Automation of Rolling Upgrade for Hadoop Cluster without Data Loss and Job Failures

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About Us

Hiroshi Yamaguchi

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Hiroyuki Adachi

- Hadoop Engineer

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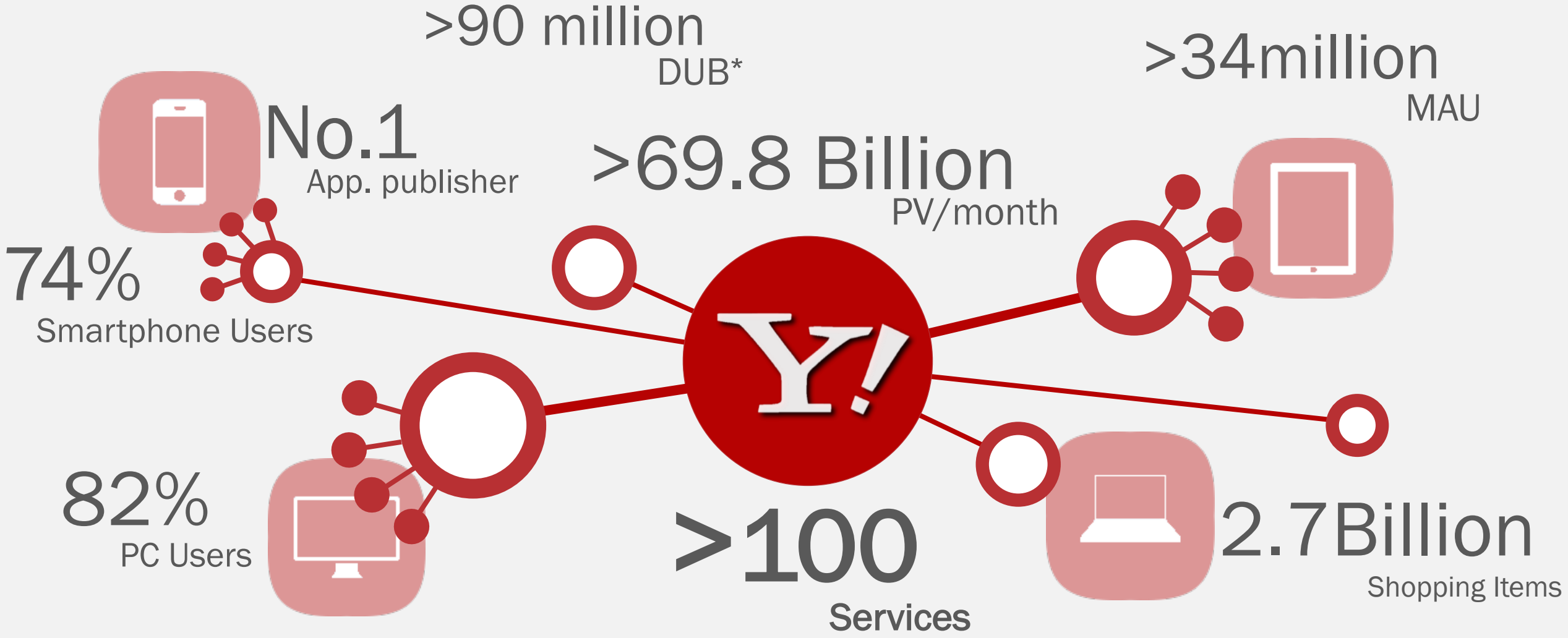
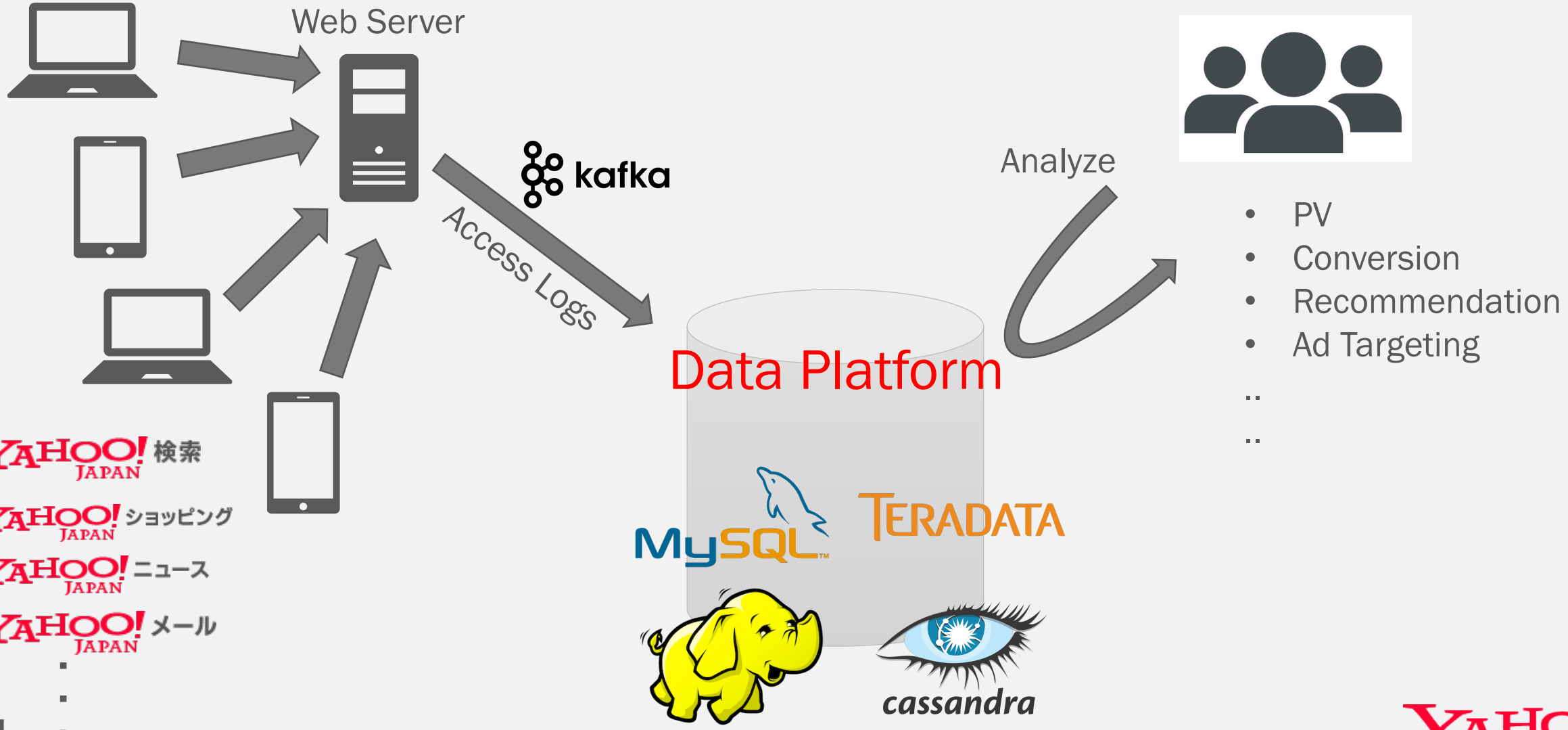
Largest Portal Site in Japan



* Daily Unique Browsers

Overview of Our Data Platform



Agenda

1. Our Hadoop Cluster
2. Issues Involved in Previous Upgrade
3. Upgrade Approach
4. How to Upgrade
5. Results
6. Conclusion

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Our Hadoop Cluster

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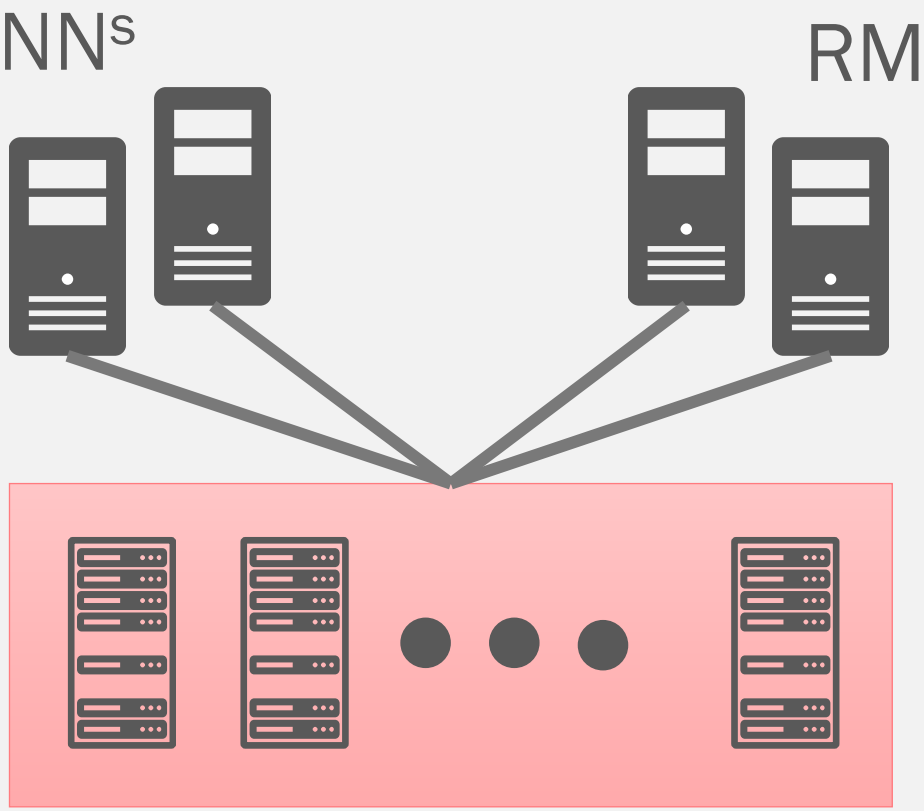
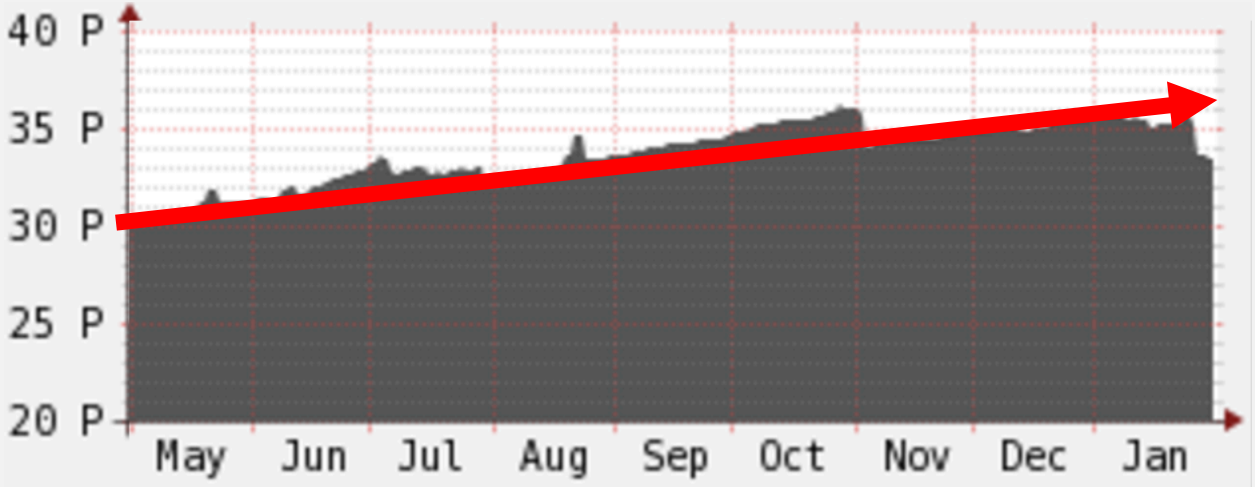
Overview

- HDP 2.3 + Ambari 2.2
- Almost all core components are configured with HA
  - HA: NameNode, ResourceManager, JournalNode, Zookeeper
  - Non HA: Application Timeline Server
- Secured with Kerberos
- 800 slave nodes
  - DataNode/NodeManager
- Other components
  - HiveServer2, Oozie, HttpFS



Data Volume



Increase in data volume

- Total stored data 37 PB
- Increases about
  50 ~ 60 TB/day

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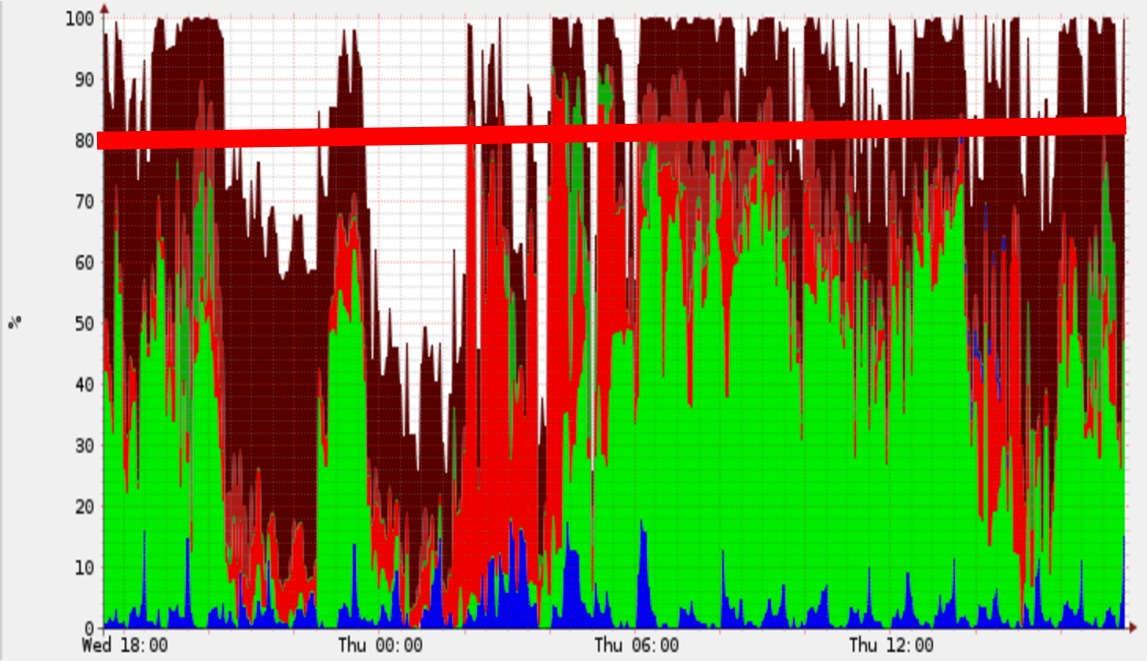
Work Load



YARN work load of the day

- Multi-tenant cluster
  - ETL / E-Commerce / Advertising / Search ...
  - 20K ~ 30K jobs/day
- Average resource utilization is over 80%
- Data processing needs are growing

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Issues Involved in Previous Upgrade

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Previous Upgrade

- Performed in Q4 2015
- Without using Ambari
- Manual Express Upgrade including above mentioned steps

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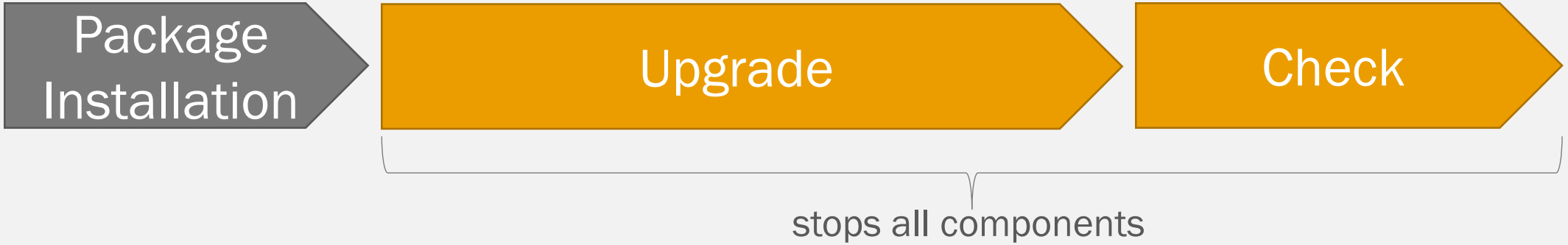
Previous Upgrade



- Upgrade
  - Restarting all components for updates to come into effect
- Check
  - Component's normality checks
  - Wait till missing blocks to be fixed

It took 12 hours

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Issue 1 : 12 Hours of Cluster Down

- Why took so long ?
  - Large number of slave nodes
  - Multiple nodes failed to start after upgrade
  - Job failed due to data loss
  - Must recover missing blocks

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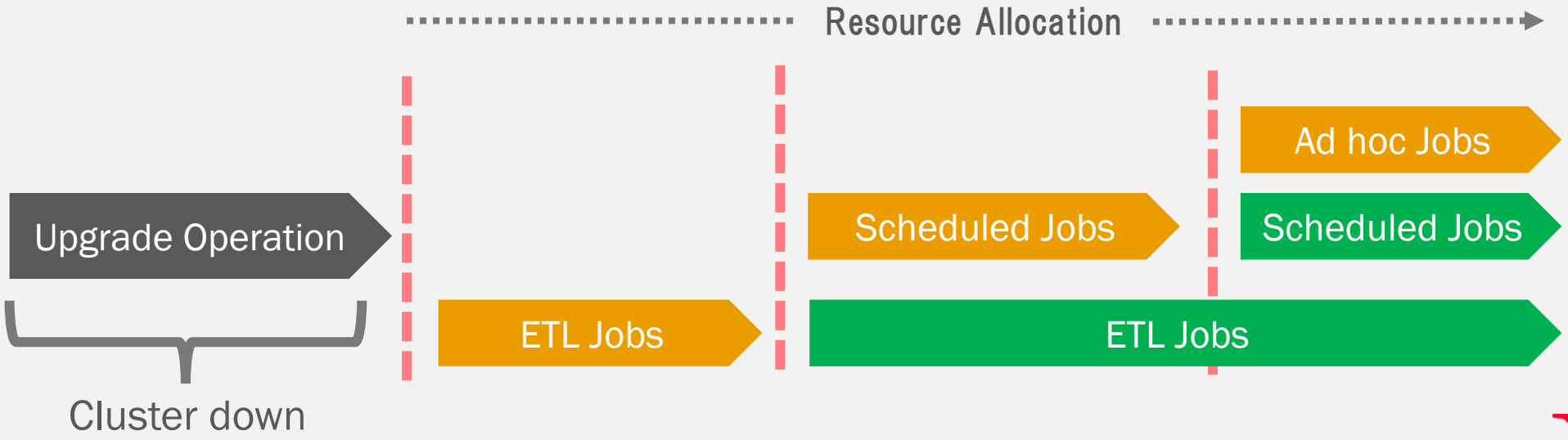
Issue 2 : Finding Right Schedule

- Challenging to find a right schedule
  - Cluster is multi-tenant, shared by hundreds of services
  - Picking a day with minimal impact
    e.g. A day without weekly or monthly running jobs

Photo by: Aflo

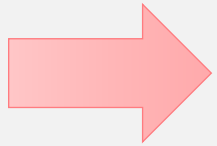
Issue 3 : Coordinating Resource Allocation

- Post-Upgrade : Restarting all jobs simultaneously caused resource exhaustion
- Jobs were recovered by precedence



Issues to be Addressed

- Storage
  - Should not affect HDFS Read/Write
  - Should prevent missing blocks
- Processing
  - To keep Components (Hive, Oozie ...) working



Impact-less upgrade operation

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Upgrade Approach

Possible Upgrading Methods

1. Ambari Provided Express Upgrade
2. Ambari Provided Rolling Upgrade
3. Manual Express Upgrade
4. Manual Rolling Upgrade

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Possible Upgrading Methods

1. Ambari Provided Express Upgrade
2. Ambari Provided Rolling Upgrade
3. Manual Express Upgrade
4. Manual Rolling Upgrade

1’st and 2’nd are not suitable for our environment
3’rd has several issues as explained earlier

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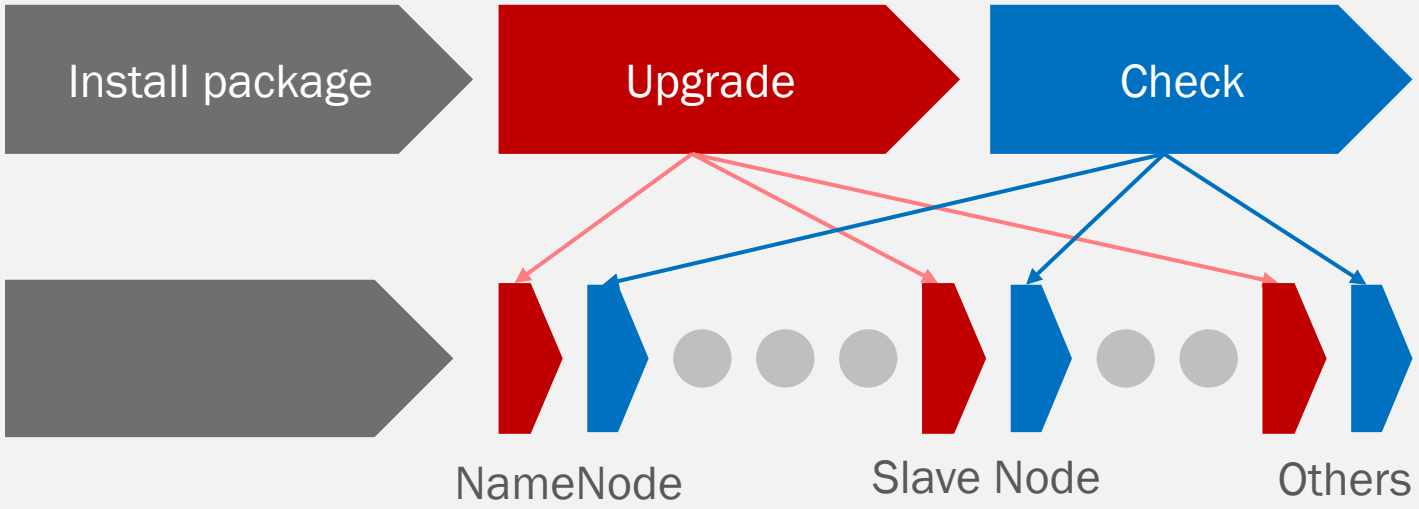
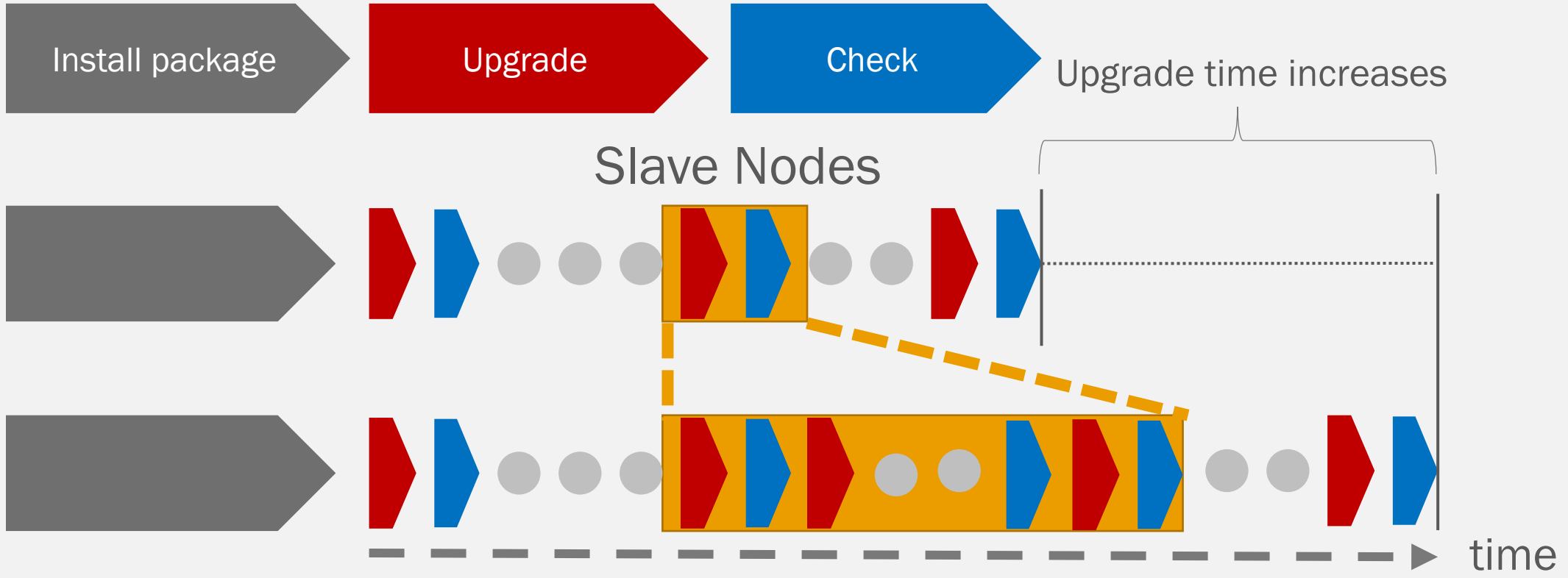
Approaches for Upgrading



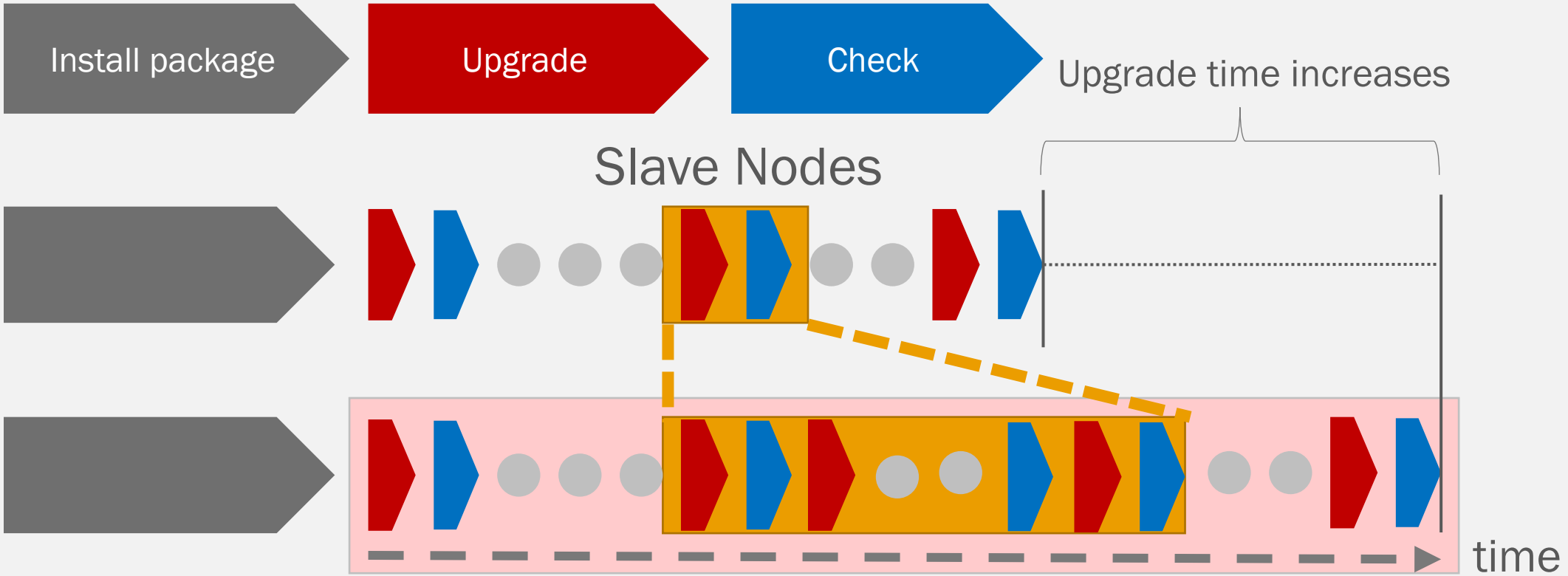
- Impact-less Rolling Upgrade
  - Grouping components e.g. NameNode
  - Upgrading & Checking each component group

Approaches for Upgrading



- Total upgrade time increases as slave nodes are upgraded one-by-one for safety

Approaches for Upgrading



- Automating upgrade and check process to reduce operation cost

Summary

- Impact-less rolling upgrade is possible
- Automating upgrade process reduces operation cost

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How to Upgrade

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Target Cluster

- HDP 2.3.x + Ambari 2.2.0
- Master nodes
  - HA: NameNode, ResourceManager, JournalNode, Zookeeper
  - Non-HA: Application Timeline Server
- Slave nodes
  - 800 DataNode/NodeManager
- Others
  - HiveServer2, Oozie, HttpFS

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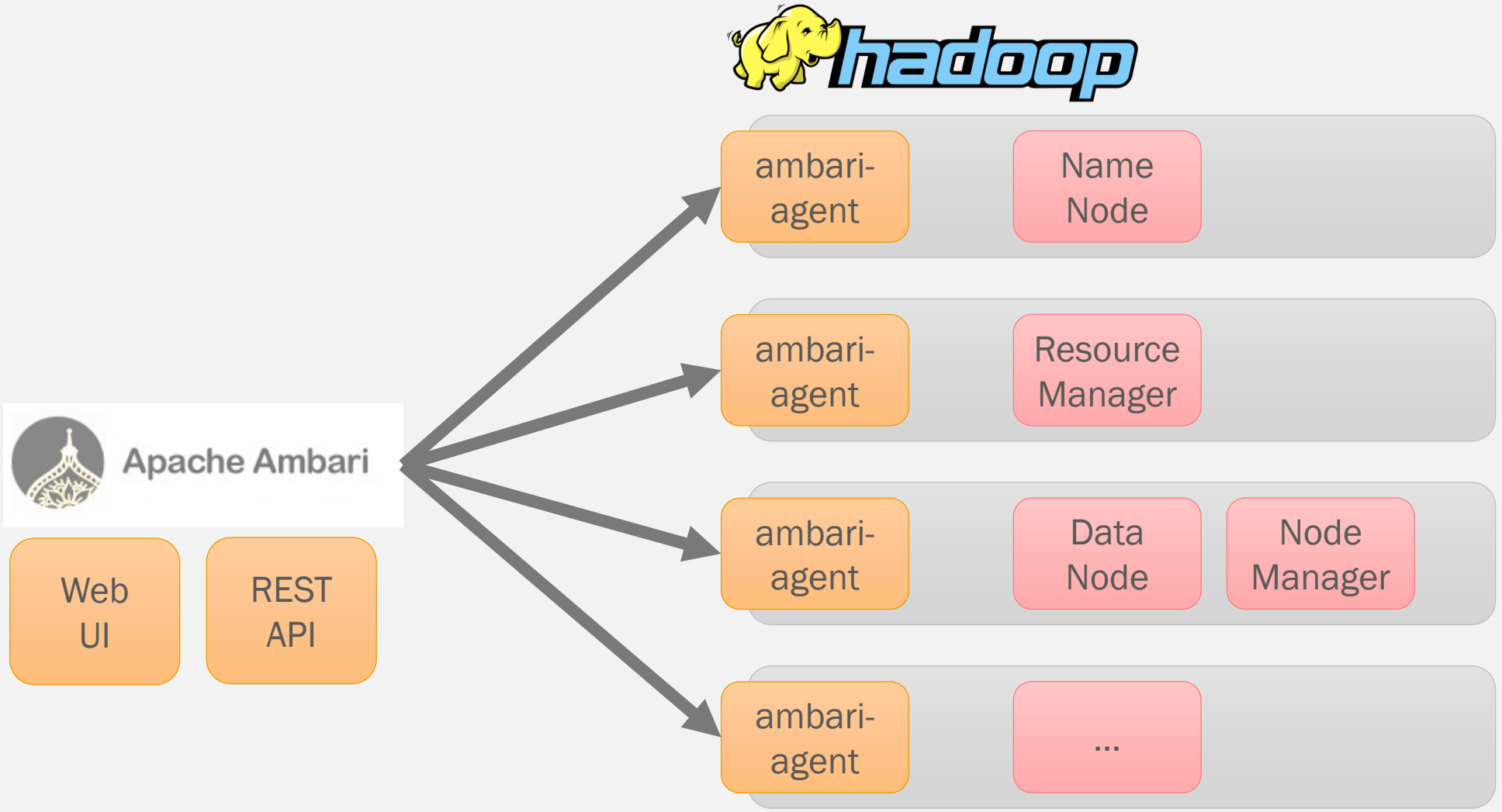
Apache Ambari



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Ambari Provided HDP Upgrade Methods

- Express Upgrade
  - Brings down entire cluster
- Rolling Upgrade
  - Cannot control
    - Load balanced HiveServer2 restart
    - Collective DataNode restart

But we can’t adopt either of these methods

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Extending Ambari's Operations

- Safety restart and our environment specific operations
  - Ambari Custom Service
    - Additional operations such as NN failover
  - API wrapper scripts
    - Additional confirmation of service normality
    - Precise control

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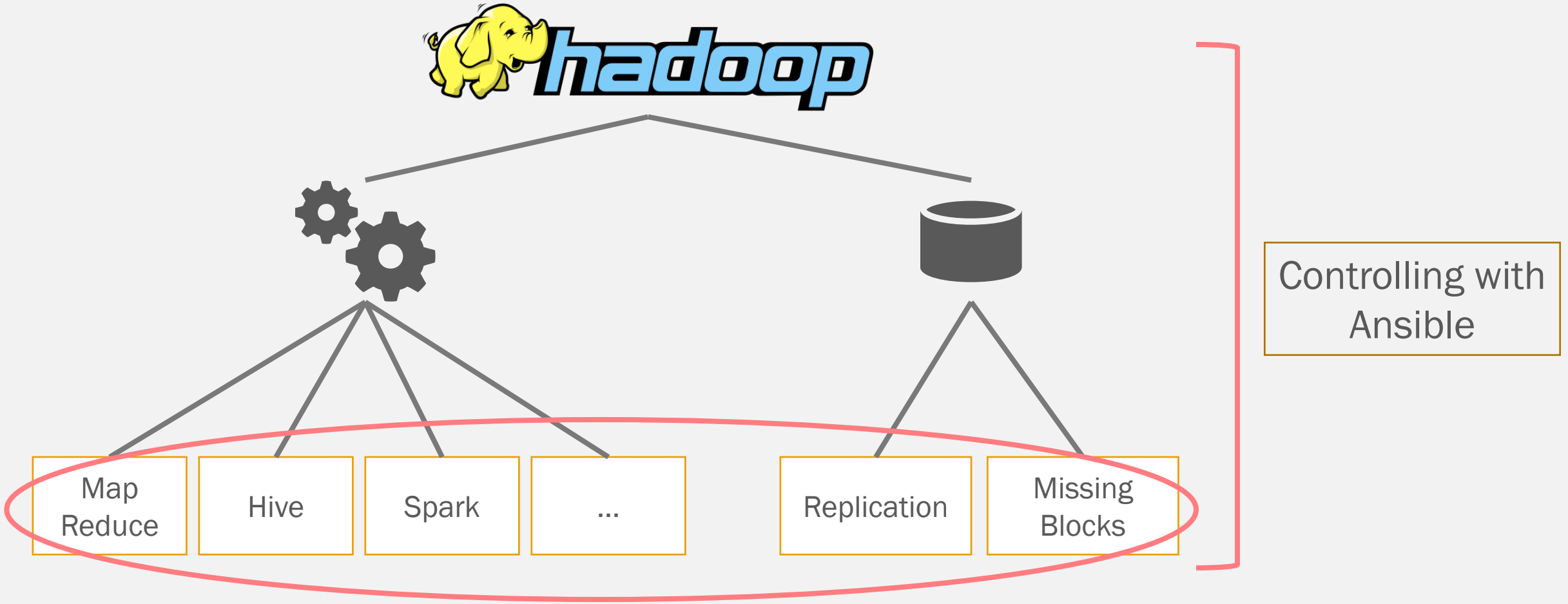
For Non-stop Upgrade



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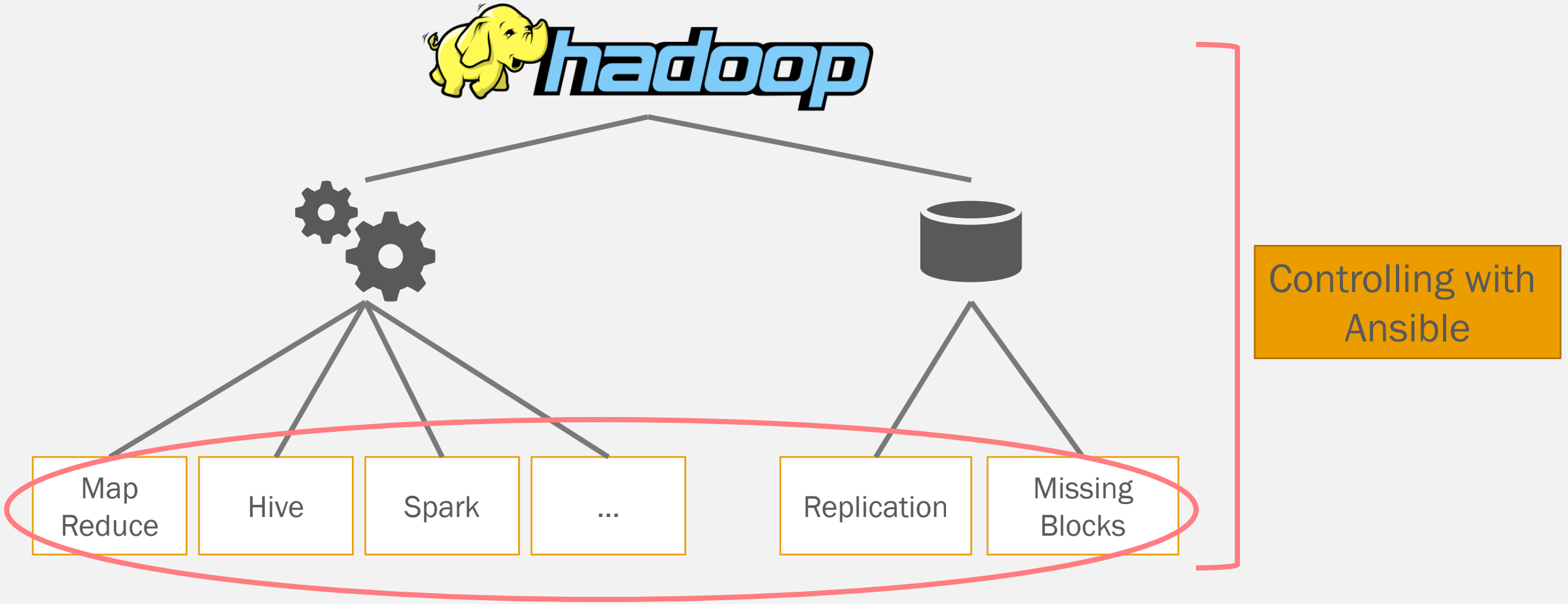
Upgrade Flow Control



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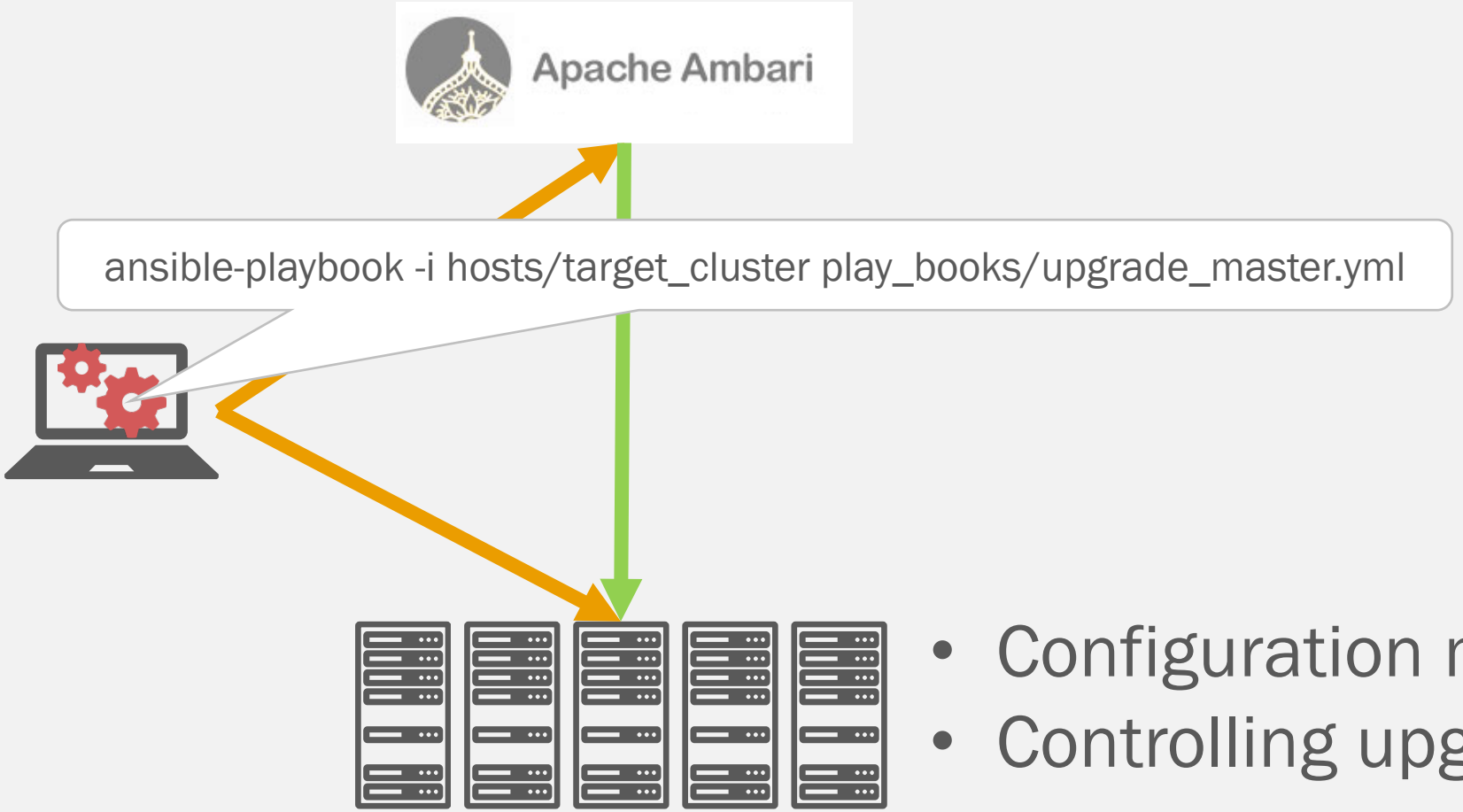
Ansible

- Configuration management tool
- Why we chose?
  - Easy to learn
  - Agent less, push based system
  - Can control upgrading workflow

Overview of Upgrading with Ansible



- Configuration management
- Controlling upgrade sequence

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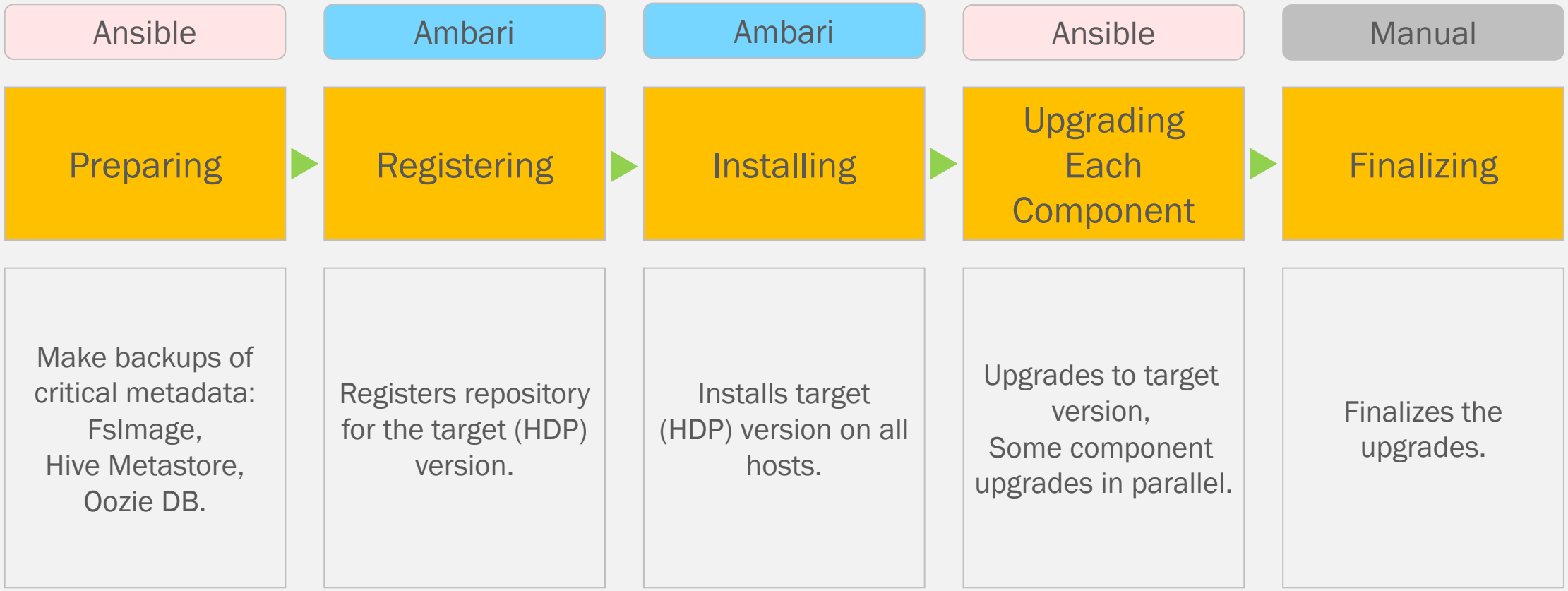
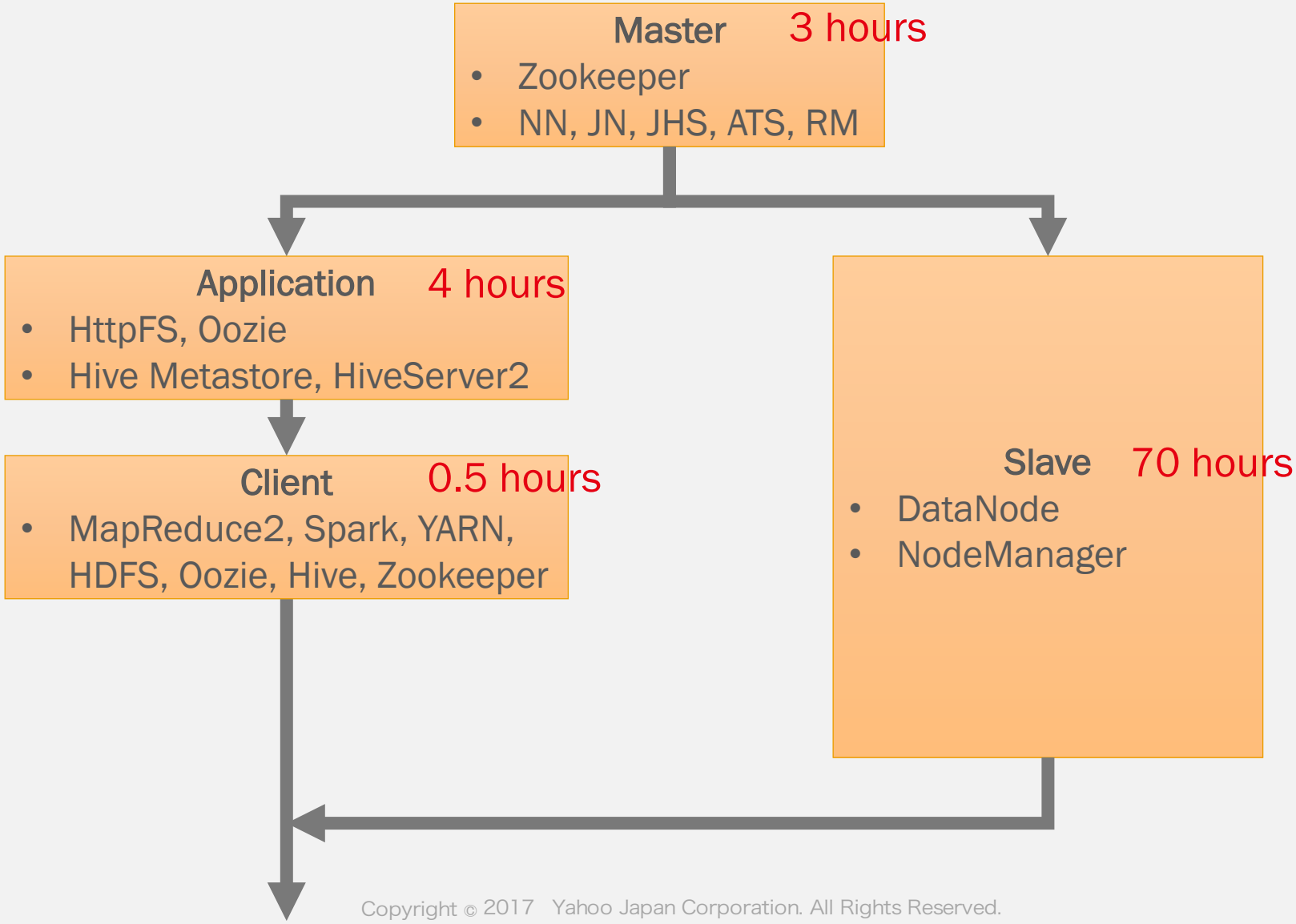
Upgrading Flow

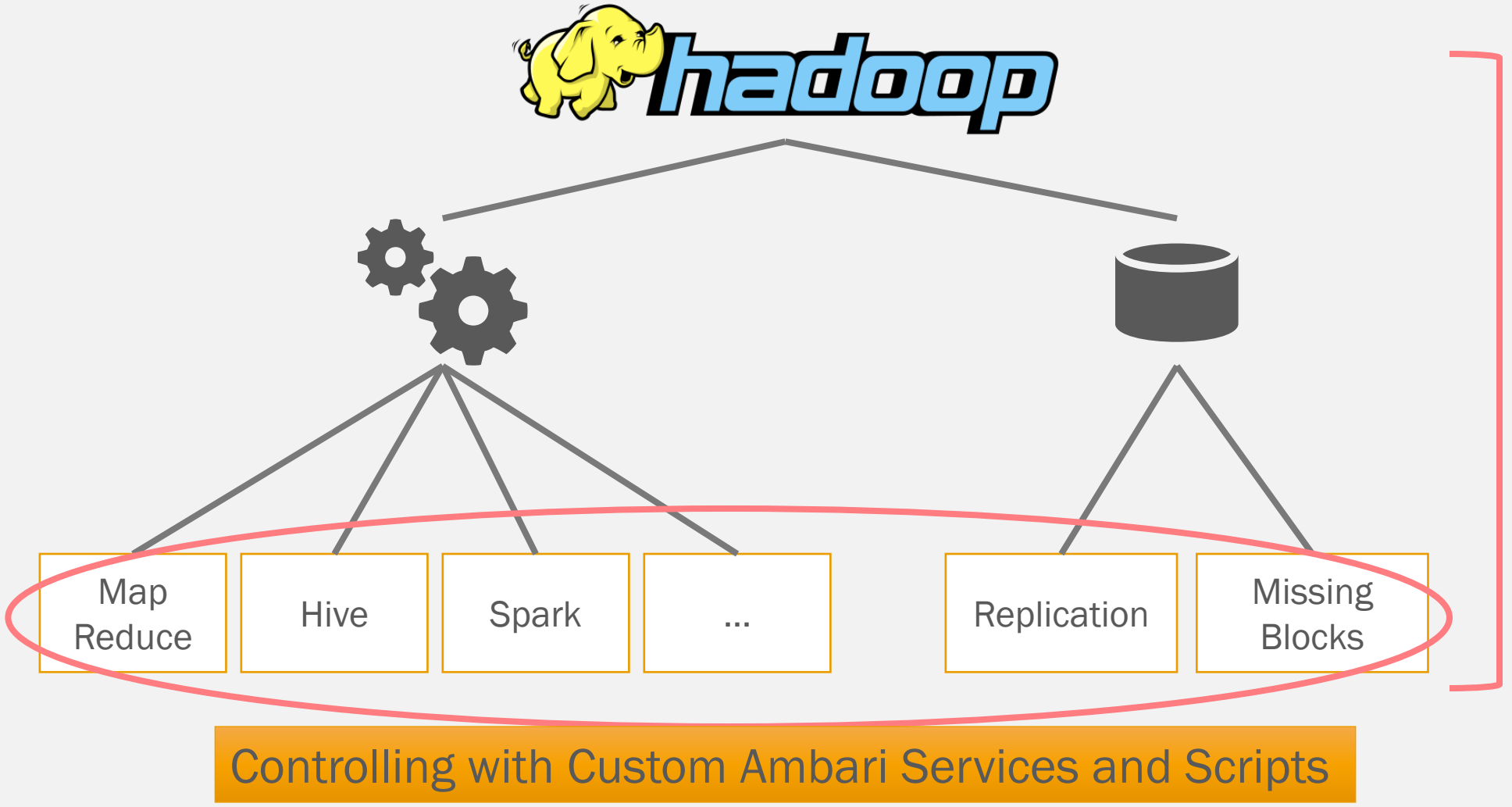


https://docs.hortonworks.com/HDPDocuments/Ambari-2.1.1.0/bk_upgrading_Ambari/content/_manual_minor_upgrade.html

Upgrading Each Component



Preventing Job Failures



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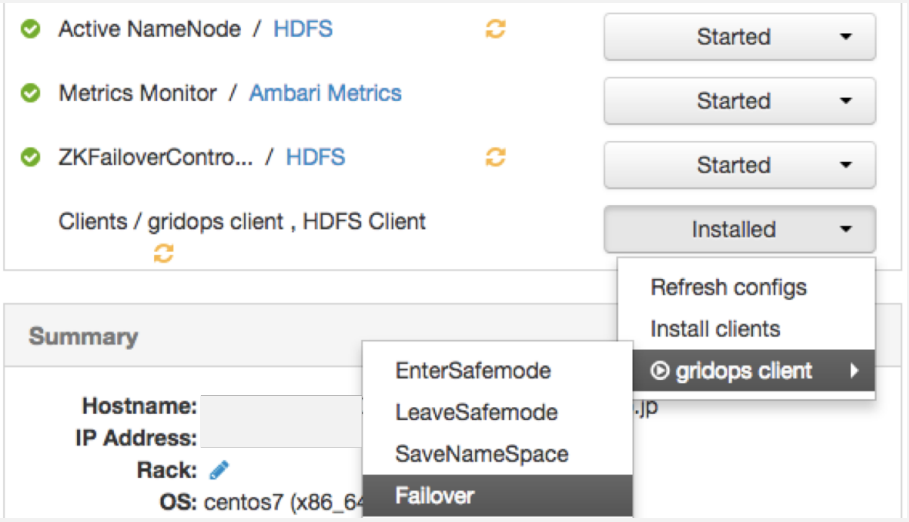
Ambari Custom Service

- Ambari can implement custom service
- Operational commands
  - NameNode F/O
  - Load balancer pool add/remove
- Can operate as existing Ambari services



Ambari Custom Service

- Add service definition xml and python scripts
- No need of manually executing commands on a server
- Prevents operation miss

```
<customCommand>
    <name>Failover</name>
    <commandScript>
        <script>scripts/gridops_client.py</script>
        <scriptType>PYTHON</scriptType>
        <timeout>600</timeout>
    </commandScript>
</customCommand>
```

```
def failover(self, env):
  '''
  Tries to failover from active NameNode to standby NameNode
  '''
  self._kinit_superuser(env)
  ha_state = {'nn1': None, 'nn2': None}
  ns = Script.get_config()['configurations']['gridops-config
  _, ha_state['nn1'], stderr = shell.checked_call('hdfs haad
  _, ha_state['nn2'], stderr = shell.checked_call('hdfs haad
  service_id = self._get_service_id(env)
  if service_id not in ha_state:
    failover_from_to = 'nn1 nn2'
  elif ha_state['nn1'] == 'standby' and ha_state['nn2'] == '
    failover_from_to = 'nn2 nn1'
  else:
    raise Fail('Faild to get HA state of NameNodes')
  Execute('hdfs haadmin -ns %s -failover %s' % (ns, failover
```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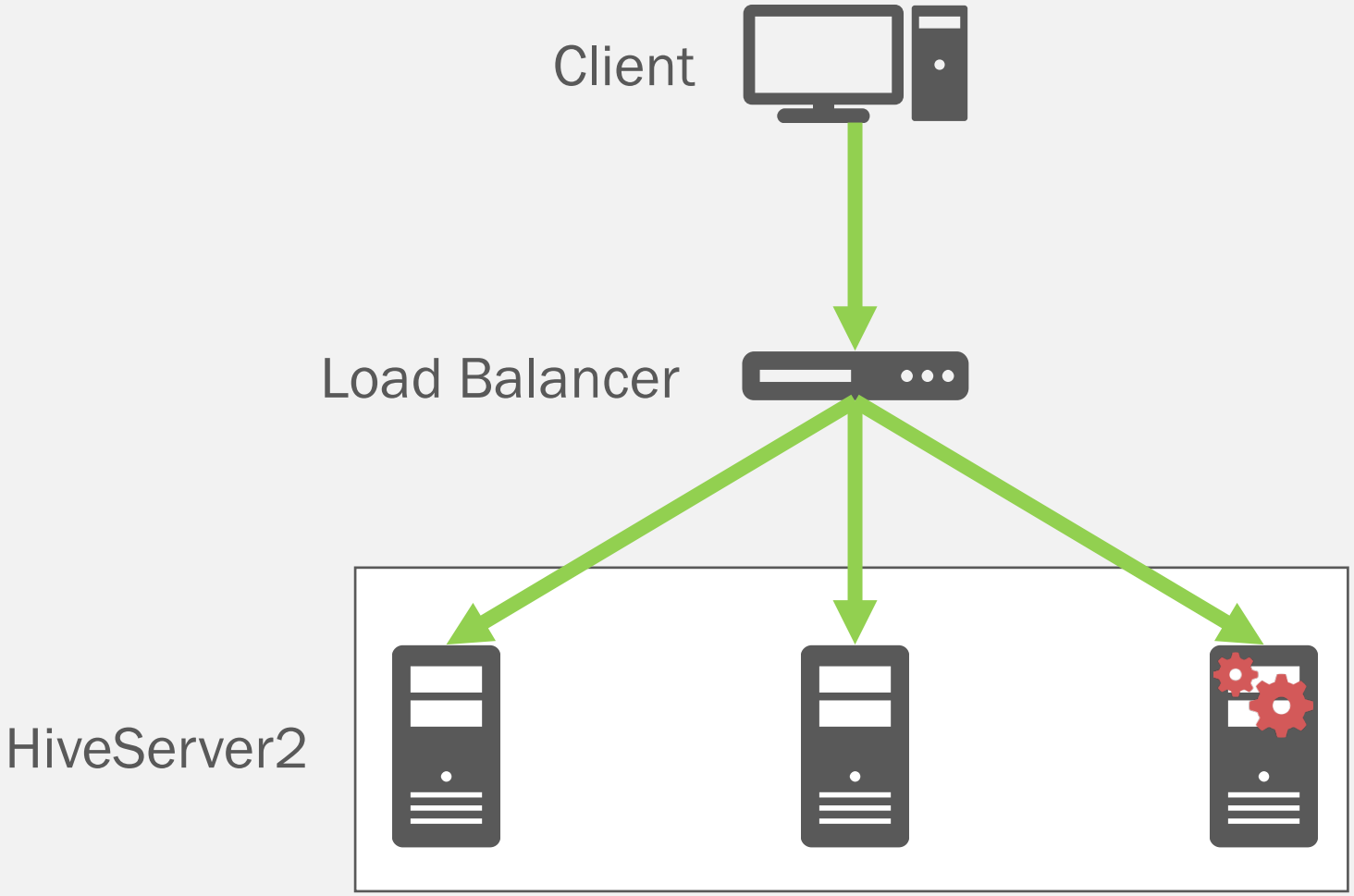
Ambari CLI

- In-house script for cluster admins
- A wrapper script using API's of Ambari, NameNode, ResourceManager etc.
- Provides safe operations
  - Pre and post restart check for each component
  - Preventing data loss

Safety Restart for HiveServer2



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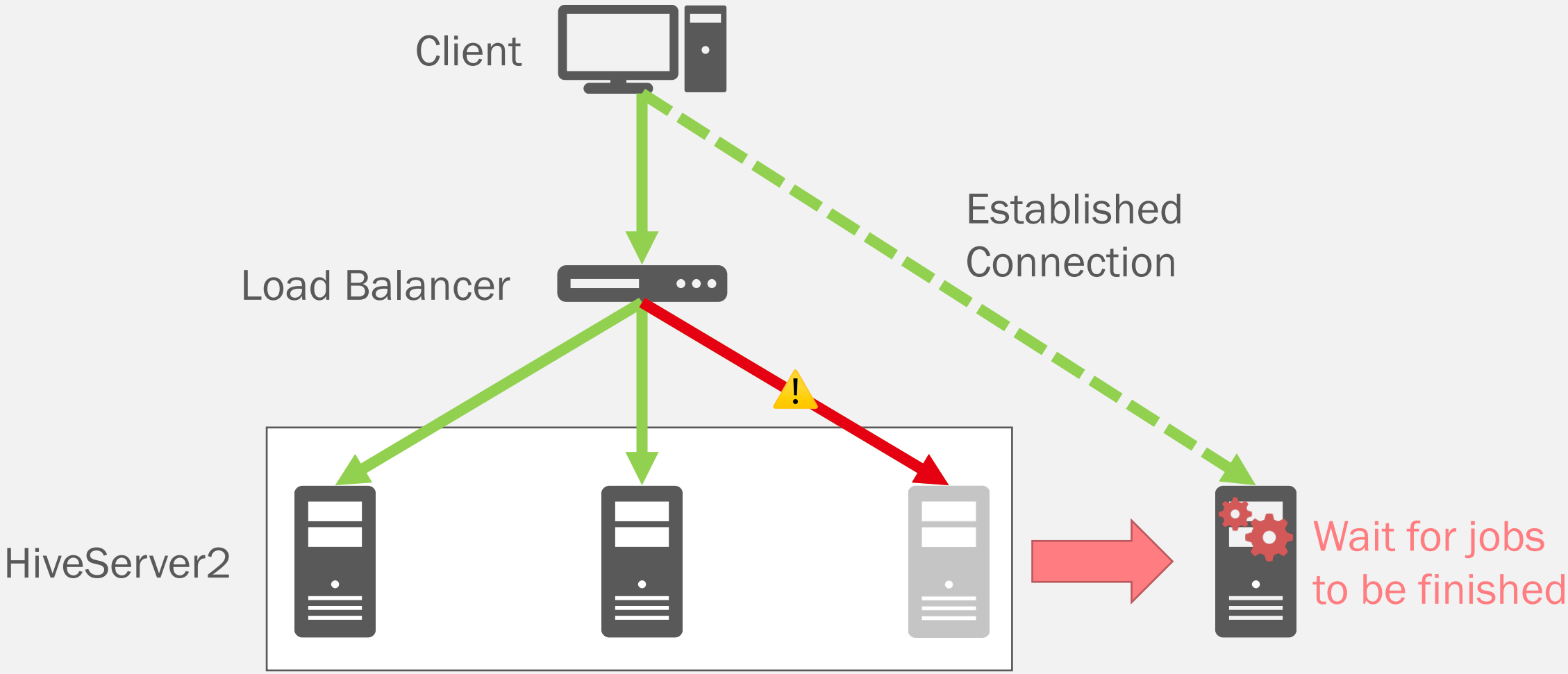
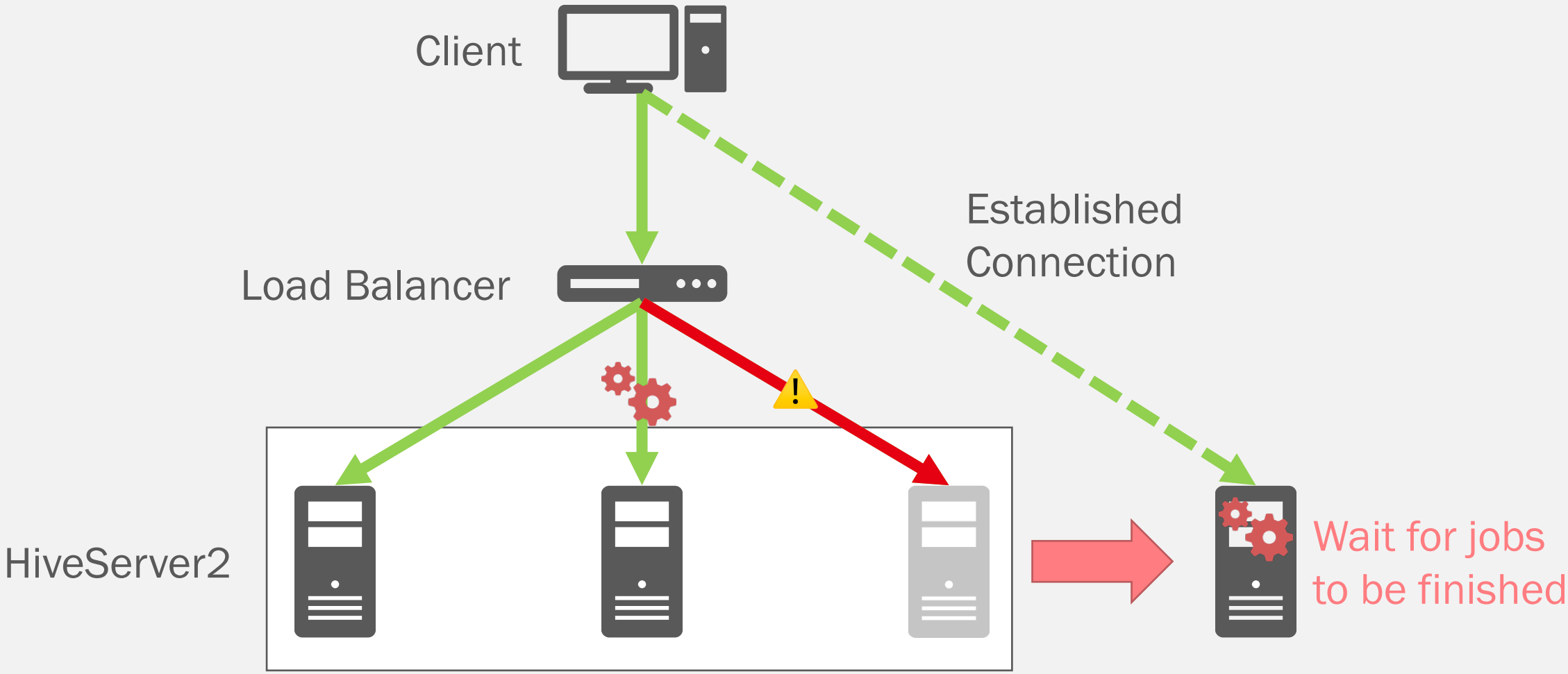
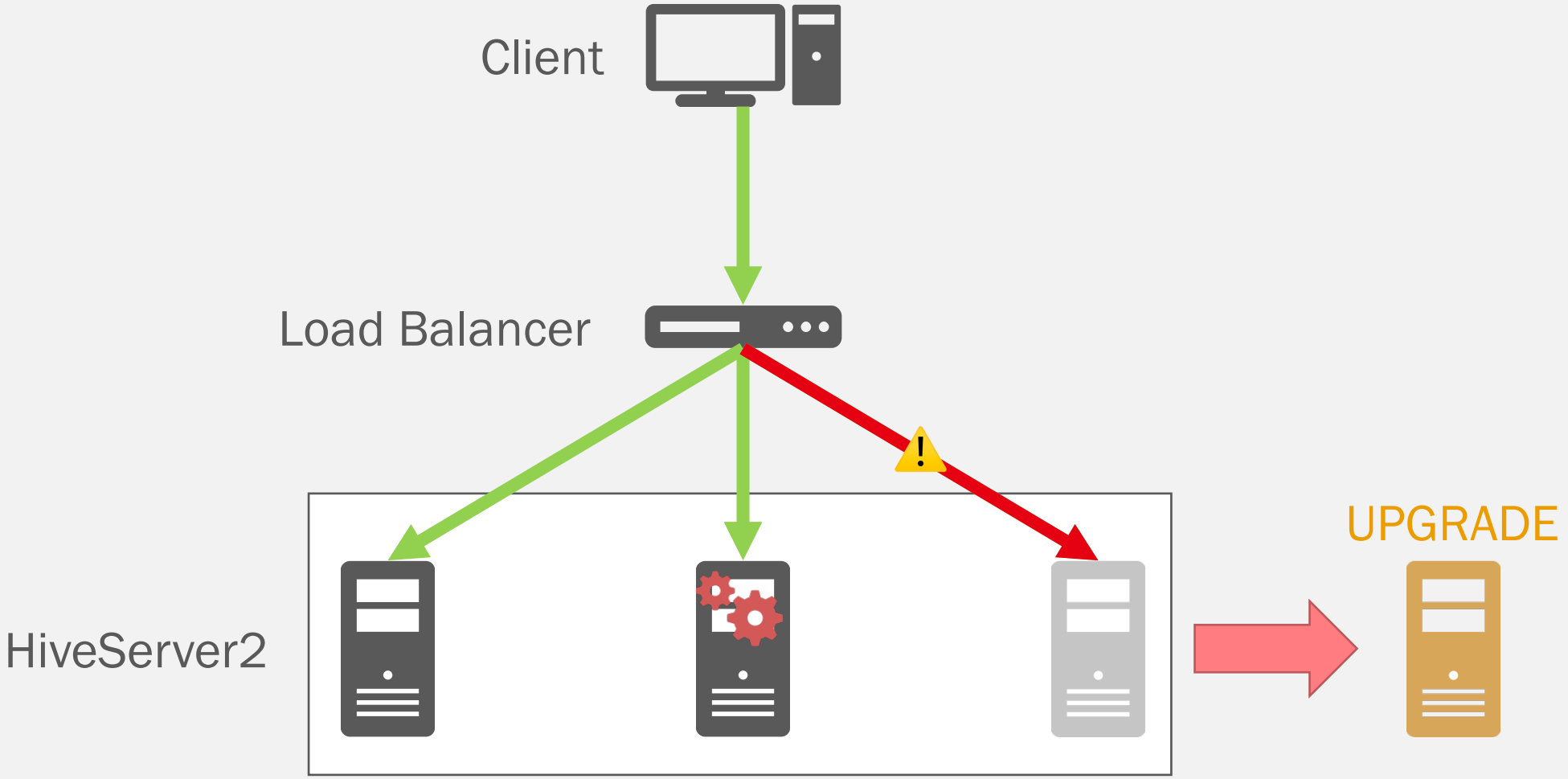
Safety Restart for HiveServer2



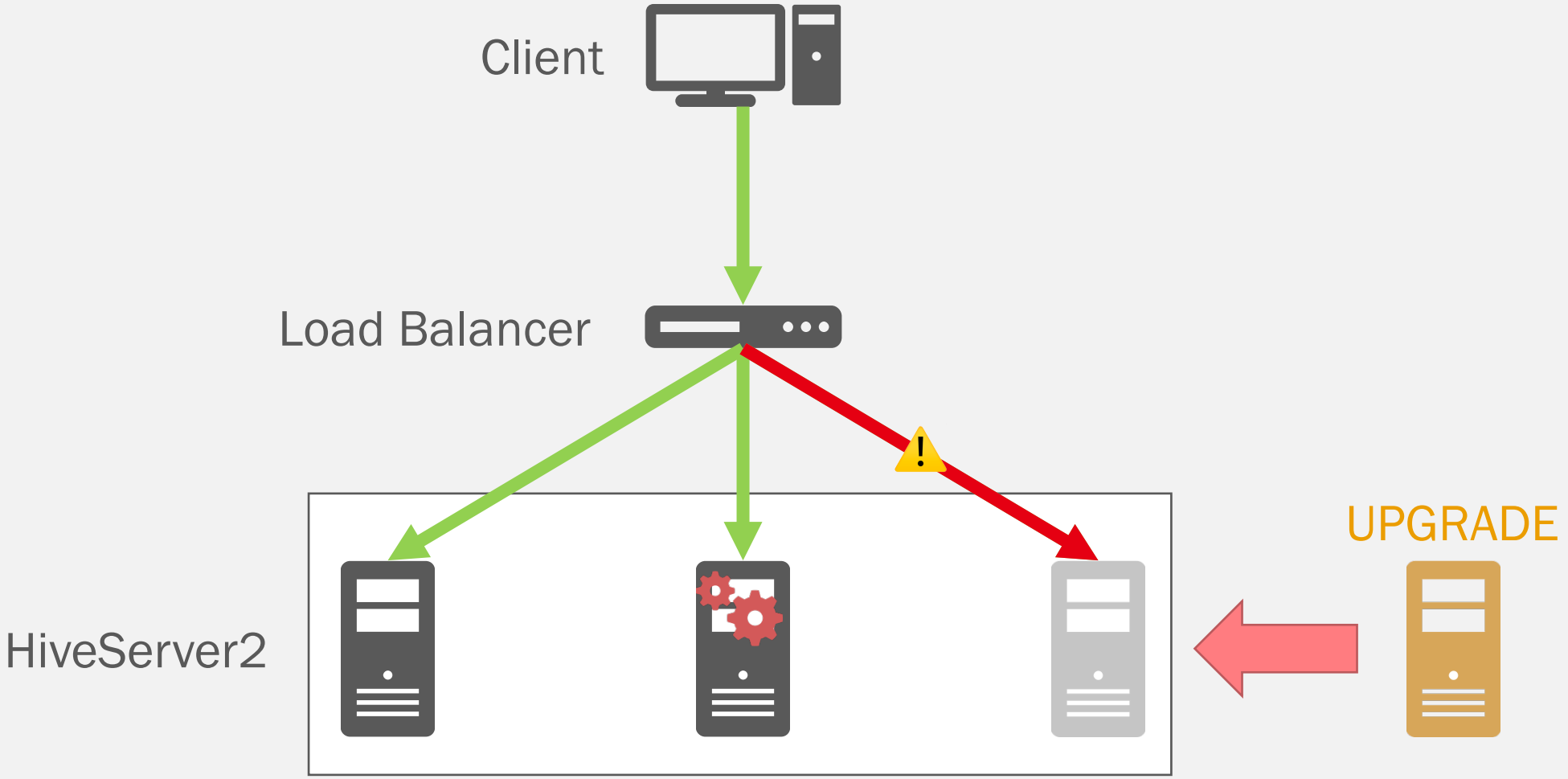
Safety Restart for HiveServer2



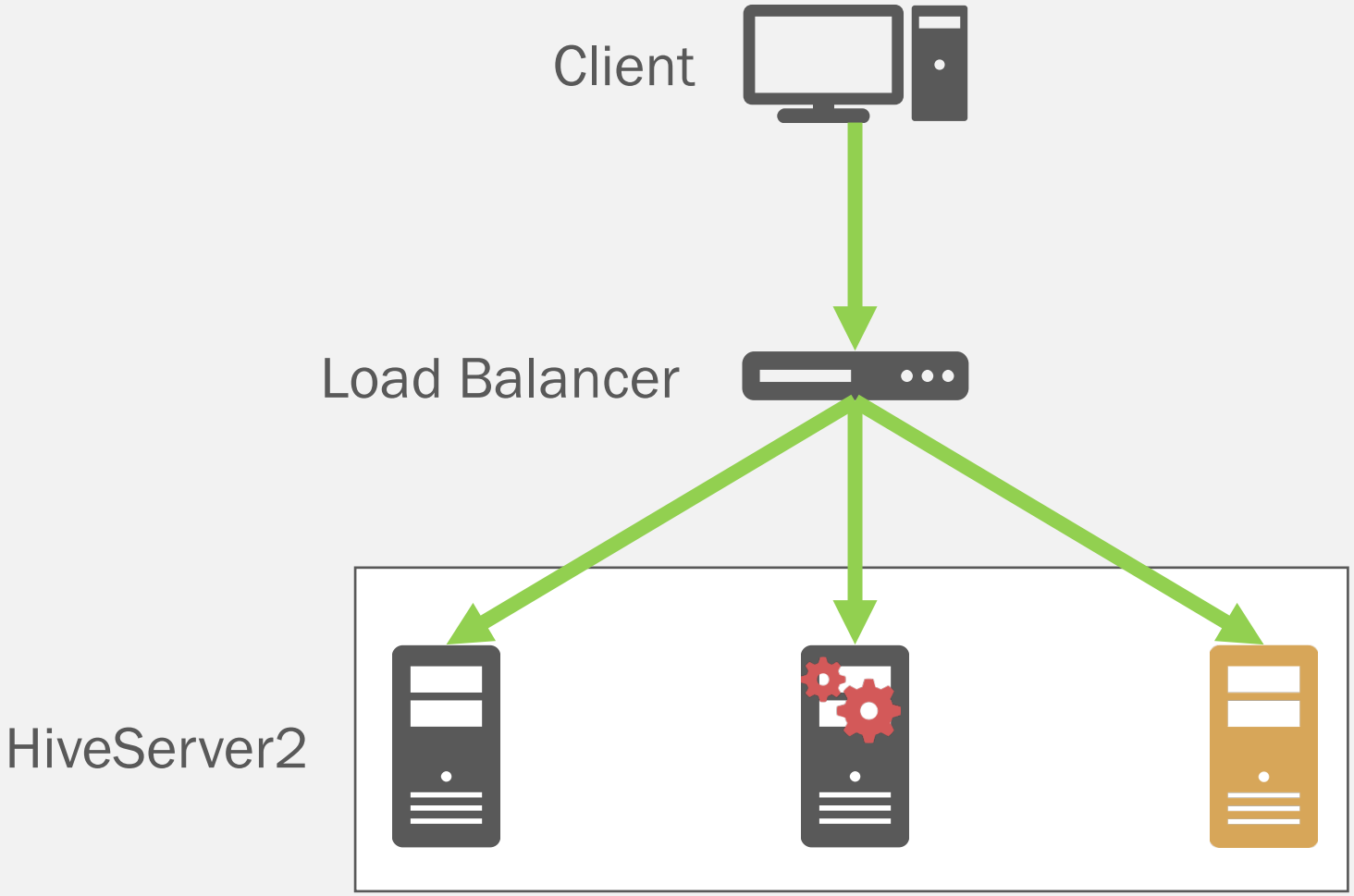
Safety Restart for HiveServer2



Safety Restart for HiveServer2



Safety Restart for HiveServer2



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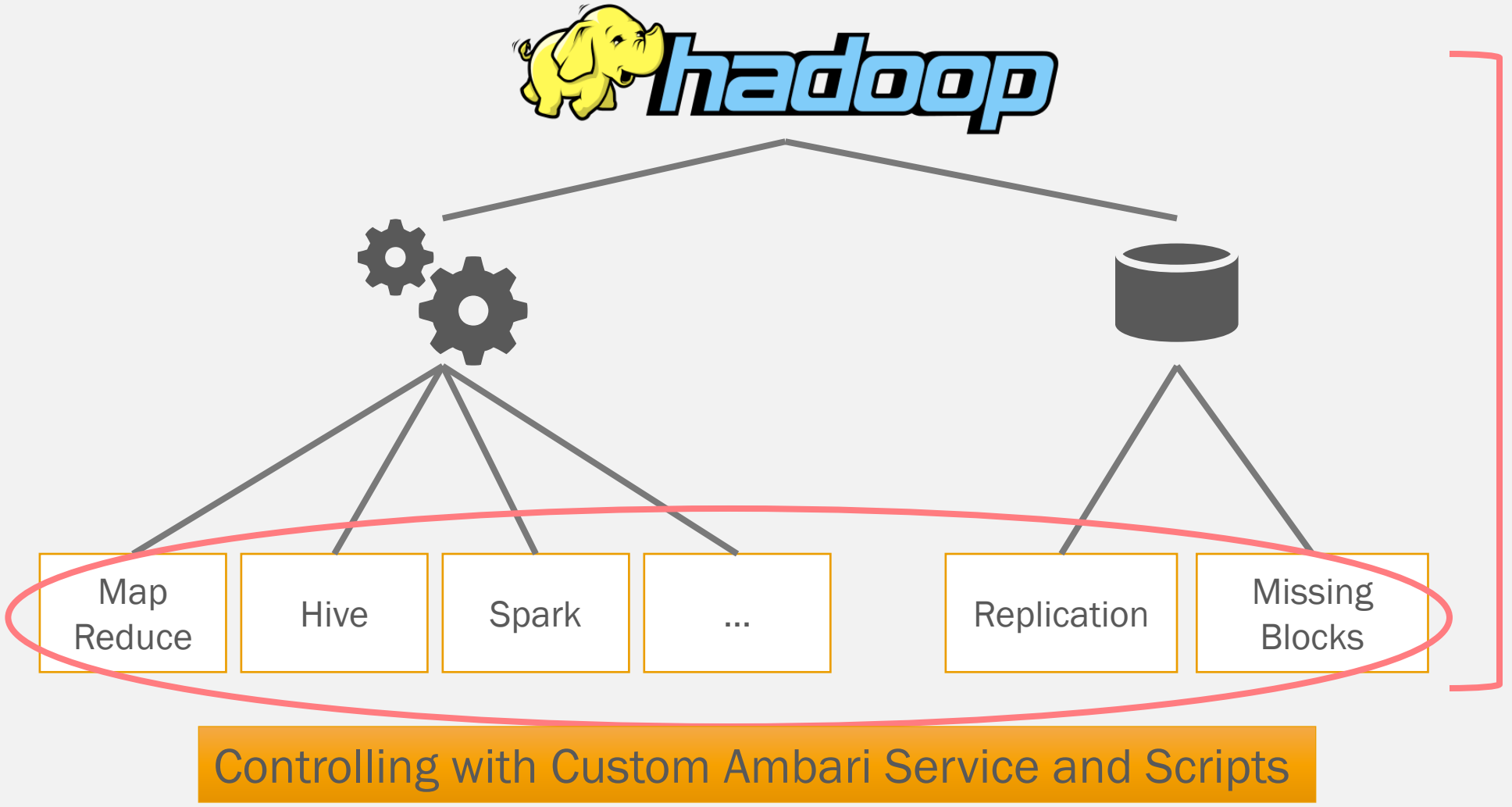
Preventing Data Loss



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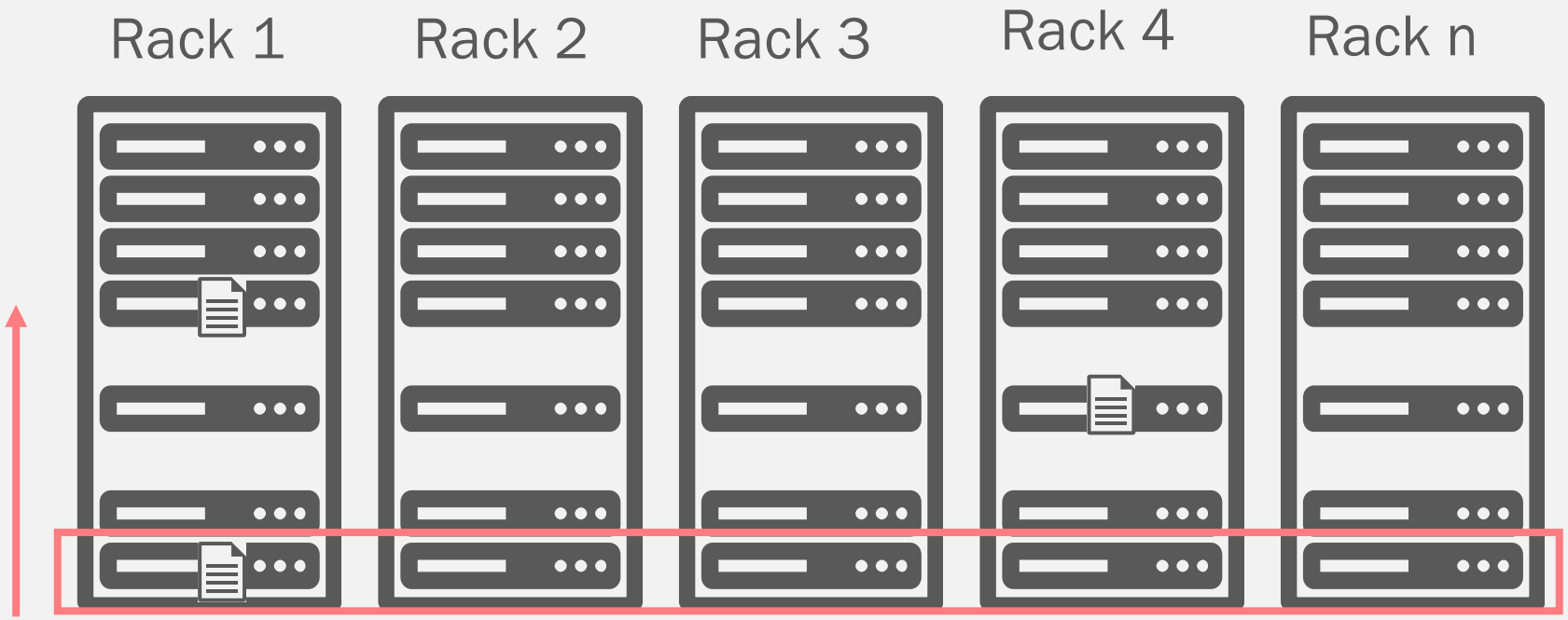
Safety Restart for DataNode



Missing Blocks: 0
Under Replicated Blocks: 0
Corrupt Blocks: 0

Group of DataNodes
at a time

Upgrade, restart and wait for Missing Blocks to be 0

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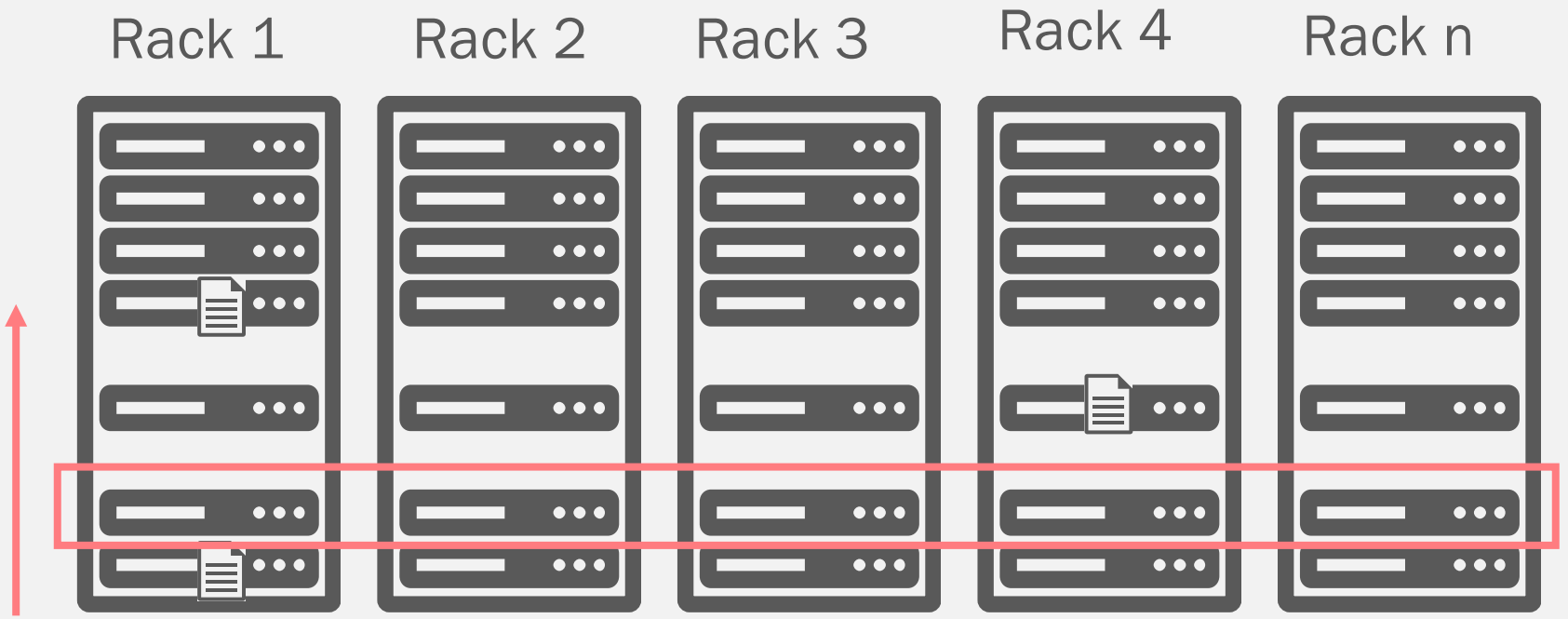
Safety Restart for DataNode



Missing Blocks: 0
Under Replicated Blocks: 0
Corrupt Blocks: 0

Group of DataNodes
at a time

Upgrade, restart and wait for Missing Blocks to be 0

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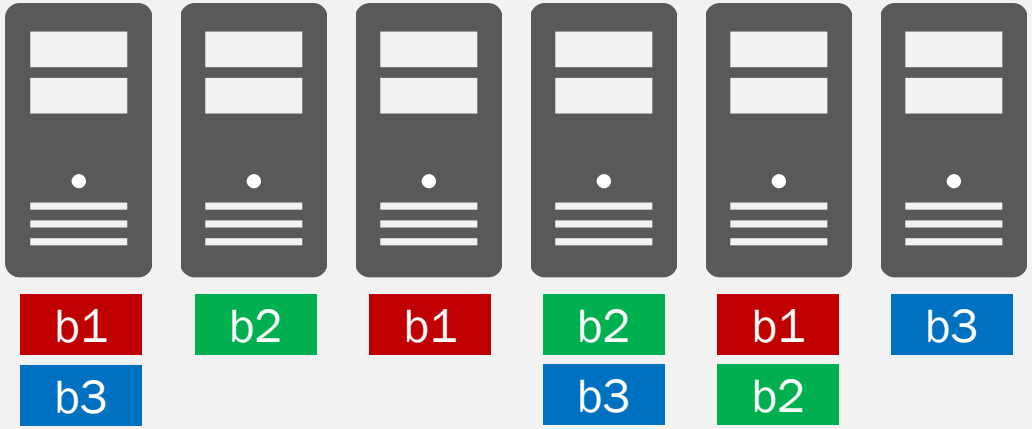
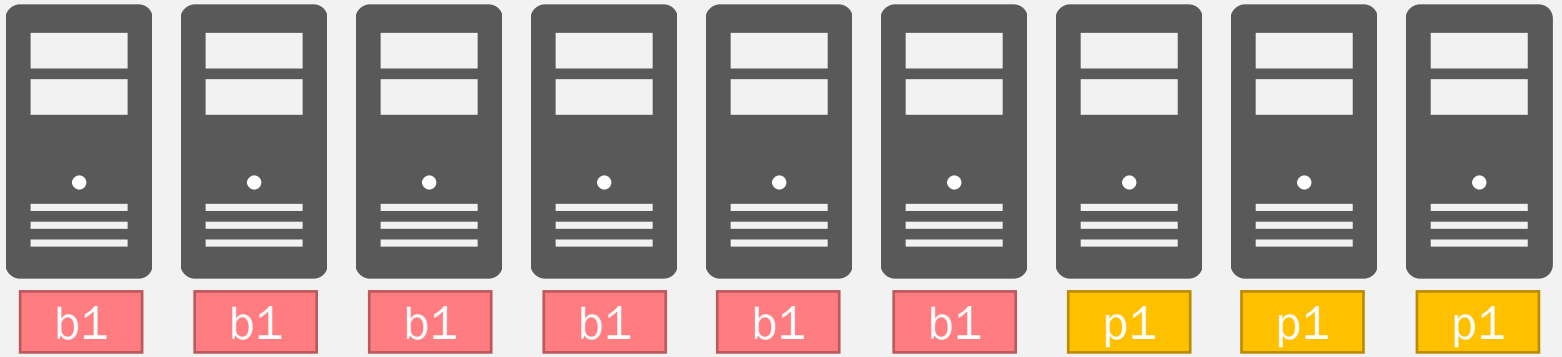
Replication Vs Erasure Coding

Replication



Erasure Coding (EC)



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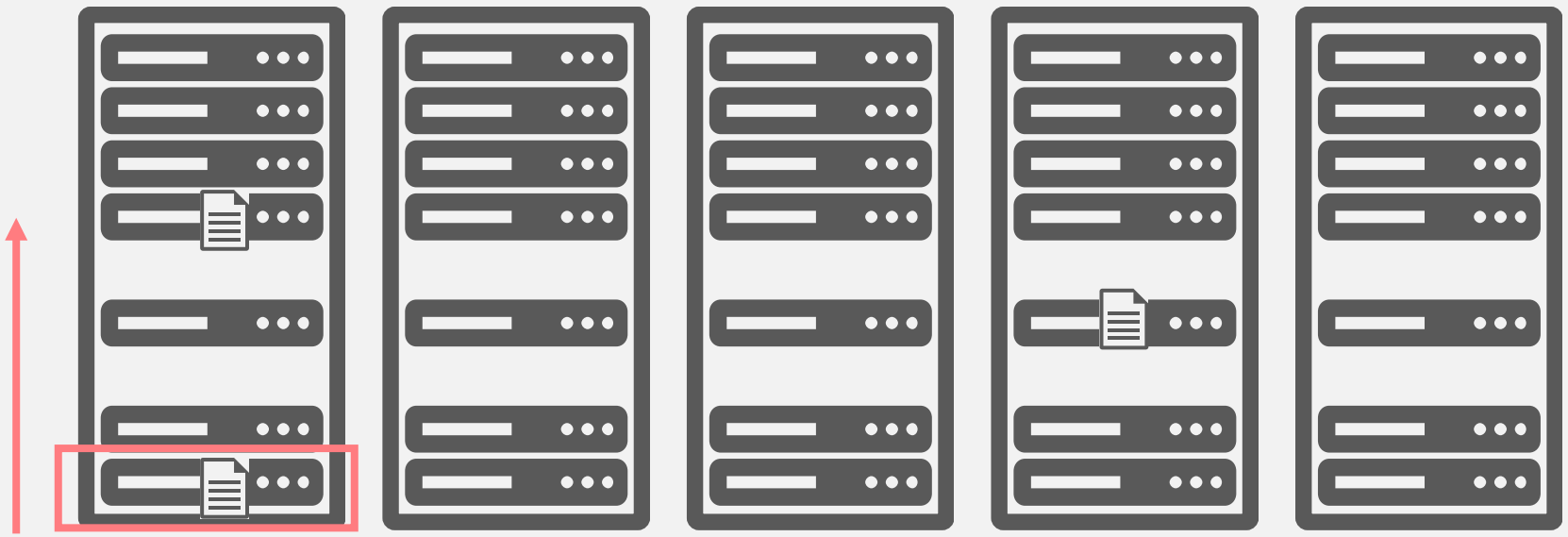
Safety Restart for DataNode (EC)



Missing Blocks: 0
Under Replicated Blocks: 0
Corrupt Blocks: 0

One DataNode at a time

Upgrade, restart and wait for Missing Blocks to be 0

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Test Jobs for Each Component

- HDFS Read/Write
- MapReduce
- Hive, Hive on Tez
- Pig, Spark
- HttpFS, Oozie

```
hdfs dfs -put /tmp/test
```

```
yarn jar hadoop-mapreduce-examples.jar pi 5 10
```

```
hive -e “select x from default.dual group by x”
```

```
curl --negotiate -u : “https://.../webhdfs/v1/?op=liststatus”
```


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Results

Results of Non-stop Upgrade

- Hadoop 2.3.x to 2.3.y upgrade
- 7 minutes of downtime
- 0.3% of job failure
- 0% data loss

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Results of Non-stop Upgrade

Component	Non-stop	Description
HDFS	✅	
HttpFS	✅	
MapReduce	✅	
Hive	✅	
Pig	✅	
Spark	△	Disconnected from Hive Metastore, few jobs failed
HiveServer2	△	Checksum error occurred for some jobs
Oozie	△	Non-HA component

✅ successful upgrade without any job failures
△ Upgrade was affected up to some extent

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Problems During the Upgrade

- NameNode restart
- DataNode restart
- Spark and Hive job failure

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NameNode Restart

- NN metadata was huge and it took long to free memory
- As a workaround, stop NN → wait → start NN

DataNode Restart

- Restart failed due to existence of old pid file
- 2 DataNode Processes
  - Parent: /var/run/hdfs/hadoop-hdfs-datanode.pid
  - Child: /var/run/hdfs/hadoop_secure_dn.pid

Usually gets deleted automatically, but

Starting regular datanode initialization
Still running according to PID file /var/run/hdfs/hadoop_secure_dn.pid

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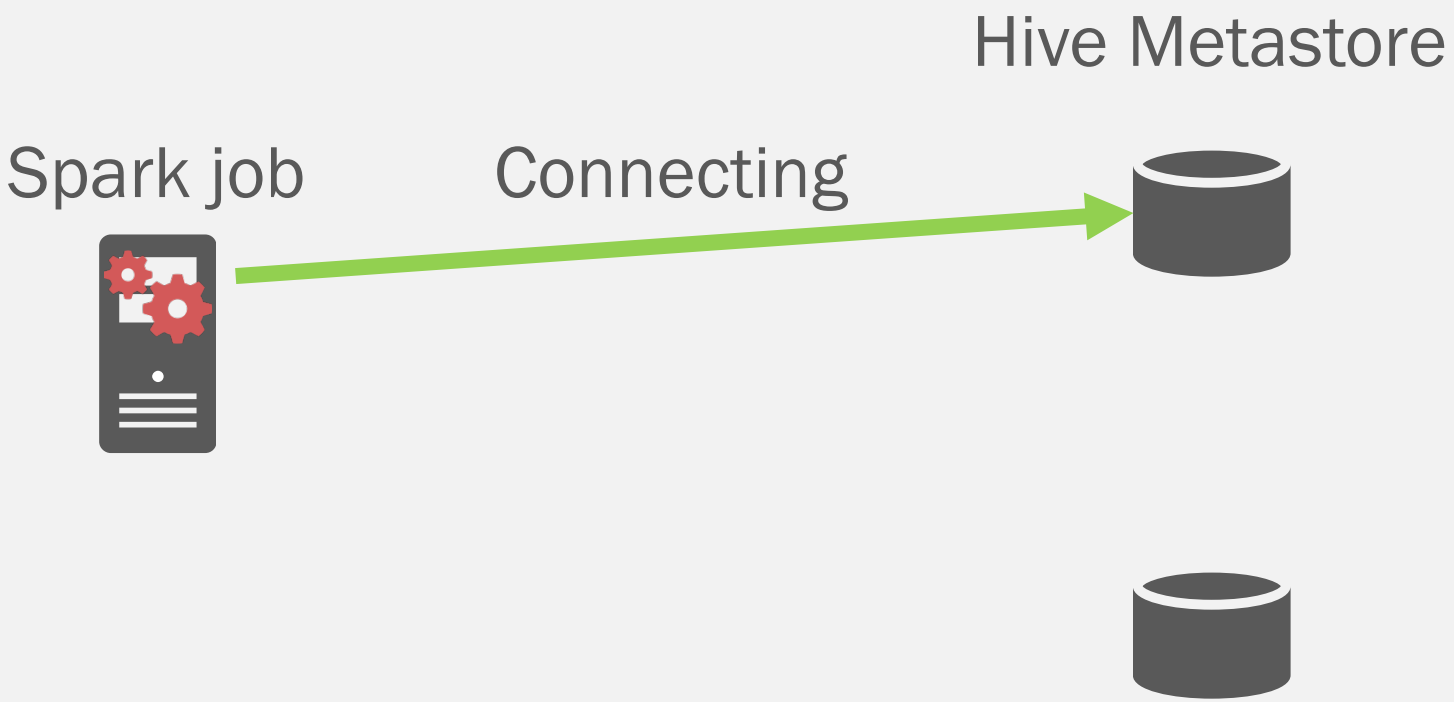
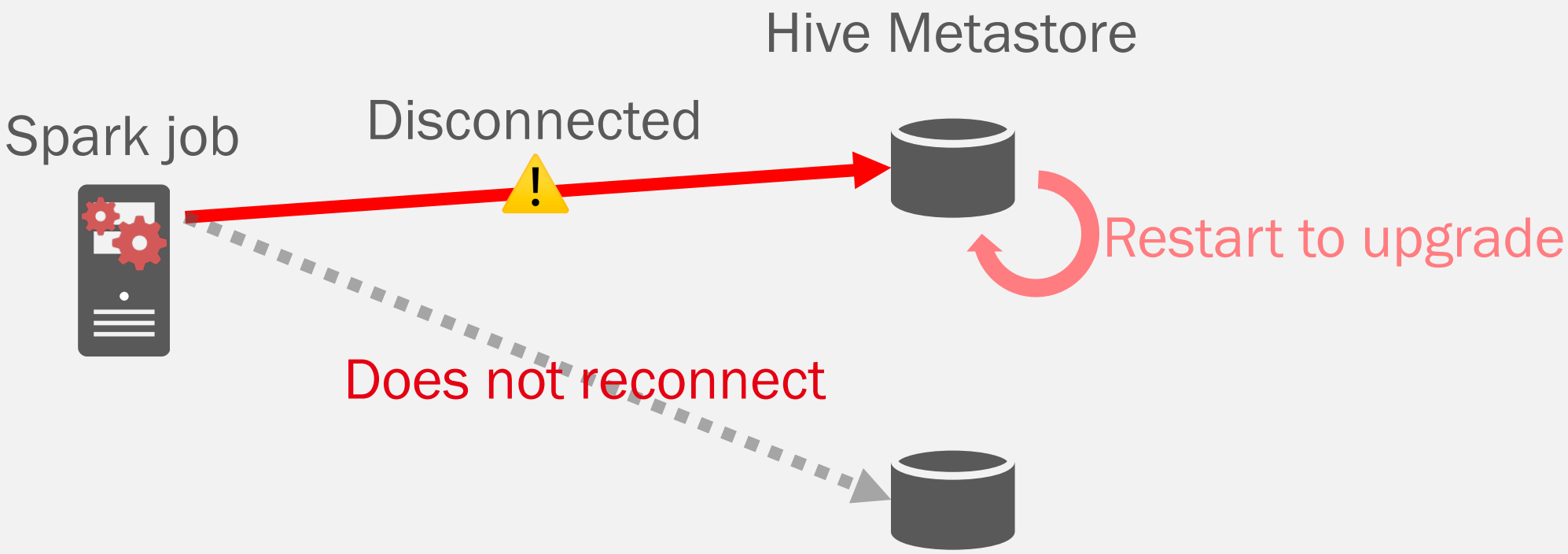
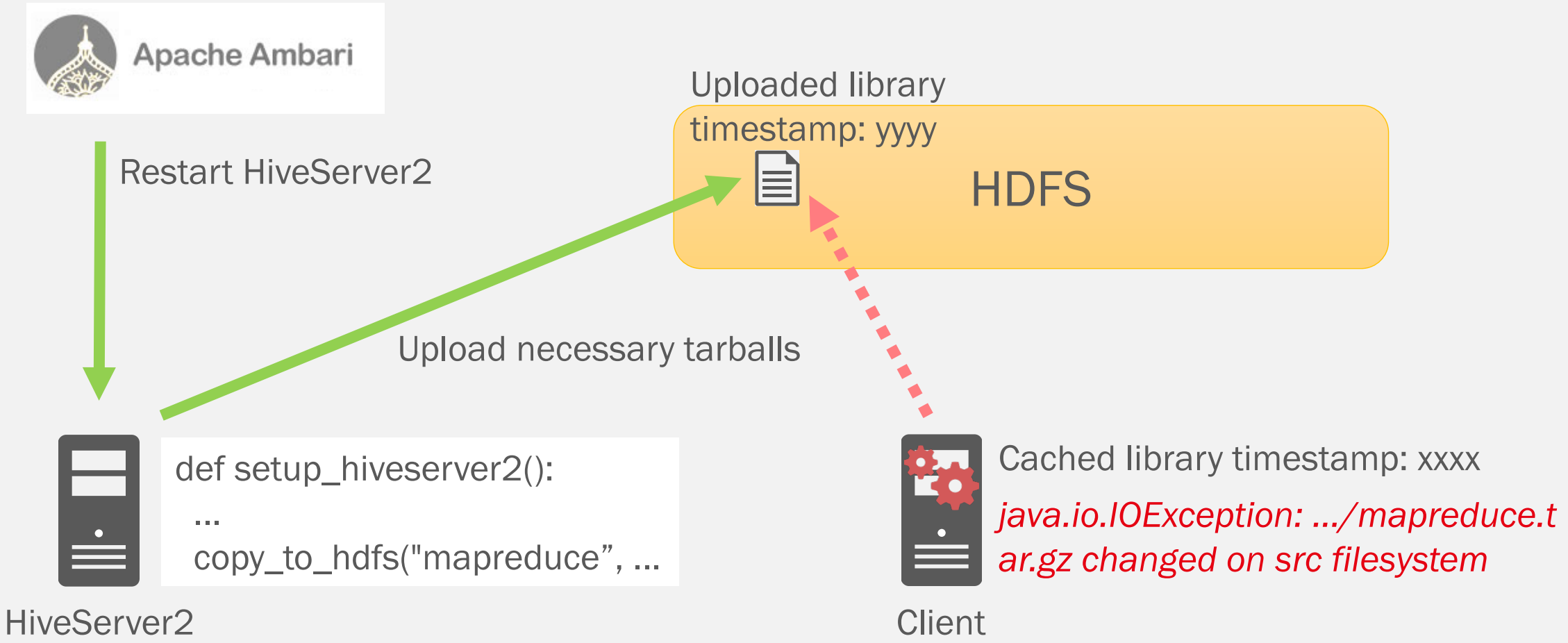
Spark (v1.5) Job Failure



Spark (v1.5) Job Failure



Hive Job Failure



Conclusion

Non-stop Upgrade

- Hadoop 2.3.x to 2.3.y upgrade
- 7 minutes of downtime
- 0.3% of job failure
- 0% data loss
- No need of separate resource scheduling

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Comparison of Upgrade Results

	Previous	Proposed (without automation)	Proposed (with automation)	
Cluster Downtime	12h	0min	7min	User impact 
Maintenance Time	12h	72h	72h	—
Man-hour	108h	648h	21h	Operating cost 

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Future Work

- Improving non-stop upgrade by bringing down
  - Cluster downtime to 0
  - Job failures to 0
- To be able to perform major upgrades (upgrades involving NameNode metadata changes)
- Automating of preparation stage and handle failures with recovery operations
- Contributing to OSS

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