IBM Big SQL – Vendor Landscape

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Why SQL for Hadoop?

- **Lower cost DW, exploration and discovery, data lake or reservoir**
- **Open up Hadoop data to familiar SQL tools such as Cognos**

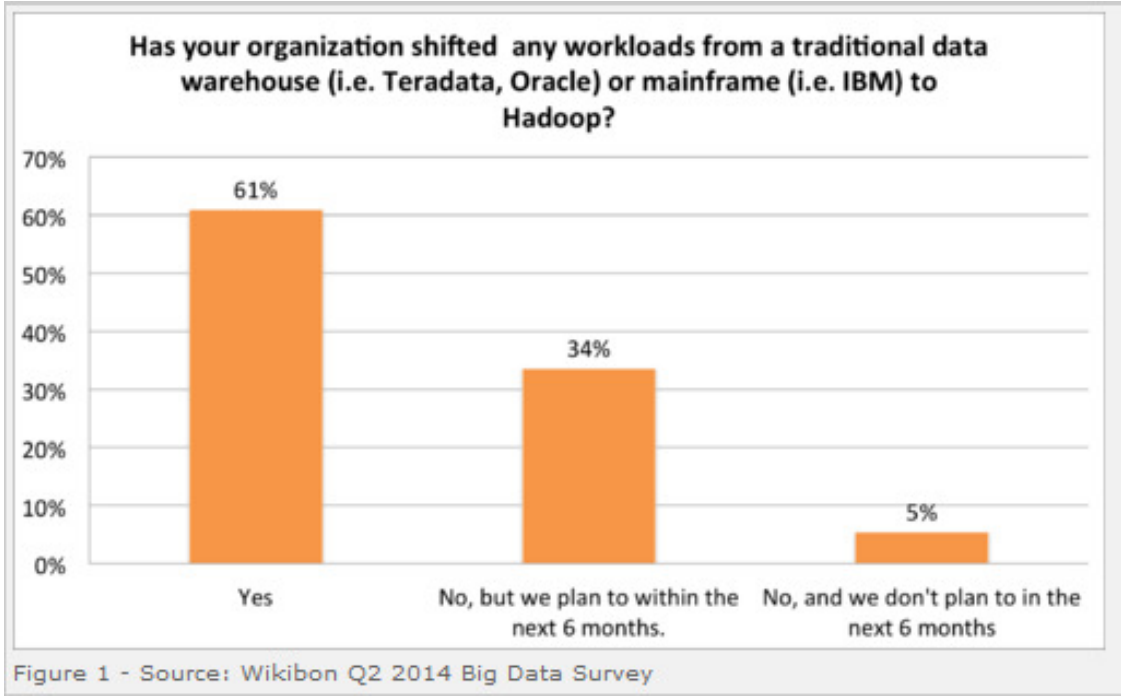
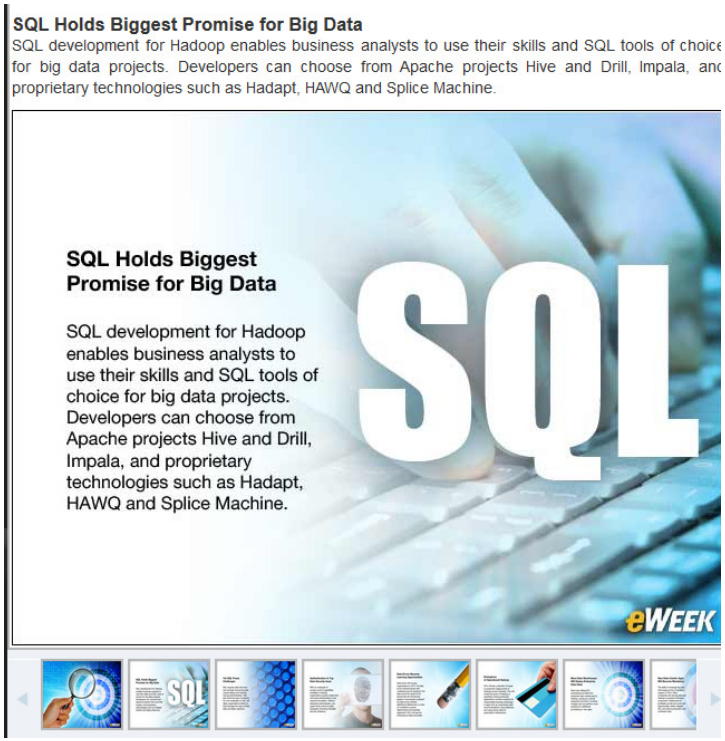


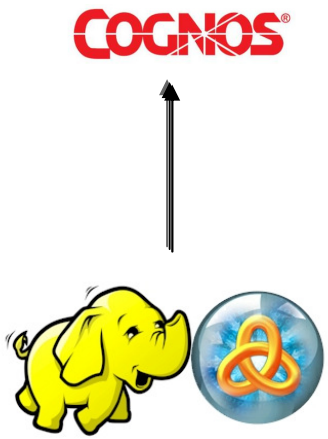
Figure 1 - Source: Wikibon Q2 2014 Big Data Survey



*"This trend is expected to continue as Hadoop vendors continue to improve so-called SQL-on-Hadoop offerings. These technologies from vendors such as Cloudera, Hortonworks and Actian allow data scientists and less sophisticated business analysts and business users to query data in Hadoop using ANSI SQL-like tools (**some SQL-on-Hadoop offerings have more complete SQL functionality than others**) and developers to build Hadoop-based data-driven applications"*

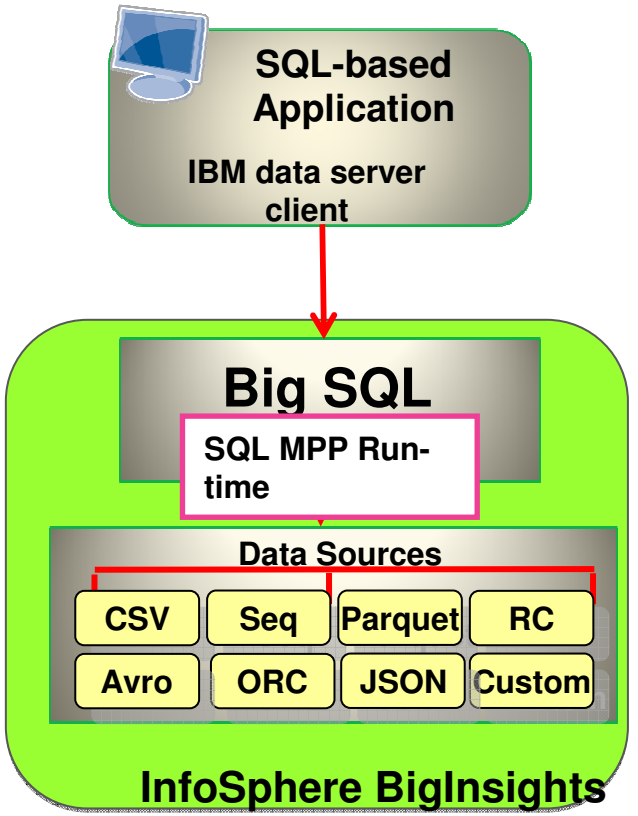
What is IBM Big SQL?

- **IBM's SQL for Hadoop**
  - Opens Hadoop data to a wider audience
  - Familiar, widely known syntax
- **Complements the Data Warehouse**
  - Exploratory analytics
  - Sandbox
  - Data Lake
- **Included in BigInsights**
- **Use familiar SQL tools**
  - Like Cognos



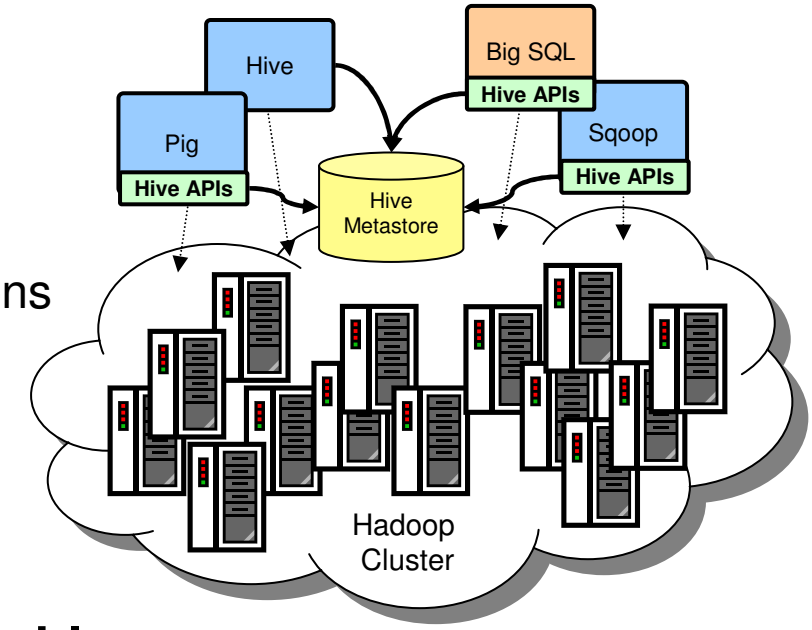
IBM Big SQL is Architected for Performance

- **Architected from the ground up for low latency and high throughput**
- **MapReduce replaced with a modern MPP architecture**
  - Compiler and runtime are native code (not java)
  - Big SQL worker daemons live directly on cluster
    - Continuously running (no startup latency)
    - Processing happens locally at the data
  - Message passing allows data to flow directly between nodes
- **Operations occur in memory with the ability to spill to disk**
  - Supports joins, aggregations, and sorts larger than available RAM



IBM Big SQL Embraces Open Source HDFS file formats

- **Big SQL applies SQL to your existing Hadoop data**
  - No propriety storage format
  - Only vendor to support Parquet and ORC
- **A "table" is simply a view on your Hadoop data**
  - All data is Hadoop data
  - In files in HDFS
  - SEQ, RC, delimited, Parquet …
- **Table definitions shared with Hive**
  - The Hive Metastore catalogs table definitions
  - Reading/writing data logic is shared with Hive
  - Definitions can be shared across the Hadoop ecosystem



- **Data stored in Hive immediately query-able**

Different Approaches to SQL on Hadoop

Better

Just the Query Engine

- MPP SQL query engine
- Uses Hive metadata
- Runs on Hadoop cluster
- Operates directly on HDFS files

- **Best integration with Hadoop**
- Native HDFS file formats

Full RDBMS on Hadoop

- Complete database, including storage layer and query engine
- Uses proprietary metadata
- Runs on Hadoop cluster

- **Proprietary formats**
- **Adds database complexities to Hadoop**

Submit a remote query

- RDBMS sends request to Hadoop
- Result returned to RDBMS
- Network may impact performance
- Ability to push down work varies

- **Requires front-end database**
- **Performance depends on network and RDBMS load**

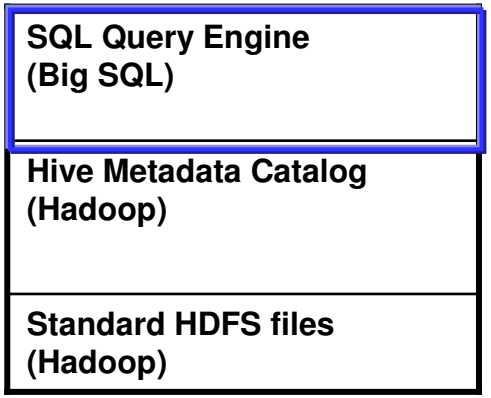
Worse

What's the Difference?

- **IBM Big SQL has an architectural advantage over other RDBMS vendors**
- **Big SQL is a MPP Query engine running natively on Hadoop**
- **IBM Big SQL uses open source HDFS file system, not proprietary RDBMS storage layer**

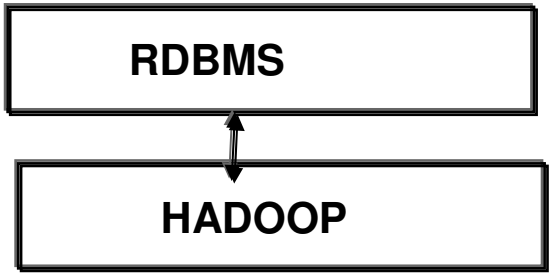
1. Just the Query Engine (IBM Big SQL)

- *Query engine, meta data, storage layers are all separate*
- *Leverages Hadoop ecosystem*



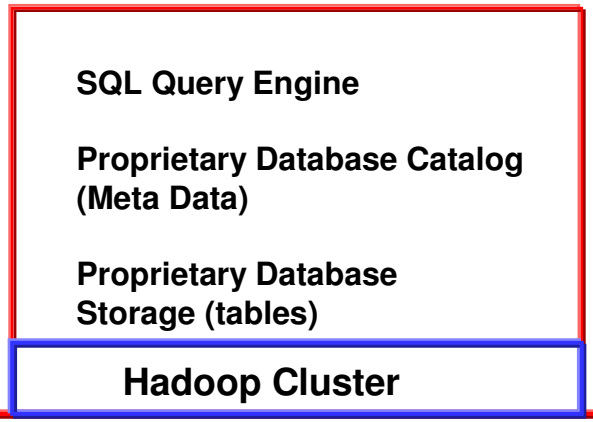
3. Remote Query (e.g. Oracle, Teradata)

Requires a completely separate front-end RDBMS system



2. Complete RDBMS on Hadoop (e.g. Pivotal HAWQ, Actian, Vertica)

Query engine, meta data, storage layer are all glued together in a proprietary bundle running on Hadoop



SQL for Hadoop Vendor Landscape

	Approach	SQL Support	Packaging	Comments	Big SQL Advantage
IBM Big SQL	MPP query engine based on DB2 runs native on Hadoop	Very Good, SQL 2003/2011	Included with IBM InfoSphere Big Insights	New MPP query engine in BigInsights 3.0	
Cloudera (Impala)	MPP query engine built by Cloudera runs native on Hadoop	Poor, subset of Hive 0.9	Included with Cloudera Enterprise Available for MapR and Amazon EMR	Perception leader	SQL support Memory usage Concurrency
Hortonworks (Hive / Stinger)	Enhance Hive, replace MapReduce with Tez, runs native on Hadoop	Better with Hive .13 but sub-query restrictions	Hive .13 Included with Hortonworks; Hive .12 included in Cloudera, BigInsights, MapR	Microsoft, Teradata, SAP, HP are partners	SQL support Performance
Pivotal HD (HAWQ)	Port Greenplum database to Hadoop including storage layer	Good, based on Greenplum	Optional feature of Pivotal HD	Funded by EMC and GE Capital	Architecture Elastic Scalability
Teradata (SQL-H)	Remote query from Teradata by treating Hive tables as a view	Good, based on Teradata	Optional feature of Teradata 14.1, 15. Included with Teradata Distribution for Hadoop (TDH)	QueryGrid coming in 3Q will provide filtering and push-down in Hadoop via Hive 13	Architecture, Performance
Oracle Big Data SQL	Remote query from Oracle Exadata via external tables	Good, based on Oracle	Available only with Oracle Big Data Appliance	Announced July 15 2014 for GA 3Q 2014	Architecture, Performance
Microsoft (Polybase)	Remote query from PDW using external tables	Good, based on Microsoft	Available only with Microsoft PDW V2	Limited to Microsoft PDW customers	Architecture, Performance
Presto	MPP query engine built by Facebook runs native on Hadoop	Good	Open source download	New, unproven	Commercial support

IBM Big SQL Advantages

- **Native Hadoop architecture**
  - Designed for Hadoop Ecosystem
  - Uses native Hadoop data types
  - Elastic scalability
- **Leading performance**
  - Better value for money
- **ANSI compliant SQL – broad language support**
  - Minimize re-coding retains tools investments
- **Automatic memory management**
  - Other vendors may require that queries be “hand-optimized”
- **Security –** row, column level, field masking
- **Rich analytic and aggregation functions**

Cloudera Impala Overview

Interactive SQL for Hadoop

- Responses in seconds
- Nearly ANSI-92 standard SQL with Hive SQL

Native MPP Query Engine

- Purpose-built for low-latency queries
- Separate runtime from MapReduce
- Designed as part of the Hadoop ecosystem

Open Source

- Apache-licensed

cloudera® IMPALA

Is Cloudera Impala Open Source?

- **Yes**
  - Impala code is available for download on Github, and available under Apache license
  - Impala is available for Amazon EMR and MapR Hadoop distributions
- **No**
  - Customers assume that the open source community contributes to Impala
  - But *Impala is Not* an Apache Software Foundation open source project
  - **Cloudera is the only contributor (developer) to Impala code**

- **IBM has decades of SQL research and development being invested into IBM Big SQL**
  - Impala has no advantage over IBM Big SQL in terms of code contribution or product development

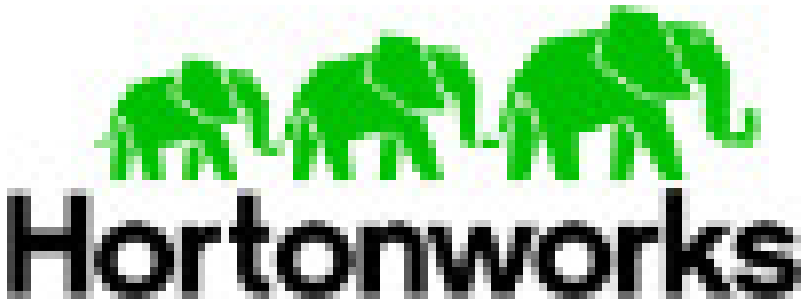
IBM Big SQL Compared to Cloudera Impala

- **Better SQL Support for end user tools and queries**
  - SQL 2003/2011+ (Impala only supports a subset of SQL92)
  - Impala doesn't support sub-queries in where-clause, nested-subqueries, windowed aggregates, common table expressions, rollup, cube, for example
  - Translates to better end-user tool usage and performance

- **Guaranteed execution for complex queries for reliability and ease of use**
  - Big SQL has Automatic Memory Management
  - Unlike Impala, Big SQL has no limitation that joined tables have to fit in aggregated memory of data nodes which can cause queries to run out of memory and fail

- **Fine grained row and column access control for enhanced security**
  - Easy development for multi-tenancy applications
  - Does not require the use of views
  - Impala requires use of views which increases complexity

- **More Features**
  - Federation
  - Stored procedures
  - More Scalar functions
  - More Aggregate functions



Hortonworks Stinger Initiative Improved Apache Hive

The Stinger Initiative

Interactive Query on Hadoop

Apache Hive is the de facto standard for SQL-in-Hadoop with more enterprises relying on this open source project than any alternative. The Stinger Initiative is a broad, community-based effort to drive the future of Apache Hive, delivering 100x performance improvements at petabyte scale with familiar SQL semantics.

IBM Big SQL Extends Value of Apache Hive

- **Big SQL can immediately query data already stored in Hive**
  - Big SQL uses Hive Metadata and extends value of Hive
  - Big Insights includes both Hive and Big SQL
- **Better SQL Support for end user tools and queries**
  - IBM Big SQL runs all 99 TPC-DS queries un-modified
  - Hive .12 runs only 43 TPC-DS queries un-modified (Hive .13 testing pending)
  - Hive still has many sub-query restrictions and doesn't support non equi-joins, etc.
  - Translates to better end-user tool usage and performance
- **Faster Performance**
  - Up to 41x faster than Hive .12 on TPC-H like benchmark*
  - Hive .13 benchmarks pending
- **Fine grained row and column access control for enhanced security**
  - Easy development for multi-tenancy applications
  - Does not require the use of views
- **More Features**
  - Federation
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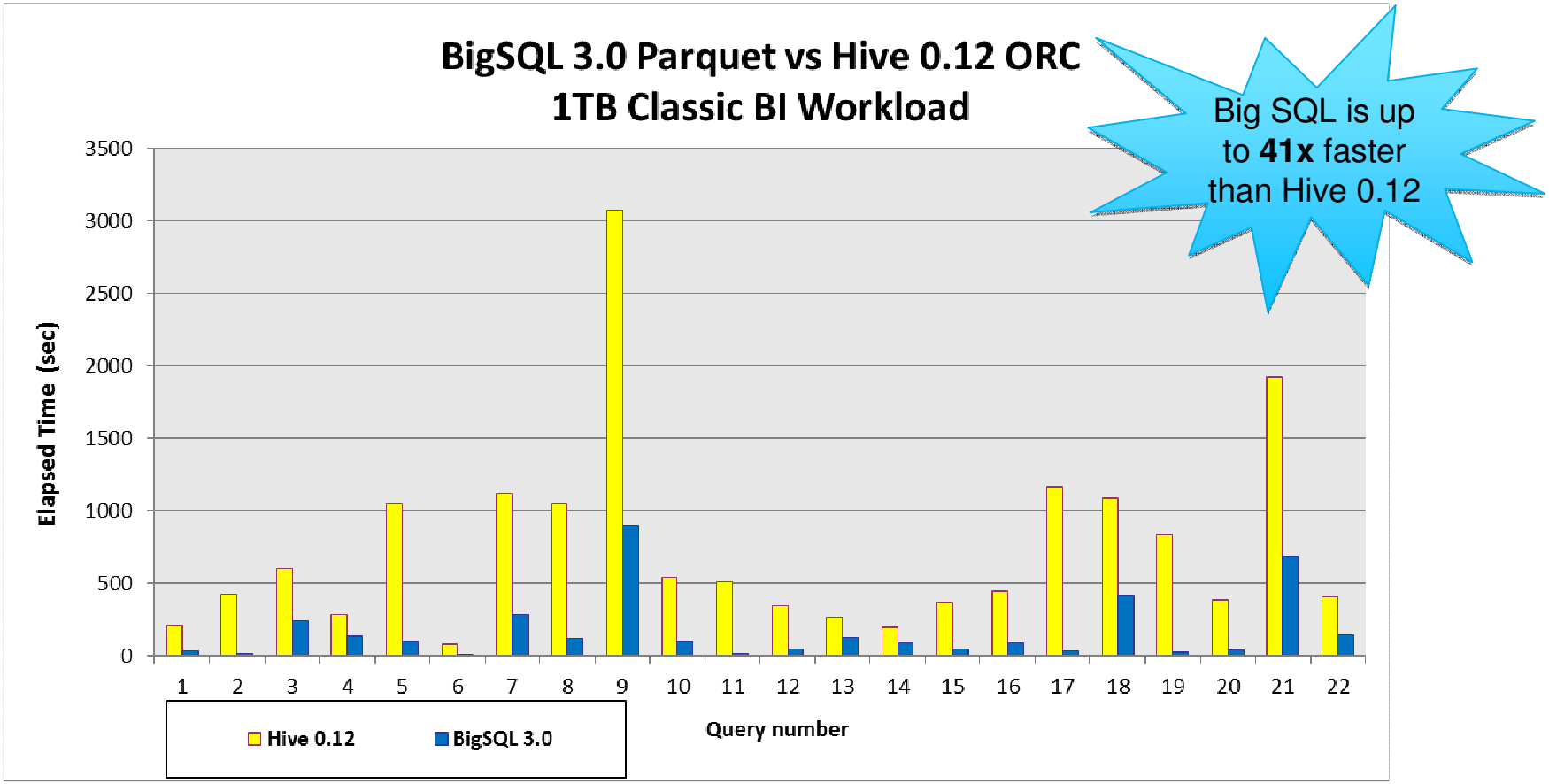
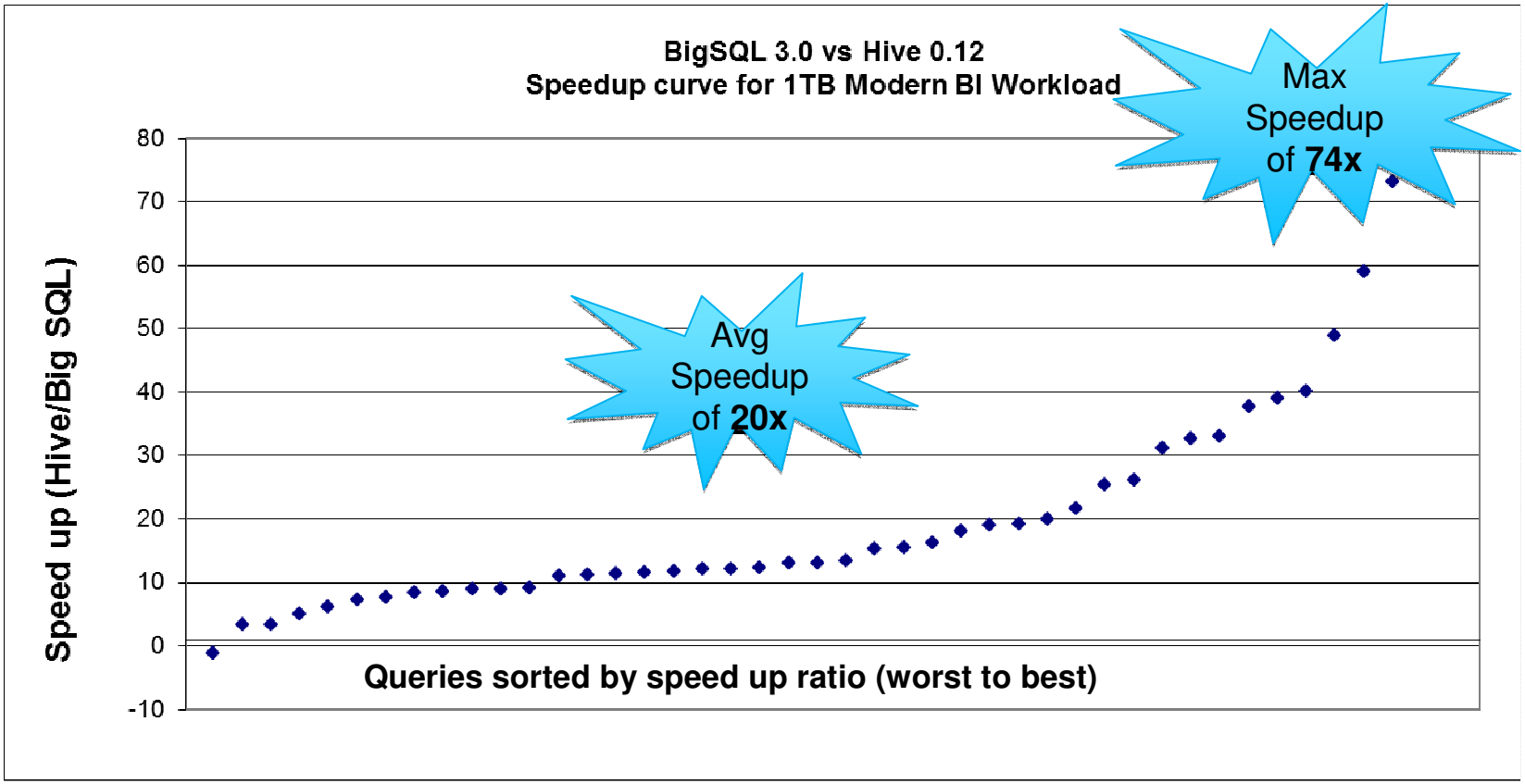
Comparing Big SQL and Hive 0.12 for Ad-Hoc Queries



*Based on IBM internal tests comparing IBM Infosphere Biginsights 3.0 Big SQL with Hive 0.12 executing the "1TB Classic BI Workload" in a controlled laboratory environment. The 1TB Classic BI Workload is a workload derived from the TPC-H Benchmark Standard, running at 1TB scale factor. It is materially equivalent with the exception that no update functions are performed. TPC Benchmark and TPC-H are trademarks of the Transaction Processing Performance Council (TPC). Configuration: Cluster of 9 System x3650HD servers, each with 64GB RAM and 9x2TB HDDs running Redhat Linux 6.3. Results may not be typical and will vary based on actual workload, configuration, applications, queries and other variables in a production environment. Results as of April 22, 2014

How many times Faster is Big SQL than Hive 0.12?



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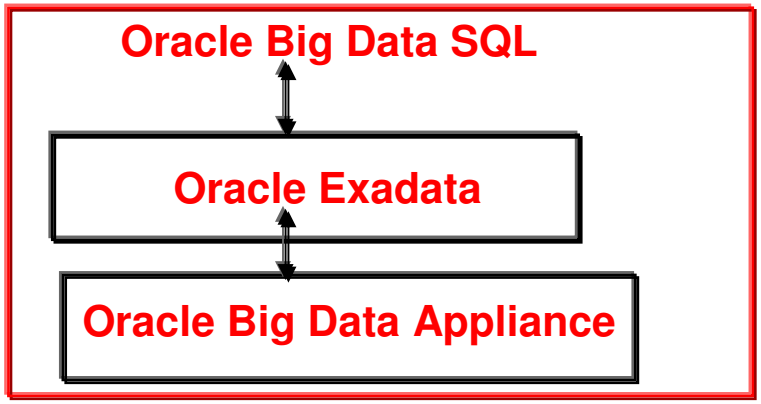
Results as of April 22, 2014

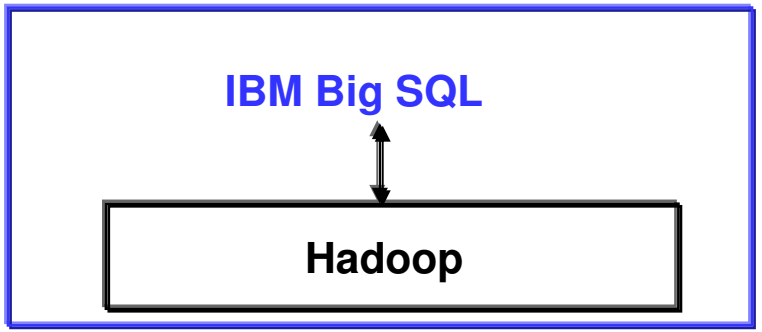
Oracle Big Data SQL Requires Exadata and Big Data Appliance

- Oracle Big Data SQL will allow an Oracle Exadata user to issue a remote SQL query to Oracle's Big Data Appliance and return the result
- Not Yet Available



Not Yet Available

- IBM Big SQL, part of BigInsights, gives customers the ability to issue SQL queries directly to Hadoop
- IBM Big SQL is available today



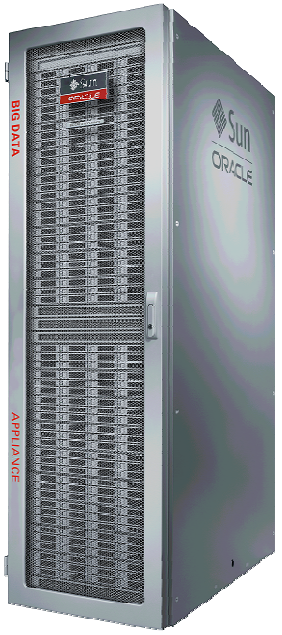
Available Today

Oracle Big Data SQL – Exadata to Big Data Appliance

Oracle Big Data SQL = Remote query from Exadata to Oracle Big Data Appliance

SQL query issued

Results returned



Oracle Exadata
(Oracle 12 c Database)

Oracle Big Data Appliance
(Cloudera Hadoop)

Oracle Big Data SQL – Not What it Seems

- **Oracle's solution requires Oracle 12c Database to submit the query to Hadoop**
  - Oracle Big Data SQL requires the Oracle 12c database on Exadata as the front-end system to issue the query to Hadoop
- **Oracle's solution requires both Oracle Exadata and the Oracle Big Data Appliance**
  - Likely to be of interest only to customers willing to buy into the complete Oracle stack

- **IBM Big SQL queries Hadoop directly**
  - No need for a front-end relational database
- **IBM Big SQL runs on any commodity x86 or Power Linux hardware**
  - No need for proprietary, lock-in Big Data Appliance

IBM Big SQL Compared to Oracle Big Data SQL

- **IBM Big SQL offers faster performance**
  - Hadoop data does not need to be transferred across a network to an Oracle database for additional processing (joins, aggregations, etc)
- **IBM Big SQL offers "Direct Connect"**
  - Front-end query tools such as Cognos can connect directly to Hadoop with IBM Big SQL, and more efficiently, by not having to connect first to the Oracle database
- **IBM Big SQL offers true MPP on Hadoop**
  - Big SQL deploys directly on the physical Hadoop cluster
  - Big SQL accesses Hadoop data natively for reading and writing
- **IBM Big SQL offers query federation**
  - Big SQL can federate queries across DB2, Netezza, Teradata, and even Oracle
  - Integrating existing relational database data with Hadoop
- **IBM Big SQL is available today**
  - Oracle Big Data SQL is not even available in Beta yet

Pivotal HD HAWQ

HAWQ

Expand the Productivity and Possibilities of Hadoop with Existing SQL Skillsets

HAWQ, adds SQL's expressive power to Hadoop. By adding rich, proven parallel SQL processing facilities, HAWQ renders Hadoop queries faster than any Hadoop-based query interface on the market today.

HAWQ leverages existing BI and analytics products and your workforce's SQL skills to accelerate data analytics projects, simplify development, expand Hadoop's capabilities, increase productivity and cut costs.

- World's fastest SQL query engine on Hadoop
- 100% SQL Compliant
- Proven with 10 years of technology innovation
- Dynamic Pipelining technology delivers 100X performance improvement with mature SQL query optimization and powerful analytics
- Scatter/Gather data loading, polymorphic storage, third-party tools certification and language support

HAWQ: THE MARRIAGE OF HADOOP AND PARALLEL SQL DATABASE TECHNOLOGY

HAWQ is a parallel SQL query engine that combines the key technological advantages of the industry-leading Pivotal Analytic Database with the scalability and convenience of Hadoop. HAWQ reads data from and writes data to HDFS natively. HAWQ delivers industry-leading performance and linear scalability. It provides users the tools to confidently and successfully interact with petabyte range data sets. HAWQ provides users with a complete, standards compliant SQL interface.

Or is it

The complexity of Hadoop married to the complexity of the Greenplum Database?

Pivotal HD – HAWQ is based on Greenplum Database

- **HAWQ is based on the Greenplum database with modifications that enable data to be stored on HDFS**
  - Or HDFS compatible file systems (such as EMC ISILON OneFS)
- **The data is still stored in Greenplum relational tables, in a proprietary format (.GDB) on HDFS, separate from Hadoop data**
  - Readable only through the Greenplum interface*
- **HAWQ SQL access to Hadoop data (including HBase) is done via the Greenplum Database External Table feature**
  - Part of what is now called PXF – Pivotal Extension Framework.
- **HAWQ uses its own internal proprietary metadata**
  - Does not use Apache Hadoop Hive Metadata Catalog (HCatalog)

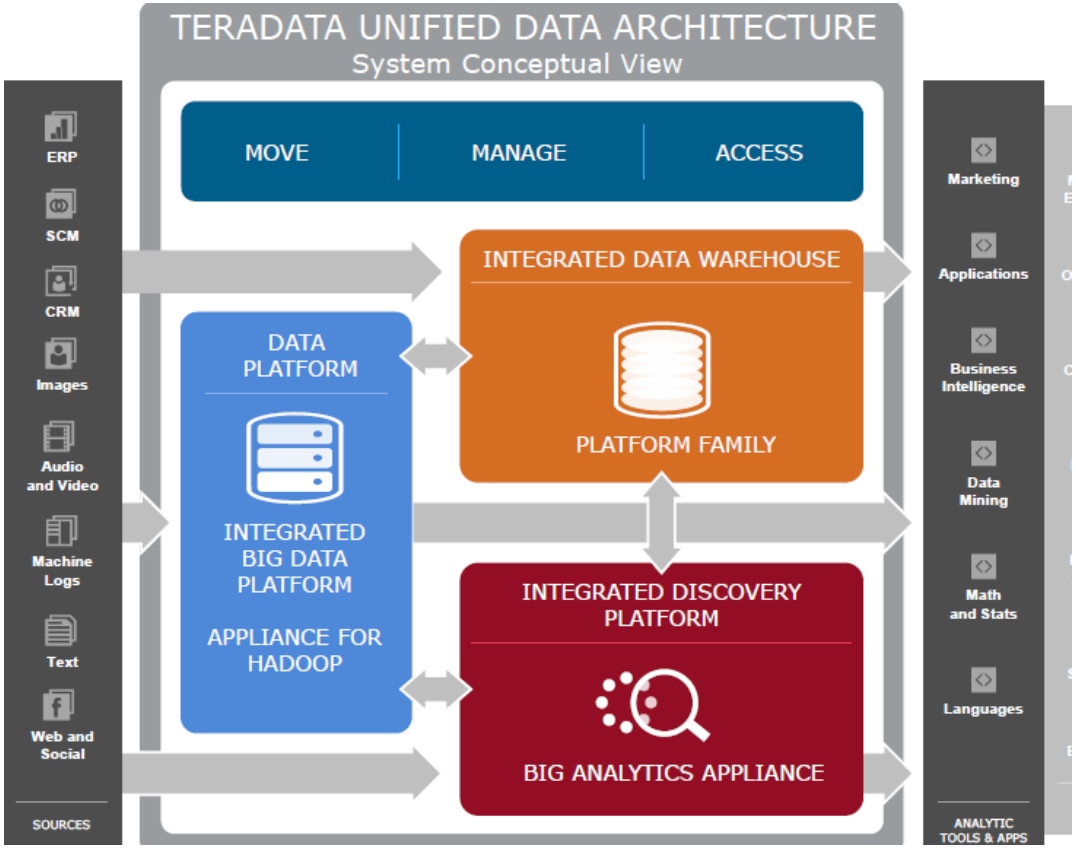
***Hawq recently added support for Parquet files**

IBM Big SQL Advantages Compared to Pivotal HAWQ

- **Architecture designed for Hadoop Ecosystem**
  - Big SQL uses meta data and standard files on HDFS
  - HAWQ uses its own metadata and database tables
- **Elastic Scalability**
  - With Big SQL, nodes can be added or removed from cluster on-line
  - HAWQ requires complex, disruptive, off-line MPP database re-distribution
- **Federation**
  - DB2, Netezza, Oracle, Teradata
- **Fine grained row and column access control**
  - Easy development for multi-tenancy applications
  - Does not require the use of views
- **Packaging**
  - Big SQL included in BigInsights
  - HAWQ is extra cost license for Pivotal HD

Teradata "Unified Data Architecture"

- Hadoop purpose is for data capture and transformation
- Aster Data used for discovery and exploratory analytics
- SQL-H is used to query Hadoop using SQL from either Aster Data or Teradata
- SQL-H issues a remote query to Hadoop and brings the data back to the RDBMS for processing



Teradata SQL-H – Remote Query to Hadoop

What is SQL-H?

- Imports Hadoop data into Teradata
  - > Using SQL query
  - > Import only in the first version
  - > Schema dynamically determined at runtime
  - > Parallel data transfer

How do I use SQL-H?

```
SELECT  Price
      , CAST(Make AS VARCHAR(20))
      , CAST(Model AS VARCHAR(20))
FROM LOAD_FROM_HCATALOG(
  USING

SERVER('sdl14364.labs.teradata.com')
     PORT('9083')
     USERNAME ('hive')
     DBNAME('default')
     TABLENAME('CarPriceData')
     COLUMNS('*')
     TEMPLETON_PORT('1880')
) as DT;
```

Teradata SQL-H – Teradata SQL-H gives any user or application across the enterprise direct, on-the-fly access to data stored within Hadoop through standard ANSI SQL, leveraging the security, workload management, and performance of the Teradata data warehouse. This allows users to quickly query the data where it lies - easily combining data from Hadoop as needed with production data in the Teradata data warehouse to expand and enrich their insights. With Teradata SQL-H, analytics run directly in-memory on Teradata with only the data required for a query being pulled from Hadoop—boosting performance—while lowering costs associated with data movement and replication. Teradata SQL-H supports Hortonworks Data Platform, leveraging the open-source Apache HCatalog project for intelligent data access.

IBM Big SQL Compared to Teradata SQL-H

- **Big SQL operates and processes the data directly on Hadoop**
  - Does not need to move data to relational database for analytics
- **Big SQL does not require separate licensing or complexity of an MPP relational database like Teradata**
  - SQL-H requires deployment of the Aster or Teradata relational database
  - Big SQL provides direct SQL access to Hadoop as part of BigInsights
- **Big SQL supports SQL access to HBase**
  - SQL-H does not support HBase
- **SQL-H depends on network latency/speed and Teradata system configuration for performance**
  - Teradata system may already be overburdened
  - Teradata system likely not sized for additional processing of Hadoop data
- **Aster Data and Teradata are complex**
  - Relational MPP engine with partitioning, indexing, tuning requirements
  - Aster has operational limitations including having to rebuild indexes on load, vacuum operations to reclaim space, managing freespace, etc.

Summary

Summary

- **SQL on Hadoop presents huge opportunity**
  - Data Lake, Data Warehouse offload, Sandbox and exploration
- **IBM Big SQL Architecture is designed for Hadoop Ecosystem**
  - MPP query engine runs natively on Hadoop
- **Big SQL provides many advantages over Cloudera Impala**
  - SQL support, memory management, more features
- **Big SQL also has advantages over Hive**
  - SQL support, performance
  - But Big SQL works on top of Hive, extending value of Hive
- **Big SQL designed for Hadoop, queries Hadoop data directly**
  - Neither Oracle, nor Teradata, nor Microsoft have a similar solution
  - Many SQL Hadoop solutions submit remote queries to Hadoop
  - Other SQL solutions are ports of database, including storage layer

Backup: Vendor Landscape

- Cloudera has developed a MPP SQL engine for Hadoop called Impala, which is now also offered by MapR and Amazon EMR (Elastic Map Reduce)
- Hortonworks is enhancing the breadth of SQL coverage, and performance of Hive, under the project name Stinger
- Pivotal HAWQ is based on the Greenplum MPP database, and provides similar MPP database capability on Hadoop as part of the Pivotal HD (Hadoop) product
- Teradata offers SQL-H which enables a Teradata end-user to issue a remote query to Hadoop and bring the data back into Teradata for analysis or integration with Teradata data. Teradata Query Grid (3Q 2014) will enable SQL-H result sets to be filtered on Hadoop prior to being returned to Teradata.
- Oracle announced Oracle Big Data SQL which enables an Oracle Exadata end user to issue remote queries to the Oracle Big Data Appliance and bring back a filtered result set to Oracle database for analysis or integration with Oracle data. GA 3Q 2014.
- Microsoft's Polybase enables their PDW appliance to issue remote SQL queries to Hortonworks Hadoop on Windows or Microsoft HDInsight
- Actian has consolidated ParAccel and Vectorwise technologies, ported to Hadoop and released it as Actian Analytics Platform Hadoop SQL Edition.
- HP Vertica has released Dragline which can run on a MapR cluster and share storage with Hadoop

Backup: Vendor Landcape

- Facebook has developed Presto, an open source SQL engine for Hadoop designed for interactive query analysis on large data sets
- Apache Drill is an open source project based on Google Dremel to provide a distributed SQL execution engine for interactive, low latency queries. Currently in Beta
- Spark SQL is a new SQL engine being developed from the ground up for Spark by Databricks, and replaces the previous Shark project. Currently in Alpha.
- Splice Machine claims to be a full ACID compliant RDBMS on Hadoop, by taking the Apache Derby Java relational database and removed its storage layer, replacing it with the Apache HBase NoSQL database. Then the company modified the planner, optimiser and executor inside Derby to take advantage of HBase's distributed architecture. Currently in Beta.
- Citus DB is built on PostgreSQL and runs on Hadoop nodes
- JethroData is an index-based SQL engine for Hadoop automatically indexes data as it is written into Hadoop
- InfiniDB has recently announced InfiniDB for Apache Hadoop, which is positioned for analytics and claims “if you know MySQL, you know InfiniDB”