Efficiently Manage your Hadoop and Analytics Workflow with IBM Spectrum Scale

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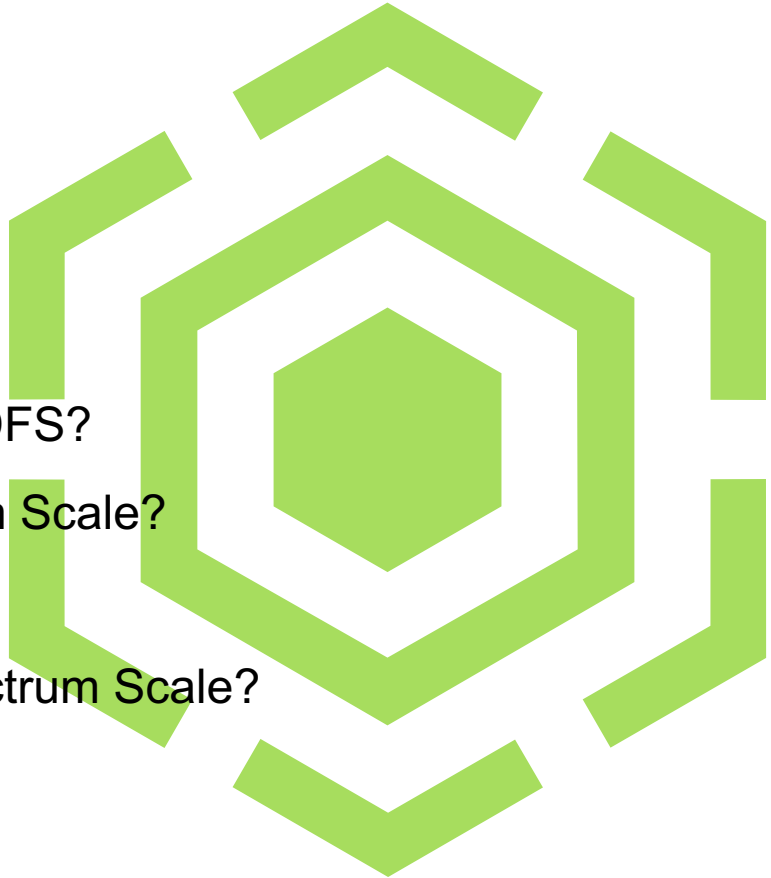
IBM Spectrum Scale Big Data and Analytics

IBM

Questions

- Who runs Spectrum Scale?
- Who runs an ESS?
- Who runs a native HDFS cluster?
- Who runs HDFS on Spectrum Scale?
- Who runs NFS Gateway or S3 on native HDFS?
- Who runs SMB, NFS or Object on Spectrum Scale?
- Who runs Kubernetes or OpenShift?
- Who runs Kubernetes or OpenShift on Spectrum Scale?

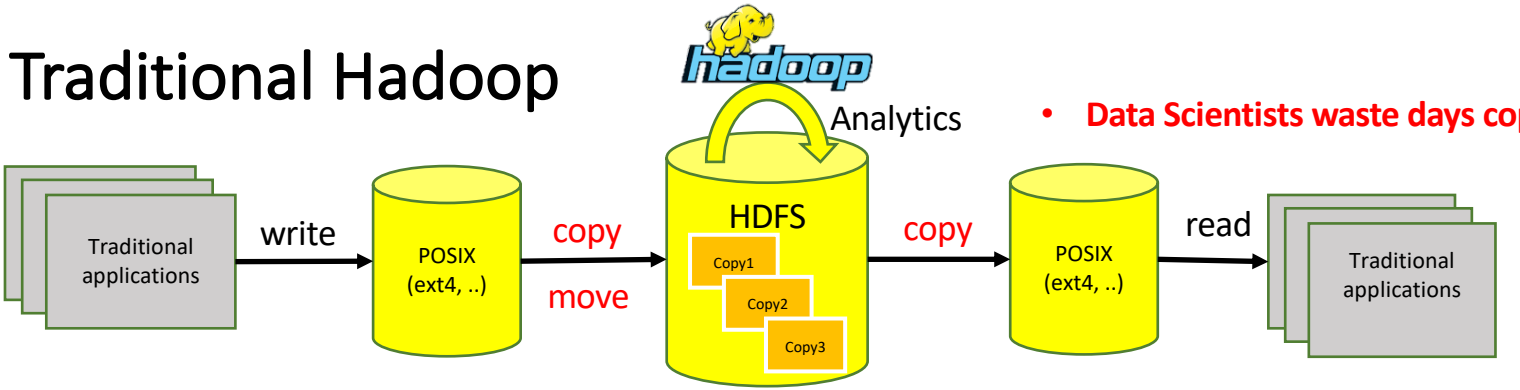


Outline

- Traditional Hadoop vs. Spectrum Scale
- Use Case 1: HDFS on Spectrum Scale
- Use Case 2: HDFS Storage Tiering & Federation
- Use Case 3: HDFS Backup
- Use Case 4: Spectrum Scale as Ingest Tier
- Use Case 5: Next-gen workloads
- Use Case 6: Disaster Recovery

- Spectrum Scale HDFS integration into CES

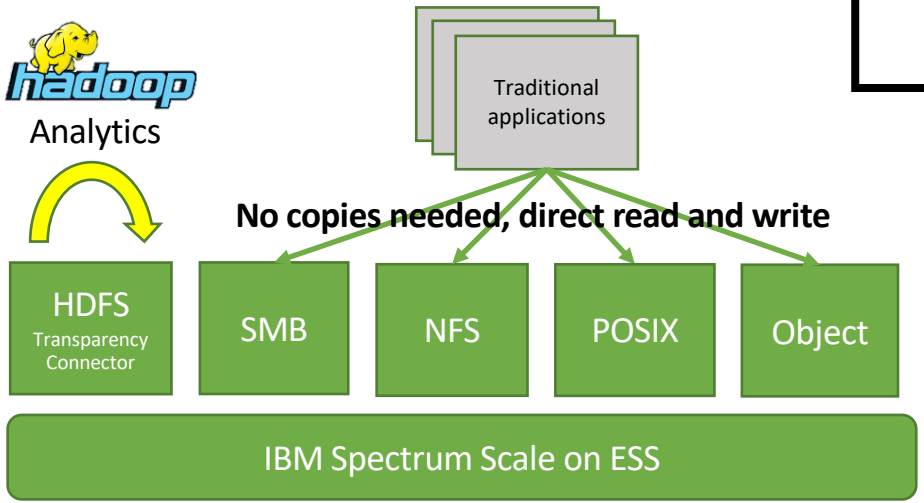
Traditional Hadoop



- **Data Scientists waste days copying data around**

- **Multiple copies** = Analytics based on stale data
- **Costly data protection**: 3-way replication
  → 5 PB data = 15 PB storage
  (Erasure Coding in HDFS has limitations, e.g. append not supported)

HDFS with Spectrum Scale



- **Multi-protocol access** to the same data
  → No copies, direct read, one version
- **Software RAID** eliminates the need for expensive 3-way replication
  → Only 30% overhead
  → 5 PB data = 6.5 PB storage
- **Stateless NameNode:** Fast failover, low memory footprint

Use Case 1: HDFS on Spectrum Scale

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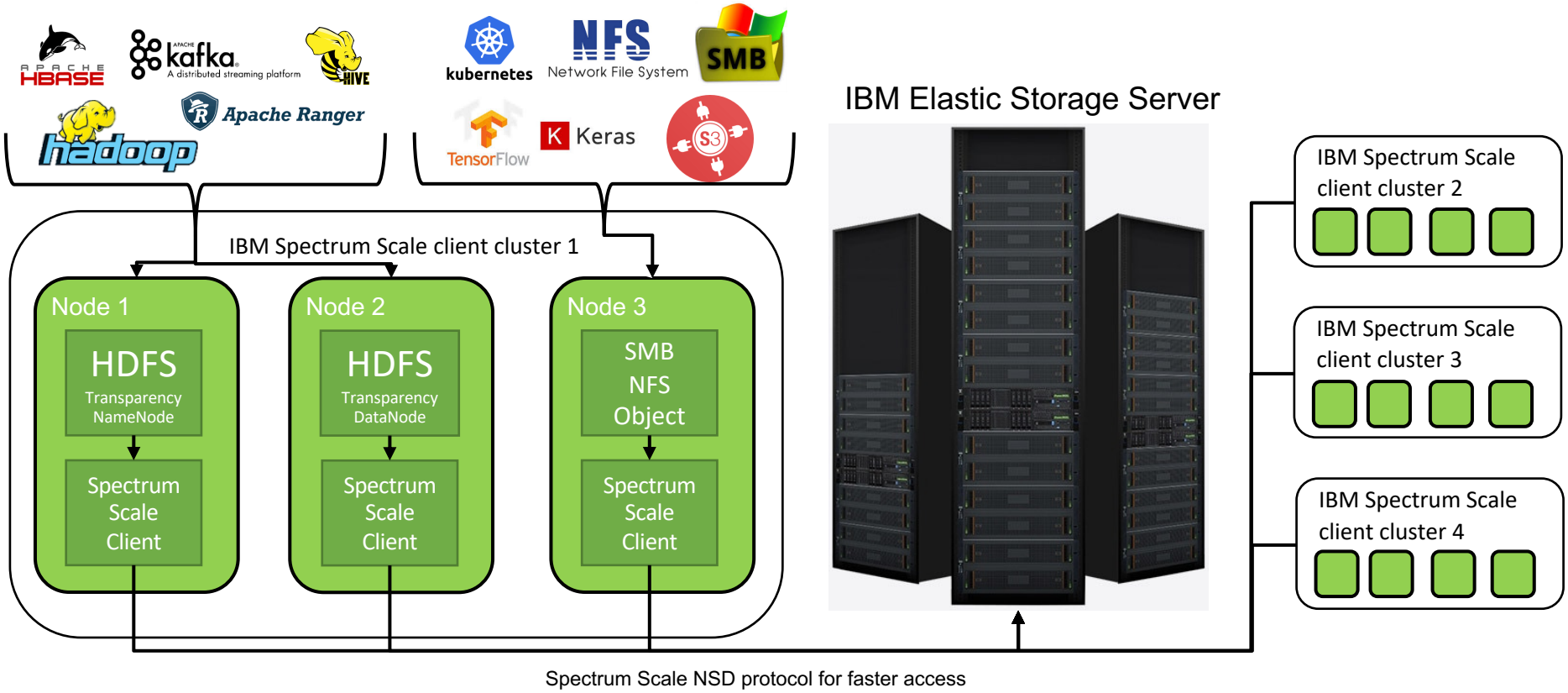

Use Case 1: HDFS on Spectrum Scale

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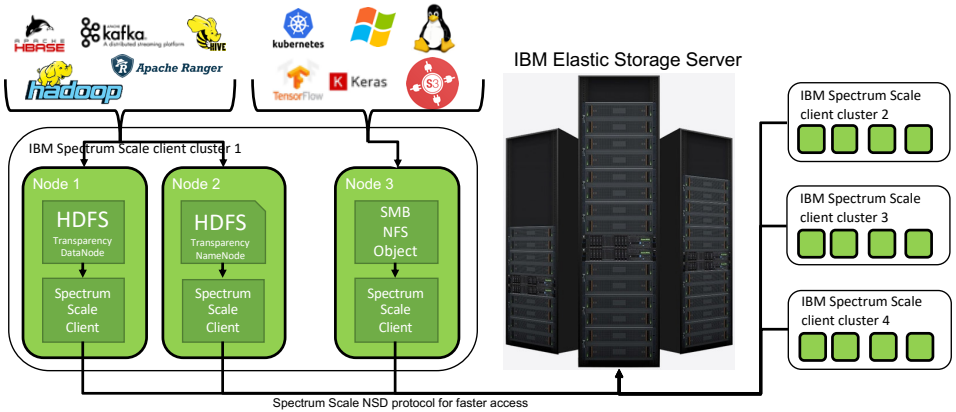
All data and metadata is stored in ESS

→ **No additional storage** needed on DataNodes or NameNodes

→ **Low memory footprint** for NameNodes which allows faster failover (only Kerberos tickets are stored in shared edits log)



Multi-protocol access

→ **Single source of truth**: Access the same data through HDFS, NFS, SMB, Object and POSIX without any copying

IBM Spectrum Scale on ESS

→ **Erasure Coding**: Lower storage footprint, higher performance since no replication needed

→ **Easy to scale:** Add more building blocks if you need more storage or bandwidth

→ **Easy to manage:** GUI and REST API available, single storage system instead of hundreds of storage nodes

Use Case 2: HDFS Storage Tiering & Federation

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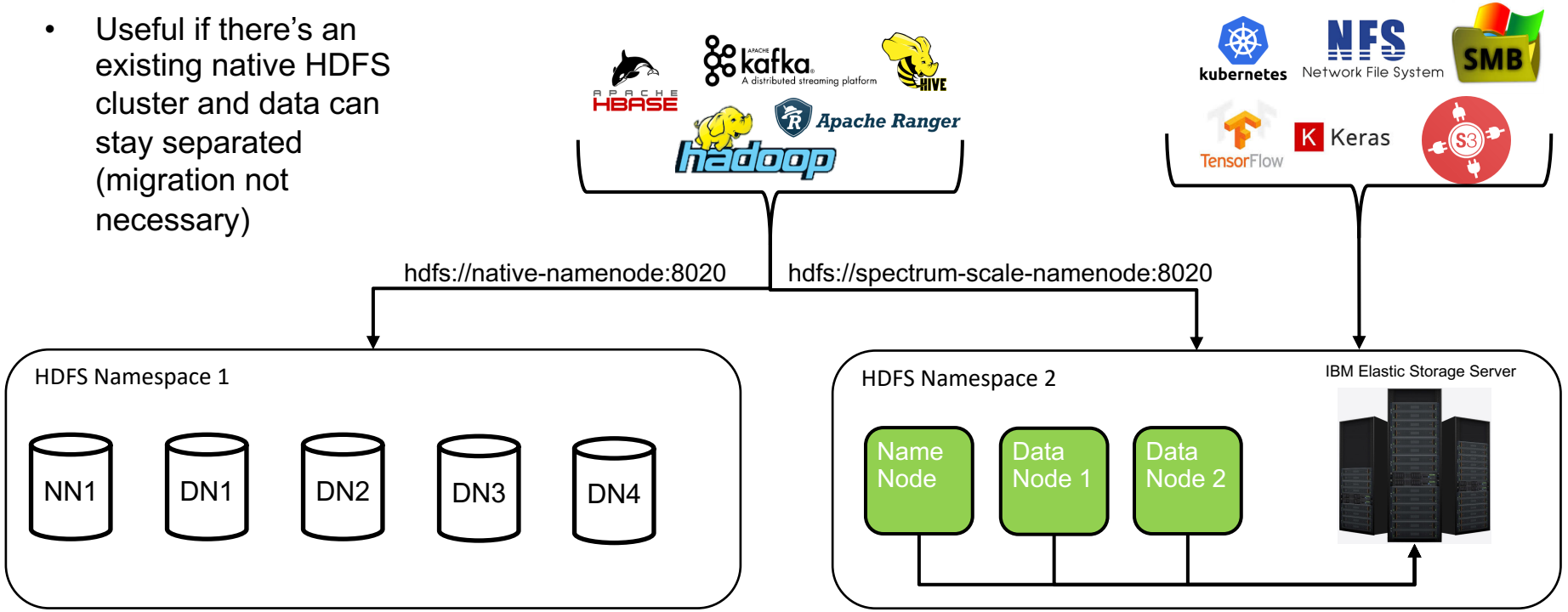
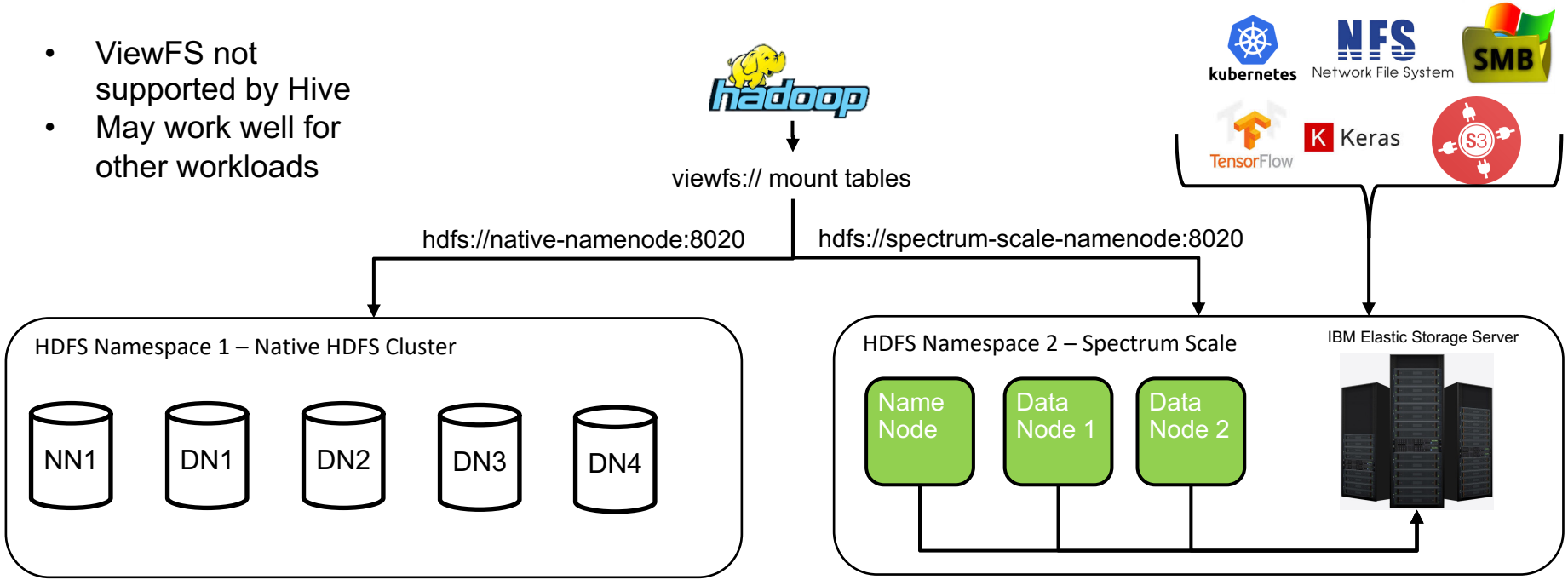
- Useful if there's an existing native HDFS cluster and data can stay separated (migration not necessary)



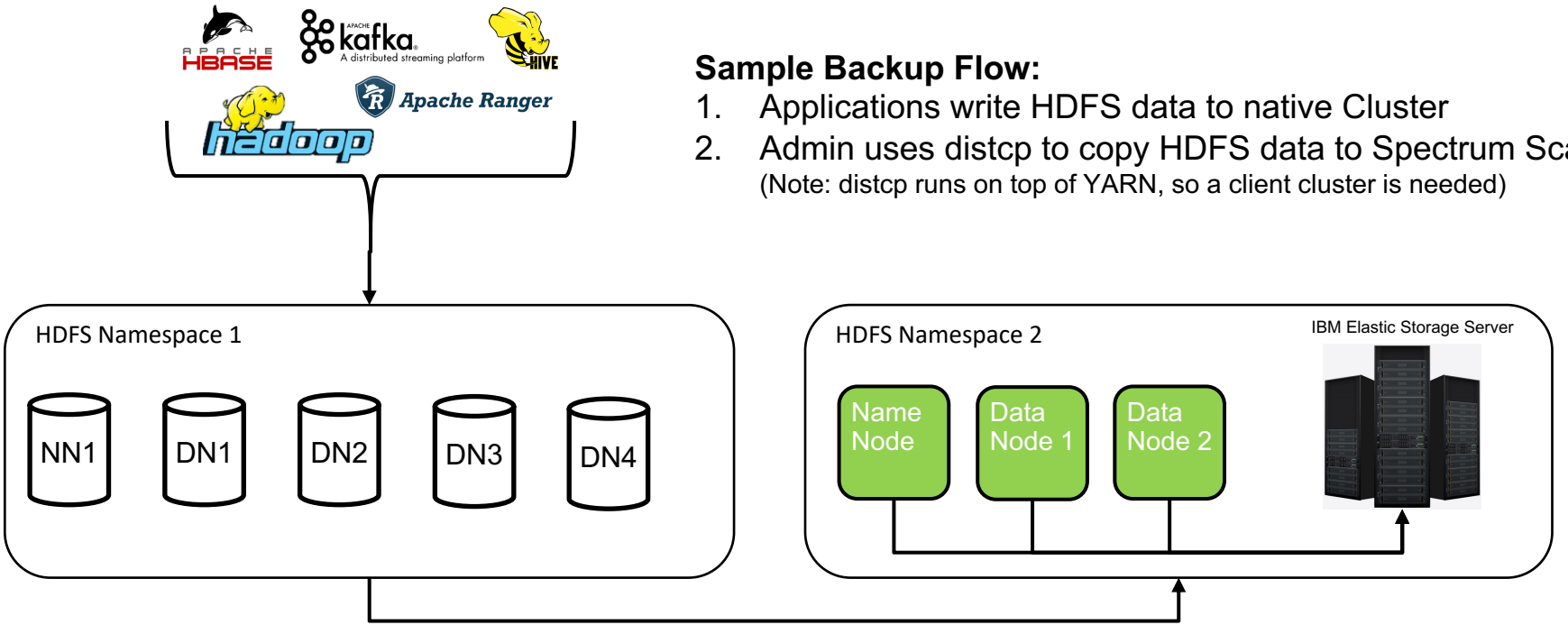
Use Case 2: HDFS Storage Tiering & Federation

IBM Spectrum Scale

- ViewFS not supported by Hive
- May work well for other workloads



Use Case 3: HDFS Backup



Sample Backup Flow:

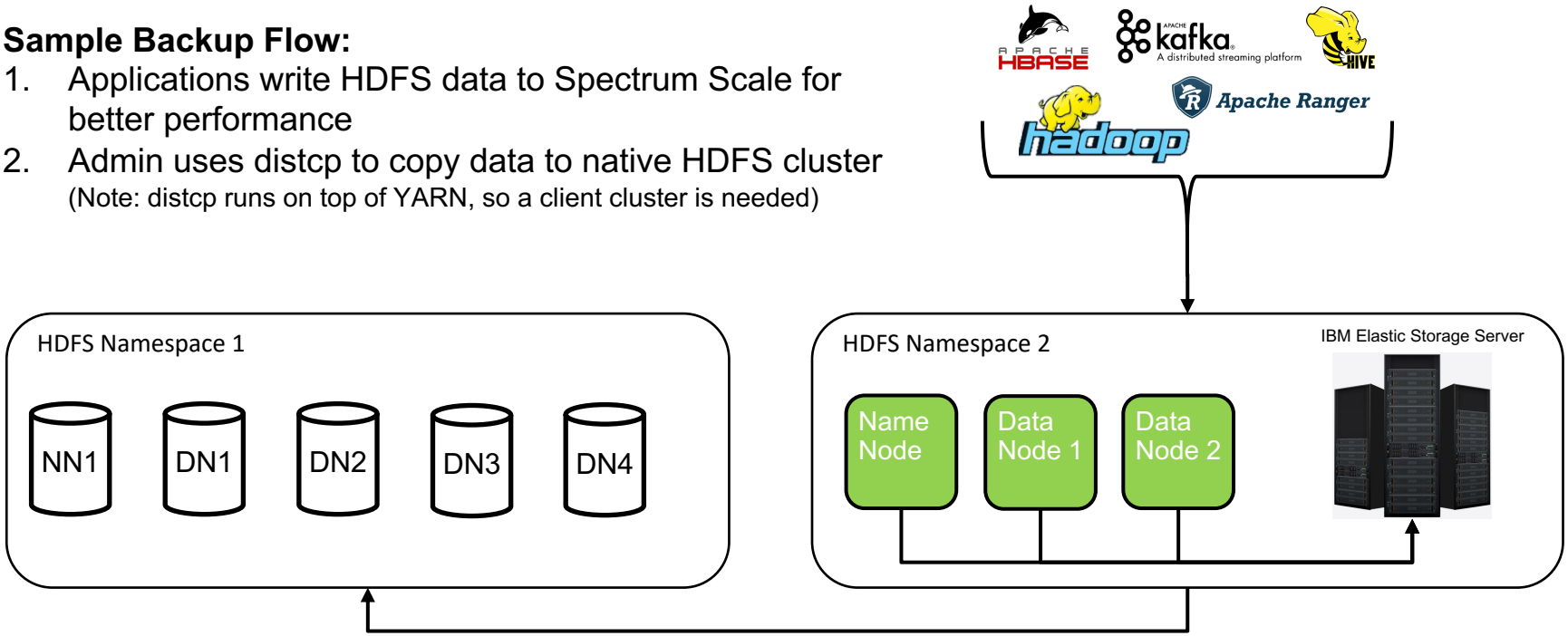
1. Applications write HDFS data to native Cluster
2. Admin uses distcp to copy HDFS data to Spectrum Scale
   (Note: distcp runs on top of YARN, so a client cluster is needed)

Use Case 3: HDFS Backup

IBM Spectrum Scale

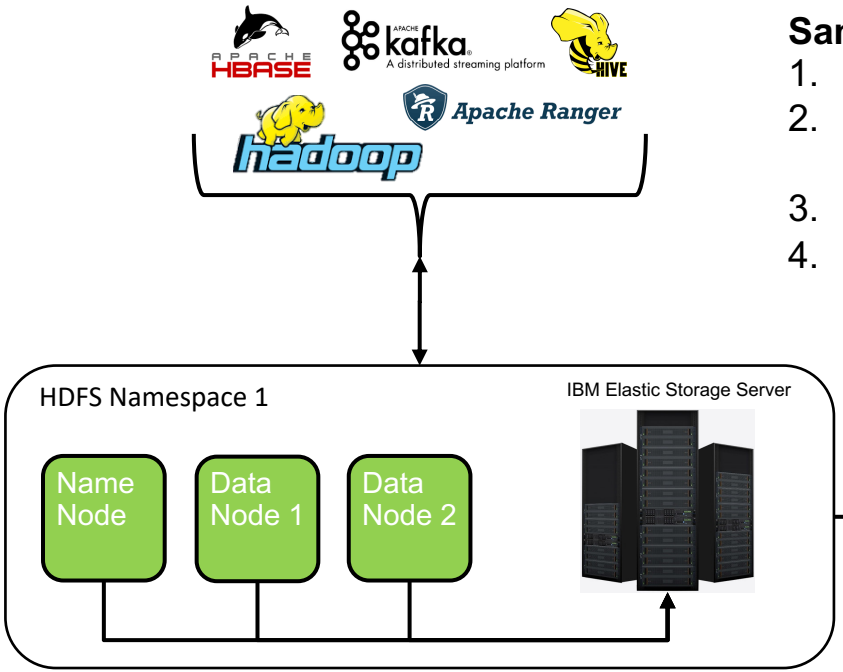
Sample Backup Flow:

1. Applications write HDFS data to Spectrum Scale for better performance
2. Admin uses distcp to copy data to native HDFS cluster
   (Note: distcp runs on top of YARN, so a client cluster is needed)



> hadoop distcp hdfs://spectrum-scale-namenode:8020 hdfs://native-namenode:8020

Use Case 3: HDFS Backup

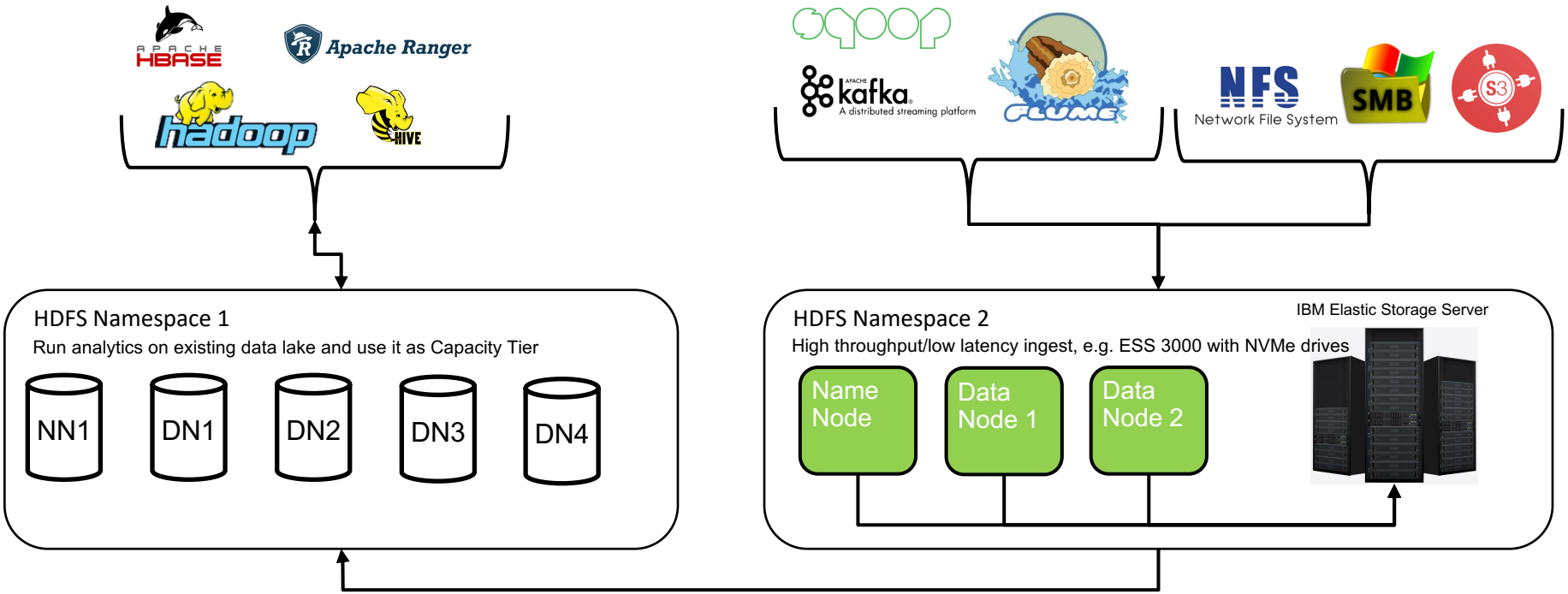


Sample Backup Flow:

1. Applications write HDFS data to Spectrum Scale
2. Admin dumps databases storing metadata (e.g. Hive Metastore, Ranger DB, …) to Spectrum Scale
3. Admin creates a Spectrum Scale Filesystem snapshot
4. Snapshot is backed up using Spectrum Protect or Spectrum Archive

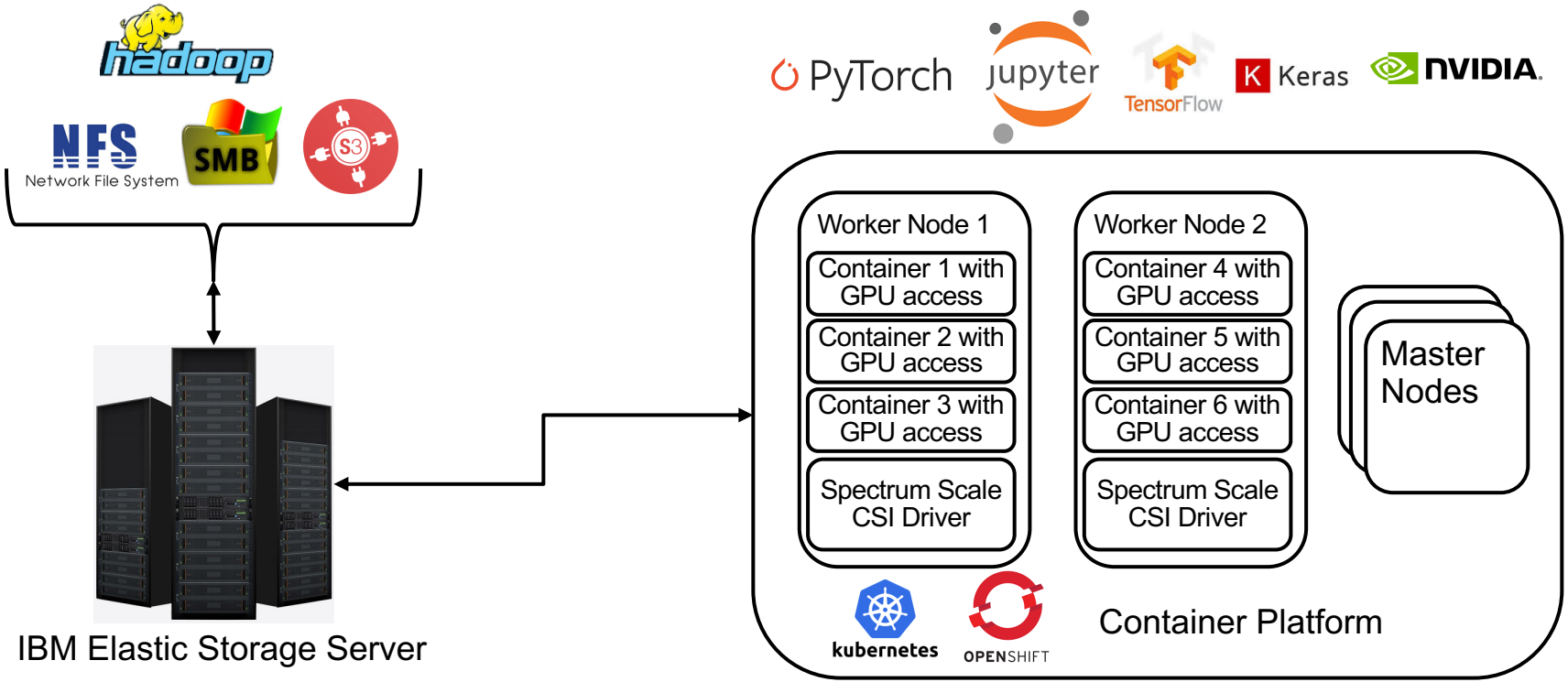
Use Case 4: Spectrum Scale as Ingest Tier

IBM Spectrum Scale

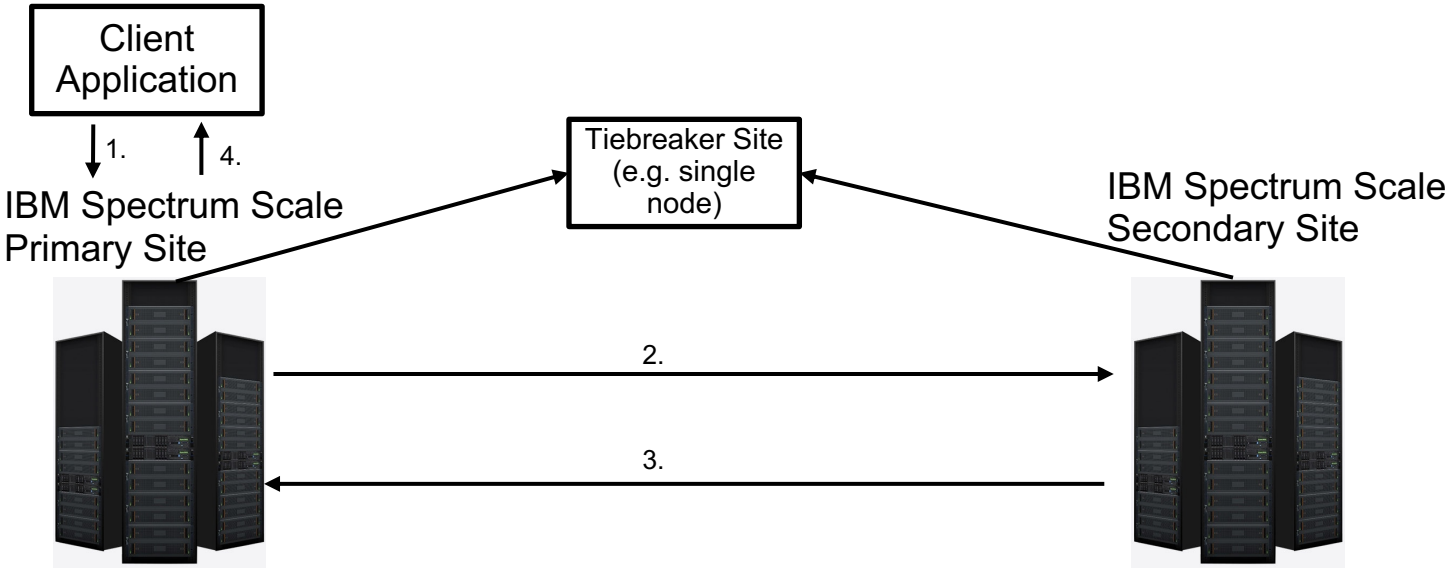


> hadoop distcp hdfs://spectrum-scale-namenode:8020 hdfs://native-namenode:8020

Use Case 5: Next generation workloads



Use Case 6: Disaster Recovery and Fault Tolerance



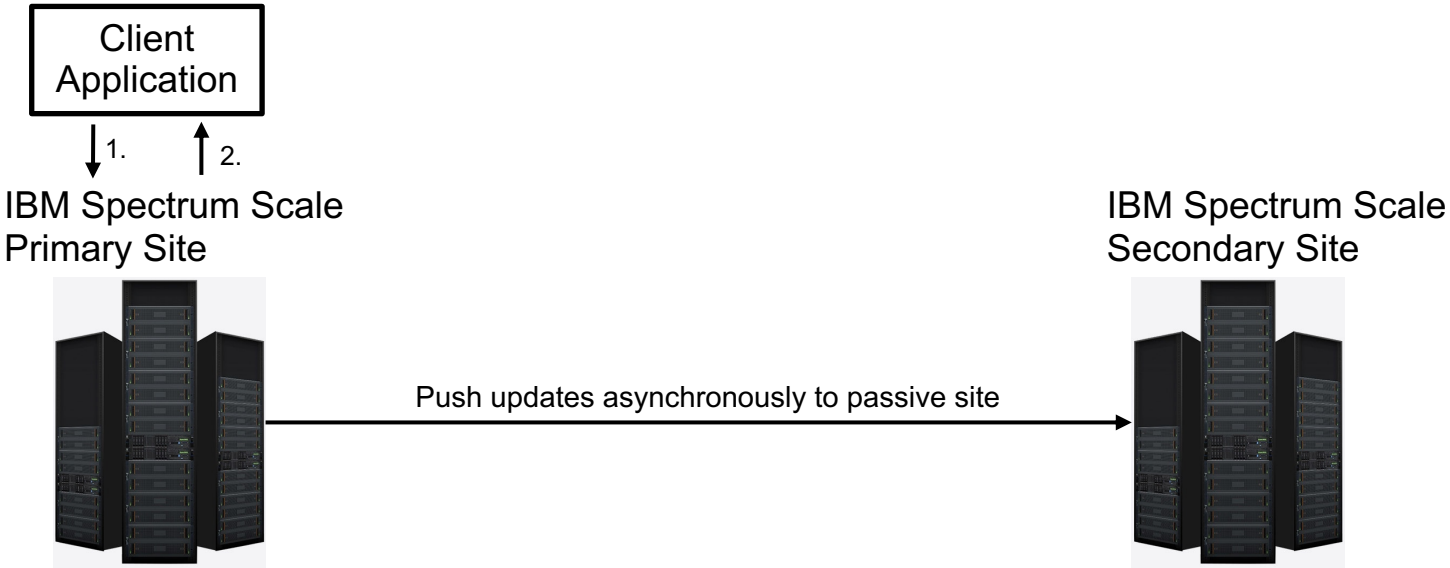
Active/Active: Stretch Cluster configuration

→ All nodes are members of one Spectrum Scale cluster

→ Network between the sites is critical for performance (< 100km distance recommended)

→ Tiebreaker Site needed so that the remaining site can continue the operation

Use Case 6: Disaster Recovery and Fault Tolerance



Active/Passive: Async DR with Active File Management

→ Two separate Spectrum Scale clusters

→ Network between the sites is not critical (e.g. high latency, low bandwidth, WAN-like)

→ Snapshots can be used as Recovery Point Objective (RPO)

Spectrum Scale HDFS integration into CES

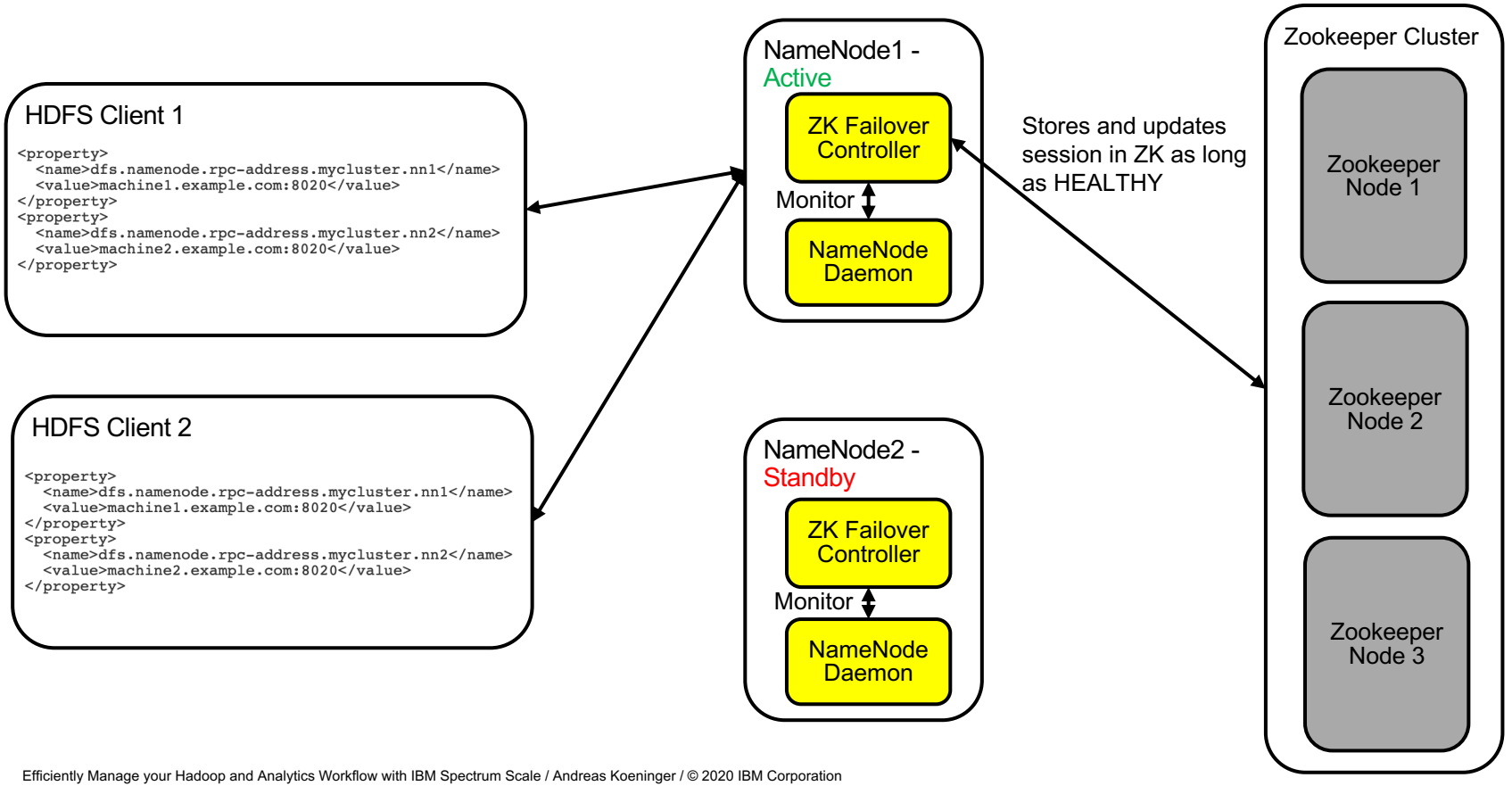
Spectrum Scale HDFS integration into CES

IBM Spectrum Scale

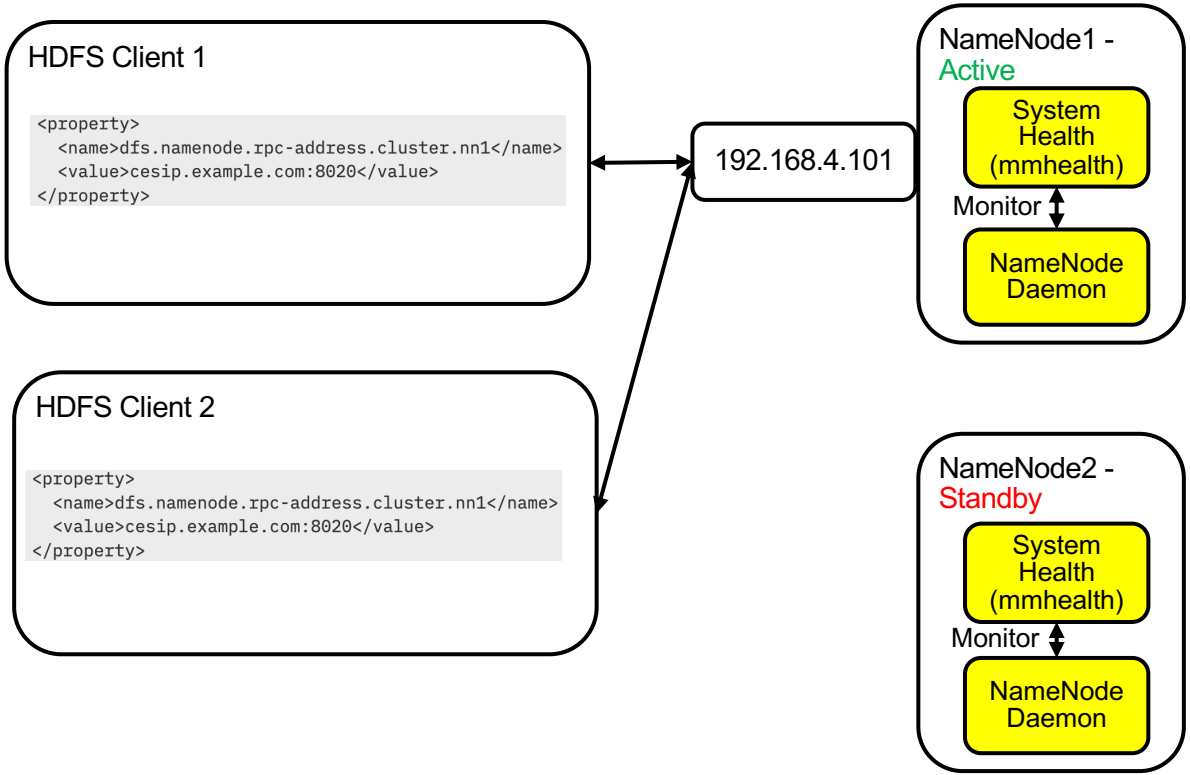
- Available in:
  - Spectrum Scale 5.0.4.2 and later
  - HDFS Transparency 3.1.1.0 and later
  - Supported with Open Source Apache Hadoop only
- Only new installations supported for now (no upgrade support)
- HDP customers stay on HDFS Transparency 3.1.0-x
- CDP will be based on the CES HDFS model for light integration between IBM Spectrum Scale and CDP
- Fully integrated in Spectrum Scale Installation Toolkit

Traditional Hadoop/HDFS Transparency <= 3.1.0.x

IBM Spectrum Scale

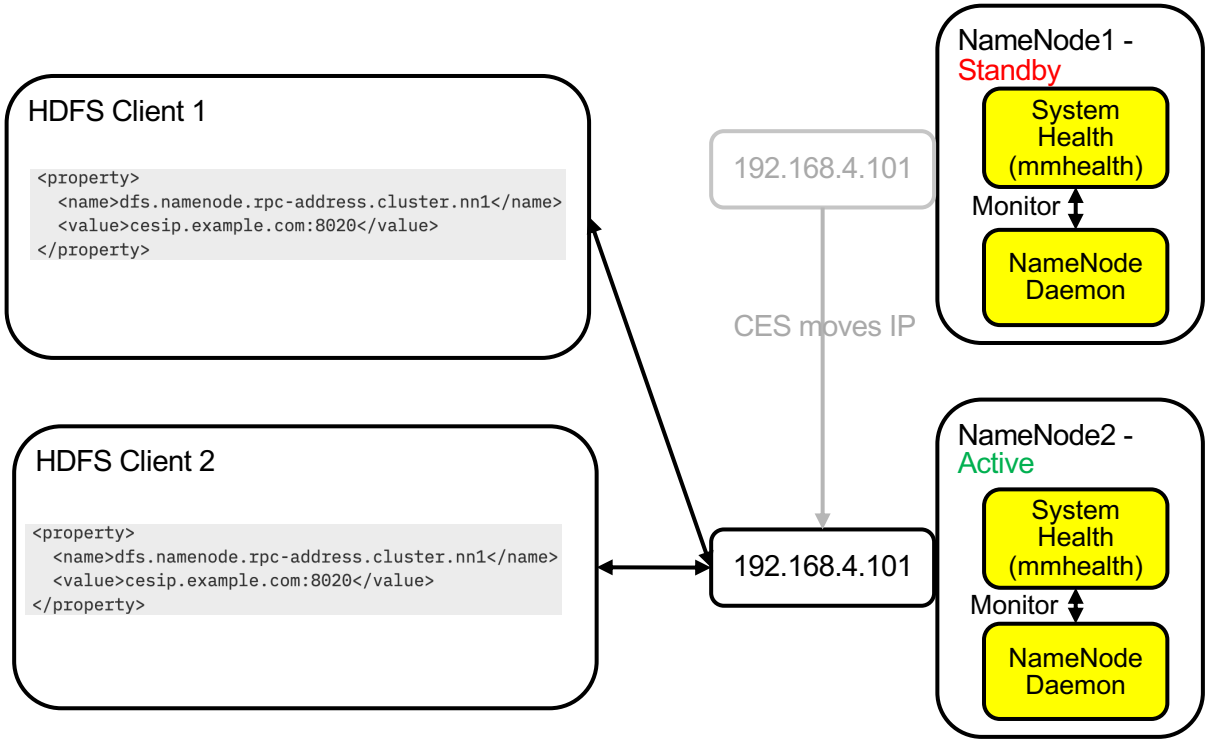


Spectrum Scale CES/HDFS integration
HDFS Transparency >= 3.1.1.0



- CES IP is assigned to the active NameNode
- HDFS clients always talk to this single CES IP
- SystemHealth monitors the active NameNode
- If something goes wrong CES moves the CES IP to another NameNode and sets the new NameNode to active and the old NameNode to standby

Spectrum Scale CES/HDFS integration
HDFS Transparency >= 3.1.1.0



- CES IP is moved to the new NameNode
- New NameNode is active, old NameNode is standby
- HDFS clients retry connection during failover

Spectrum Scale CES/HDFS configuration

IBM Spectrum Scale

- Two HDFS clusters in the same Spectrum Scale cluster:
  - hdfsmycluster1
  - hdfsmycluster2
- Active NameNodes:
  - hdfsmycluster1: ak-43
  - hdfsmycluster2: ak-44
- Other CES IPs are available for other protocols (SMB, NFS, Object)

```
[root@ak-44 ~]# mmces address list
Address         Node                  Ces Group        Attributes
--------------- --------------------- ---------------- ------------
192.168.4.100   ak-43.localnet.com    hdfsmycluster1   hdfsmycluster1
192.168.4.101   ak-44.localnet.com    hdfsmycluster2   hdfsmycluster2
192.168.4.102   ak-42.localnet.com    none             none
192.168.4.103   ak-42.localnet.com    none             none
192.168.4.104   ak-42.localnet.com    none             none
192.168.4.105   ak-43.localnet.com    none             none
192.168.4.106   ak-44.localnet.com    none             none
192.168.4.107   ak-43.localnet.com    none             none
192.168.4.108   ak-44.localnet.com    none             none
192.168.4.109   ak-42.localnet.com    none             none
192.168.4.110   ak-43.localnet.com    none             none
192.168.4.111   ak-44.localnet.com    none             none
```

Spectrum Scale CES/HDFS configuration

IBM Spectrum Scale

Active protocol services:

```
[root@ak-42 ~]# mmces service list -N cesNodes
Enabled services: SMB NFS HDFS
ak-43.localnet.com:  SMB is running, NFS is running, HDFS NameNode is running
ak-44.localnet.com:  SMB is running, NFS is running, HDFS NameNode is running
ak-42.localnet.com:  SMB is running, NFS is running, HDFS NameNode is running
```

NameNode state of mycluster1:

```
[root@ak-42 ~]# /usr/lpp/mmfs/hadoop/bin/hdfs haadmin -checkHealth -scale -all
------------------------------------------------------------------------
Cluster Name:          mycluster1
Namenode Service ID:   nn1
Health State:          OK
Service State:         STANDBY
Error Message:
------------------------------------------------------------------------
------------------------------------------------------------------------
Cluster Name:          mycluster1
Namenode Service ID:   nn2
Health State:          OK
Service State:         ACTIVE
Error Message:
------------------------------------------------------------------------
```

Spectrum Scale CES/HDFS monitoring

IBM Spectrum Scale

Query NameNode state using `mmhealth`:

```
[root@ak-41 ~]# mmhealth node show -N cesNodes

Node name:      ak-42.localnet.com
Node status:    DEGRADED
Status Change:  6 days ago

Component         Status        Status Change     Reasons
------------------------------------------------------------------------------------------------------------------------------------------------------
GPFS              TIPS          19 days ago       gpfs_maxstatcache_low, gpfs_pagepool_small
NETWORK           HEALTHY       19 days ago       -
FILESYSTEM        HEALTHY       19 days ago       -
DISK              HEALTHY       19 days ago       -
CES               FAILED        6 days ago        hdfs_namenode_process_down(mycluster1), hdfs_namenode_failed(mycluster1), hdfs_namenode_unknown_state(mycluster1)
HDFS_DATANODE     FAILED        2 days ago        hdfs_datanode_process_down
PERFMON           HEALTHY       19 days ago       -
THRESHOLD         HEALTHY       19 days ago       -

Node name:      ak-43.localnet.com
Node status:    TIPS
Status Change:  6 days ago

Component      Status        Status Change     Reasons
-----------------------------------------------------------------------------------------
GPFS           TIPS          19 days ago       gpfs_maxstatcache_low, gpfs_pagepool_small
NETWORK        HEALTHY       19 days ago       -
FILESYSTEM     HEALTHY       19 days ago       -
DISK           HEALTHY       19 days ago       -
CES            HEALTHY       6 days ago        -
PERFMON        HEALTHY       19 days ago       -
THRESHOLD      HEALTHY       15 days ago       -

Node name:      ak-44.localnet.com
Node status:    TIPS
Status Change:  6 days ago

Component         Status        Status Change     Reasons
------------------------------------------------------------------------------------------
GPFS              TIPS          19 days ago       gpfs_maxstatcache_low, gpfs_pagepool_small
NETWORK           HEALTHY       19 days ago       -
FILESYSTEM        HEALTHY       19 days ago       -
DISK              HEALTHY       19 days ago       -
CES               HEALTHY       6 days ago        -
HDFS_DATANODE     HEALTHY       14 days ago       -
PERFMON           HEALTHY       19 days ago       -
THRESHOLD         HEALTHY       19 days ago       -
```

Spectrum Scale CES/HDFS monitoring

IBM Spectrum Scale

Drill down into component HDFS_NAMENODE:

```
[root@ak-41 ~]# mmhealth node show HDFS_NAMENODE -N cesNodes

Node name:      ak-42.localnet.com

Component         Status        Status Change     Reasons
-------------------------------------------------------------------------------------------------------------------------------------------------------------
HDFS_NAMENODE     FAILED        6 days ago        hdfs_namenode_process_down(mycluster1), hdfs_namenode_failed(mycluster1), hdfs_namenode_unknown_state(mycluster1)


Event                          Parameter         Severity    Active Since      Event Message
-------------------------------------------------------------------------------------------------------------------------------------
hdfs_namenode_process_down     HDFS_NAMENODE     ERROR       6 days ago        HDFS NameNode process for hdfs cluster mycluster1 is down
hdfs_namenode_failed           HDFS_NAMENODE     ERROR       6 days ago        HDFS NameNode health for hdfs cluster mycluster1 failed
hdfs_namenode_unknown_state    HDFS_NAMENODE     WARNING     6 days ago        HDFS NameNode service state for hdfs cluster mycluster1 is UNKNOWN

Node name:      ak-43.localnet.com

Component         Status        Status Change     Reasons
-----------------------------------------------------------
HDFS_NAMENODE     HEALTHY       7 days ago        -

There are no active error events for the component HDFS_NAMENODE on this node (ak-43.localnet.com).

Node name:      ak-44.localnet.com

Component         Status        Status Change     Reasons
-----------------------------------------------------------
HDFS_NAMENODE     HEALTHY       7 days ago        -

There are no active error events for the component HDFS_NAMENODE on this node (ak-44.localnet.com).
```

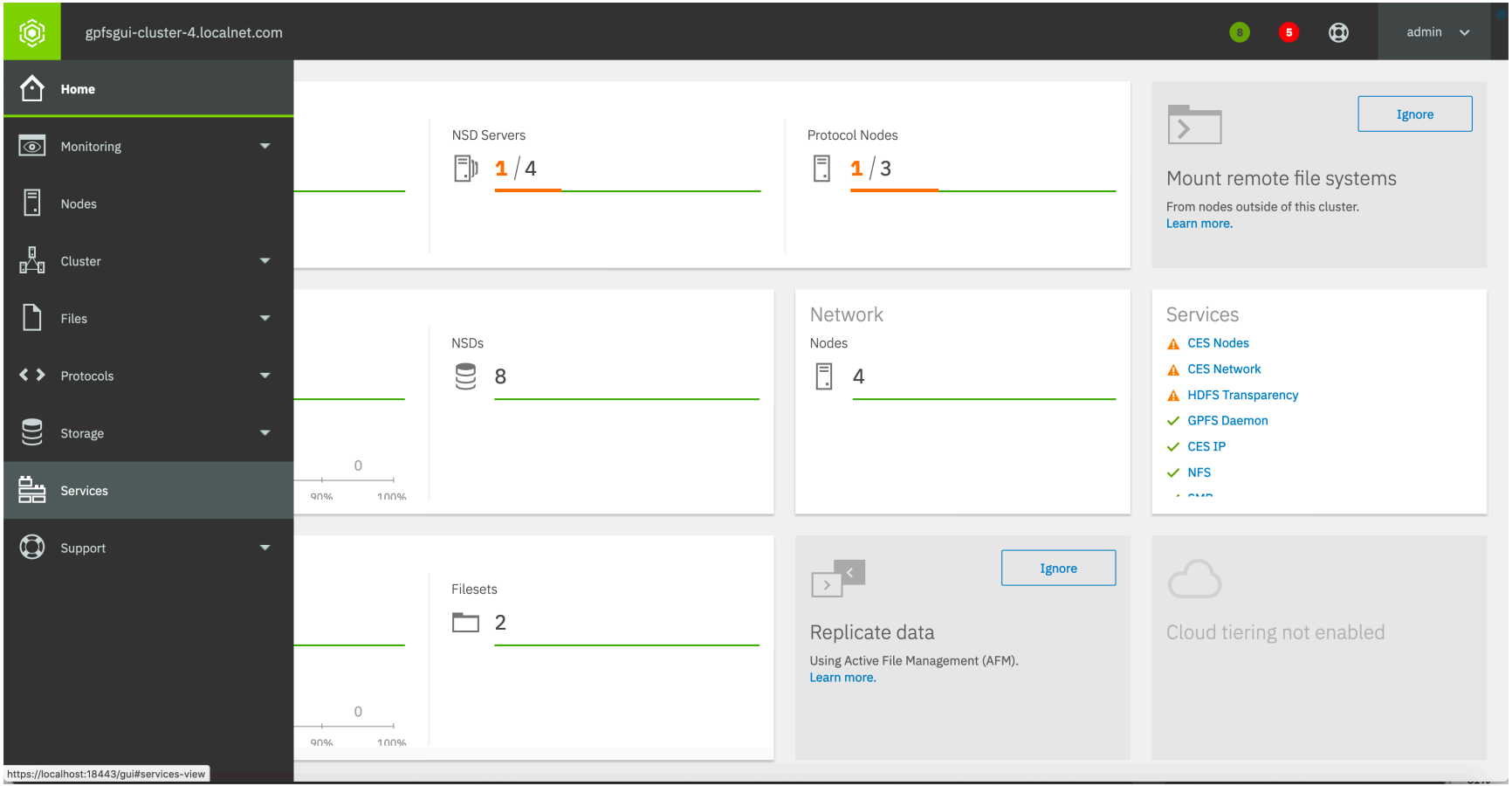
Spectrum Scale CES/HDFS monitoring

IBM Spectrum Scale

Display HEALTHY events for component HDFS_NAMENODE as well:

```
[root@ak-41 ~]# mmhealth node show HDFS_NAMENODE -v -N cesNodes

Node name:      ak-42.localnet.com

Component         Status        Status Change            Reasons
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------
HDFS_NAMENODE     FAILED        2020-01-29 14:33:44      hdfs_namenode_process_down(mycluster1), hdfs_namenode_failed(mycluster1), hdfs_namenode_unknown_state(mycluster1)


Event                          Parameter         Severity    Active Since            Event Message
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------
hdfs_namenode_process_down     HDFS_NAMENODE     ERROR       2020-01-29 14:33:44     HDFS NameNode process for hdfs cluster mycluster1 is down
hdfs_namenode_failed           HDFS_NAMENODE     ERROR       2020-01-29 14:33:43     HDFS NameNode health for hdfs cluster mycluster1 failed
hdfs_namenode_unknown_state    HDFS_NAMENODE     WARNING     2020-01-29 14:33:43     HDFS NameNode service state for hdfs cluster mycluster1 is UNKNOWN

Node name:      ak-43.localnet.com

Component         Status        Status Change            Reasons
-----------------------------------------------------------------
HDFS_NAMENODE     HEALTHY       2020-01-28 17:31:54      -


Event                        Parameter         Severity    Active Since            Event Message
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------
hdfs_namenode_active         HDFS_NAMENODE     INFO        2020-01-29 12:49:51     HDFS NameNode service state for hdfs cluster mycluster1 is ACTIVE
hdfs_namenode_ok             HDFS_NAMENODE     INFO        2020-01-28 17:31:54     HDFS NameNode health for hdfs cluster mycluster1 is ok
hdfs_namenode_process_up     HDFS_NAMENODE     INFO        2020-01-28 17:31:26     HDFS NameNode process for hdfs cluster mycluster1 is ok

Node name:      ak-44.localnet.com

Component         Status        Status Change            Reasons
-----------------------------------------------------------------
HDFS_NAMENODE     HEALTHY       2020-01-28 17:33:09      -


Event                        Parameter         Severity    Active Since            Event Message
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------
hdfs_namenode_active         HDFS_NAMENODE     INFO        2020-01-28 17:33:09     HDFS NameNode service state for hdfs cluster mycluster2 is ACTIVE
hdfs_namenode_ok             HDFS_NAMENODE     INFO        2020-01-28 17:32:10     HDFS NameNode health for hdfs cluster mycluster2 is ok
hdfs_namenode_process_up     HDFS_NAMENODE     INFO        2020-01-28 17:31:42     HDFS NameNode process for hdfs cluster mycluster2 is ok
```

Spectrum Scale CES/HDFS monitoring



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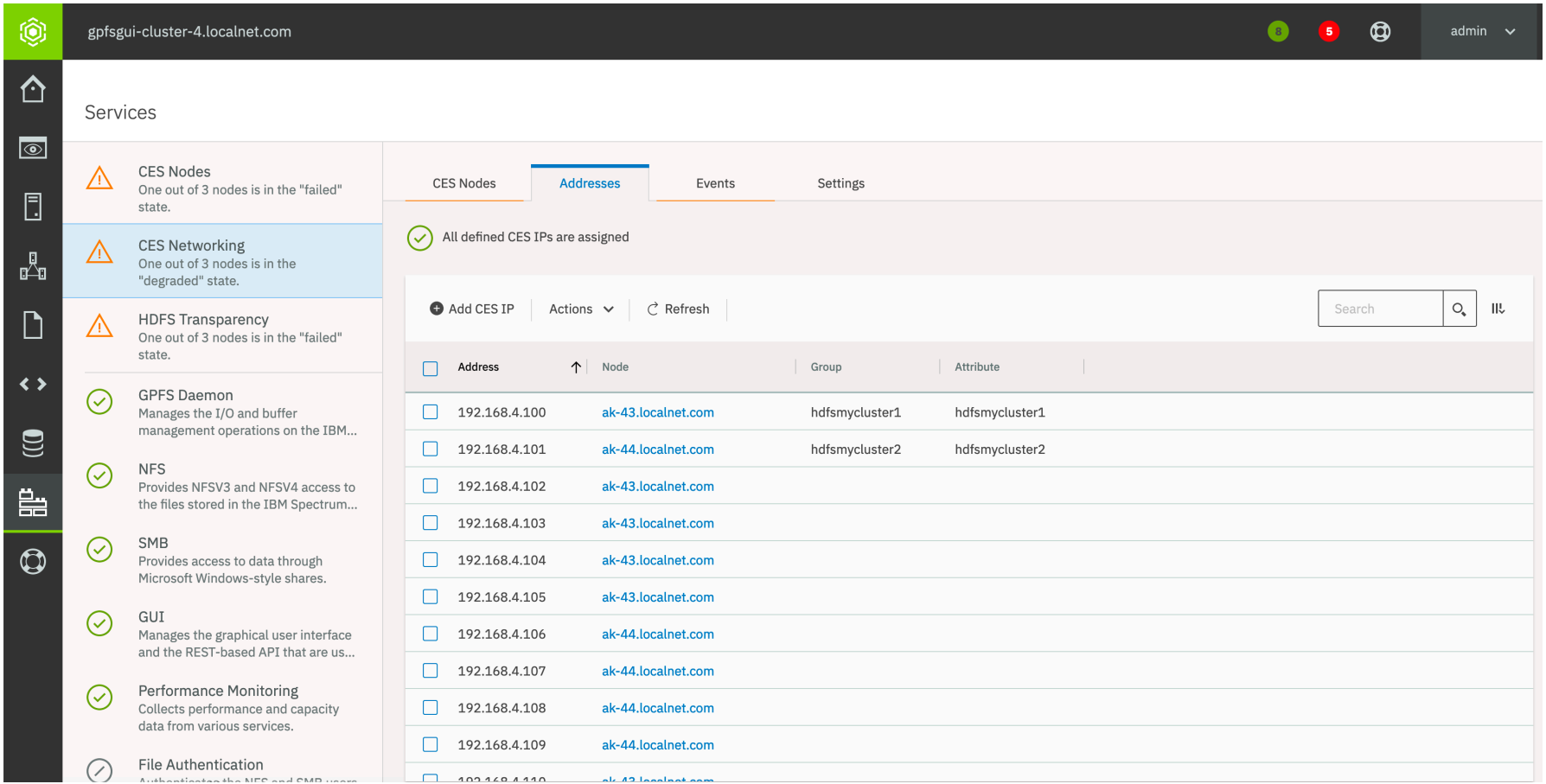

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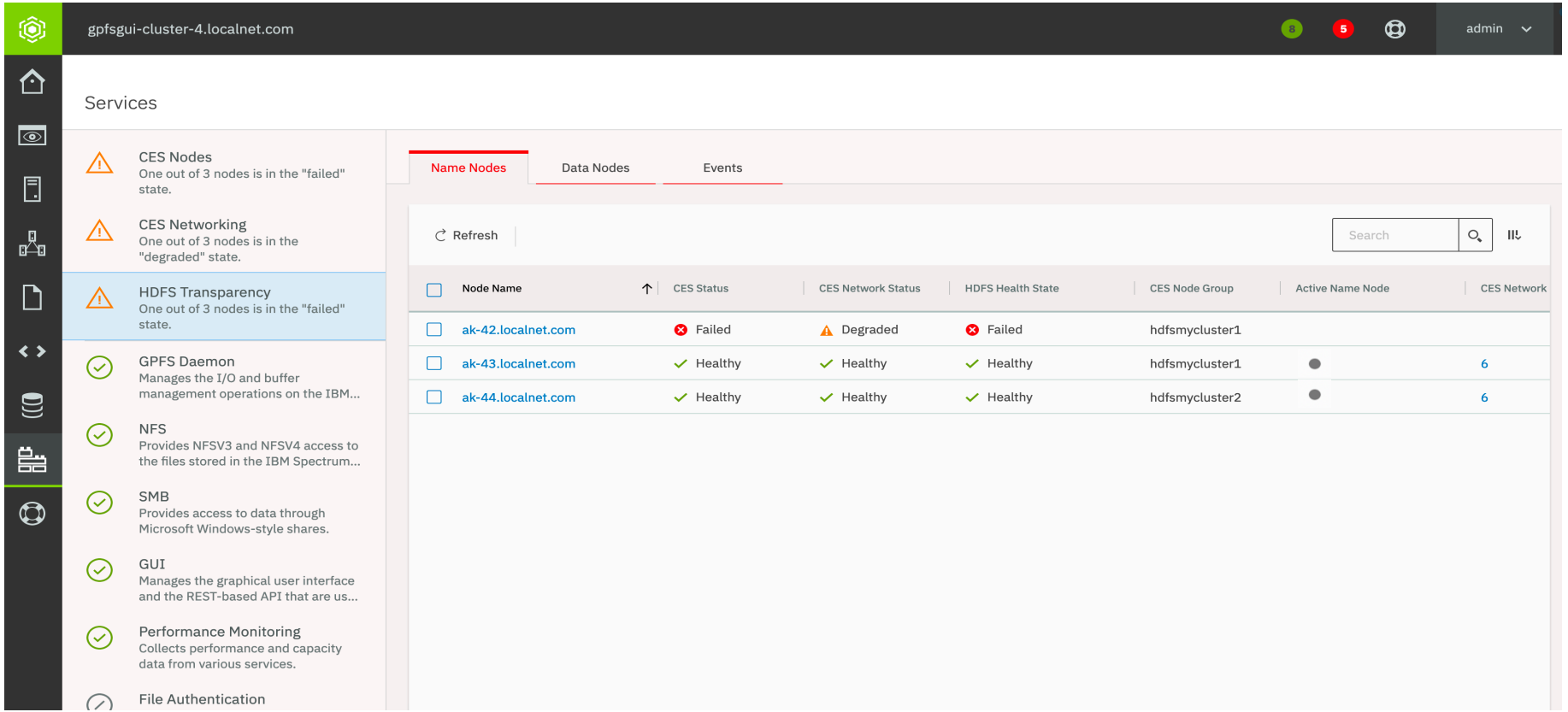

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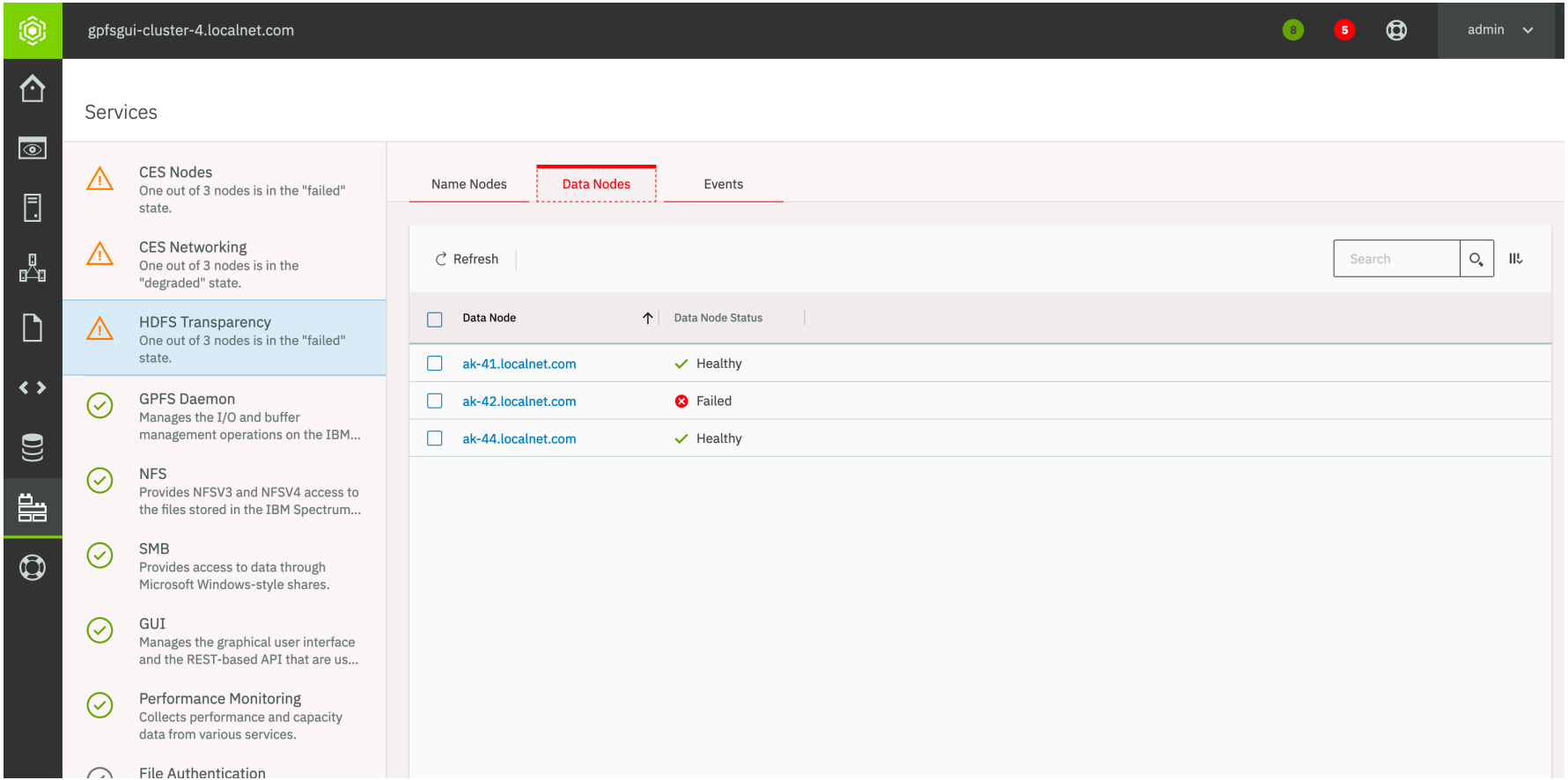
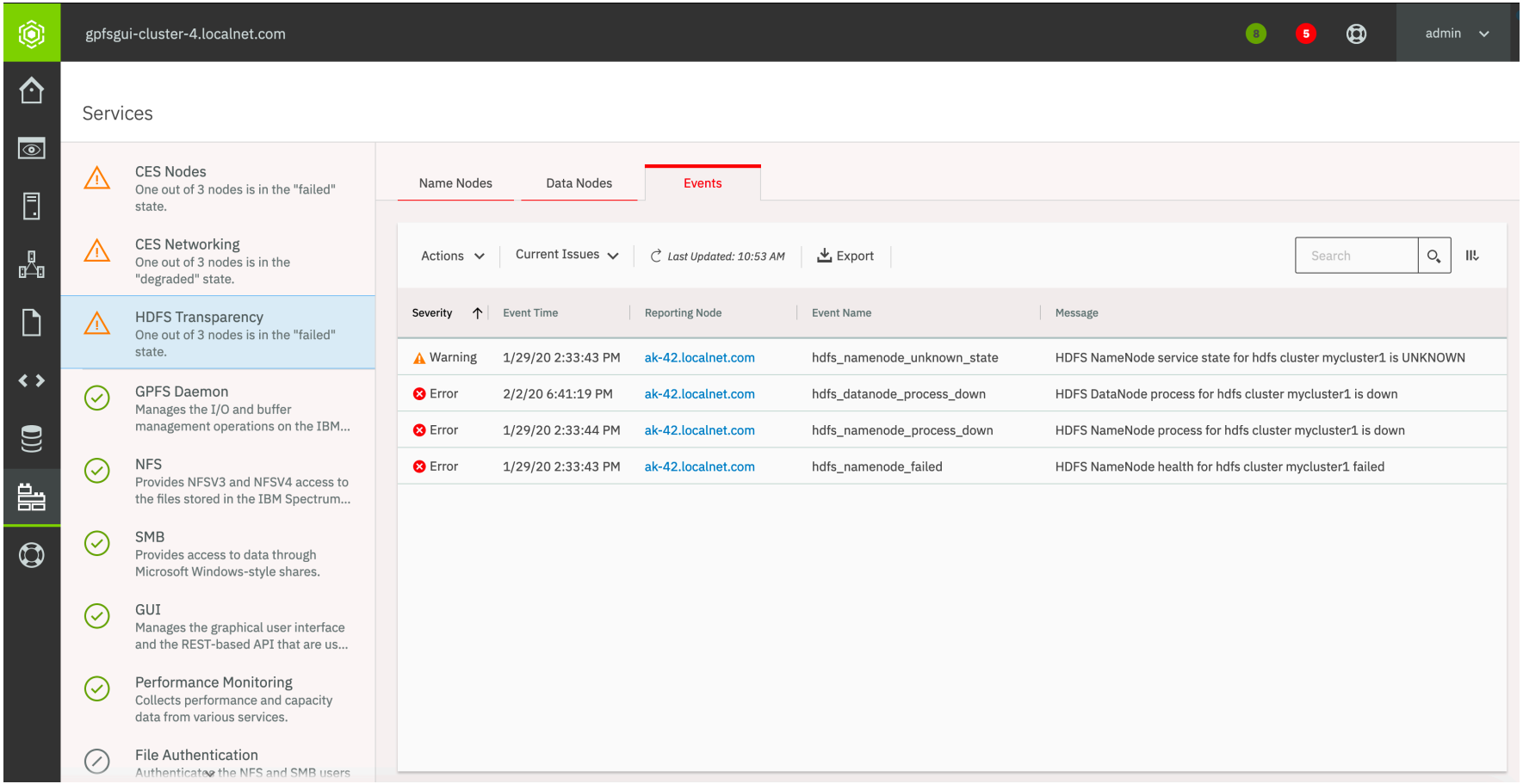


Spectrum Scale CES/HDFS monitoring



Useful links

IBM Spectrum Scale Big Data and Analytics support in IBM Knowledge Center:
https://www.ibm.com/support/knowledgecenter/STXKQY_BDA_SHR/bl1adv_kc_bigdataanalytics_kclanding.htm

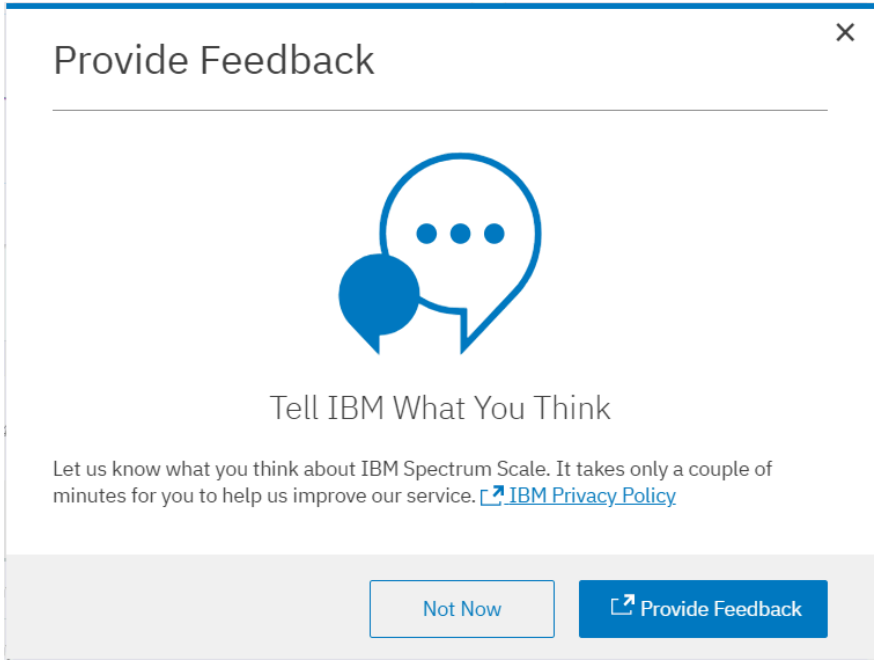
Native HDFS to IBM Spectrum Scale HDFS migration:
https://developer.ibm.com/storage/2019/01/18/migrating-data-from-native-hdfs-to-ibm-spectrum-scale-based-shared-storage/

CES HDFS support Blog Post:
https://developer.ibm.com/storage/2020/02/03/ces-hdfs-transparency-support/

CES HDFS support in IBM Knowledge Center:
https://www.ibm.com/support/knowledgecenter/STXKQY_BDA_SHR/bl1bda_ceshdfs.htm

Contact:
Andreas Koeninger <andreas.koeninger@de.ibm.com>

Thank you!



Please help us to improve Spectrum Scale with your feedback

- If you get a survey by email or a popup in the GUI, please respond
- We read every single reply