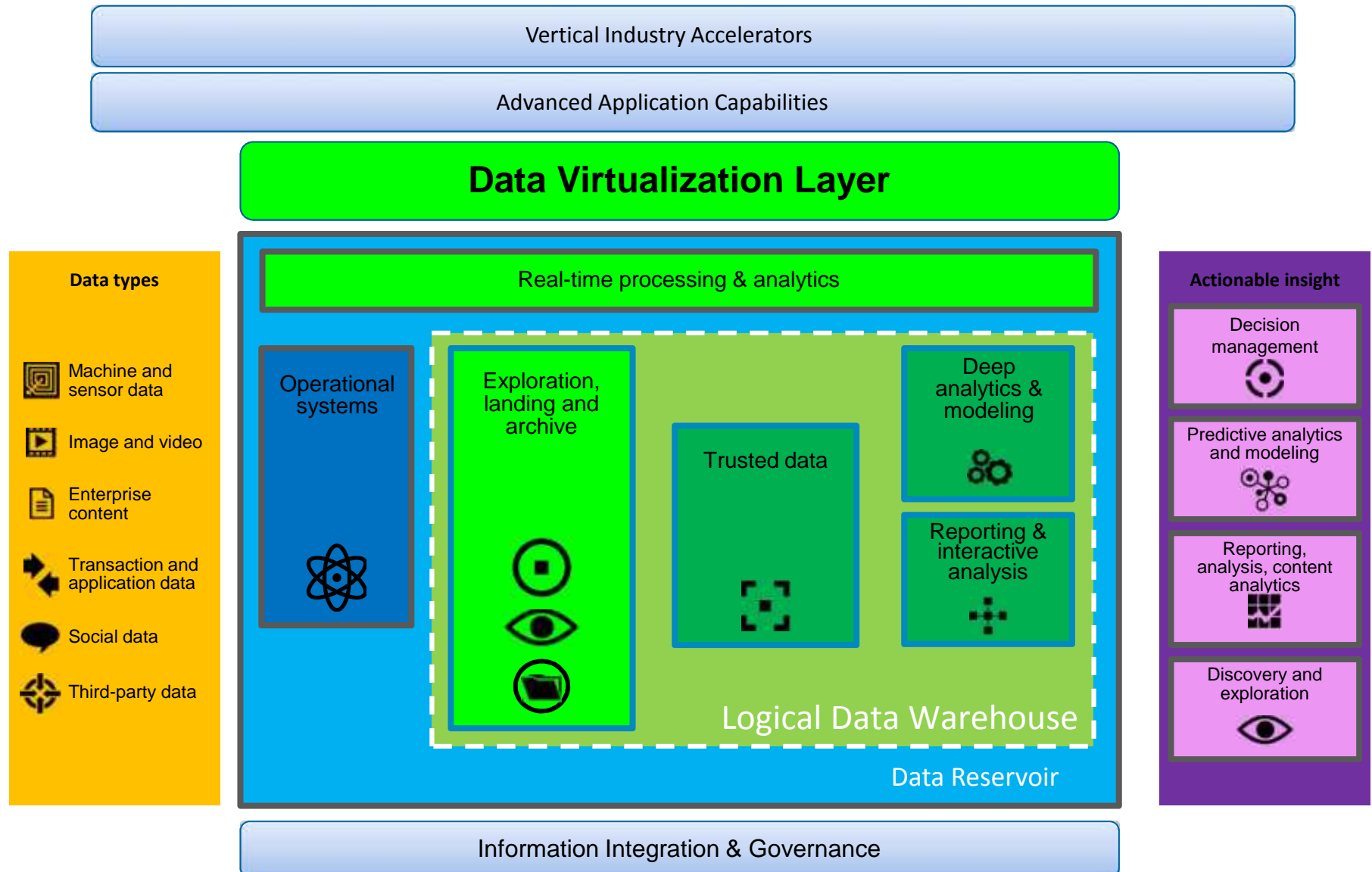


BDA400 – Lecture 4

Big Data Ecosystem

Big Data Analytics – LDW and Data Virtualization



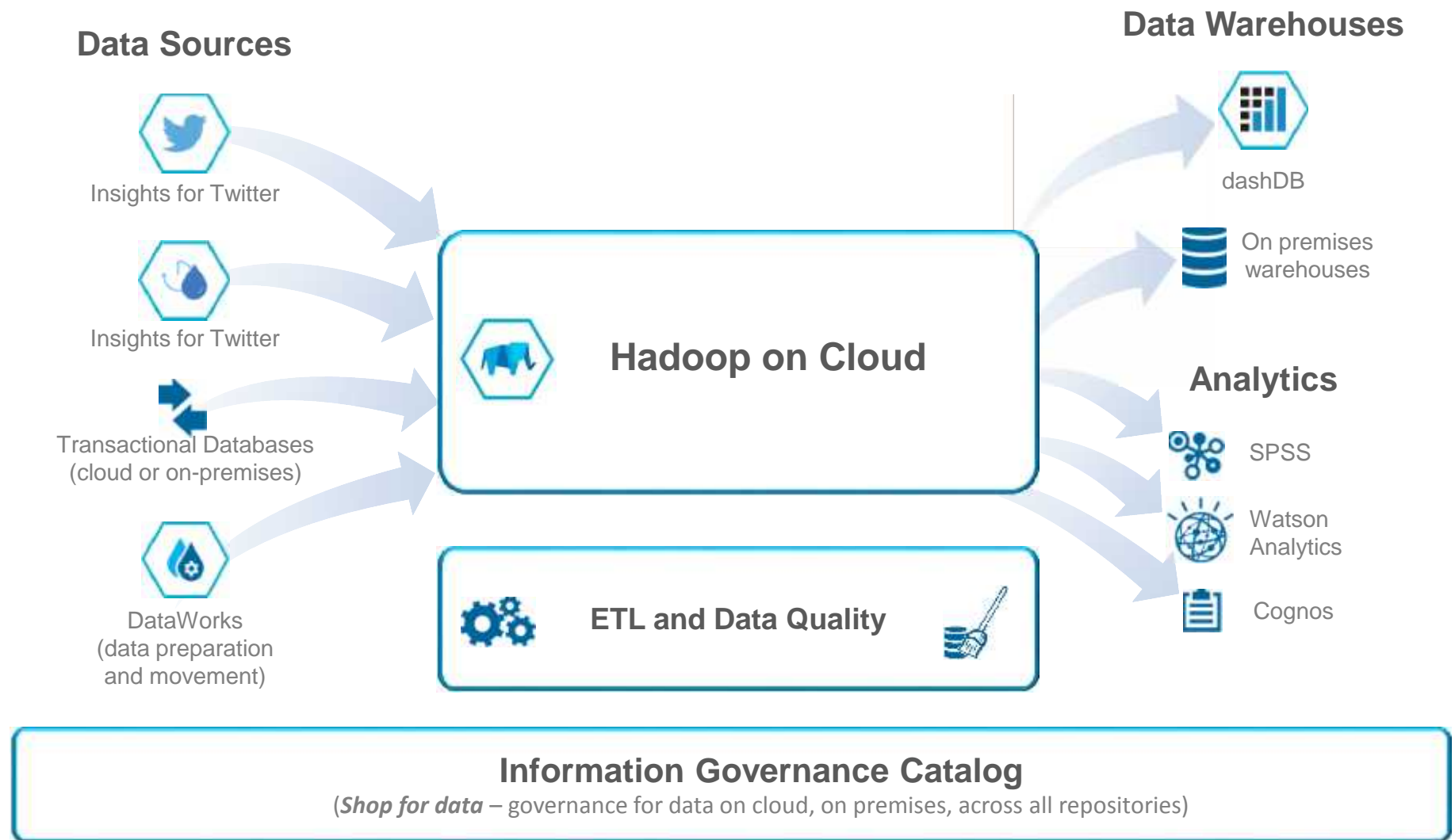
Big Data Analytics Ecosystem – Key Topics

- Data Ingestion
 - Data Movement
 - Data Quality
 - Data Cleansing
- Data Governance
 - Security
 - Encryption
 - Life Cycle Management
- Resilience and Availability
 - Replication
 - High Availability
 - Disaster Recovery

Big Data Analytics Ecosystem – Key Topics

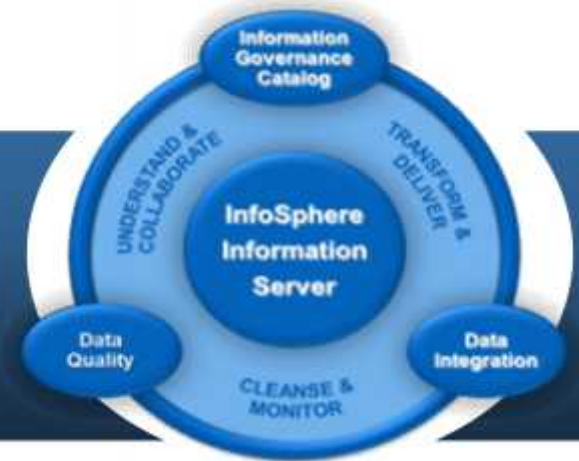
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Data Lake Architecture for Self-Service Analytics



Information Empowerment for your Data Ecosystem

Integrating and transforming data and content to deliver accurate, consistent, timely and complete information on a single platform unified by a common metadata layer



Information Governance Catalog

Understand & Collaborate

- Catalog technical metadata & align w/ business language
- Manage (big) data lineage
- compliance reporting

Data Quality

Cleanse & Monitor

- Analyze & validate w/ enhanced classification
- Cleanse & standardize
- Define, manage & monitor data rules + exceptions

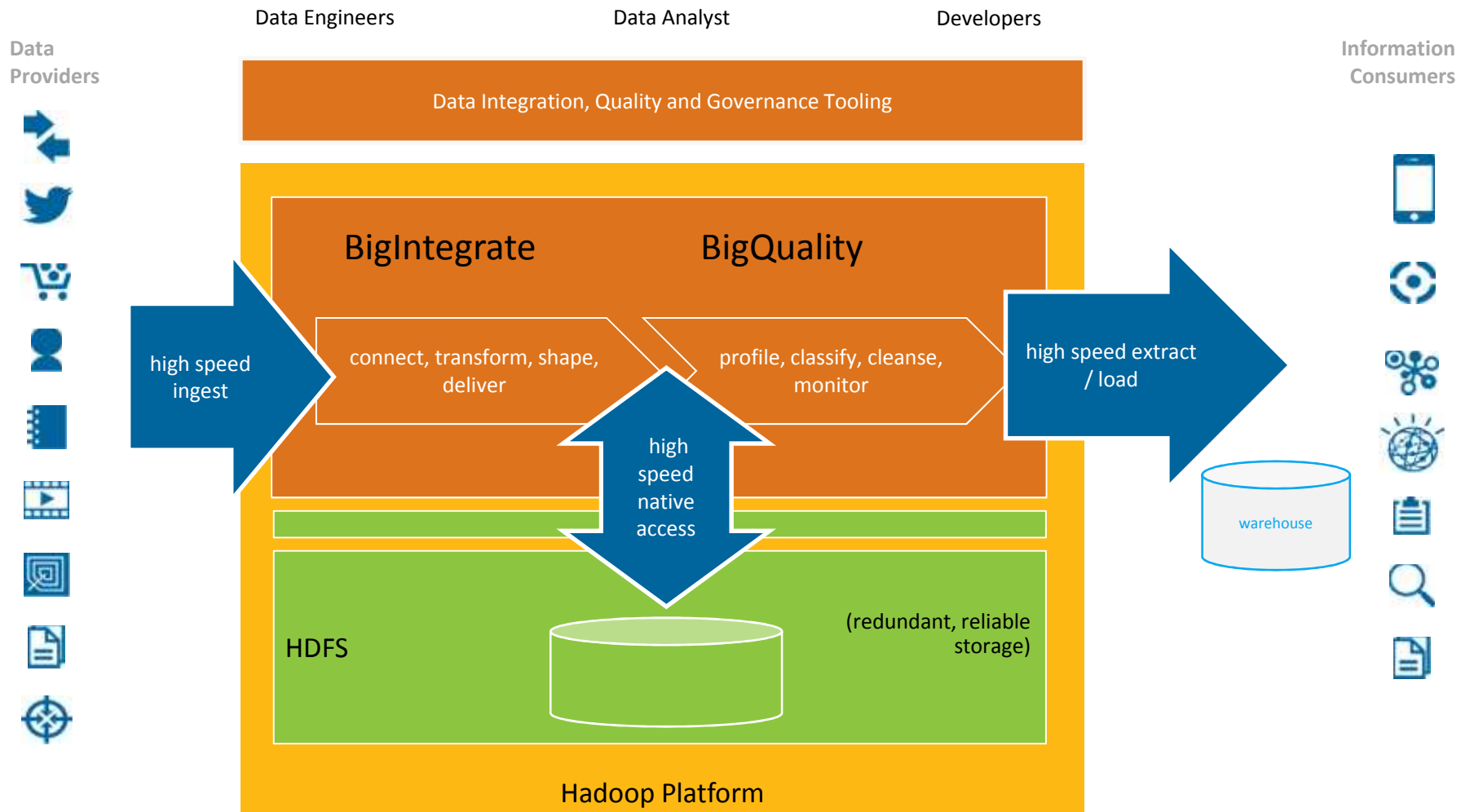
Data Integration

Transform & Deliver

- **Massive scalability**
- Power for any complexity
- Deliver in batch and/or real-time with change capture

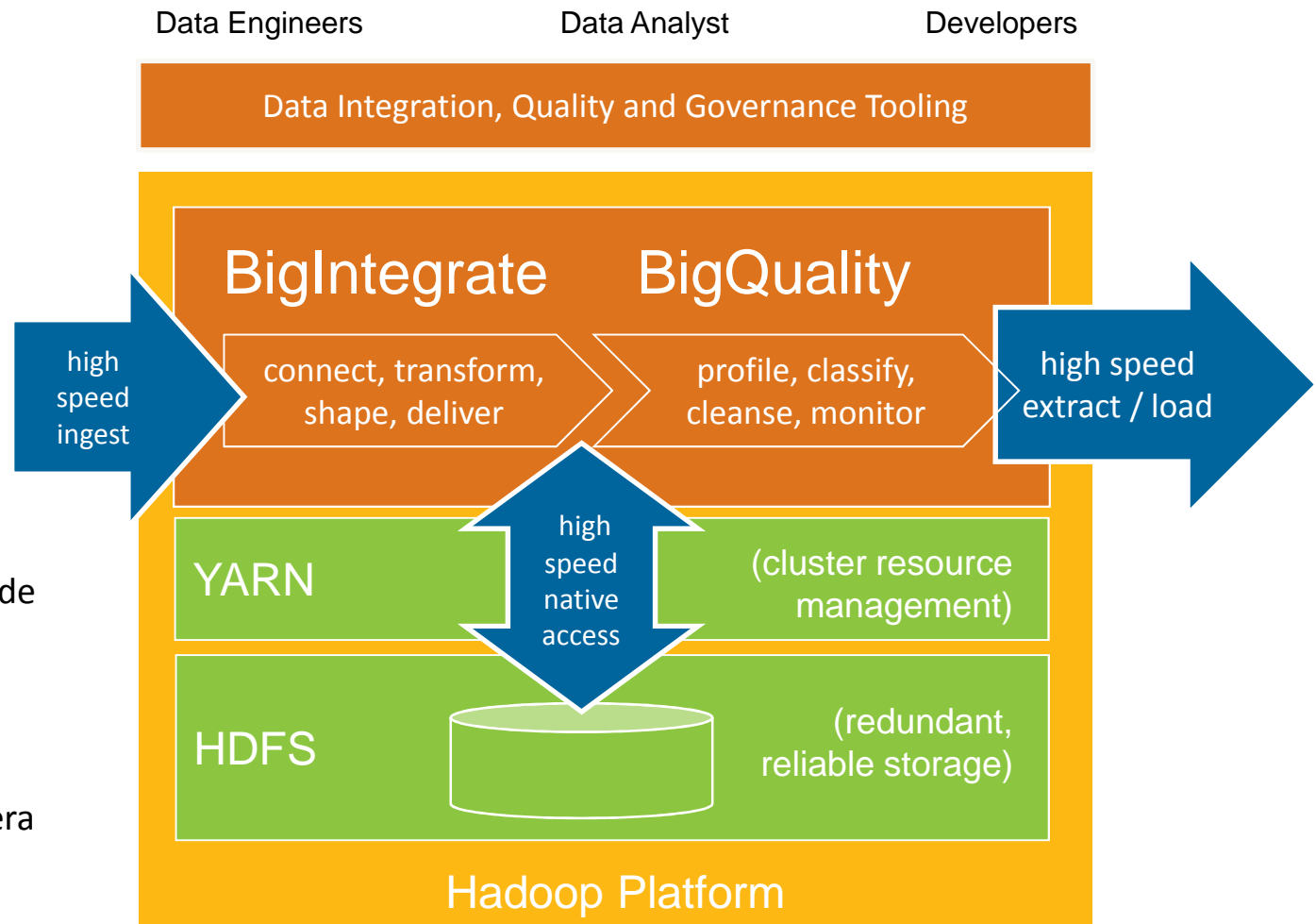
- common connectivity • shared metadata • security (common execution engine with flexible deployments)
- **New native MPP runtime on Hadoop**

Data Integration & Data Quality



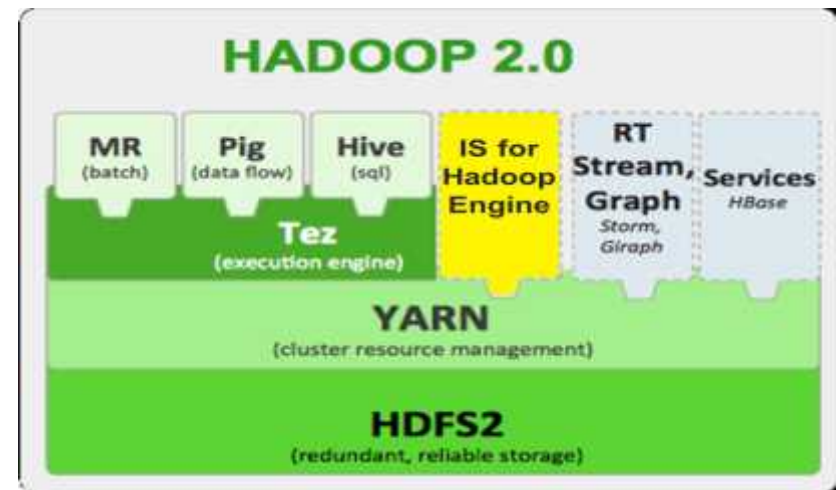
Data Integration & Data Quality

- The most scalable Transformation and Data Integration and Quality engine now runs natively on Hadoop
- Get enterprise-class transformation and cleansing for your Hadoop data
- Use the power of your Hadoop cluster to integrate, transform & cleanse data without writing a single line of code
- Hadoop distribution currency: BigInsights 4.0, Open Data Platform, HortonWorks 2.2, Cloudera 5.3



Data Integration & Data Quality

- Information Server MPP engine running natively on Hadoop
- Code-free enterprise-class transformation and cleansing for your Hadoop data
- Up to 20x faster than M/R and 6x faster than Spark
- Fully integrated into the Hadoop stack:
 - Resource managed by YARN
 - Support for Data Locality
 - Support for Hadoop Node Labels
 - Support for YARN scheduler queues
 - Support for Kerberos enabled cluster



Data Integration

Ingest, transform, process and deliver any data into & within Hadoop

Satisfy complex transformation requirements with the most scalable runtime available in batch or real-time

•Connect

- Connect to wide range of traditional enterprise data sources as well as Hadoop data sources
- Native connectors with highest level of performance and scalability for key data sources

•Design & Transform

- Transform and aggregate any data volume
- Benefit from hundreds of built-in transformation functions
- Leverage metadata-driven productivity and enable collaboration

•Manage & Monitor

- Use a simple, web-based dashboard to manage your runtime environment



Data Quality

Analyze, cleanse and monitor your big data

Most comprehensive data quality capabilities that run natively on Hadoop

•Analyze

- **Discovers** data of interest to the org based on business defined data classes
- **Analyzes** data structure, content and quality
- **Automates** your data analysis process

•Cleanse

- **Investigate, standardize, match and survive data** at scale and with the full power of common data integration processes

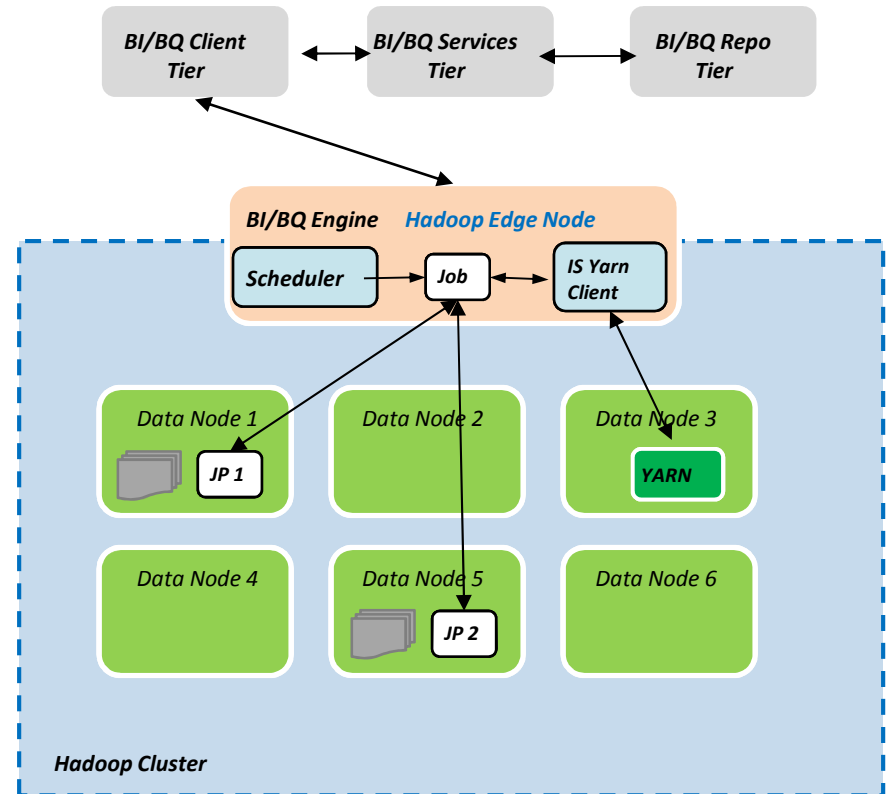
•Monitor

- **Assess and monitor** the quality of your data in any place and across systems
- **Align** quality indicators to business policies
- **Engage data steward team** when issues exceed thresholds of the business



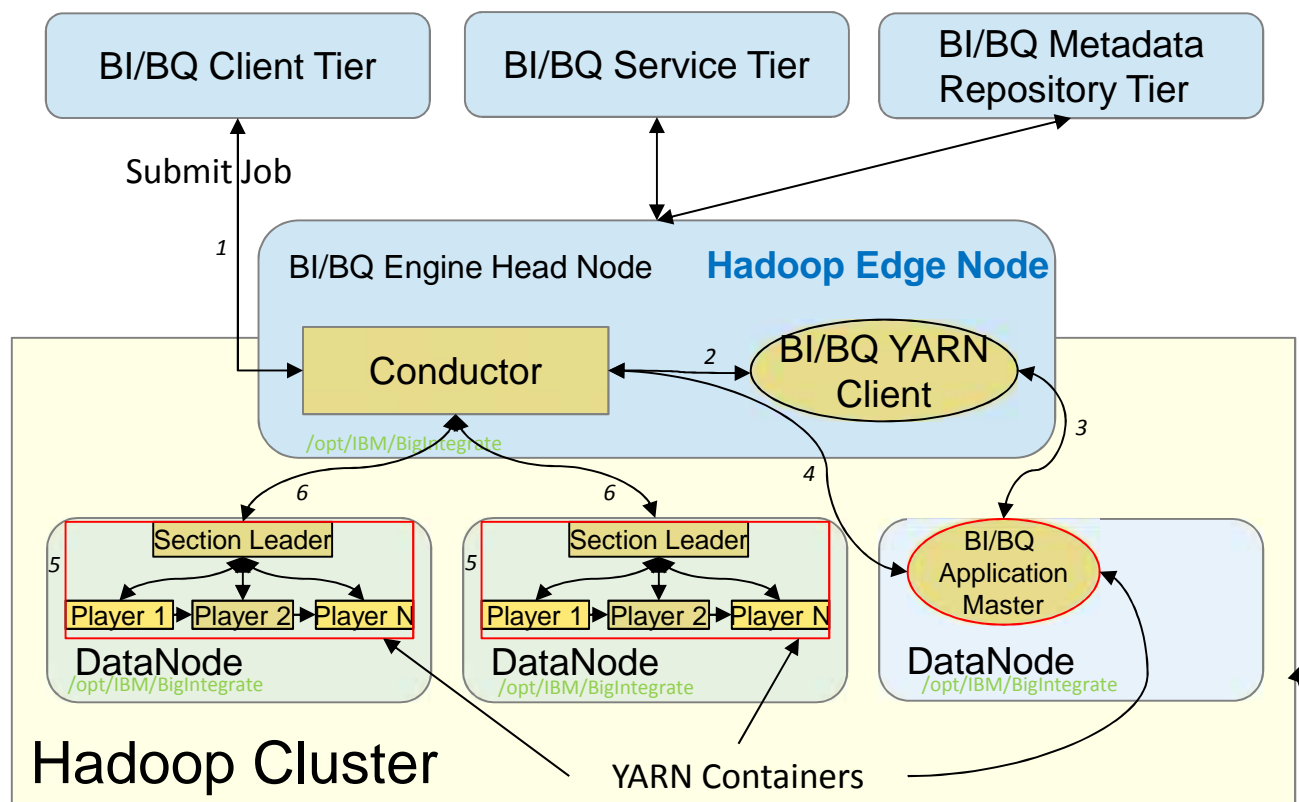
System Topology

- BI/BQ Engine Head node installed on Hadoop Edge Node
- Other Tiers can reside on the Edge Node or outside the cluster
- BI/BQ Engine libraries live on all Hadoop Data Nodes that will run BI/BQ workloads
- BI/BQ engine binaries are dynamically copied to Data Nodes at job run time using HDFS if binaries don't already exist



Job run time architecture on Hadoop

- Jobs are submitted from an BI/BQ Client (1)
- Conductor asks BI/BQ YARN Client for an Application Master(AM) to run the job (2)
- BI/BQ YARN Client manages BI/BQ AM pool, starts new ones when necessary (3)
- Conductor passes BI/BQ AM resource requirements and commands to start Section Leaders (4)
- BI/BQ AM gets containers from YARN Resource Manager(not pictured)
- YARN Node Managers(NM) on DataNodes start YARN containers with Section Leaders (5)
- Section Leaders connect back to Conductor and start players (6)



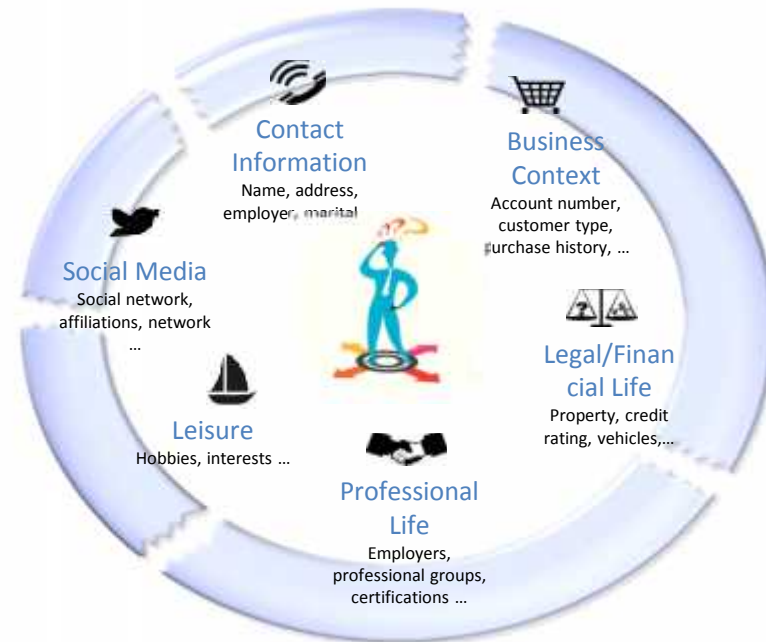
Object Matching

Object matching leverages proven algorithms **natively in Hadoop** to accurately and economically link all customer data across **structured and un-structured** data sources to provide customer information that consuming applications can act on **with confidence**.

Object Matching

Inhibitors to successful big data initiatives include:

- Missing Customer Context for actionable insights
- Disconnected Data in Hadoop
- Bad Data Quality for Analytics
- Inaccurate Customer 360 view
- High Cost of Missed Opportunity & Low Confidence



IBM InfoSphere Big Match for Hadoop

Runs **natively in Hadoop** to accurately link all customer data across **structured and un-structured** sources with a high level of **confidence** to provide customer **context for analytics**

Accurate

Matches via statistical learning algorithms based on your data

Simple,

Fast Time to Value

Hours to use configurable pre-built algorithms and templates instead of weeks/months of developing code

Performance

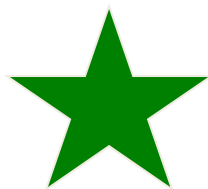
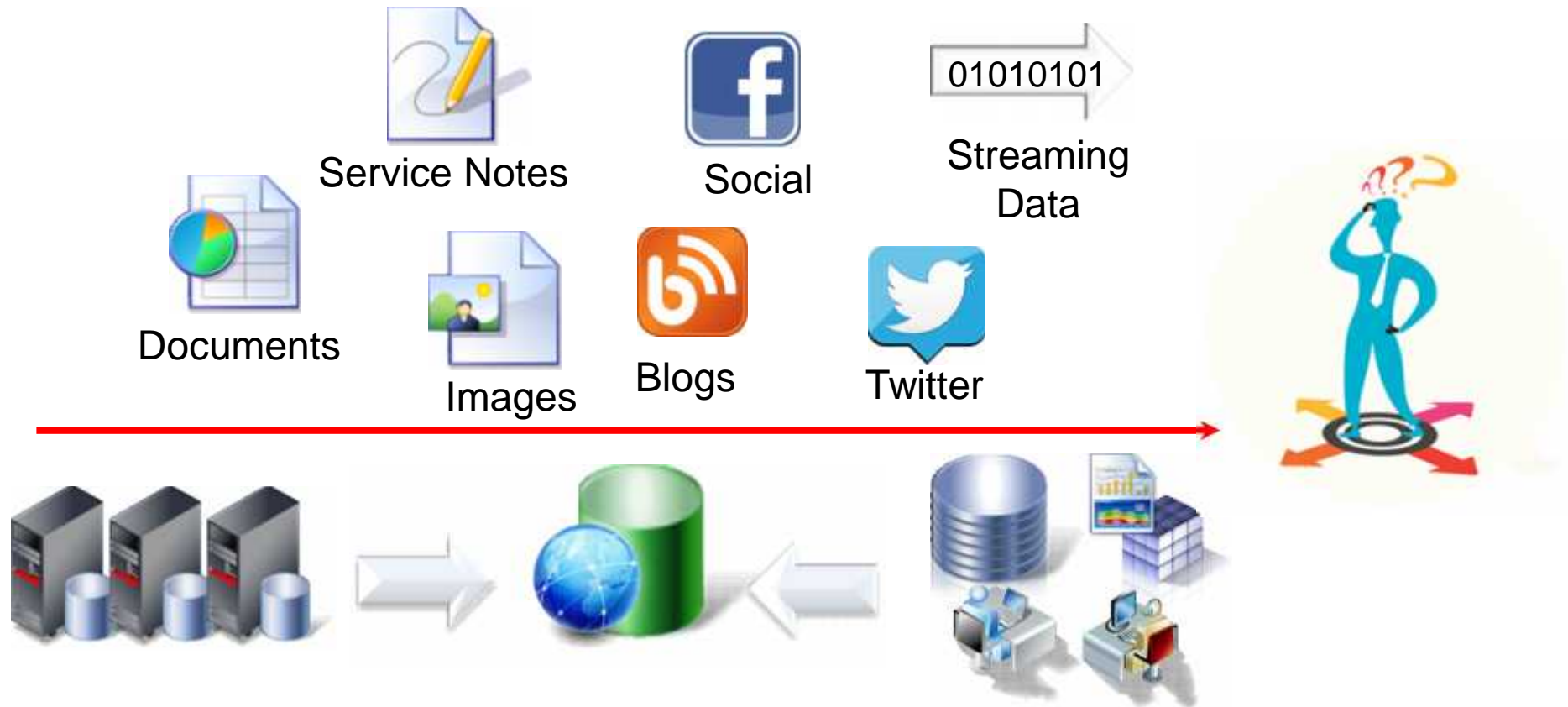
Hours to match Big Data volumes by leveraging MapReduce distributed processing

Proven

Leverages the experience of over 10 years across worldwide deployments

InfoSphere Big Match for Hadoop provides accurate, trusted business information with rapid time to value for Big Data projects

Connect Customer Information to Big Data Sources *With Confidence*



InfoSphere Big Match for Hadoop

Object Matching

Leveraging Fuzzy Matching Algorithms

Phonetics

Mohammed vs.
Mahmoud

Synonyms

Andrew = Andy
George = Jorge
1st = First

Abbreviations

AIG = American
International
Group
Road = Rd

Concatenation

Van de Velde =
Vandavelde

Edit Distance

867-5309 ~ 876-
5309

Region Specific

トヨタ =
トヨタ株式会社

Date Similarity

01/01/1973 ~
01/03/1973

Proximity

Geocodes and
great-circle
distance

Typographical Errors

John Smith vs.
John Snith

Noise Words

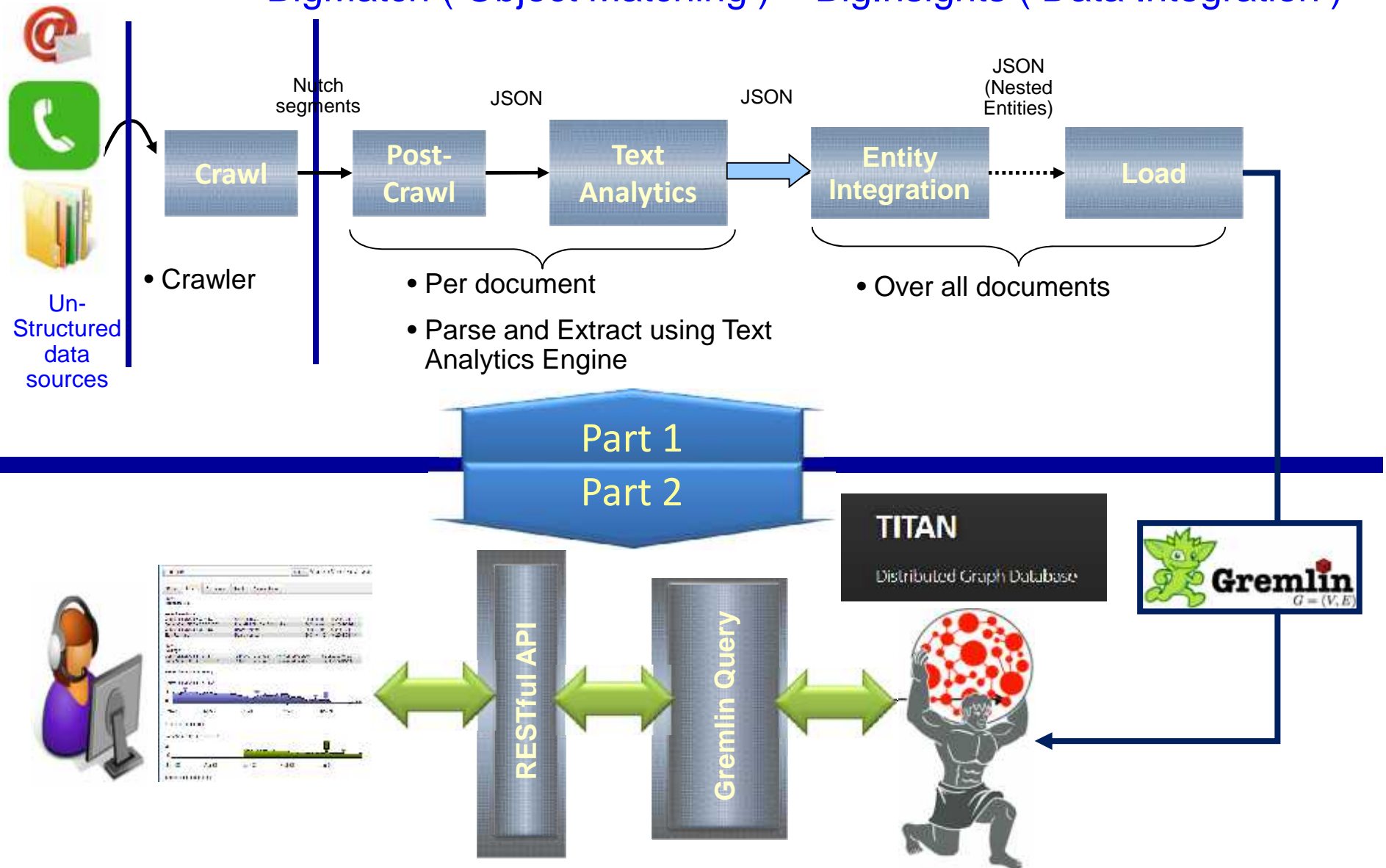
Roadster Inc. =
Roadster

Misalignment

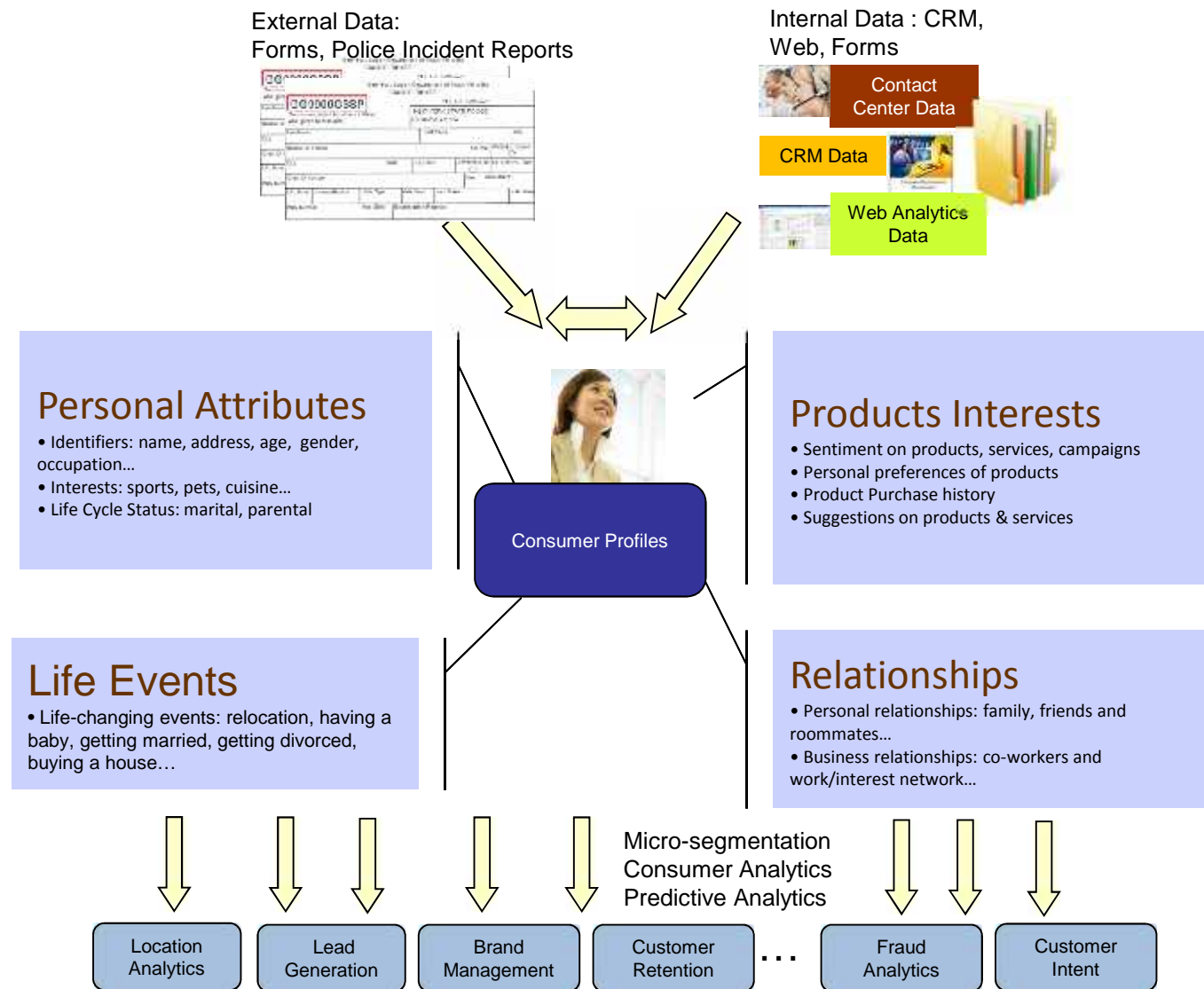
Kim Jung-il =
Kim il Jung

Un-Structured Data Entity Extraction

BigMatch (Object Matching) + BigInsights (Data Integration)



Un-Structured to Structured Data Matching



All names and identifiers are fictitious

Understanding Personal Attributes

Using Advanced Text Analytics



Example Twitter Metadata

Personal Identifiers from Metadata

Location

variations from "San Jose in California", to "the lovely Big Apple" to "21.1222950, -86.873546"

Name

variations from "Bernard Odom" to "Steven the Great" to "someoneelse"

Personal Identifiers from Messages

Location

I'm at Mickey's Irish Pub Downtown (206 Main St, Des Moines) w/ 2 others <http://4sq.com/gbmdYR>

Name

@janedoe good!!! U shouldnt! Think about the important stuff, like ur birthday ;) btw [happy birthday Jane](#) ;)

Location

Name

| | |
|---------------------------------|------------------|
| Teresina,PI | david rc |
| null | makie christos |
| imperial valley, California | Mr. Kickserve |
| null | E. H. |
| Somewhere along the broken road | Morgan |
| Virginia | Leslie |
| On your cieling | Fatima Al-Kaabi |
| Belm, PA | Stteeeeeeveennnn |
| null | Saleem |
| South-Wales init! | Fredann |
| North Wales | Angie' Londono |
| The Internet | jose gomes |
| Brasil | GreatLie |
| Brasil, SP | Rachel |
| Mexico City | C.J |

All names and identifiers are fictitious

Data Replication for Hadoop



High Speed Data Replication

Low-latency capture of real time information



Analyze a Variety of Information

Analyze a variety of data in its native format – streaming audio, video, spatial, among others

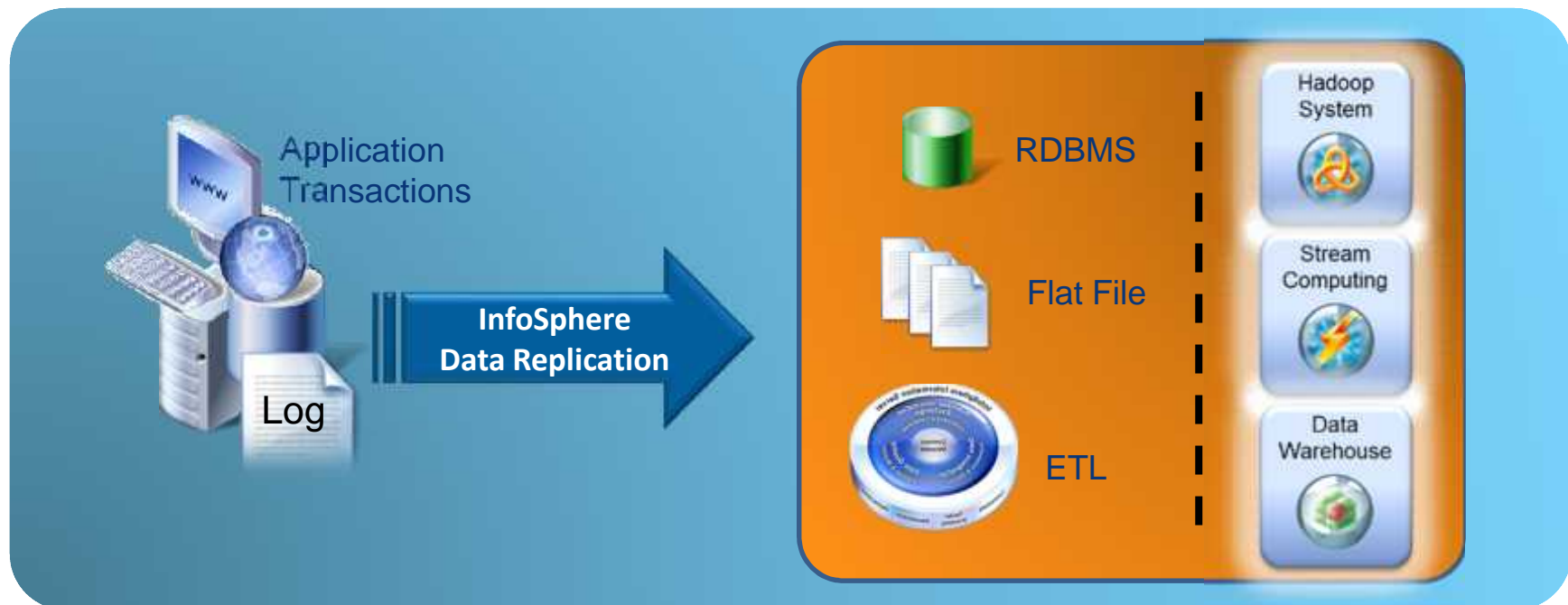


Non Invasive Record Capture

Read data from transactional database logs, distribute data to any target – including Big Data Streams, ETL for Warehouses, or Big Insights



Analyze Extreme Volumes of Information in Motion



Streaming Data

Cloud



On Premise



Integrated Development Environment

Agile and Manageable

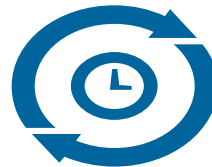


Ease of Use

- Performance monitor
- Develop environment with wizards, drag/drop development, performance dashboards, debugger
- No business disruption—Run, score & update models continuously

Scale-Out Runtime

Flexible and Scalable

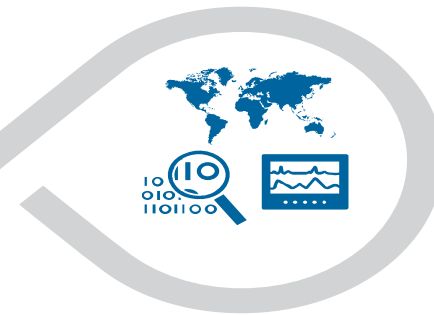


High Performance

- Millions of events/second
- Ultra-low latency clustered runtime

Analytic Toolkits

Functional and Optimized



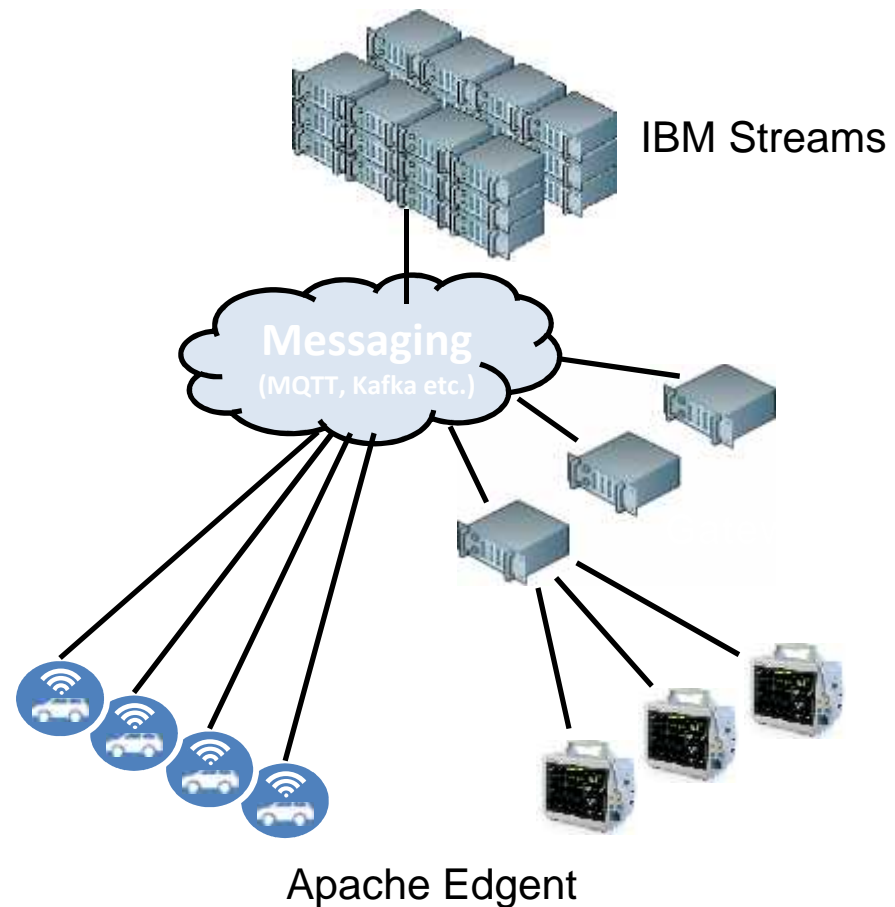
Built-In Streaming Analytics



R, Kafka, Mllib, JSON,... Github

Apache Edgent – Streaming on edge devices

- Why Quarks?
 - Too much data to push to central server for analysis
 - Need to prepare the data in prior to pushing it to the central server
- Quarks for edge analytics – on device or gateway
 - Lightweight embedded streaming analytics runtime
 - Analyze events locally on the edge
 - Reduce communication costs by only sending relevant events



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 - Replication
 - High Availability
 - Disaster Recovery

Advanced Security

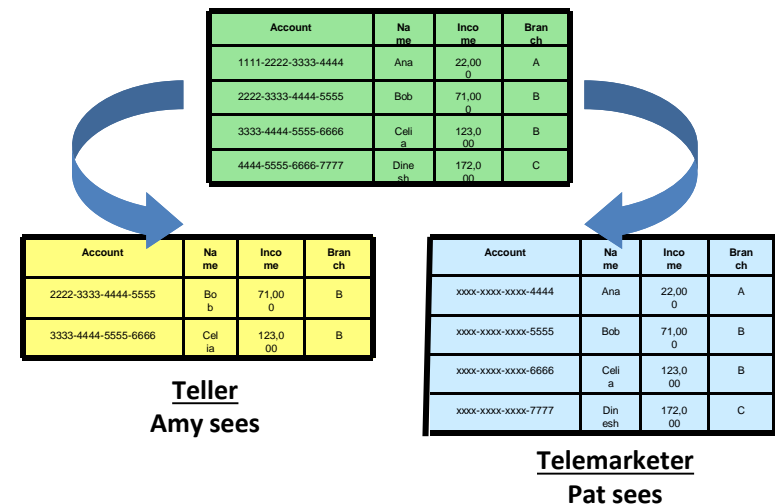
Encryption Support

- HDFS Option:
 - HDFS included
 - Uses Apache Key Management Service (KMS)
 - No Certifications
- GPFS Option:
 - GPFS Separately purchased
 - Supports native encryption since V4.1
 - Uses IBM Security Key Lifecycle Manager (IBM SKLM)
 - Separately purchased
 - NIST compliant and FIPS-140 Certified



Row & Column Access Control

- Leverages BigSQL
- Row level access control based on customer-supplied rules
 - A doctor can see rows representing his/her patients only
 - A manager can see rows representing his/her employees only
- Column level access control based on customer-supplied rules
 - This is also called data masking
 - A teller can see only the last 4 digits of the credit card number column



Governance

- ✓ Monitoring
 - Hbase, Hive, MapReduce and HDFS
 - File activity on Linux
 - Encrypted traffic
 - Hortonworks using Ranger
 - Cloudera using Kafka
- ✓ Blocking
 - Encrypted traffic
 - Hortonworks using Ranger
 - Cloudera using Kafka
- ✓ Vulnerability Assessment
 - Cloudera
- ✓ Redaction and Static Masking
 - Through application level masking libraries
- ✓ Encryption
 - HDFS or GPFS



Information Governance Catalog

Understanding and Governing your Information



You can't govern what you don't understand...the most comprehensive governance solution for end-to-end visibility into your metadata...

Understand



Collaborate



Govern



■ Understand

- Leverage a comprehensive and rich catalog of information assets
- Provide business context for information assets
- Dramatically increase business confidence in information assets

■ Collaborate

- Establish a governed business vocabulary
- Create stewards and assign responsibilities

■ Govern

- Rely on end-to-end lineage across information assets
- Link business terms and information governance rules to information assets & operational rules

Information Governance Catalog

Understand your information, transforming it into an enterprise asset

Three dimensions of understanding and governance:

Business

Gain & manage business perspective about information and align with IT

- ★ *leading technology for business-friendly access & pre-packaged terms*
- ★ *time-saving Industry Models for warehouses in key industries*

Process

Guide projects with best practices to achieve goals with reduced risk

- ★ *unique capability to architect information projects with embedded methodology that can be tracked*

Technology

Discover data structures and understand your lineage to mar compliance

- ★ *unique capability for discovering business objects*



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Hadoop with Spectrum Scale (GPFS)

Existing operational processes extend naturally to Hadoop

| Process | HDFS | Spectrum Scale |
|-------------------------------------------|------|----------------|
| Direct Backup to Tape | N | Y |
| Incremental Backups to Tape* | N | Y |
| Retrieval from Tape to Hadoop | N | Y |
| File System Vulnerability Scanning** | N | Y |
| Immutable filesystem support (compliance) | N | Y |
| Efficient File Updates and Deletes | N | Y |
| Performance Gains without configuration | N | Y |
| Automated Disaster Recovery | N | Y |
| Low Overhead Disaster Recovery | N | Y |
| Certified Native Encryption | N | Y |
| Efficient Large Distance Replication | N | Y |

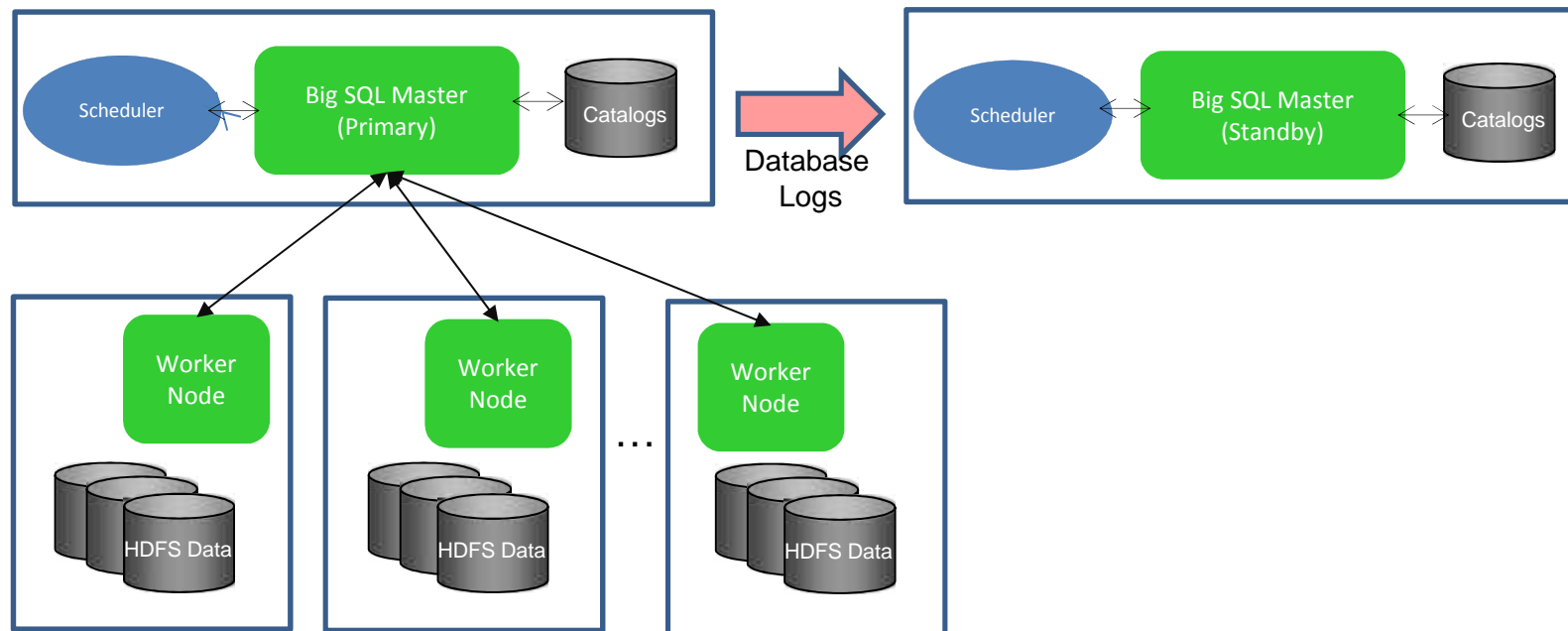
*TSM incremental backups is integrated into GPFS snapshot capability

** Has anyone left folders with weak permissions?

High Availability

Leveraging Big SQL

- Scheduler automatically restarted upon failure
- Catalog changes replicated to warm standby instance
- Warm standby automatically takes over if the primary fails
- Worker node failure leads to black listing / auto resubmission



High Availability and Disaster Recovery

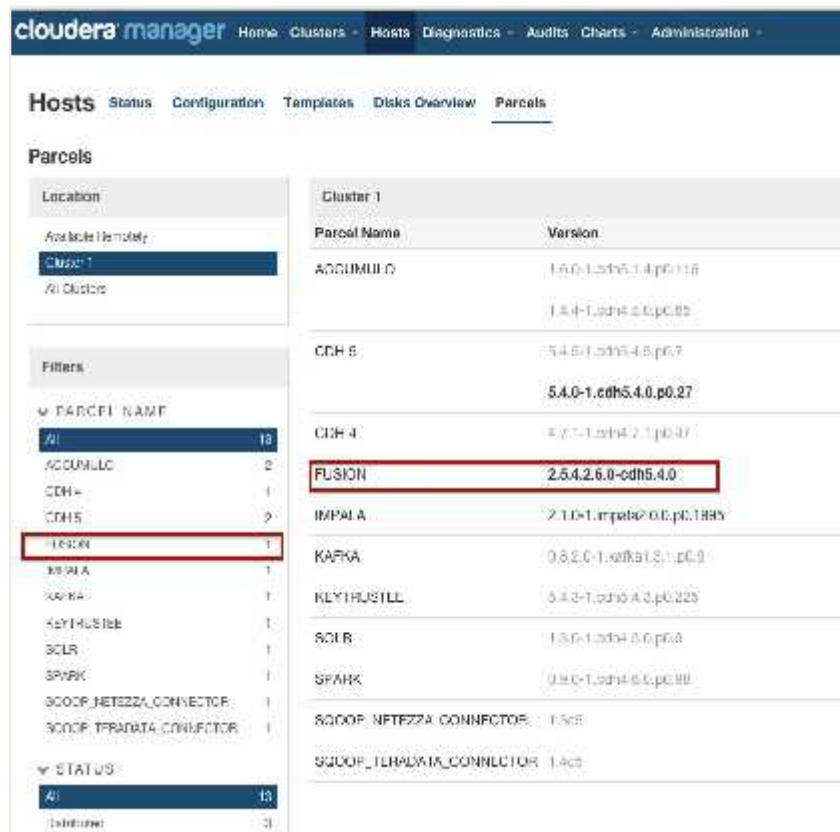
Leveraging Big Replicate

- A proxy server(s) deployed with each cluster
 - Exposes the Hadoop Compatible File System (HCFS) API
 - Client apps connect to Fusion instead of HDFS
- Unifies Hadoop clusters running on a mix of distributions, versions and storage on premise and in the cloud
 - Provides a single virtual namespace across clusters any distance apart
 - Breaks down information silos
- Replicates data across cloud object storage and local and NFS mounted file systems



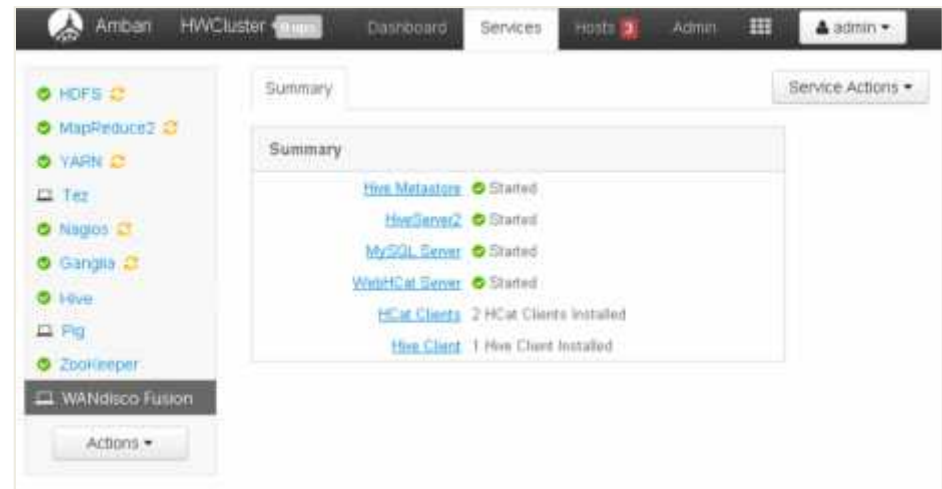
Big Replicate

- Totally Non-Invasive – Runs as a Client Application Managed from Cloudera Manager or Ambari



The screenshot shows the Cloudera Manager interface, specifically the 'Hosts' page under the 'Parcels' tab. The 'Parcels' section displays a list of installed and available parcels for 'Cluster 1'. The 'FUSION' parcel is highlighted with a red box, indicating it is the focus of the presentation. The 'FUSION' parcel is version 2.54.2.6.0-cdh5.4.0. The 'Status' column shows 'All' parcels are installed.

| Parcel Name | Version |
|--------------------------|-----------------------------|
| ACCUMULO | 1.6.0-1.cdh5.4.0.p0.116 |
| CDH 5 | 5.4.0-1.cdh5.4.0.p0.27 |
| CDH 4 | 4.7.1-1.cdh4.7.1.p0.371 |
| FUSION | 2.54.2.6.0-cdh5.4.0 |
| IMPALA | 2.1.0-1.impala2.0.0.p0.1885 |
| KARMA | 0.8.2.0-1.karma1.8.1.p0.9 |
| KEYTRUSTEE | 5.4.0-1.cdh5.4.0.p0.225 |
| SCUR | 1.3.0-1.cdh5.4.0.p0.8 |
| SPARK | 0.9.0-1.cdh5.4.0.p0.88 |
| SQOOP_HIVE222A_CONNECTOR | 1.5.0 |
| SQOOP_TERADATA_CONNECTOR | 1.4.0 |



The screenshot shows the Ambari interface for an HDFS cluster. The 'Summary' tab is selected, displaying the status of various services. The 'Hive Metastore', 'HiveServer2', 'MySQL Server', and 'WebHcat Server' are all shown as 'Started'. The 'Hcat Clients' section indicates that 2 Hcat Clients are installed, and the 'Hive Client' section indicates that 1 Hive Client is installed. The 'Actions' button is visible at the bottom.

| Service | Status |
|-----------------|---------|
| HDFS | Started |
| MapReduce2 | Started |
| YARN | Started |
| Tez | Started |
| Nagios | Started |
| Ganglia | Started |
| Hive | Started |
| Pig | Started |
| Zookeeper | Started |
| WANDisco Fusion | Started |

Big Replicate

Distributed Coordination

- Based on our enhanced Paxos algorithm
 - Multiple transactions in parallel at any distance
 - Resilience in the face of outages
- All nodes function as peers to deliver the same transaction order on every node
 - No central transaction manager or single point of failure
 - True active-active data replication
 - Not multi-master or eventual consistency
 - DConE delivers guaranteed consistency
- LAN experience at WAN distance
 - Delivers same behavior as a single cluster at one location



Big Replicate

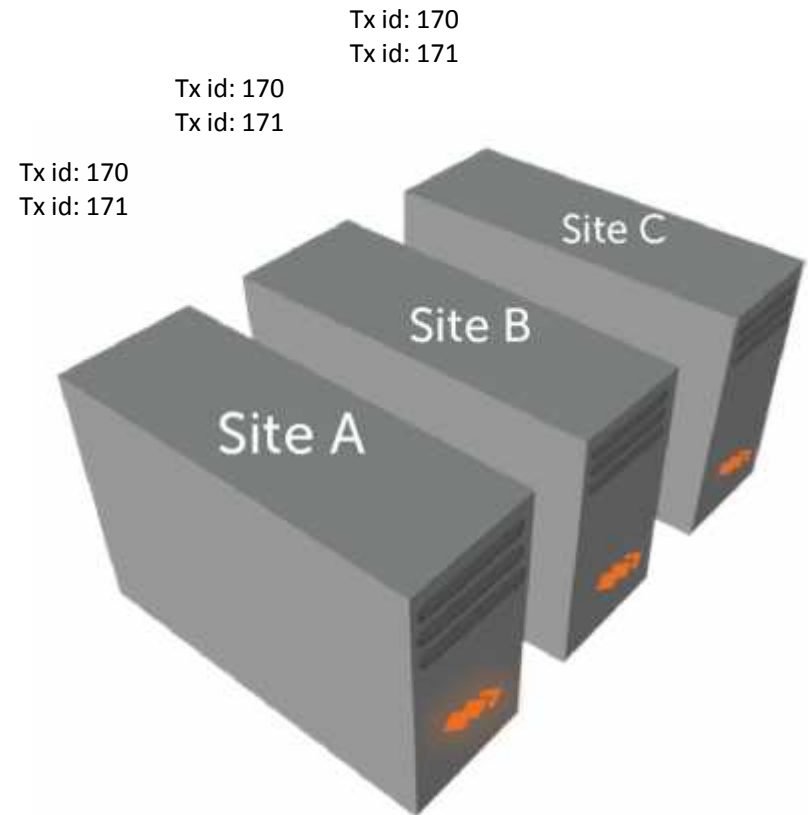
Distributed Coordination

- Achieving Consensus
 - Peer nodes assume roles in every interaction
 - Proposers, Acceptors, Learners
 - Every node plays all of these roles in a typical implementation
 - Phases
 - Any node may receive a client request and generate a proposal for it
 - Broadcast of the proposal to peers
 - Acceptance by a quorum of peers completes the process



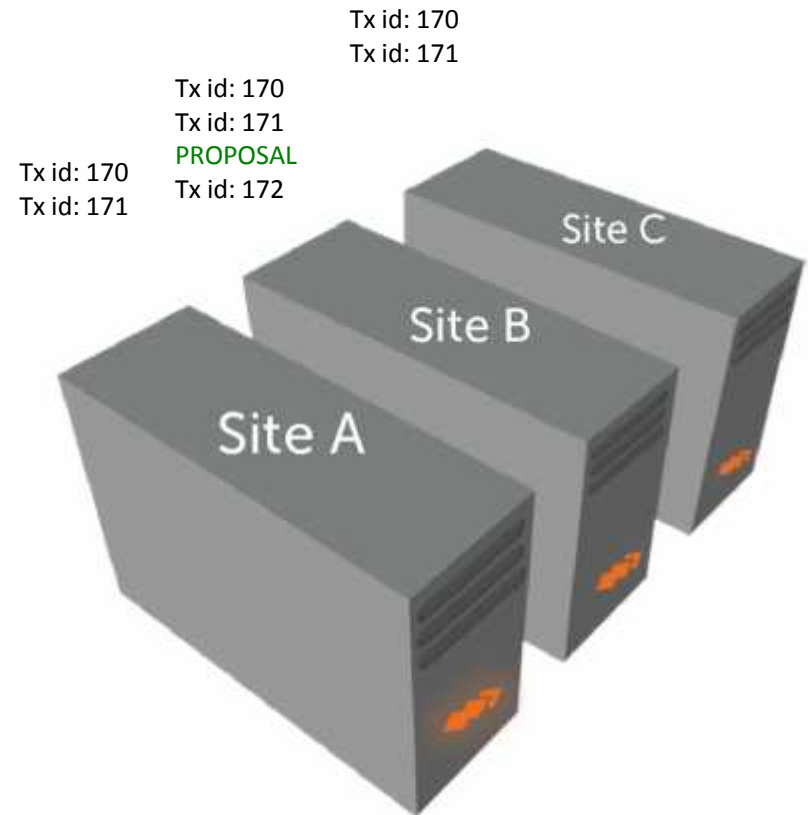
Big Replicate in Action

- Majority Quorum
 - A fixed number of participants
 - All start out in a consistent state
 - The majority must agree to change



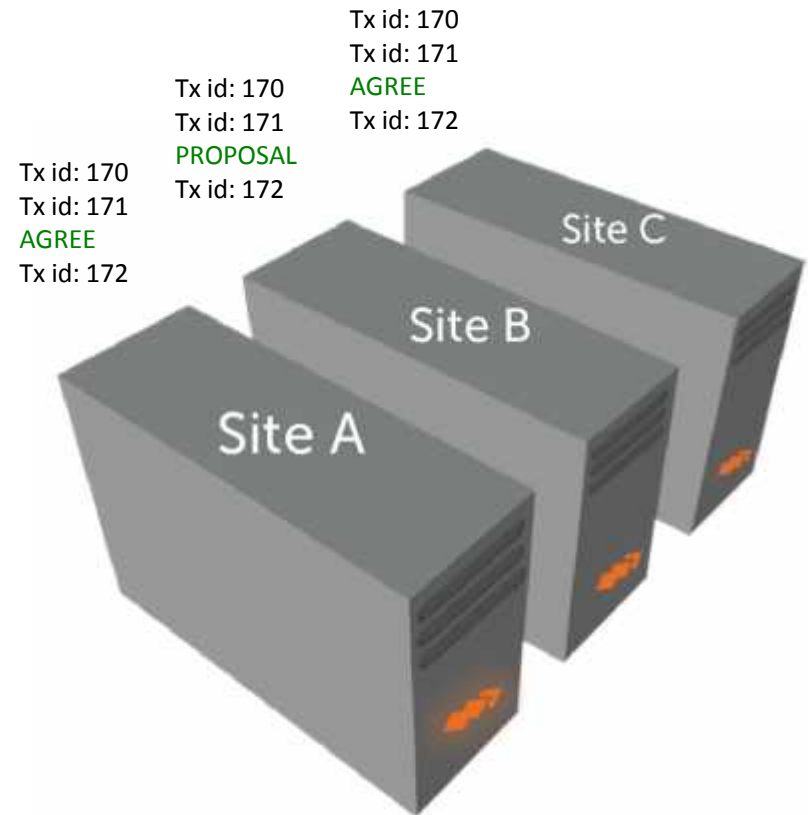
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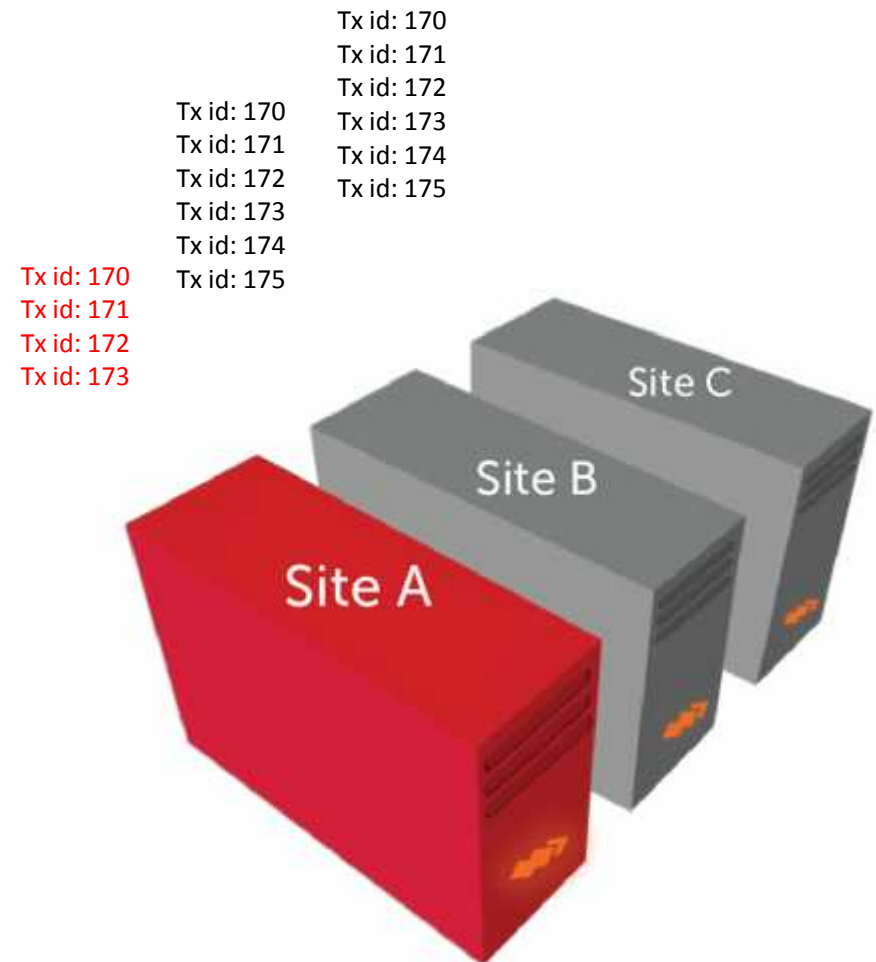
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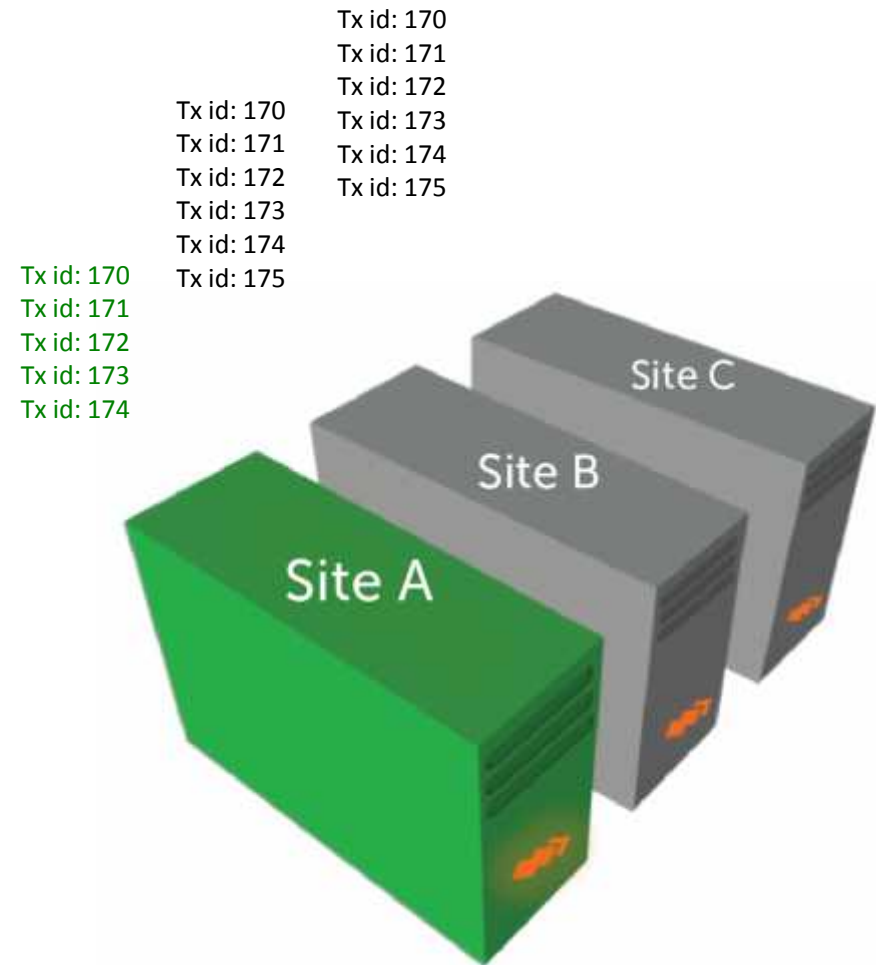
Big Replicate in Action

- Majority Quorum
 - A fixed number of participants
 - All start out in a consistent state
 - The majority must agree to change
- Planned or Unplanned Outage
 - Normal operations continue on nodes with quorum



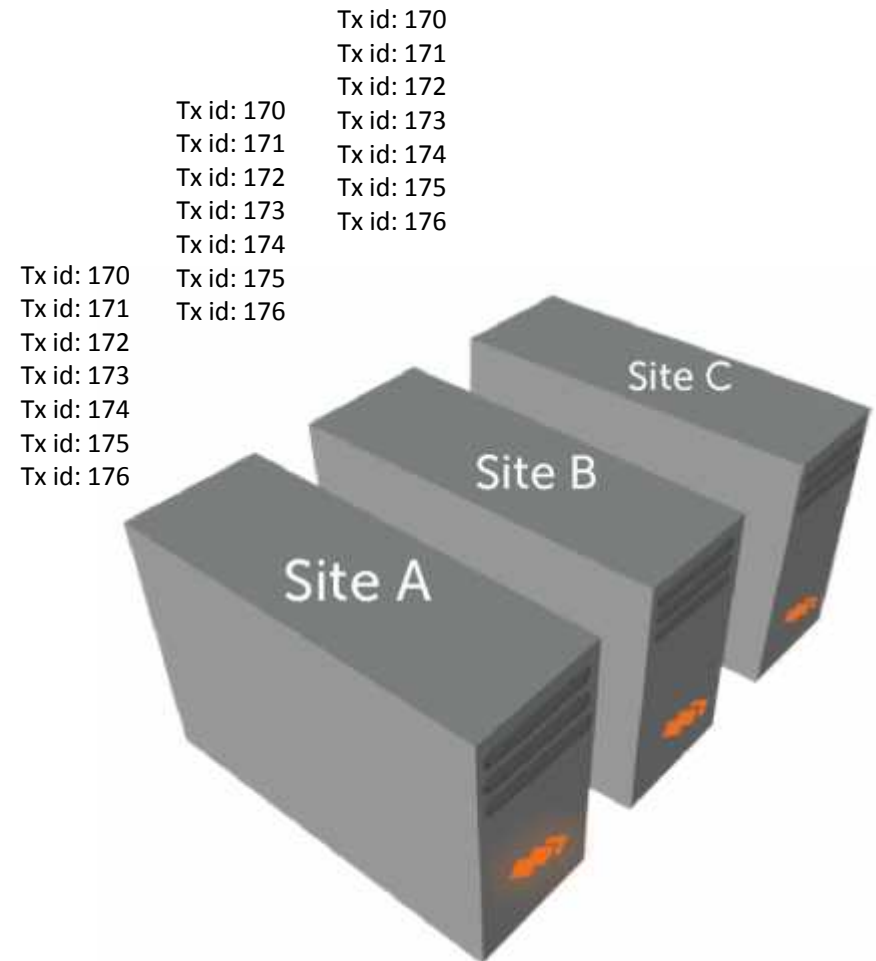
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 - Node(s) that rejoin stay in safe mode until they are caught up



Big Replicate in Action

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 - All start out in a consistent state
 - The majority must agree to change
- Planned or Unplanned Outage
 - Normal operations continue on nodes with quorum
- Recovery / Self Healing
 - Node(s) that rejoin stay in safe mode until they are caught up
 - Clients resume access once the node is caught up.



Big Replicate – Value Proposition



- **100% Uptime**
 - Designed to exceed the most demanding SLAs across LAN and WAN environments



- **Reduced Costs**
 - Double in capacity with no increase in hardware costs



- **No Vendor Lock-In**
 - Total flexibility and future proof



- **Reduced Complexity**
 - Accelerated deployment, simplified disaster recovery, migration, upgrades and expansion



- **Data Protection**
 - Lowest possible exposure to hackers



- **Cloud Made Easy**
 - Hybrid cloud? No problem!

High Availability and Disaster Recovery

Leveraging WANdisco Fusion



Continuous Availability & Performance

- LAN-speed read/write access to the same data at every location
- Data is replicated as it's ingested
- Delivers built-in continuous hot backup by default with automated failover and disaster recovery over LAN and WAN
 - DistCp solutions require scheduled backups outside of normal business hours due to resource contention.
 - DistCp solutions risk loss of data since last backup
- Install on top of live clusters without downtime
- Support for different distros and multiple versions of the same distro allows migration and upgrades across clusters and data centers without downtime.



100% Use of Compute Resources

- All clusters at all locations are fully readable and writeable
- No money wasted on read-only backup clusters
- Former backup clusters can be used to scale up deployments without spending more on hardware



Cluster Zoning

- Mix of hardware and storage to support a mix of applications requiring different SLAs
- Applications share data, not compute resources
- Isolates critical real-time applications from MapReduce and data ingest jobs