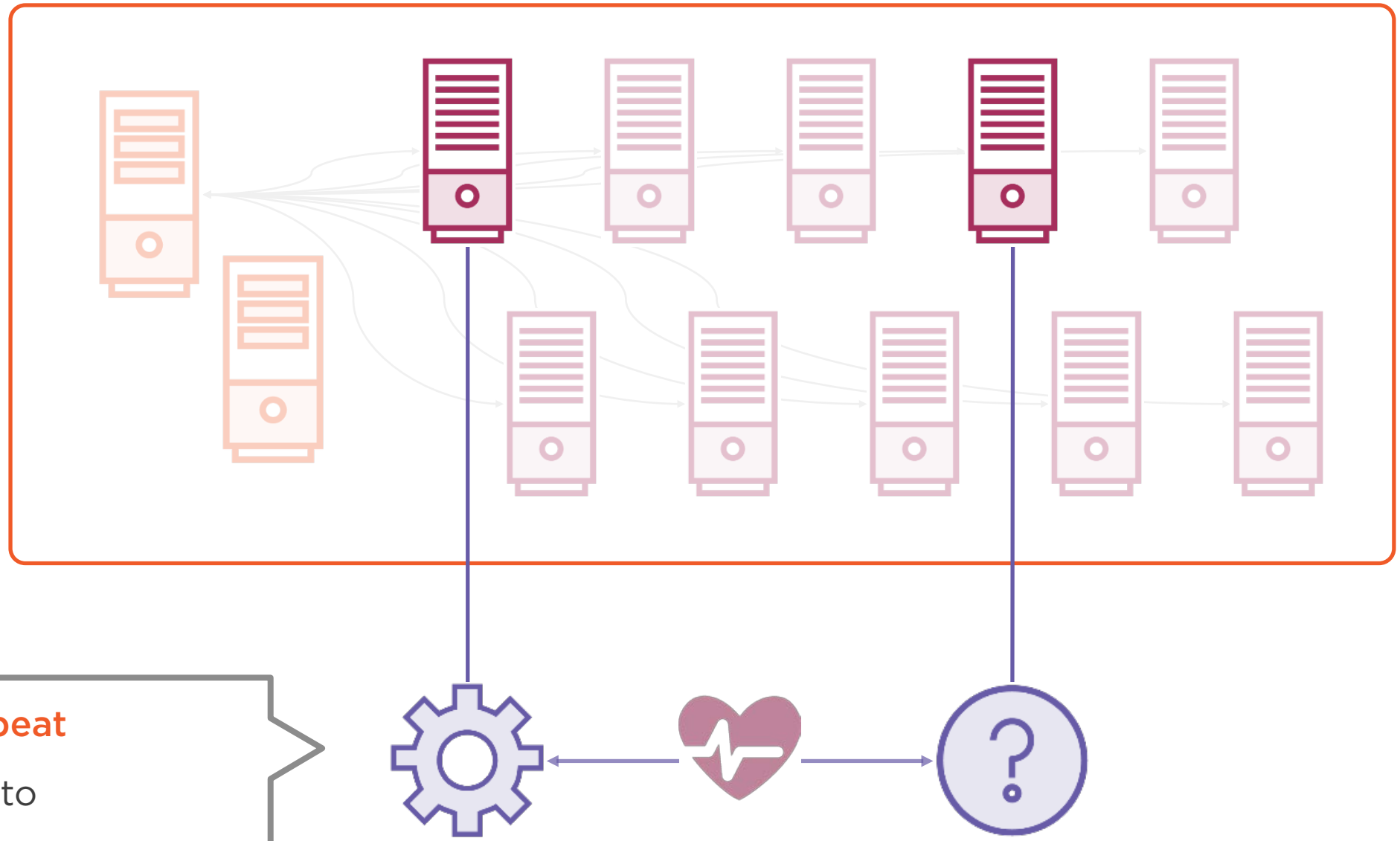
Compute: **Normal**



Cluster Health: **Degraded**

Compute: **Reduced**

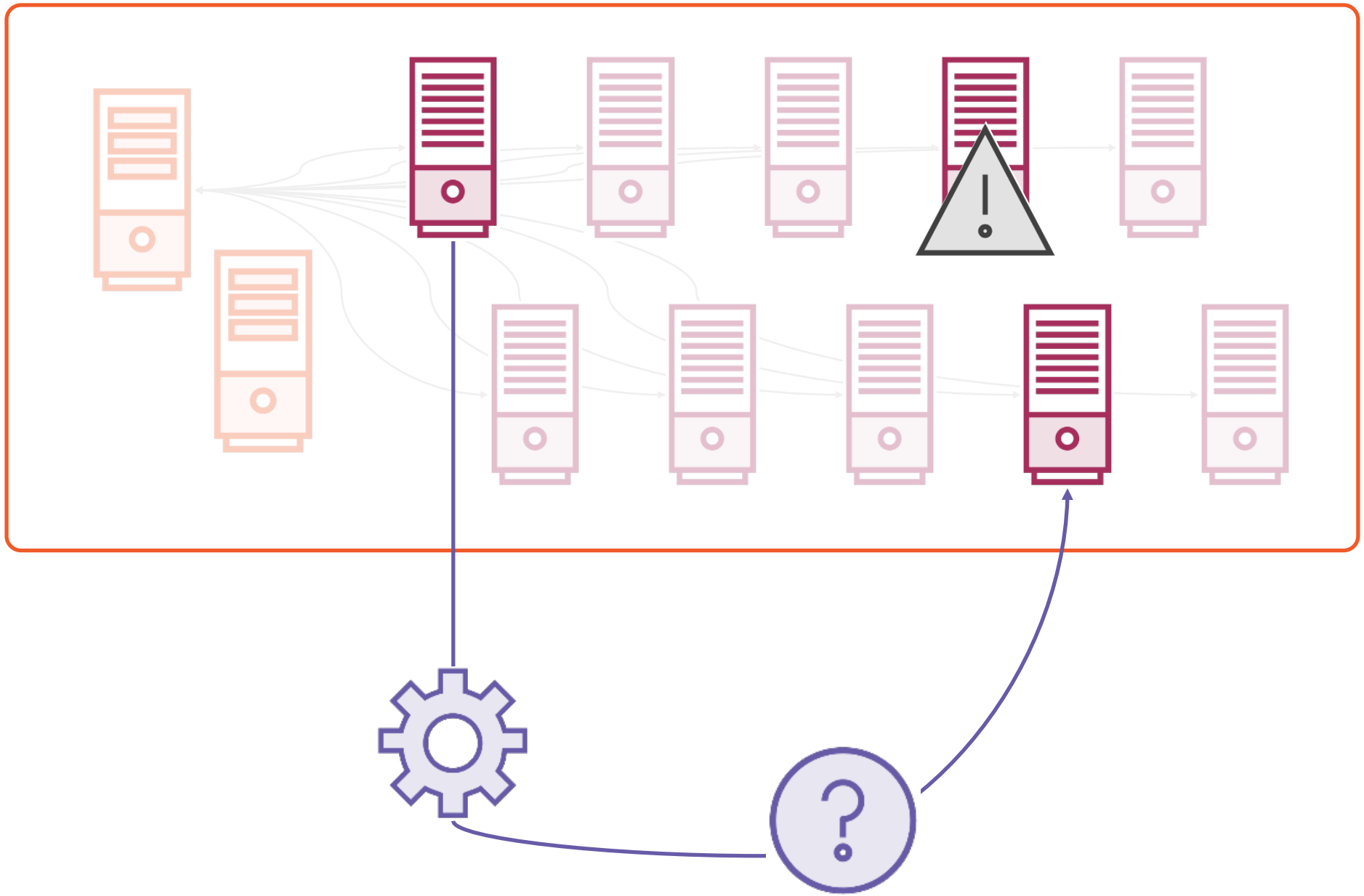


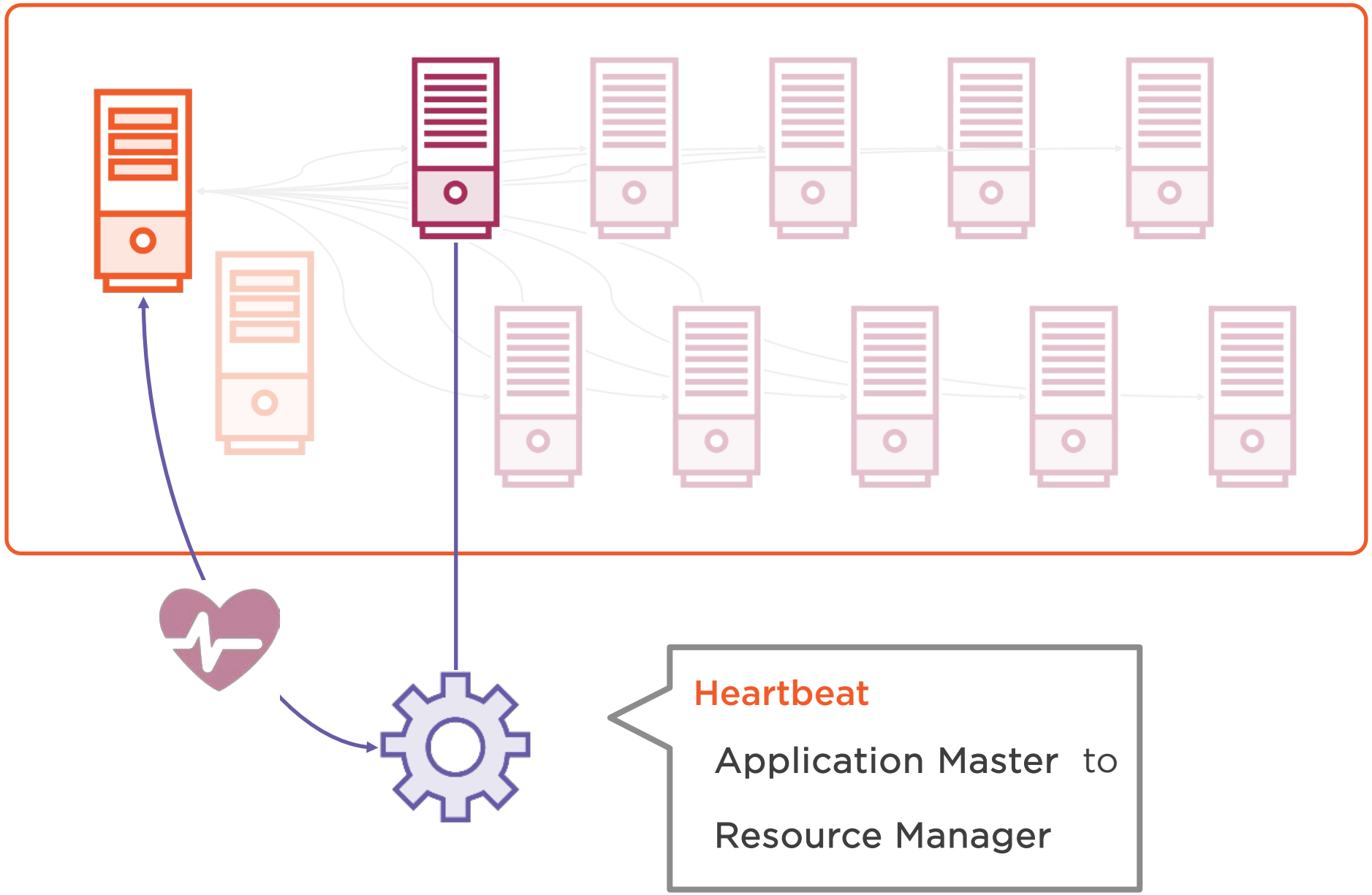


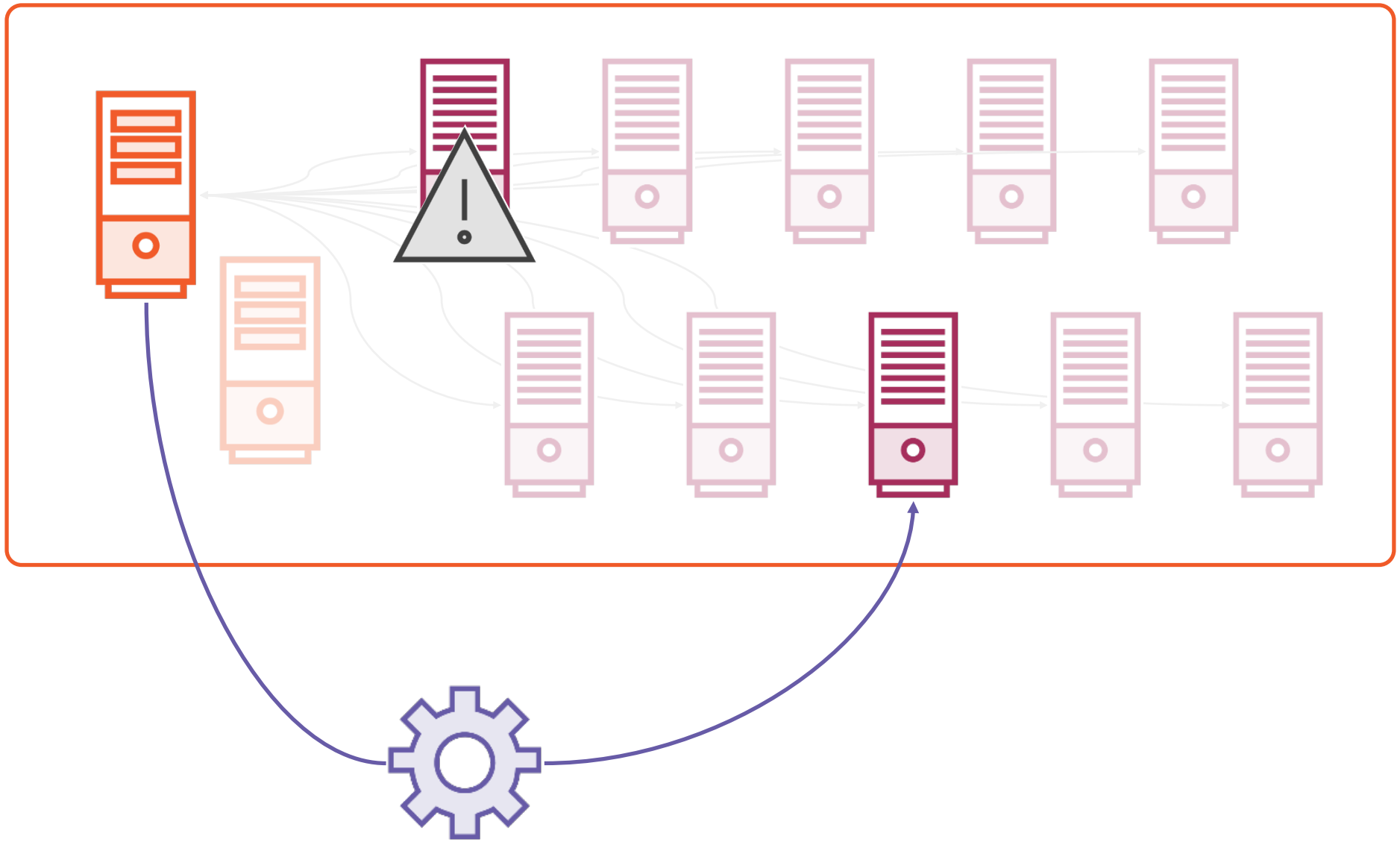
Heartbeat

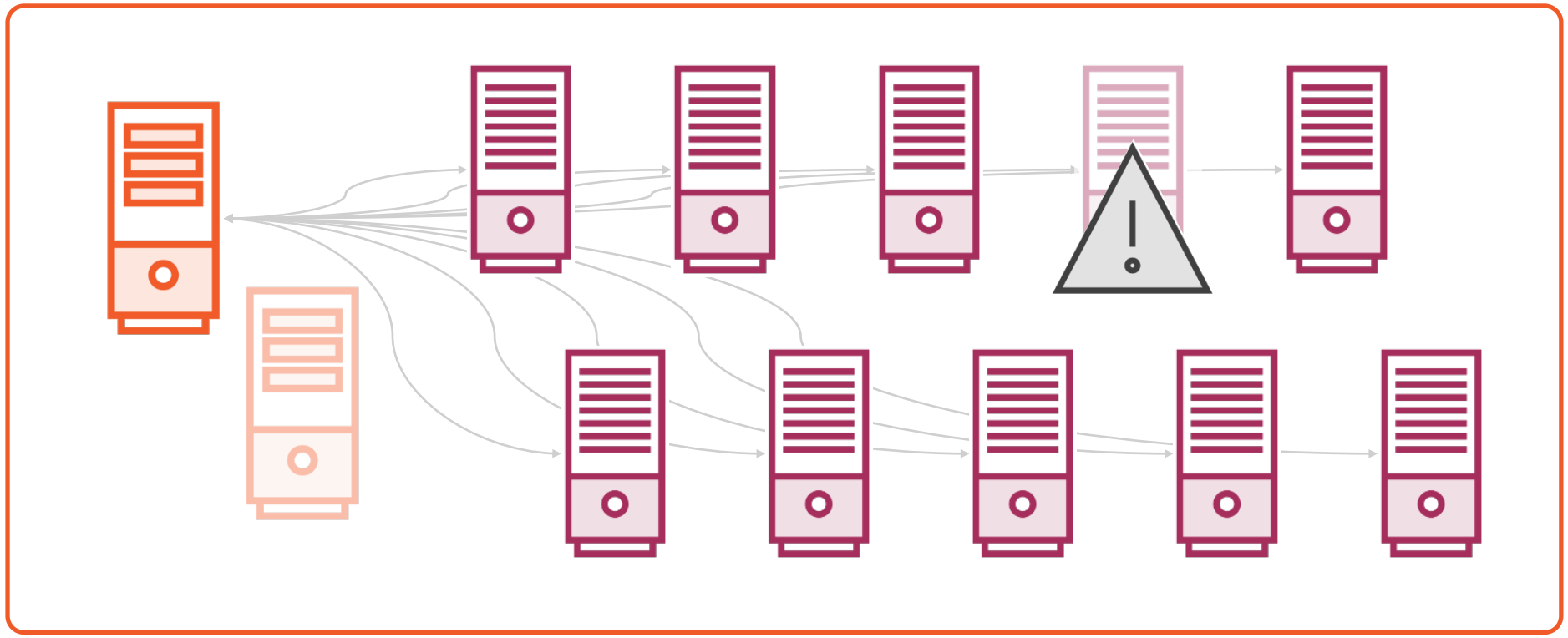
Task to

Application Master



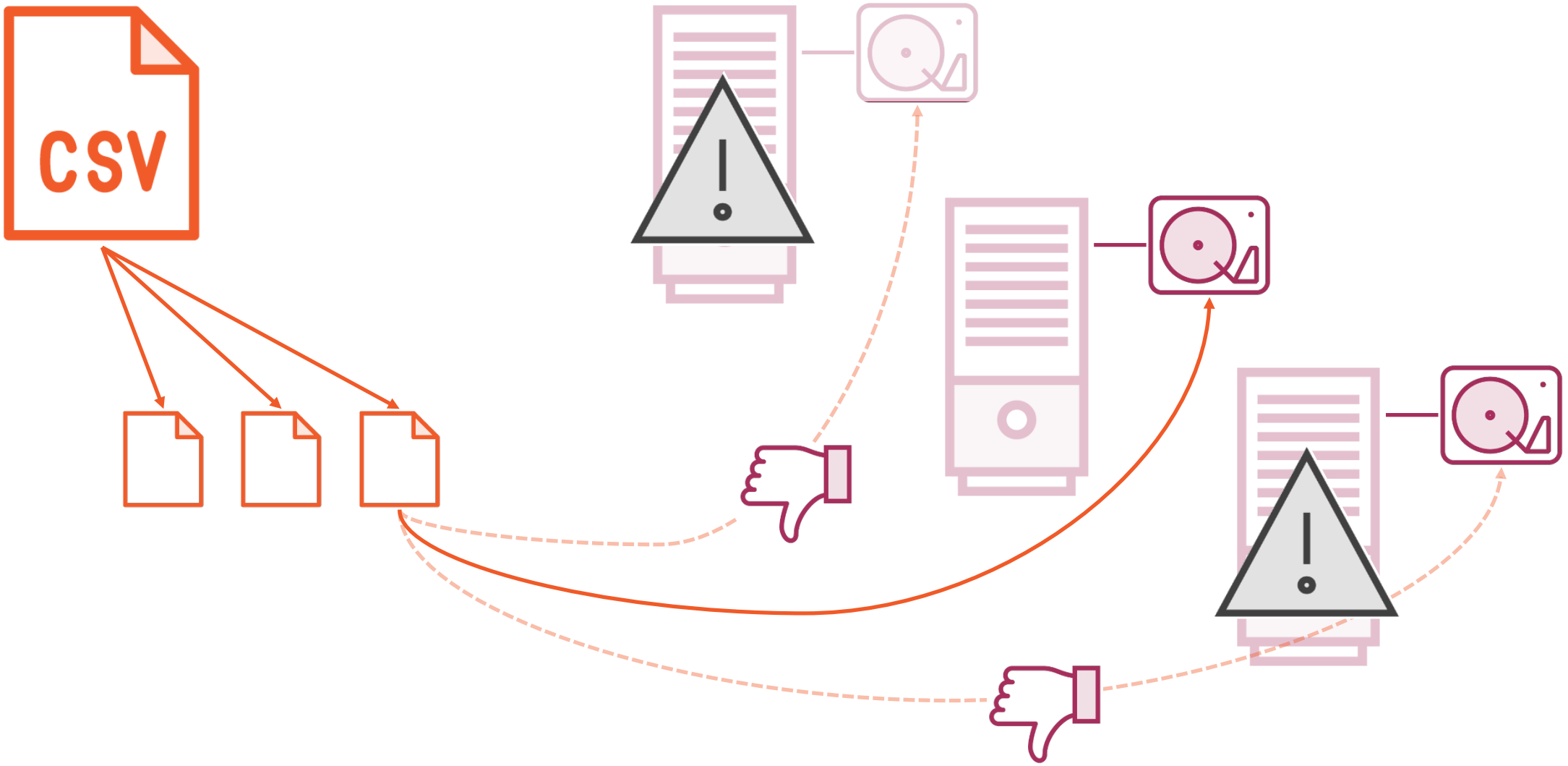

Heartbeat
Application Master to
Resource Manager

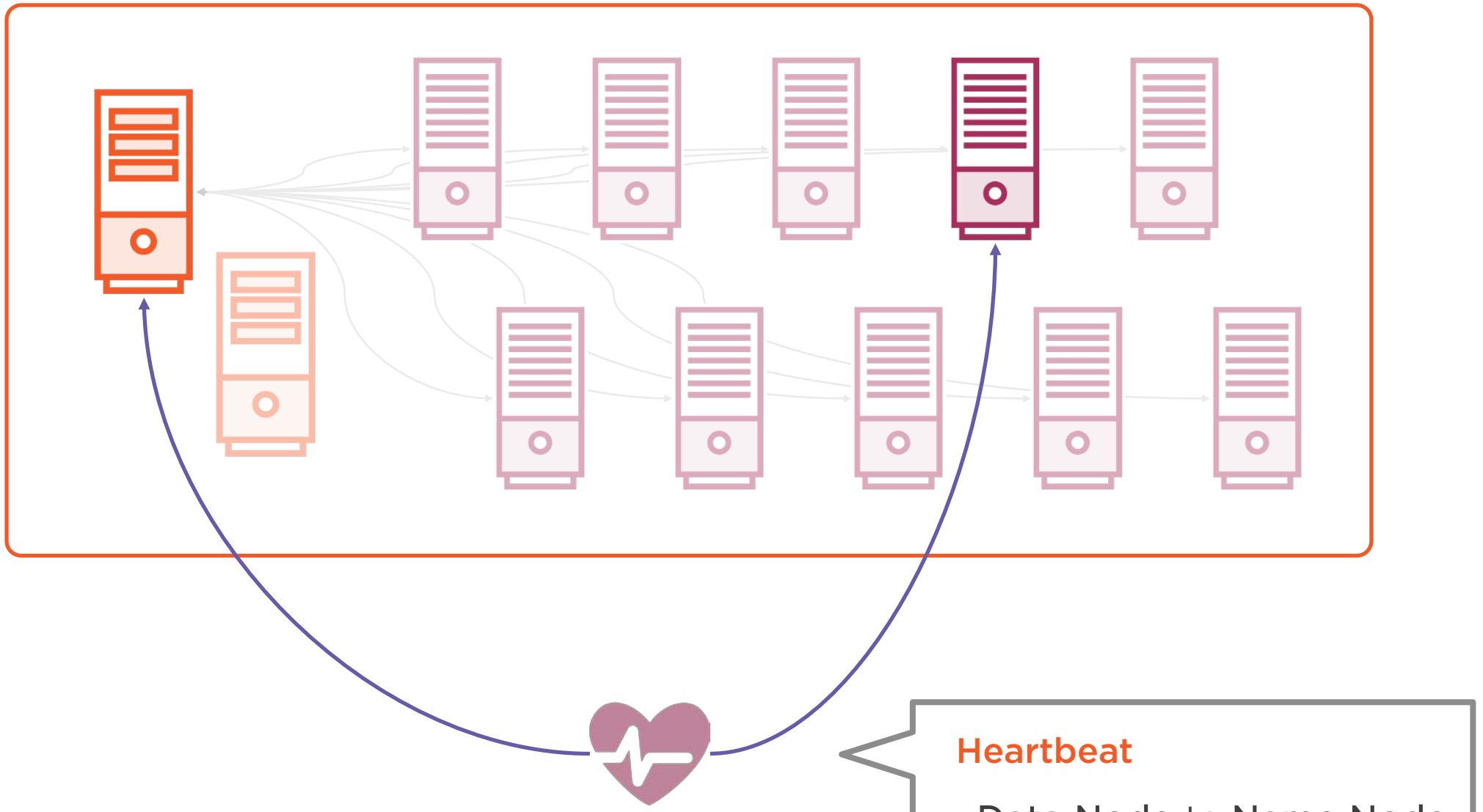


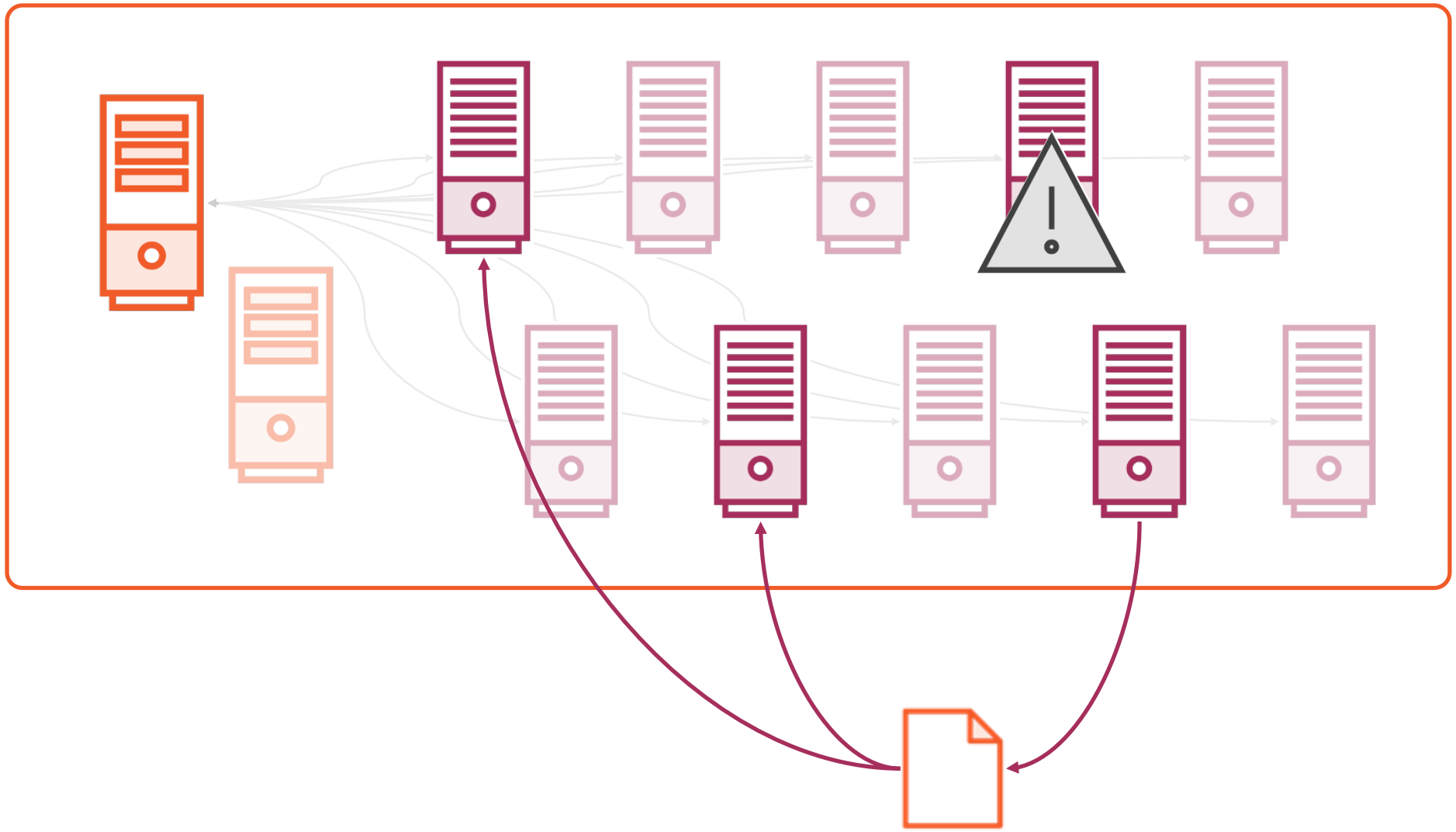


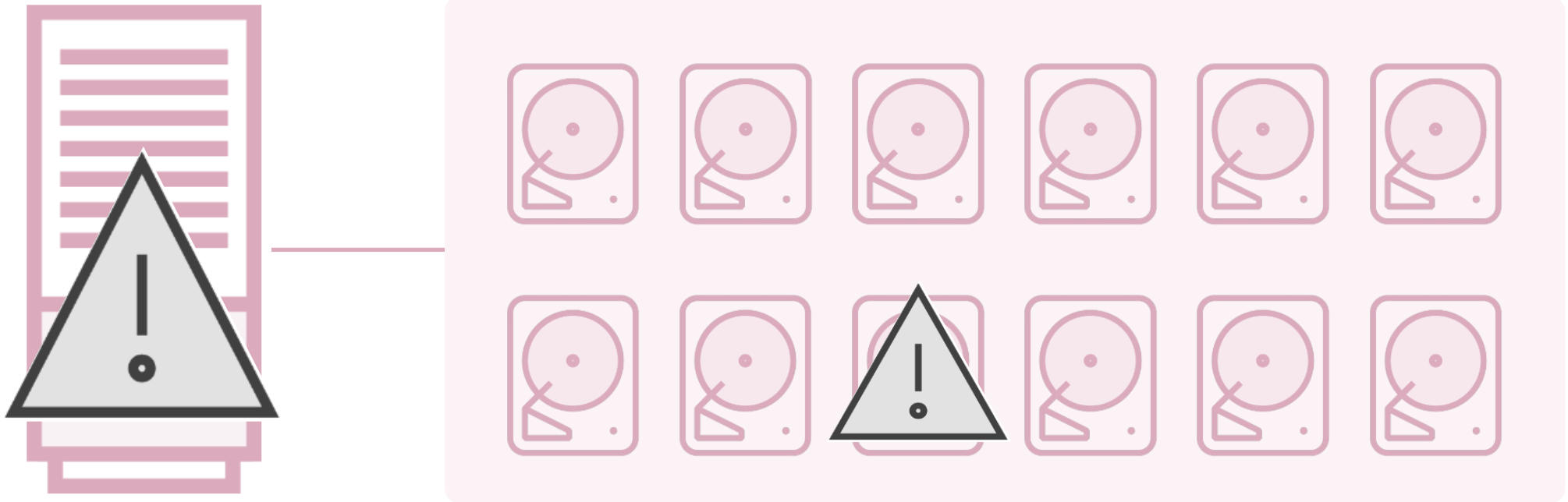
Cluster Health: **Degraded**

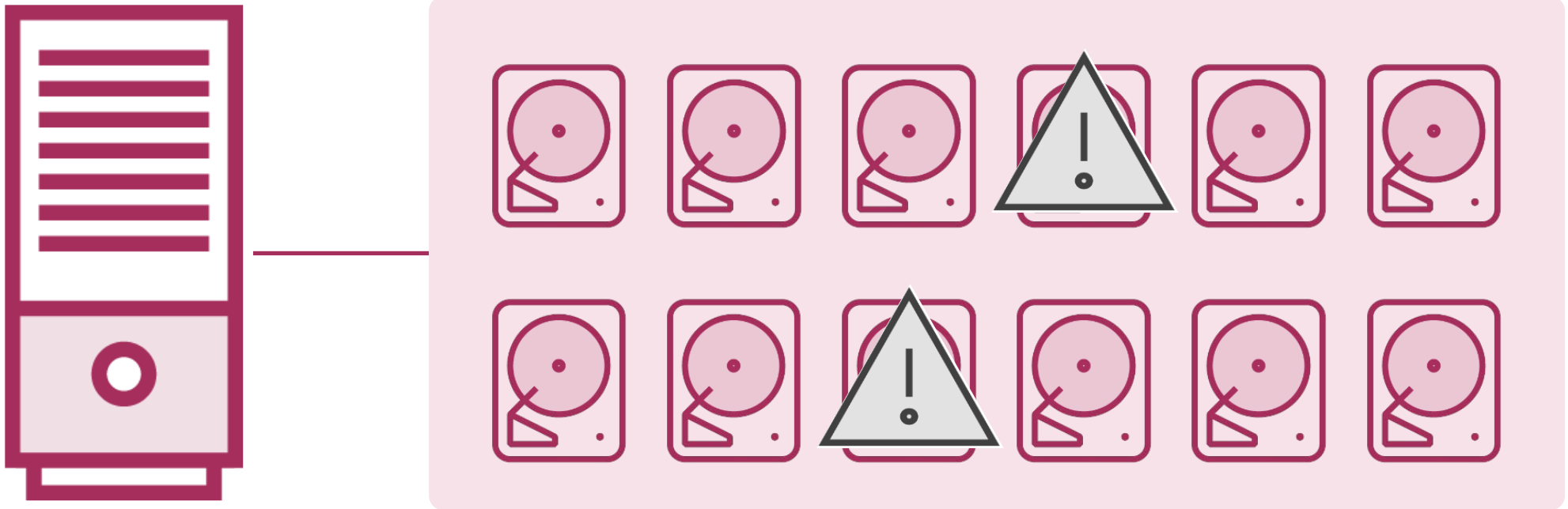
Storage: **Reduced**

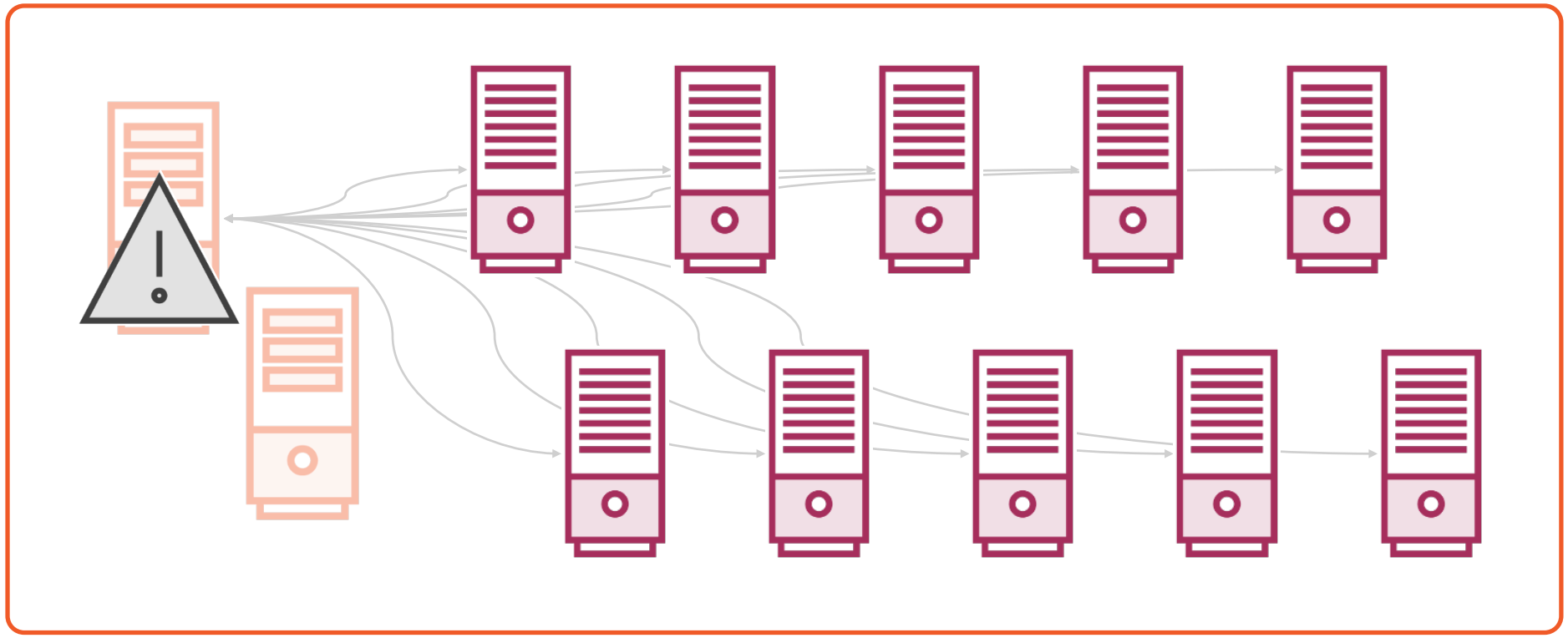

CSV


Heartbeat
Data Node to Name Node





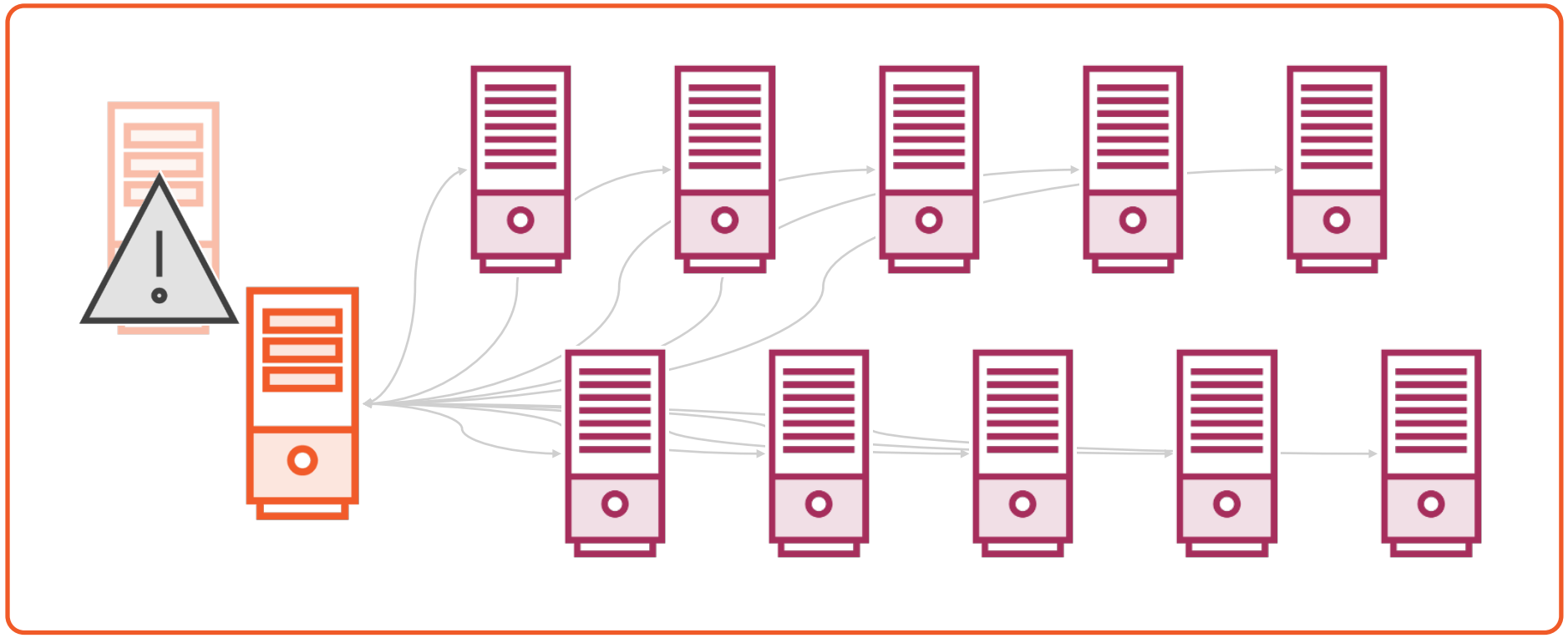




Cluster Health: Offline

Compute: **Unavailable**

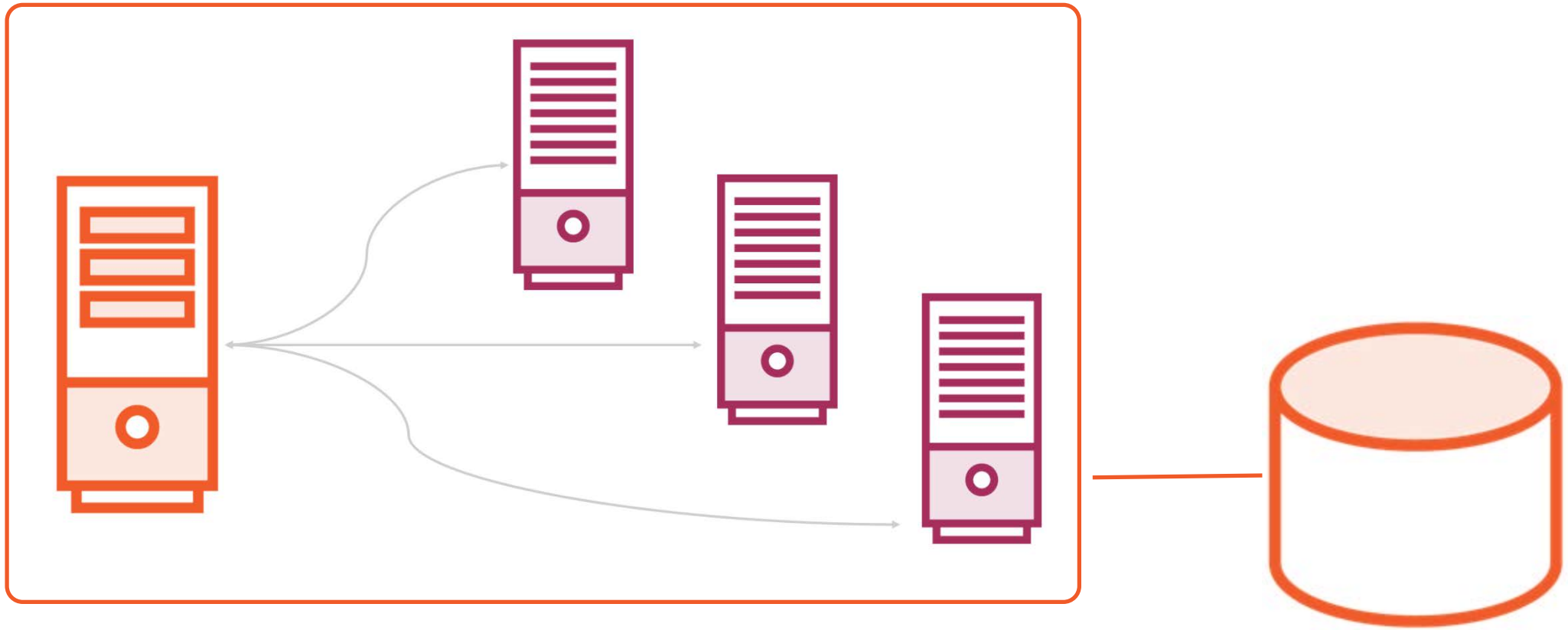
Storage: **Unavailable**



Manual Failover

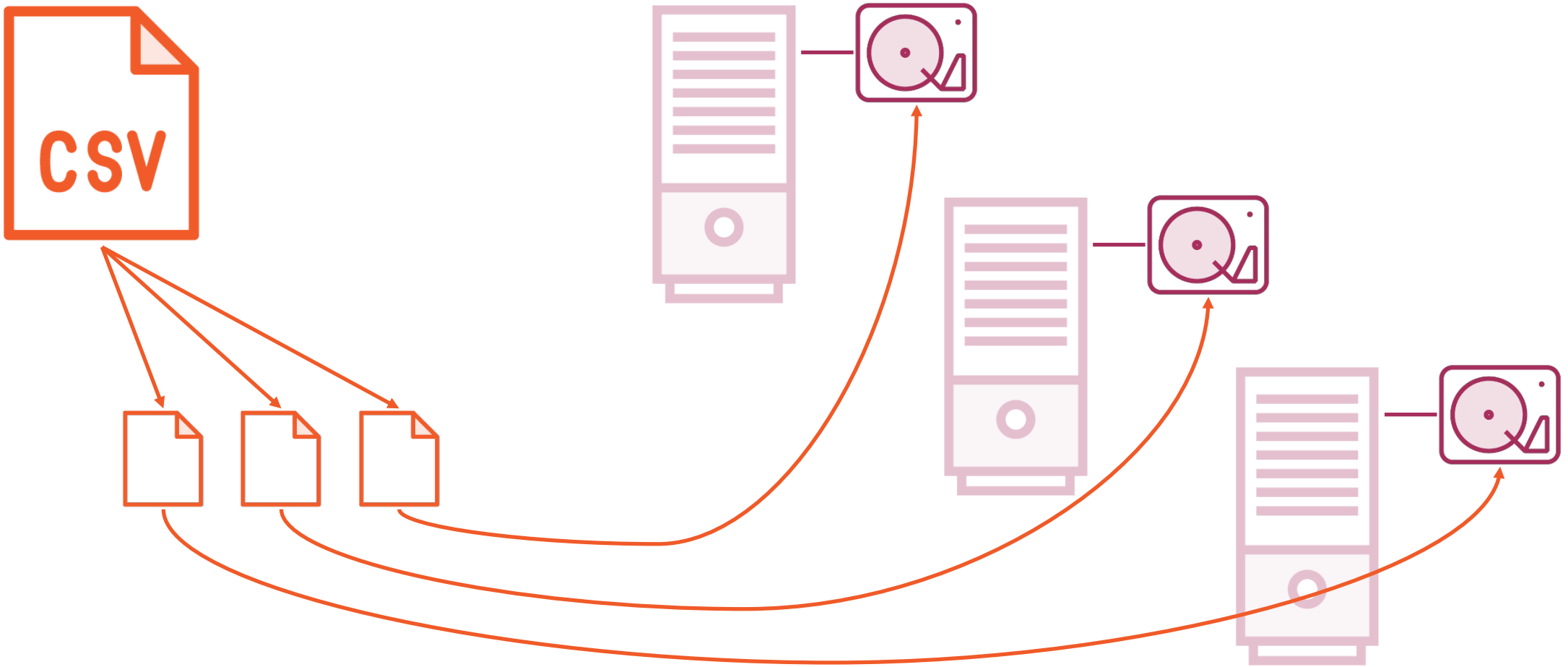
Storage: **Normal**

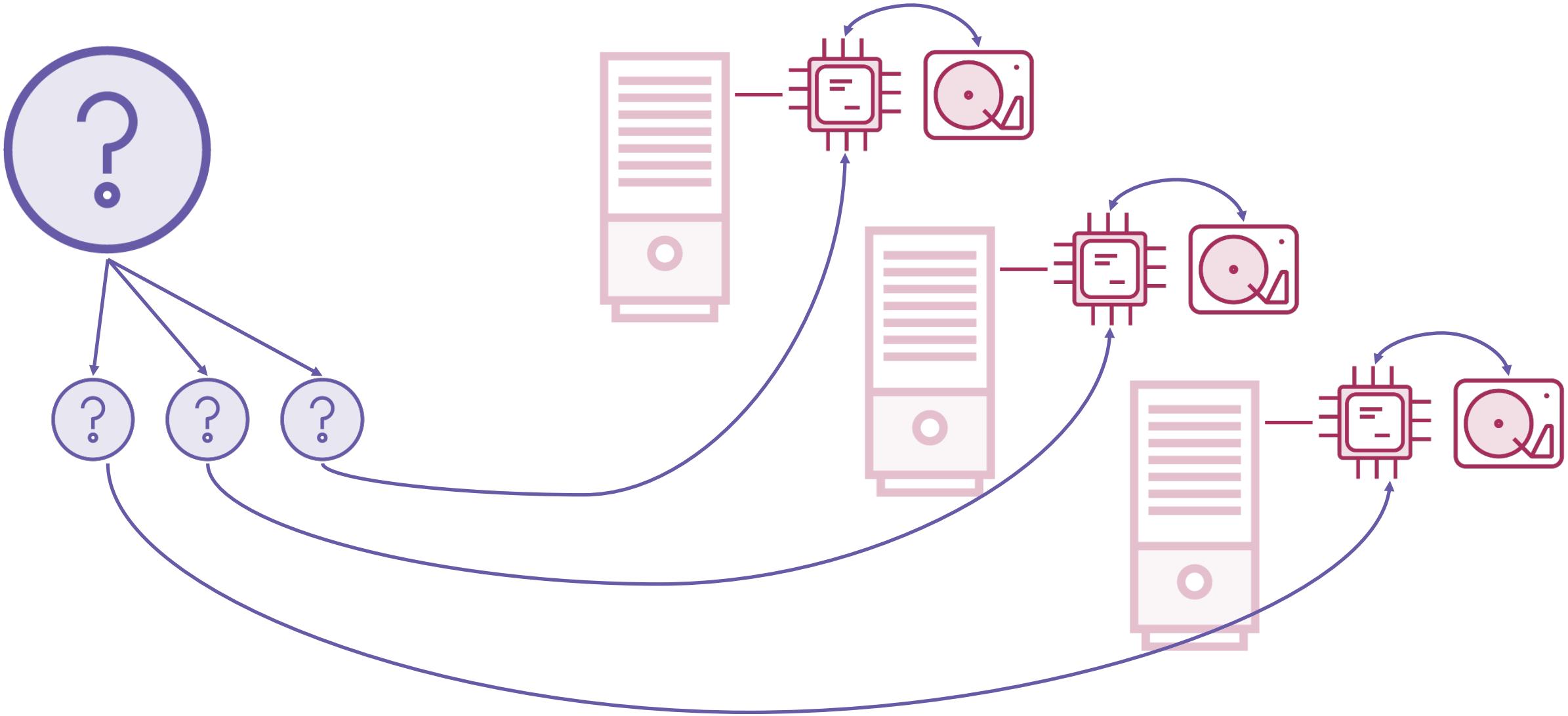
Compute: **Normal**



Hadoop Distributed File System

Yet Another Resource Negotiator


CSV



hadoop fs –put ...

◀ Copy local file to HDFS

hadoop fs –get ...

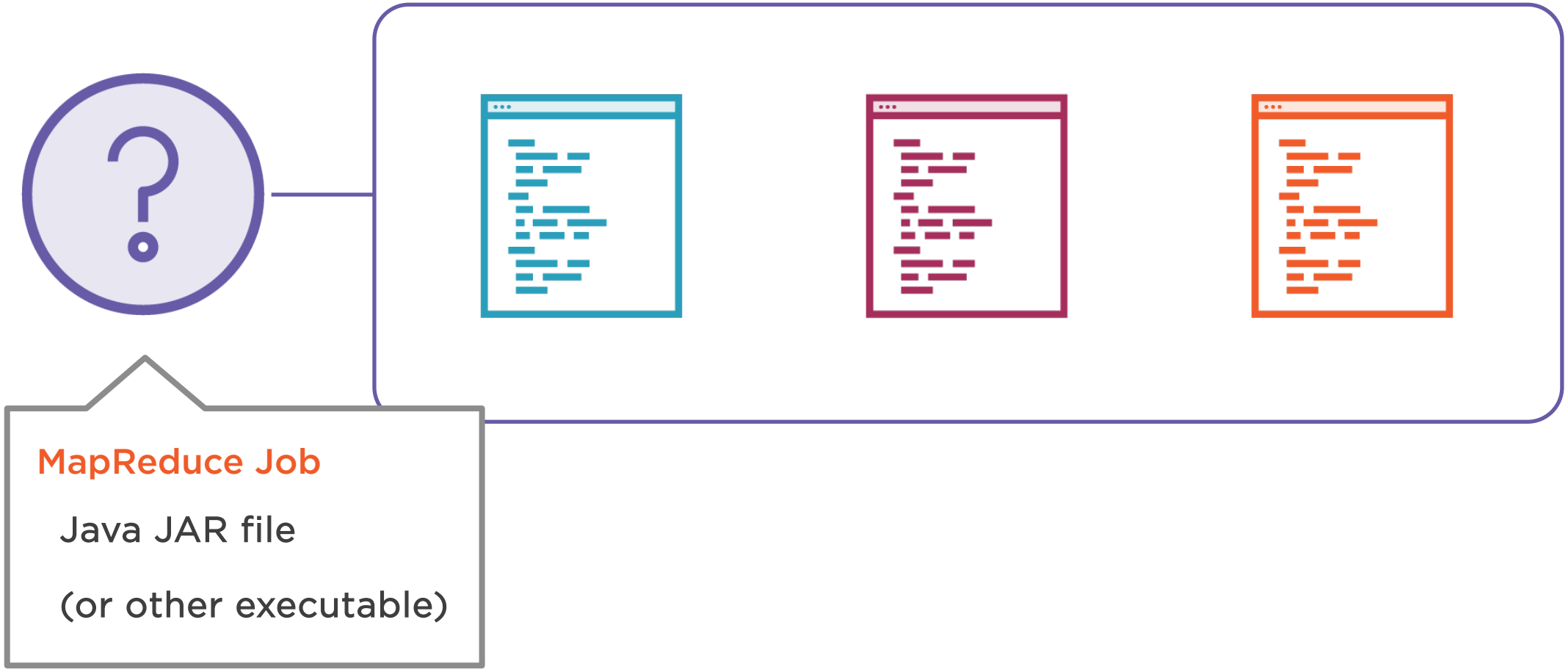
◀ Copy HDFS file to local

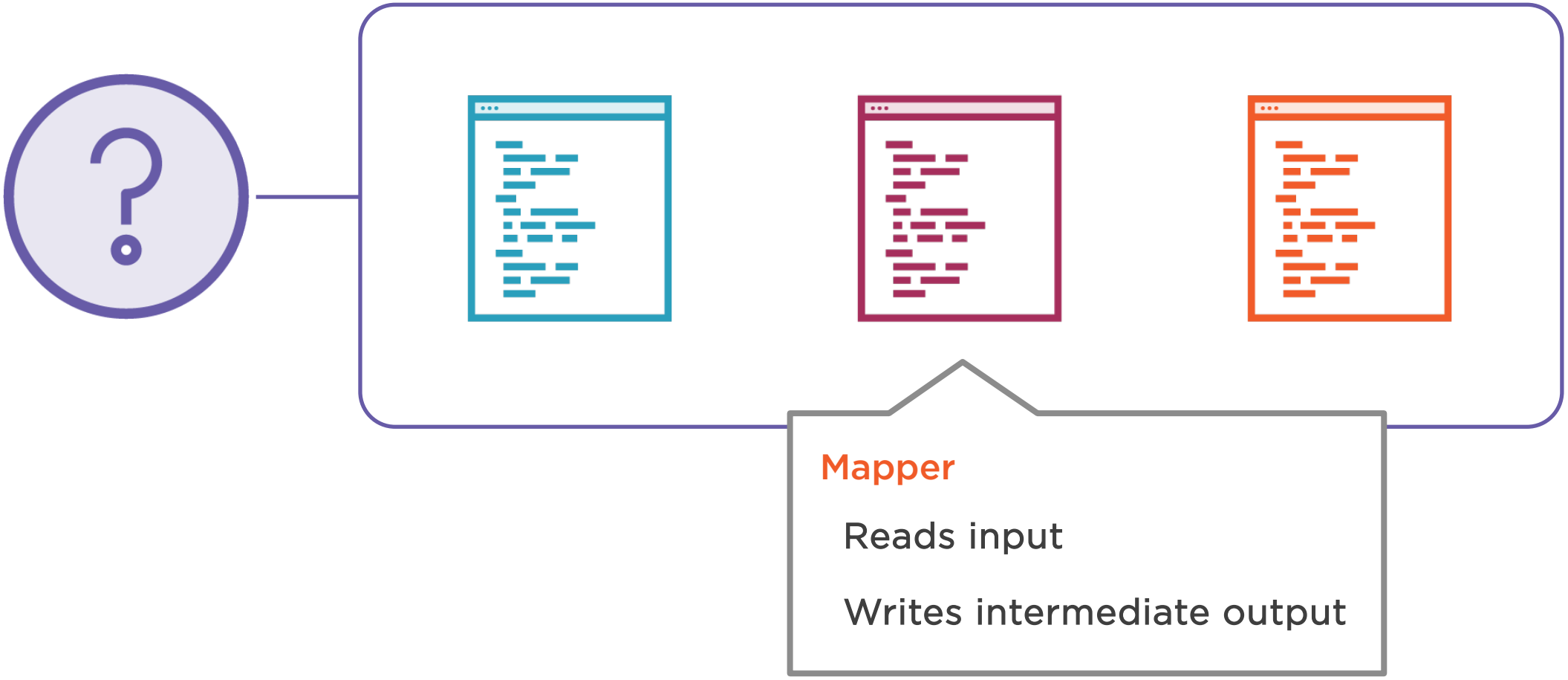
hadoop fs –ls ...

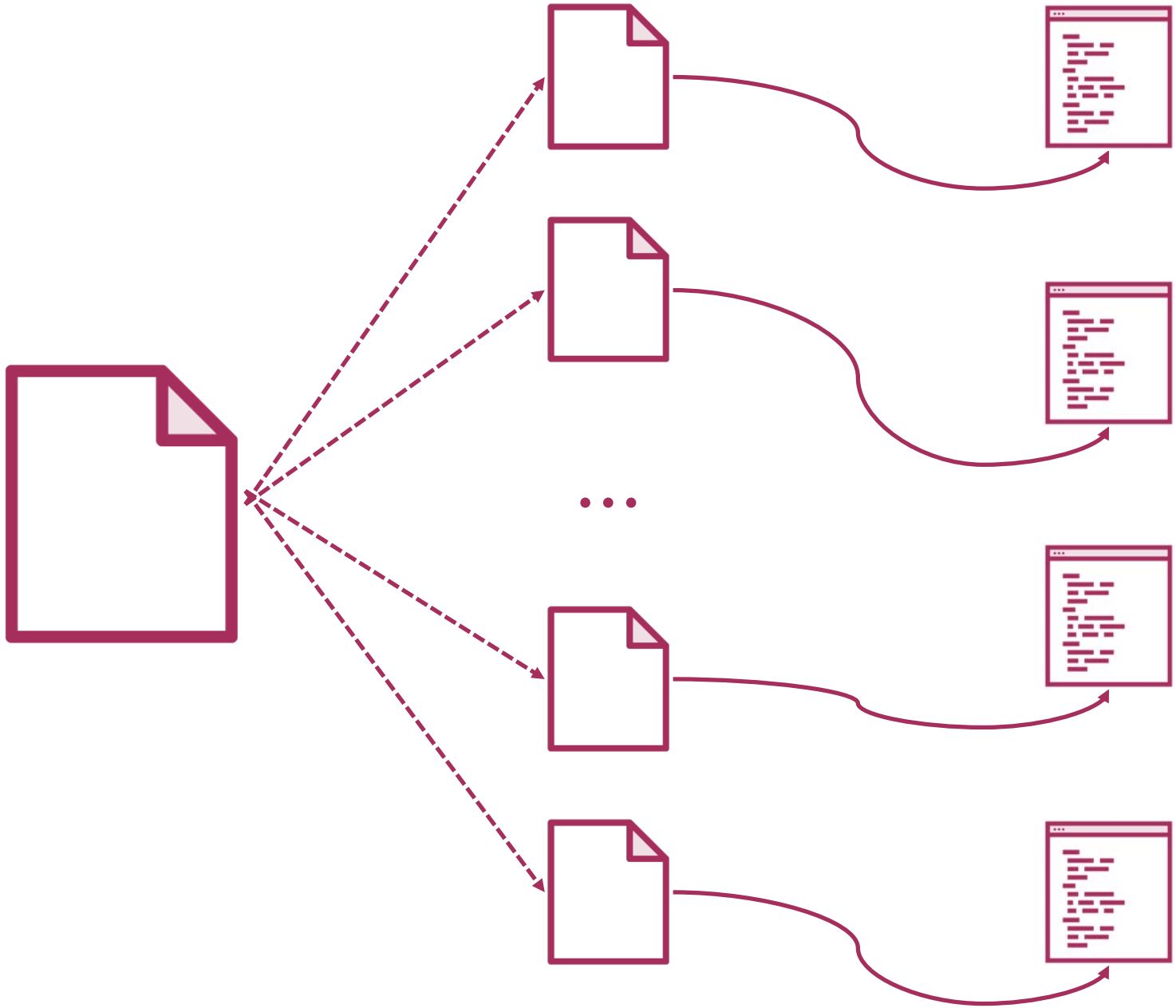
◀ List directory contents

hadoop jar ...

◀ Sumbit MapReduce job


MapReduce Job
Java JAR file
(or other executable)


Mapper
Reads input
Writes intermediate output

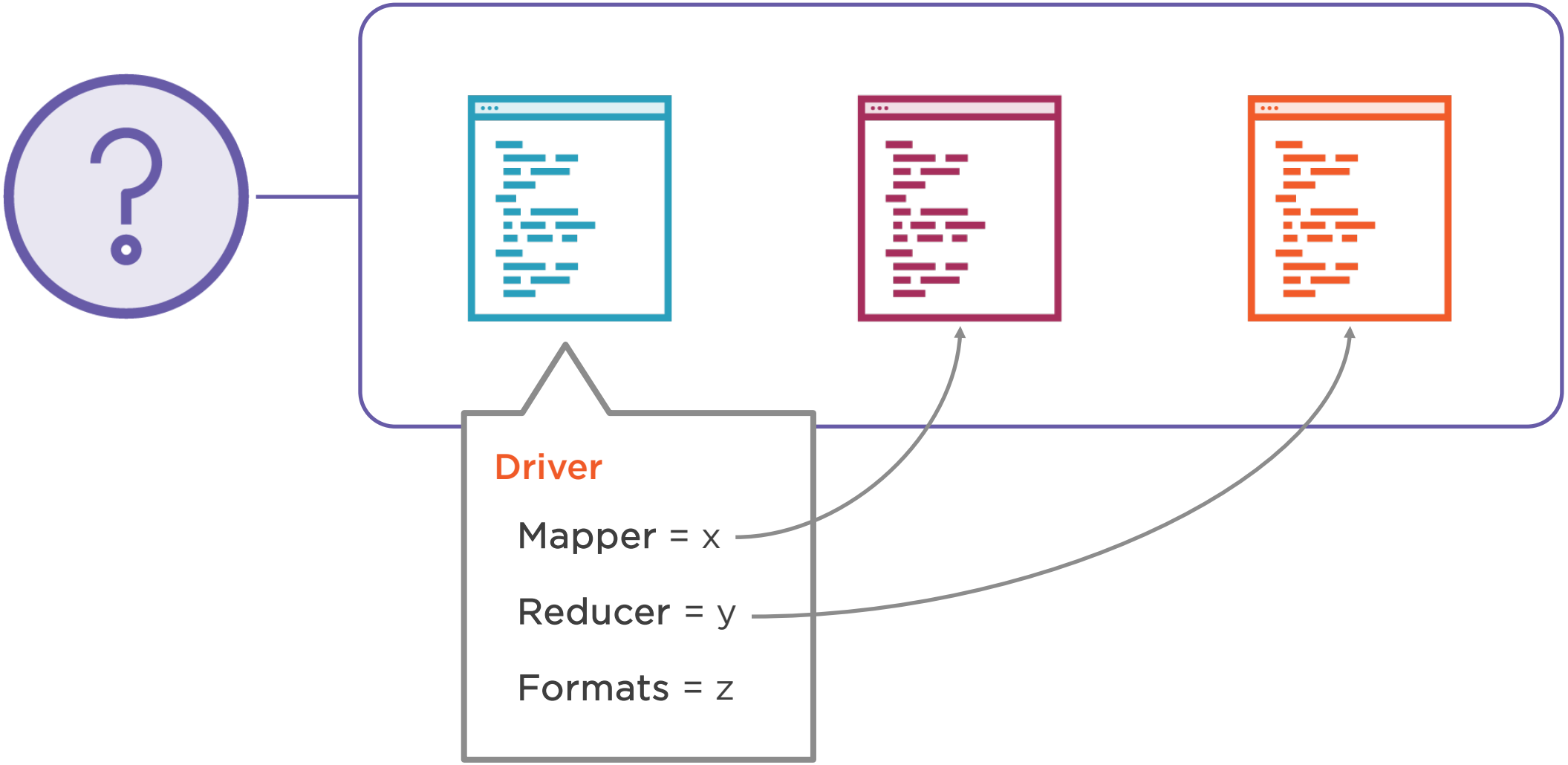


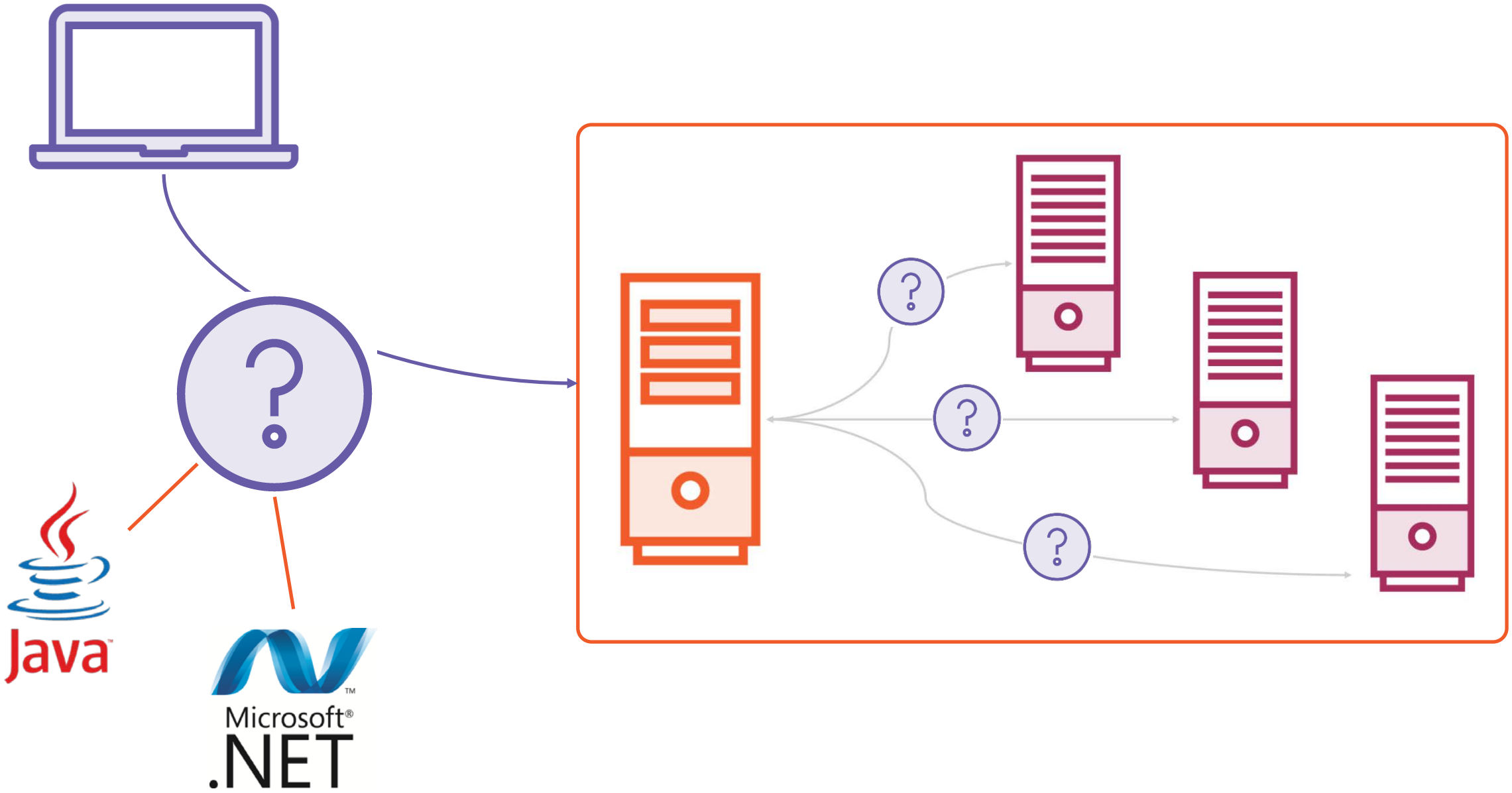
Mappers

Many concurrent tasks

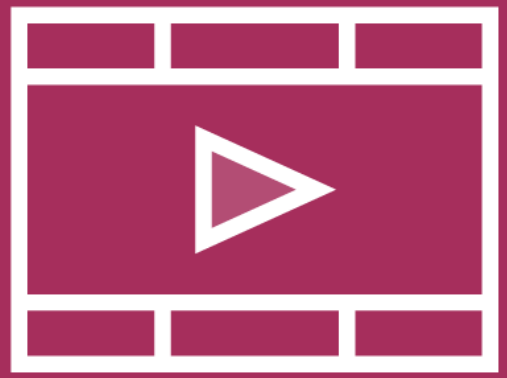
1 per file block


Reducer
Aggregates merged input
Writes final output


Driver
Mapper = x
Reducer = y
Formats = z


Java
Microsoft®
.NET

Coming Next



Running Hadoop on Windows

- Docker containers
- Packaged distributions
- Azure HDInsight