Hadoop Integration – Deep Dive
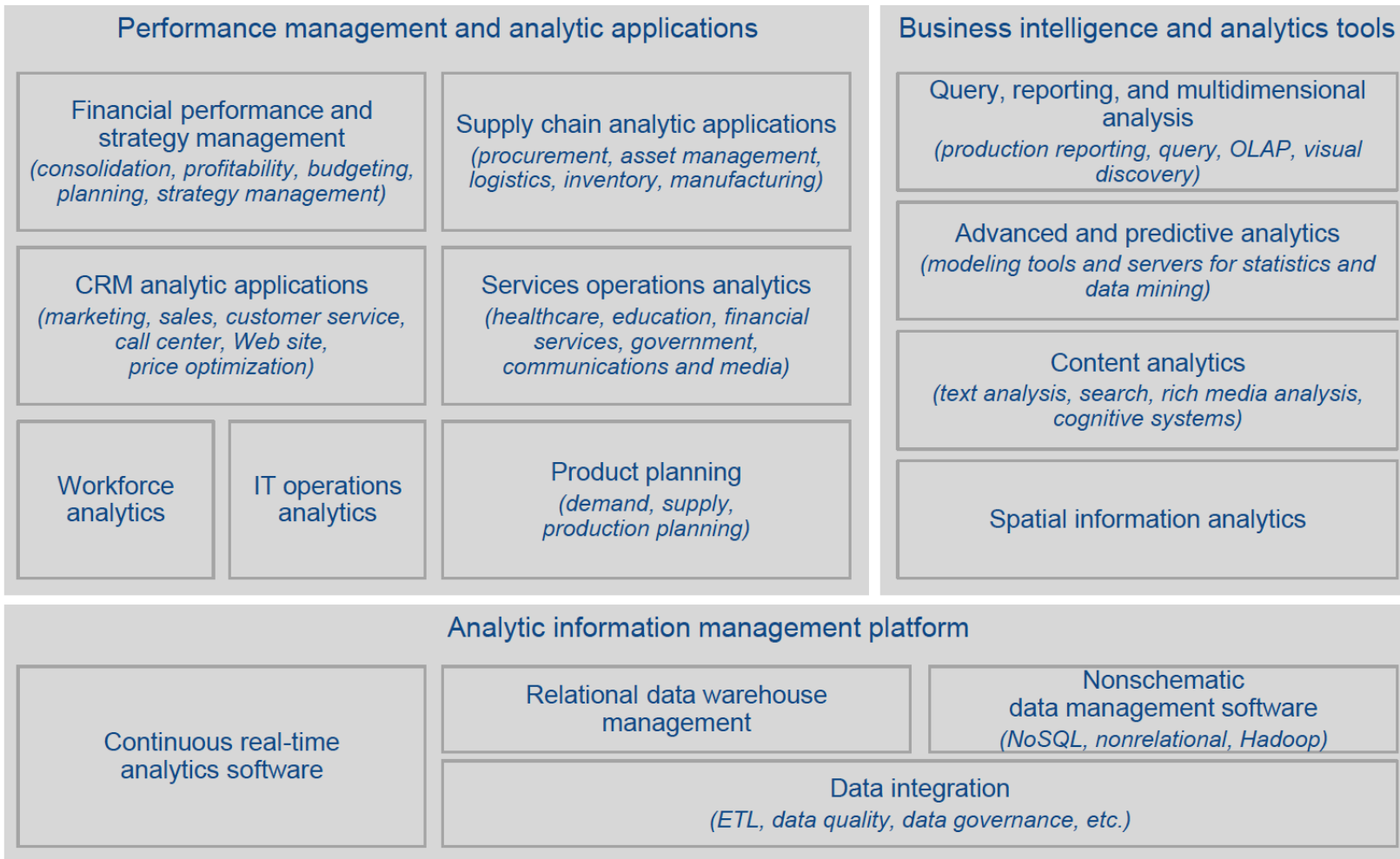
Piyush Chaudhary
Spectrum Scale BD&A Architect

Agenda

- Analytics Market overview
- Spectrum Scale Analytics strategy
- Spectrum Scale Hadoop Integration
  - A tale of two connectors
  - Old GPFS Hadoop connector
  - New Spectrum Scale HDFS Transparency connector

IDC's Business Analytics – Broader Workload Perspective

IDC's Business Analytics Software Taxonomy, 2015

Performance management and analytic applications

Financial performance and strategy management
(consolidation, profitability, budgeting, planning, strategy management)

Supply chain analytic applications
(procurement, asset management, logistics, inventory, manufacturing)

CRM analytic applications
(marketing, sales, customer service, call center, Web site, price optimization)

Services operations analytics
(healthcare, education, financial services, government, communications and media)

Workforce analytics

IT operations analytics

Product planning
(demand, supply, production planning)

Business intelligence and analytics tools

Query, reporting, and multidimensional analysis
(production reporting, query, OLAP, visual discovery)

Advanced and predictive analytics
(modeling tools and servers for statistics and data mining)

Content analytics
(text analysis, search, rich media analysis, cognitive systems)

Spatial information analytics

Analytic information management platform

Continuous real-time analytics software

Relational data warehouse management

Nonschematic data management software
(NoSQL, nonrelational, Hadoop)

Data integration
*(ETL, data quality, data governance, etc.)*

Conclusions

- Analytics market opportunity for Spectrum Scale is broader than just the Hadoop Big Data Market
- IDC definition beginning to account for new workloads
- **NEED** to consider a wide range of Analytics workloads in both Shared nothing and shared storage environments
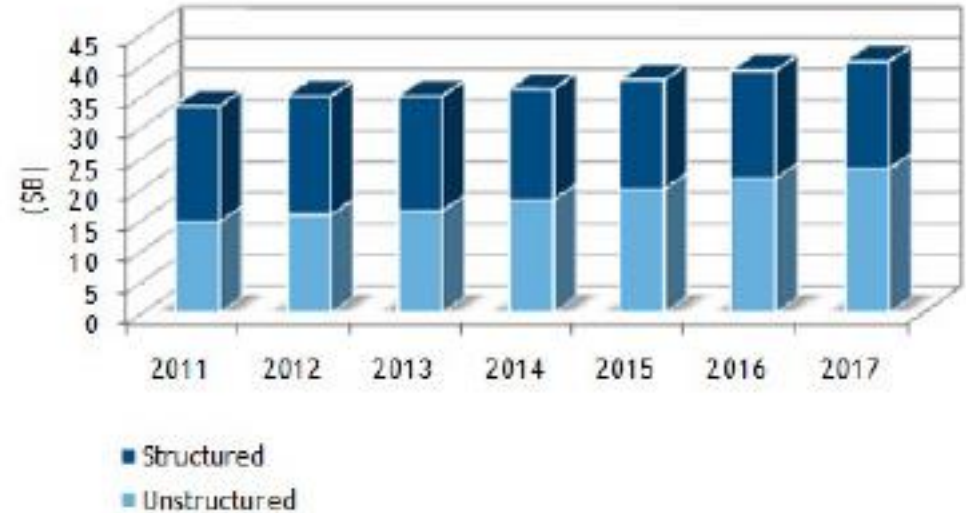
Source: IDC, 2015

Structured and Unstructured Data Market

Worldwide Structured and Unstructured Enterprise Storage Systems Capacity Shipped, 2011-2017

- Structured
- Unstructured
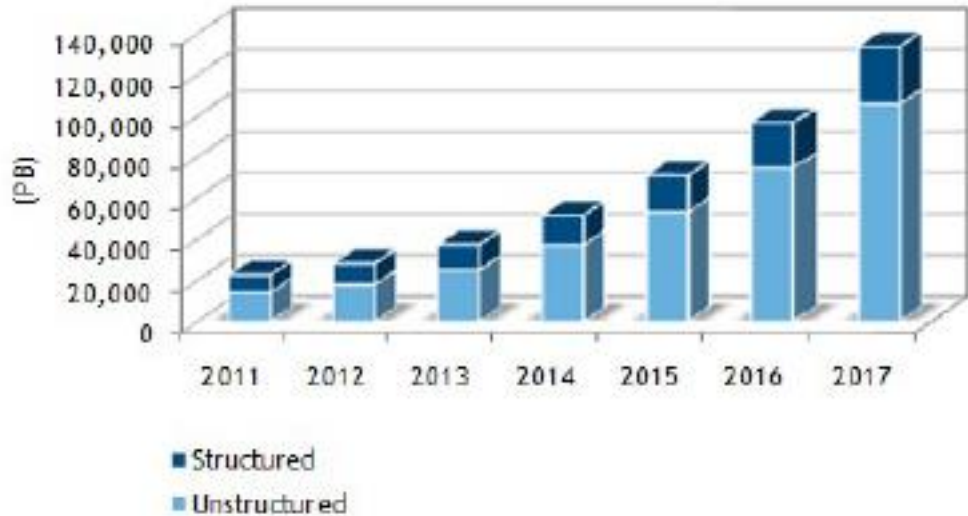
Source: IDC, 2014

Worldwide Structured and Unstructured Enterprise Storage Systems Customer Revenue, 2011-2017

- Structured
- Unstructured

Source: IDC, 2014

Worldwide Storage in Big Data Revenue by System Type, 2012-2018 ($B)

	2012	2013	2014	2015	2016	2017	2018	2013–2018 CAGR (%)
Capacity optimized	0.51	0.86	1.47	2.07	2.86	3.69	4.30	38.0
Performance optimized	0.49	0.61	0.72	0.84	0.94	1.06	1.10	12.5
I/O Intensive	0.04	0.21	0.13	0.21	0.33	0.45	0.49	18.5
Total	1.04	1.68	2.32	3.12	4.13	5.20	5.89	28.5

Note: See Table 6 for top 3 assumptions and Table 7 for key forecast assumptions.

Source: IDC, 2014

Conclusion
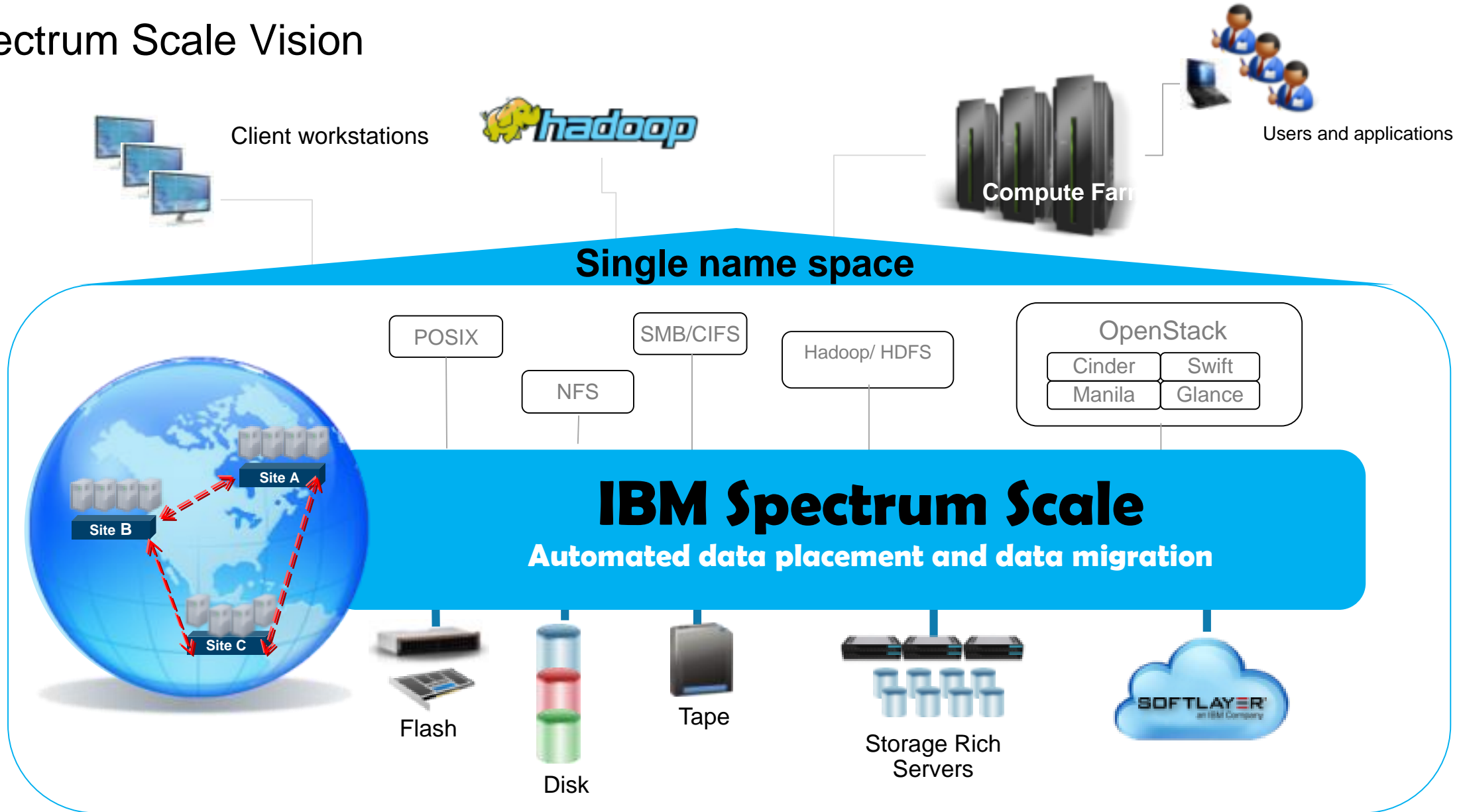- Spectrum Scale addresses the sweet spot of the growth segment for Enterprise Storage Systems.

People and devices are creating oceans of data

Data scientists and LoBs want to fish this ocean for insights

The ocean of data must be efficiently stored, managed, protected, and exploited by the right applications at the right time

Spectrum Scale Vision

Client workstations

hadoop

Compute Farm

Users and applications

Single name space

POSIX

SMB/CIFS

NFS

Hadoop/ HDFS

OpenStack

Cinder | Swift

Manila | Glance

Site A

Site B

Site C

IBM Spectrum Scale

Automated data placement and data migration

Flash

Disk

Tape

Storage Rich Servers

SOFTLAYER an IBM Company

Multi-structured Data Mashups provide the Greatest Enterprise Value

Systems of Record
Structured data from operational systems
20% of all data generated

Systems of Insight
Diverse data types that combine structured and unstructured data for business insight

Systems of Engagement
Data that "connects" companies with their customers, partners and employees
80% of all data generated

Data Warehouses

Hadoop and Streams

Structured Data

Small Data

Clearly formatted   Transaction data

Quantitative

Objective   ERP Data

Logical   Electronic Health Records

Puzzle

Repeatable   Mainframe Data

linear   OLTP System Data

Advanced Analytics

Context Accumulation

Enterprise Integration

Audio   Unstructured Data

Documents   Big Data

Images   Language based

RFID   Qualitative

Emails   Subjective

Sensors   Intuitive

Social Data   Mystery

Video   Exploratory

Web Logs   dynamic

Traditional Sources

New Data Sources

A Tale of Two Connectors

GPFS Hadoop Connector

- Henceforth known as the "old" connector
- Emulates a Hadoop compatible filesystem – i.e. replaces HDFS
- Stateless
- Free download – link
- Supports Spectrum Scale 4.1.1 and 4.2
- Currently supported with IOP 4.0 and 4.1
- Integrated with Ambari (IOP 4.1)
- Also supported with Open Source Apache Hadoop

Spectrum Scale HDFS Transparency Connector

- Henceforth known as the "new" connector
- Integrates with HDFS – reuses HDFS client and implements NameNode and DataNode RPCs
- Stateless
- Free download – link
- Supports Spectrum Scale 4.1.1 and 4.2
- Planned support for IOP 4.1 and 4.2 (6 weeks after GA)
- Ambari integration being developed for both IOP 4.1 and 4.2 (coming soon)

Old GPFS Hadoop Connector Approach

How can we be sure we're compatible?
Hadoop File System API intended to be open.

public abstract class
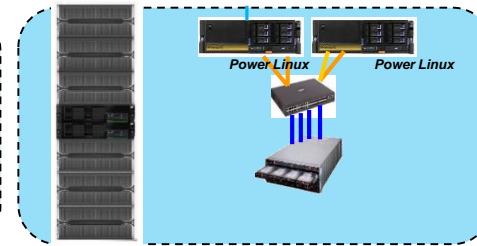   org.apache.hadoop.fs.FileSystem

Source: *hadoop.apache.org*

"All user code that may potentially use the Hadoop Distributed File System should be written to use a FileSystem object."

Latest File System APIs are described here:

https://hadoop.apache.org/docs/current/api/org/apache/hadoop/fs/FileSystem.html

Old GPFS Hadoop Connector Approach

All based on
org.apache.hadoop.fs.FileSystem API

	Optimized for
HDFS	General Hadooop
GlusterFS	file-based scale-out NAS
OrangeFS	high end computing (HEC) systems
SwiftFS	write directly to containers in an OpenStack Swift object store
GridGain	In-Memory Data Fabric
Lustre	
MapR FileSystem	
Quantcast File System	
▪etc...	

Spectrum Scale (GPFS) is no different

Source: https://wiki.apache.org/hadoop/HCFS

Old GPFS Hadoop Connector Approach

Applications communicate with Hadoop using FileSystem API.
Therefore, transparency is preserved.
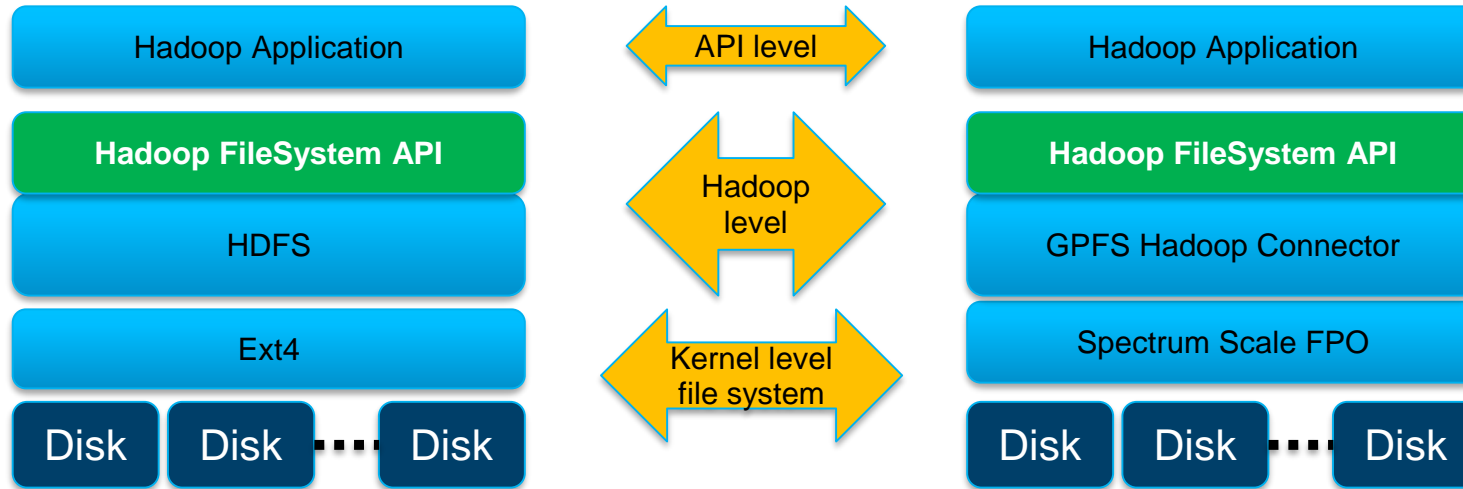
Hadoop Application	API level	Hadoop Application
Hadoop FileSystem API	Hadoop level	**Hadoop FileSystem API**
HDFS		GPFS Hadoop Connector
Ext4	Kernel level file system	Spectrum Scale FPO
Disk Disk ··· Disk		Disk Disk ··· Disk

*"All user code that may potentially use the Hadoop Distributed File System should be written to use a **FileSystem** object."*

Source: *hadoop.apache.org*

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New Spectrum Scale HDFS Transparency Design

hdfs://hostnameX:portnumber

Applications

Higher-level languages: Hive, BigSQL JAQL, Pig …

Map/Reduce API

Hadoop FS APIs

HDFS Client

HDFS RPC

Spectrum Scale Connector Server

Spectrum Scale

Supported Hadoop versions: 2.7.1

Hadoop client — Hadoop FileSystem API — HDFS Client (×3)

HDFS RPC over network

Connector

GPFS Connector Service / Connector on libgpfs,posix API / GPFS node (×2)
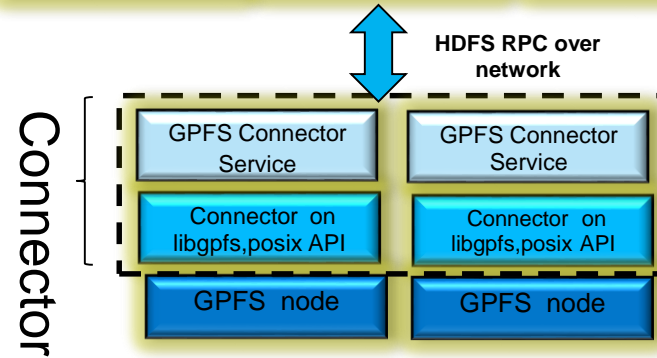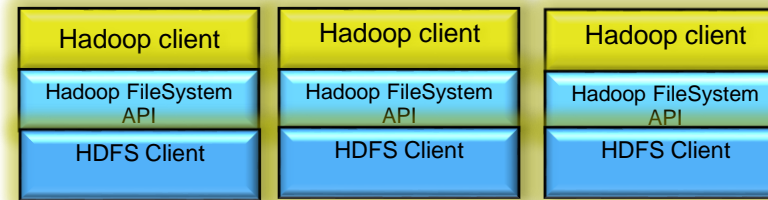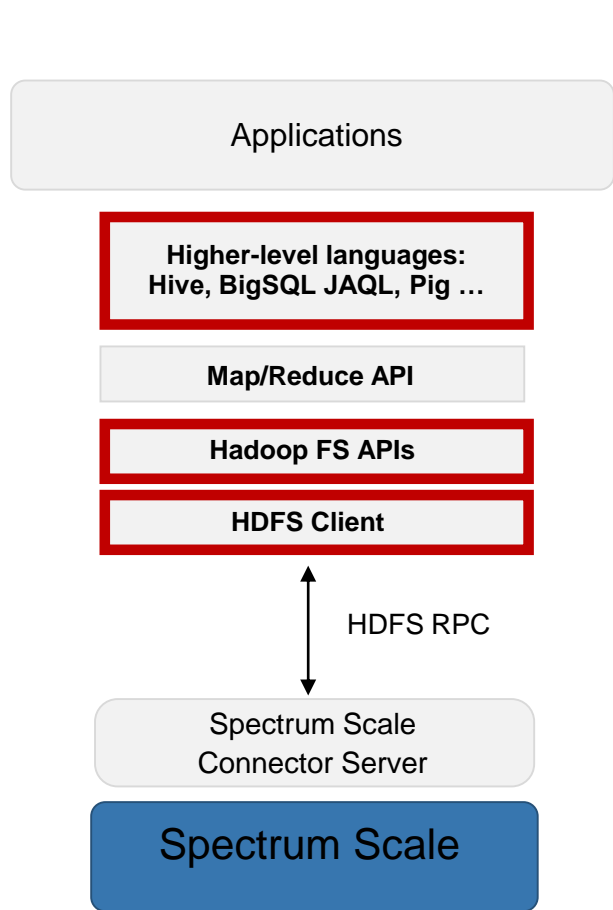
Commodity hardware   Shared storage

Power Linux   Power Linux

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New Spectrum Scale HDFS Transparency Design

- Each node is installed with connector datanode server

- Only one node is installed with connector namenode server

- Connector namenode server can be configured with HA similar to HDFS

- First released in November 2015

DFSClient

DFSClient

DFSClient

hdfs://namenode:<portnumber>

HDFS RPC over network

Connector
Namenode Service

Connector
Datanode Service

Connector
Datanode Service

GPFS FPO

GPFS FPO

GPFS FPO

GPFS/FPO cluster
Hadoop cluster

13
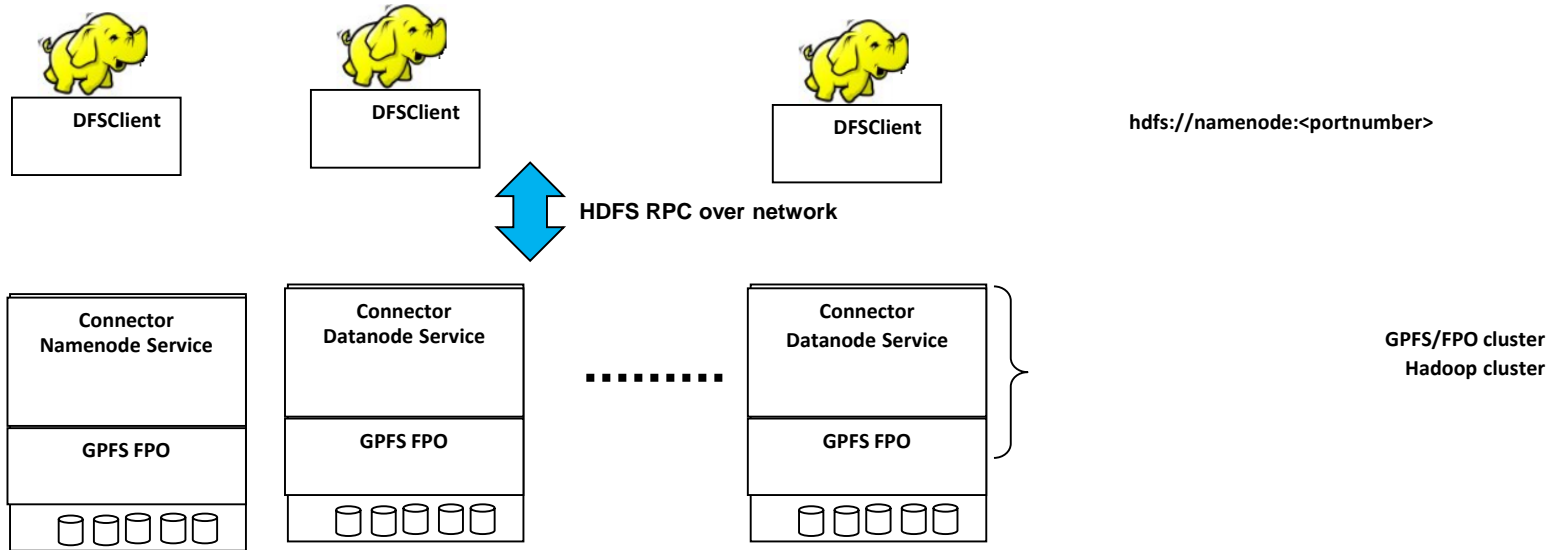
New Spectrum Scale HDFS Transparency Design

- Shared storage support

- Connector servers are installed over limited nodes (ex. GPFS NSD servers)

- GPFS client is not needed on the Hadoop computing nodes

- First released in January 2016
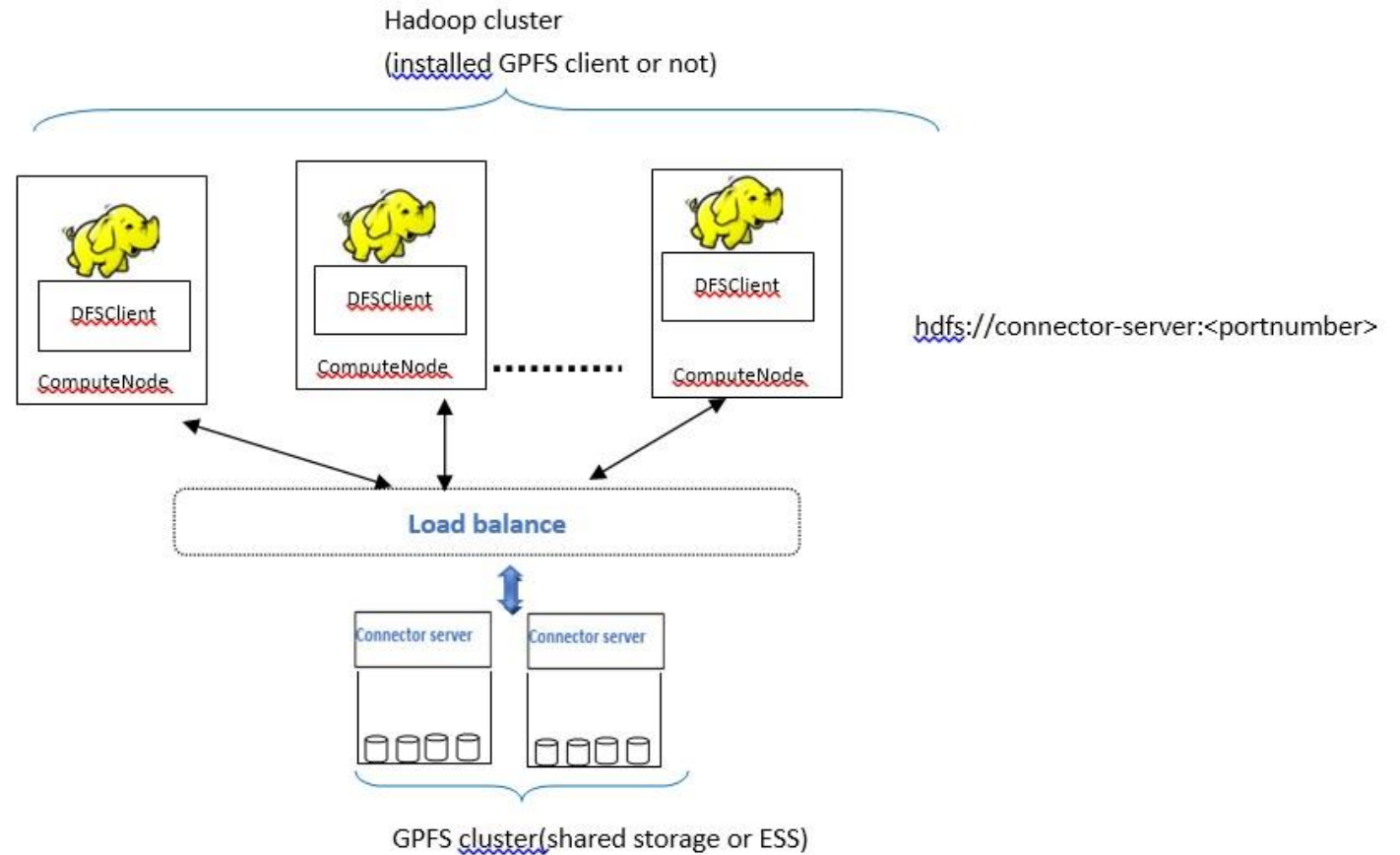
New Spectrum Scale HDFS Transparency Design

- Key Advantages
  - Support workloads that have hard coded HDFS dependencies
  - Simpler integration for currently compatible workloads & components
  - Leverage HDFS Client cache for better performance
  - No need to install Spectrum Scale clients on all nodes
  - Full Kerberos support for Hadoop ecosystem
- Recently released
  - HDFS + Spectrum Scale Federation
  - Federate multiple Spectrum Scale clusters
  - Isolate multiple Hadoop clusters on the same filesystem (restrict to sub-directory)
- Coming Soon
  - BigInsights 4.2 support (additional components)

Current Ambari Integration

- New BigInsights 4.1.SpectrumScale stack
  - Inherits from BigInsights 4.1 stack
  - Removes HDFS, add Spectrum Scale, change all dependencies

- Can install IOP + Spectrum Scale (either new GPFS filesystem or integrate with existing filesystem)
  - Value Add integration
  - Basic Spectrum Scale monitoring (AMS)
  - Support separate connector control
  - Support GPFS and connector upgrades
    - Collect GPFS snap
    - Change GPFS parameters
    - Add new nodes
    - Remove nodes
- Provide quick link to Spectrum Scale GUI for full management and monitoring

Select Stack

Install Options

Confirm Hosts

Choose Services

Assign Masters

Assign Slaves and Clients

Customize Services

Review

Install, Start and Test

Summary

Please select the service stack that you want to use to install your Hadoop cluster.

Stacks

⦿ BigInsights 4.1.SpectrumScale
◯ BigInsights 4.1

▾ Advanced Repository Options

Customize the repository Base URLs for downloading the Stack software packages. If your hosts do not have access to the internet, you will have to create a local mirror of the Stack repository that is accessible by all hosts and use those Base URLs here.

Important: When using local mirror repositories, you only need to provide Base URLs for the Operating System you are installing for your Stack. Uncheck all other repositories.

OS	Name	Base URL
☑ redhat6	GPFS-4.1.1	http://smn/repos/GPFS/RHEL6/x86_64/4.1.1
	IOP-4.1-mirror	http://birepo-build.svl.ibm.com/repos/IOP/RHEL6/x86_64/4.1
	IOP-UTILS-1.1-mirror	http://birepo-build.svl.ibm.com/repos/IOP-UTILS/RHEL6/x86_64/1.
☐ redhat7	GPFS-4.1.1	http://c902mnp08/install/repos/IOP-UTILS/rhel/7/ppc64le/1.1/
	IOP-4.1-mirror	http://c902mnp08/install/repos/GPFS/rhel/7/ppc64le/4.1.1
	IOP-UTILS-1.1-mirror	http://c902mnp08/install/repos/IOP/rhel/7/ppc64le/4.1.x/GA/4.1.0.0
☐ suse11	GPFS-4.1.1	http://192.168.9.3/repos/GPFS/SLES/x86_64/4.1.1
	IOP-4.1	http://birepo-build.svl.ibm.com/repos/IOP/SLES/x86_64/4.1/
	IOP-UTILS-1.0	http://birepo-build.svl.ibm.com/repos/IOP-UTILS/SLES/x86_64/1.1

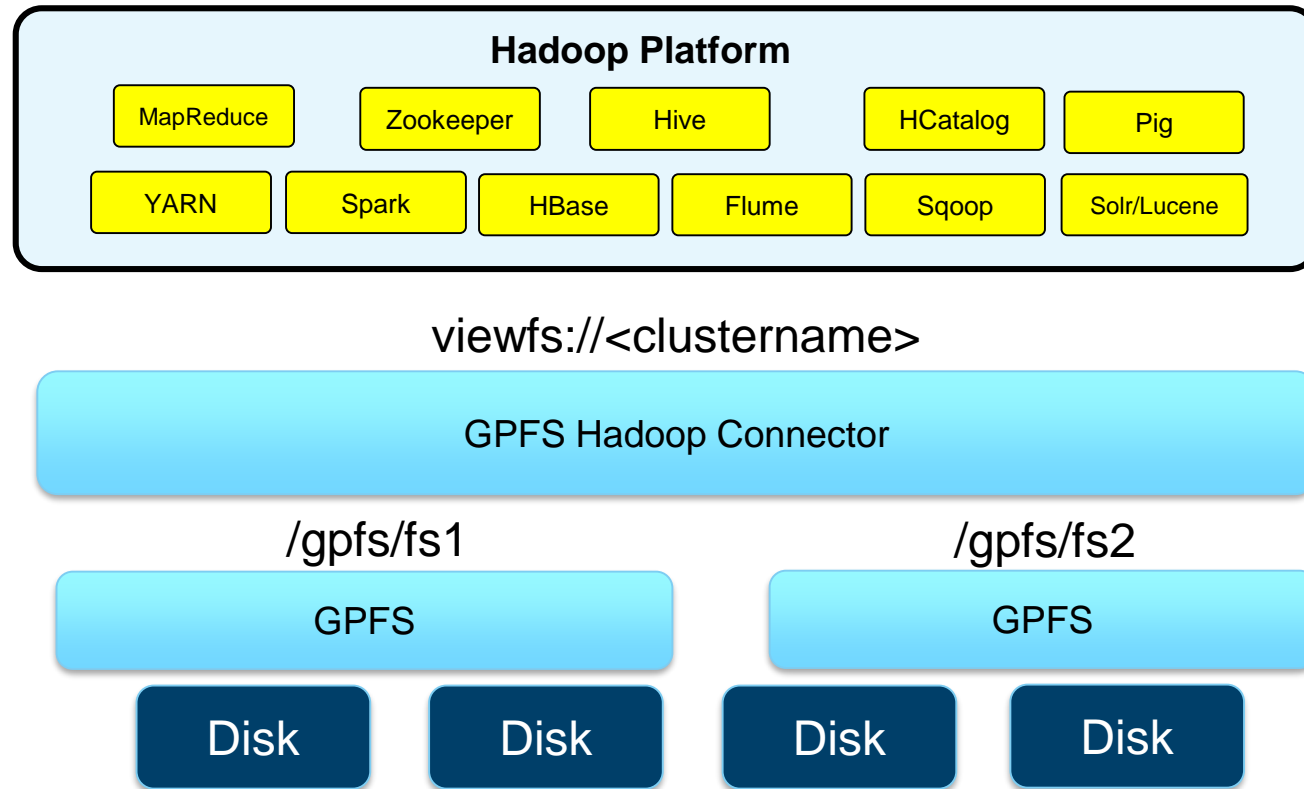☐ Skip Repository Base URL validation (Advanced) ❓

← Back   Next →

Current Ambari Integration
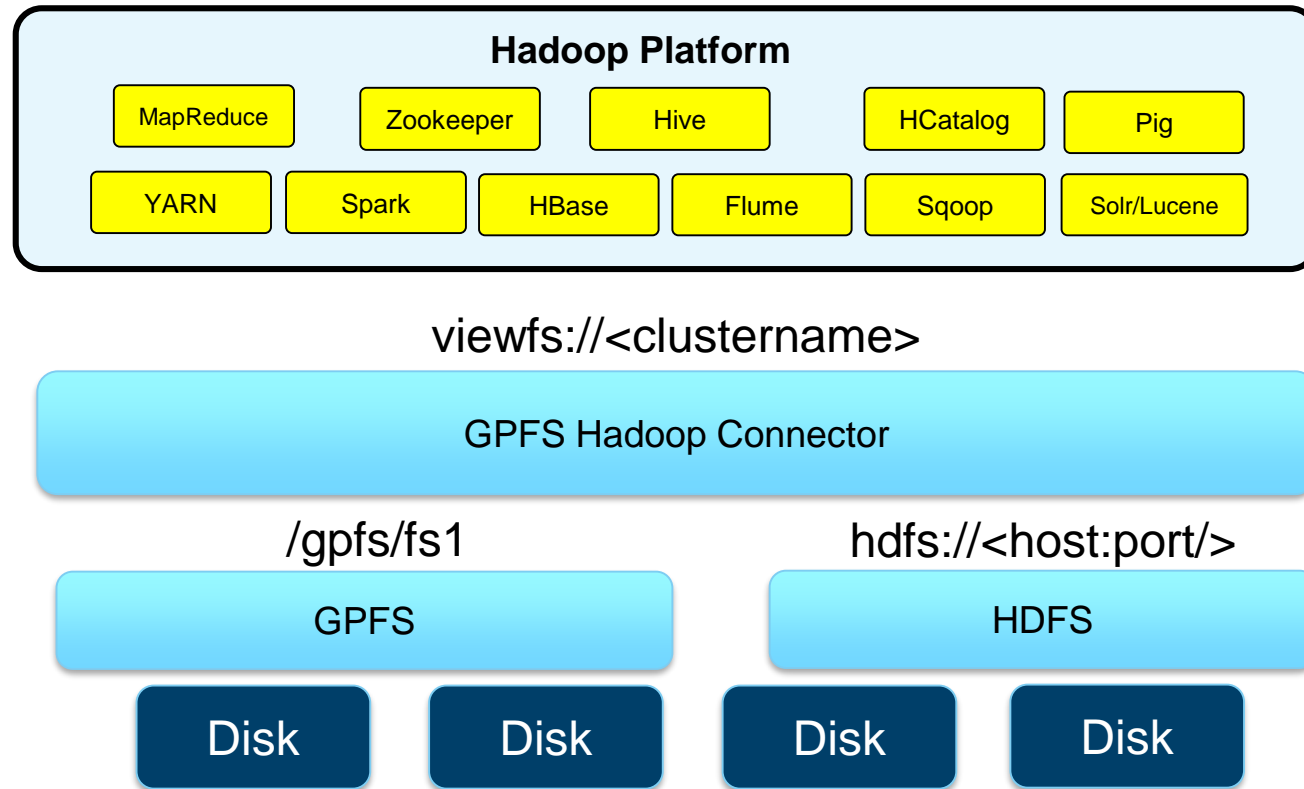
Ambari Integration with HDFS Transparency

- Biggest change is that there is no new stack
- Spectrum Scale is added as a new service after full IOP install with HDFS (use dummy directory / mount point for HDFS)
- Spectrum Scale service "integrates" with HDFS
- Will support "un-integrate" capability
  - Flip back and forth between HDFS & GPFS
  - Will not move data back and forth between HDFS & GPFS
- Will simplify future upgrades

Spectrum Scale Federation – Use Case 1

Hadoop Platform

MapReduce	Zookeeper	Hive	HCatalog	Pig
YARN	Spark	HBase	Flume	Sqoop	Solr/Lucene

viewfs://<clustername>

GPFS Hadoop Connector

/gpfs/fs1
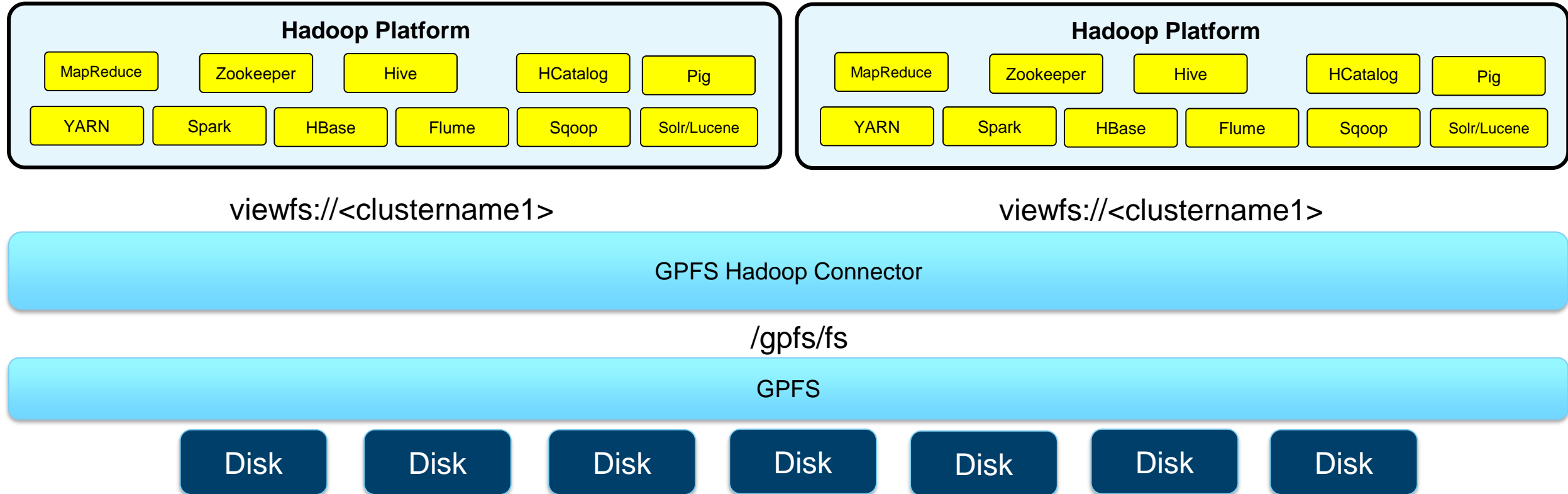
GPFS

Disk   Disk

/gpfs/fs2

GPFS

Disk   Disk

- Make 2+ GPFS file systems appear as one uniform file system for application
- Allow customer to leverage existing GPFS file system and new GPFS file system for data analysis

Spectrum Scale Federation – Use Case 2

Hadoop Platform

MapReduce	Zookeeper	Hive		HCatalog	Pig
YARN	Spark	HBase	Flume	Sqoop	Solr/Lucene

viewfs://<clustername>

GPFS Hadoop Connector

/gpfs/fs1 · · · · · · · · · · hdfs://<host:port/>

GPFS · · · · · · · · · · · · HDFS

Disk   Disk   Disk   Disk

- Allow customers to run applications over GPFS & HDFS seamlessly
- Doesn't require customers to move data from HDFS to GPFS

Spectrum Scale – Workload Isolation

Support multiple Hadoop clusters over the same GPFS filesystem for different applications, groups or LOBs

Spectrum Scale FPO – QOS Support

- Node failure is often-seen events for commodity hardware
- Restripe for data protection is painful for customer with large data
- QOS for FPO - Reduce the restripe impact in FPO because of node failure
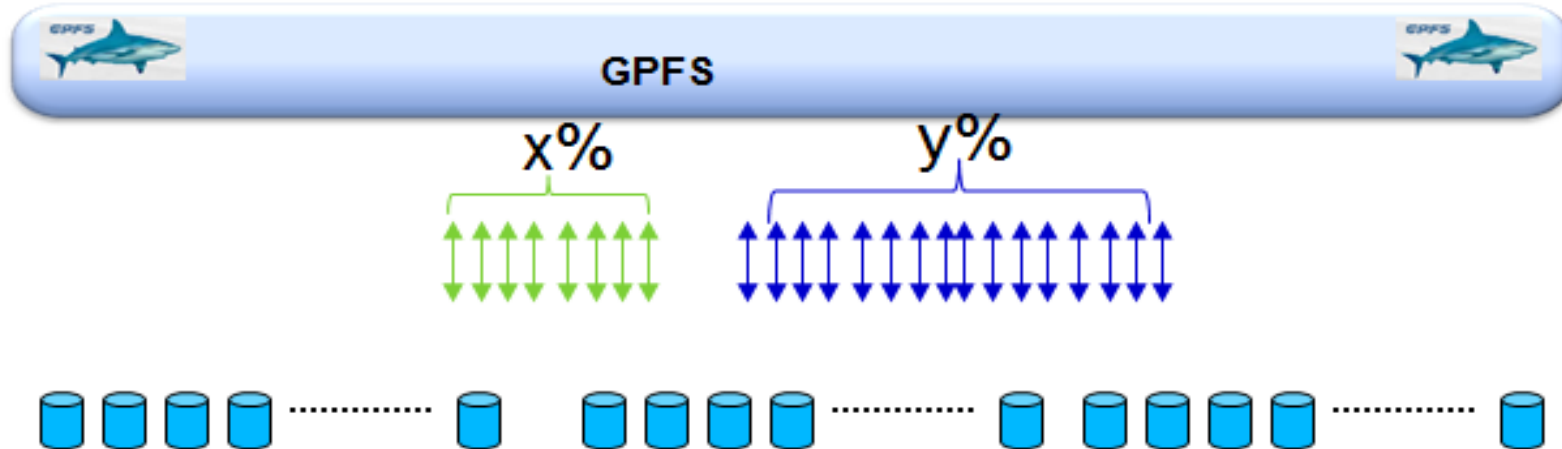
- Maintenance IO+normal IO
- Cap the io bandwidth %
- Dynamically change

Revamped Spectrum Scale Wiki Links

Spectrum Scale wiki – Analytics

Spectrum Scale wiki - FPO

Spectrum Scale wiki – Hadoop

Spectrum Scale wiki – HDFS Transparency connector