



SQL for Hadoop: Introducing Big SQL for BigInsights



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Executive Summary




- **Why SQL?**
 - Easy on-ramp to Hadoop for SQL professionals
 - Support familiar SQL tools / applications (via JDBC and ODBC drivers)
- **What SQL operations are supported?**
 - Create tables / views (and, optionally, HBase indexes)
 - Load data into tables (from local files, distributed files, RDBMSs)
 - Query data (project, restrict, join, union, sub-queries)
- **What Hadoop-based storage mechanisms are supported?**
 - Hive
 - HBase
 - Distributed file system

Agenda

- **Big SQL: motivation and architecture**
- **Using Big SQL**
 - Invocation options
 - Creating tables
 - Populating tables with data
 - Querying data
 - Developing applications and working with tools
 - . . . And a peek at some additional topics
- **What RDBMS professionals should know about Big SQL**



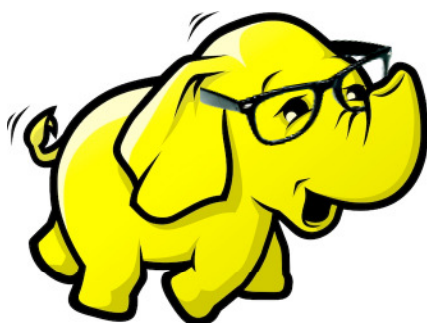
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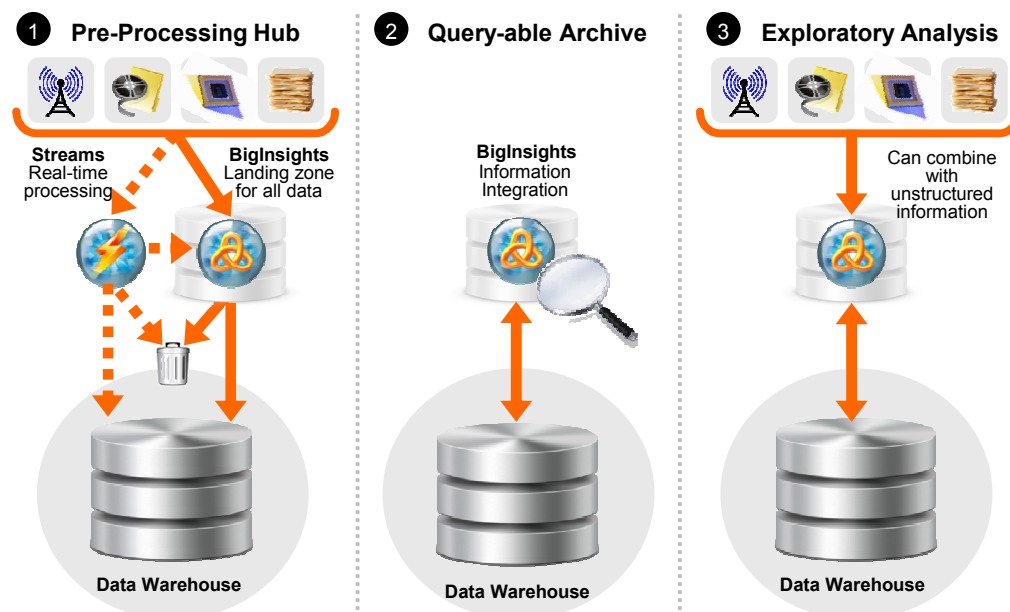


SQL Access for Hadoop: Why?

- Data warehouse augmentation is a leading Hadoop use case



- Hadoop often perceived as difficult
 - MapReduce Java API requires programming expertise
 - Unfamiliar languages (such as Pig) also require special skills
- SQL support opens the data to a much wider audience
 - Familiar, widely known syntax
 - Common catalog for identifying data and structure



Big SQL Architecture and Feature Overview

- **Standard SQL syntax and data types**

- Joins, unions, aggregates . . .
- VARCHAR, decimal, TIMESTAMP, . . .

- **JDBC/ODBC drivers**

- Prepared statements
- Cancel support
- Database metadata API support
- Secure socket connections (SSL)

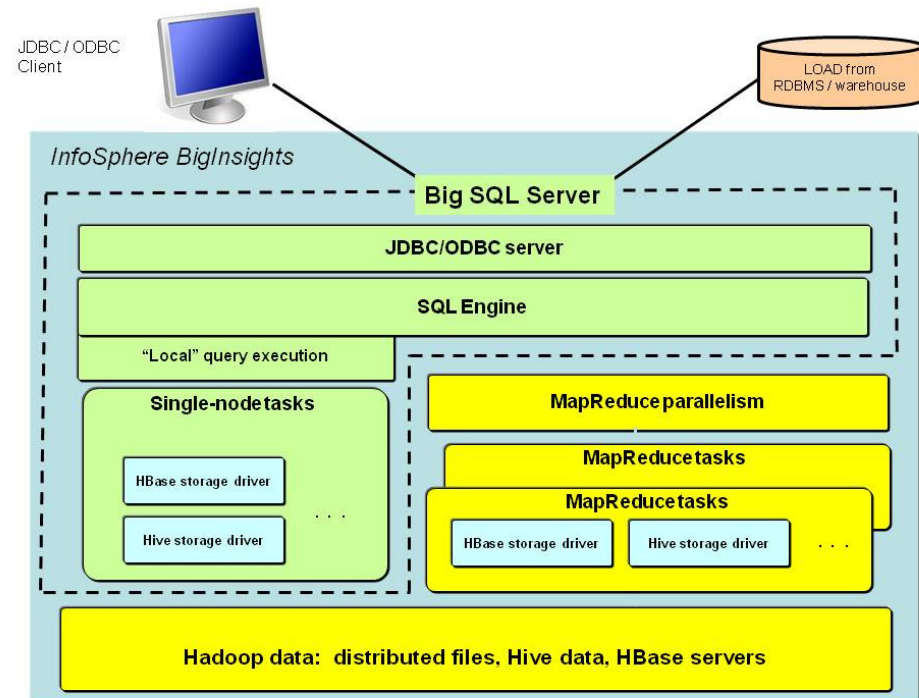
- **Optimization**

- MapReduce parallelism or...
- “Local” access for low-latency queries

- **Varied storage mechanisms appropriate for Hadoop ecosystem**


- **Integration**

- Eclipse tools
- DB2, Netezza, Teradata, Oracle*, MS-SQL*, Informix *(via LOAD)
- Cognos Business Intelligence
- , , ,



* In beta

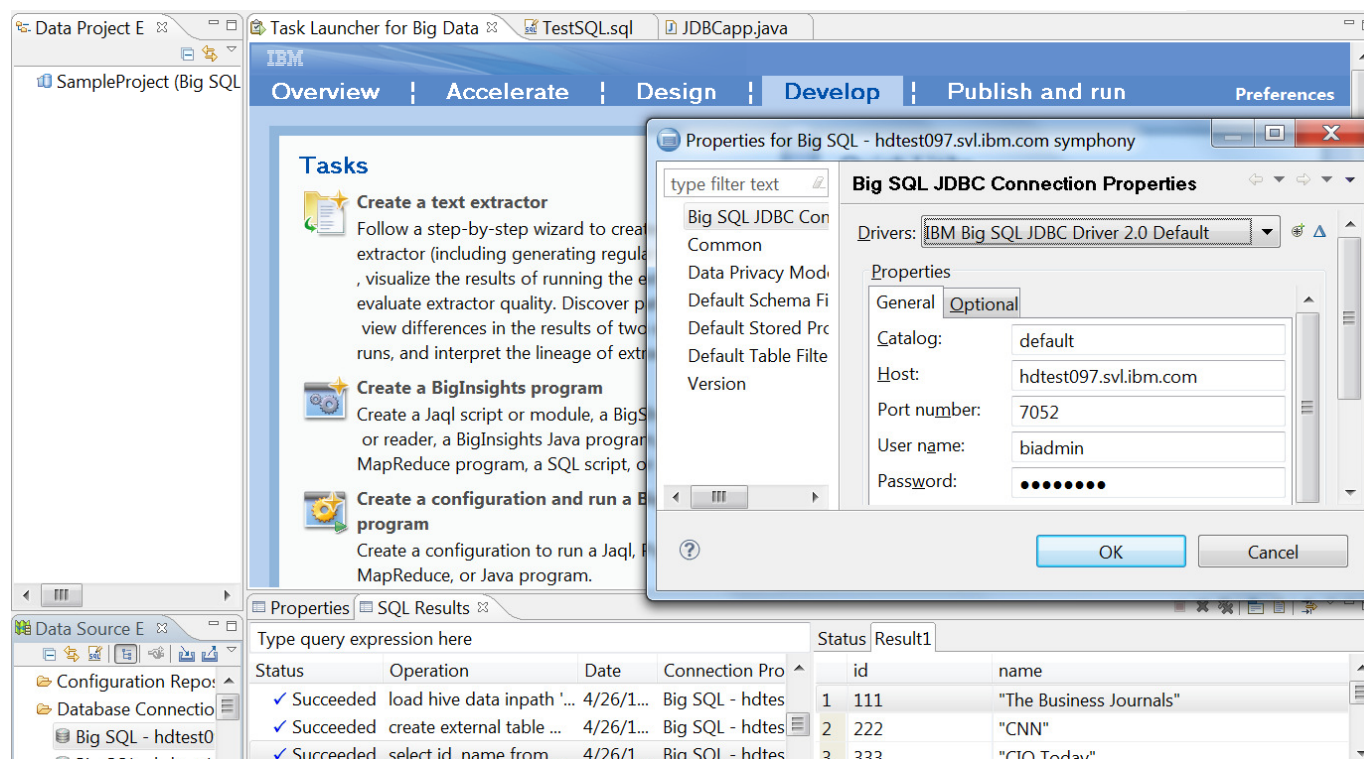
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Invocation options provided with BigInsights

- Command-line interface (JSqsh shell)
- Web-based interface (BigInsights web console)
- Eclipse (BigInsights plug-in)



Creating a Big SQL Table

- **BigSQL supports CREATE TABLE and many data types including varchar, decimals, etc. Non-ISO standard clauses leverage Hadoop ecosystem**

```
CREATE TABLE TPCH.CUSTOMER ( C_CUSTKEY INTEGER, C_NAME VARCHAR(25),  
C_ADDRESS VARCHAR(40), C_NATIONKEY INTEGER, C_PHONE CHAR(15), C_ACCTBAL  
FLOAT, C_MKTSEGMENT CHAR(10), C_COMMENT VARCHAR(117) )  
row format delimited fields terminated by '|'   
stored as textfile;
```

- **Big SQL supports CREATE VIEW***

```
CREATE VIEW IF NOT EXISTS myschema.cust_view (key, name)  
AS SELECT c_custkey, c_name  
FROM TPCH.CUSTOMER;
```

* In beta

Results from CREATE TABLE . . .

■ Table

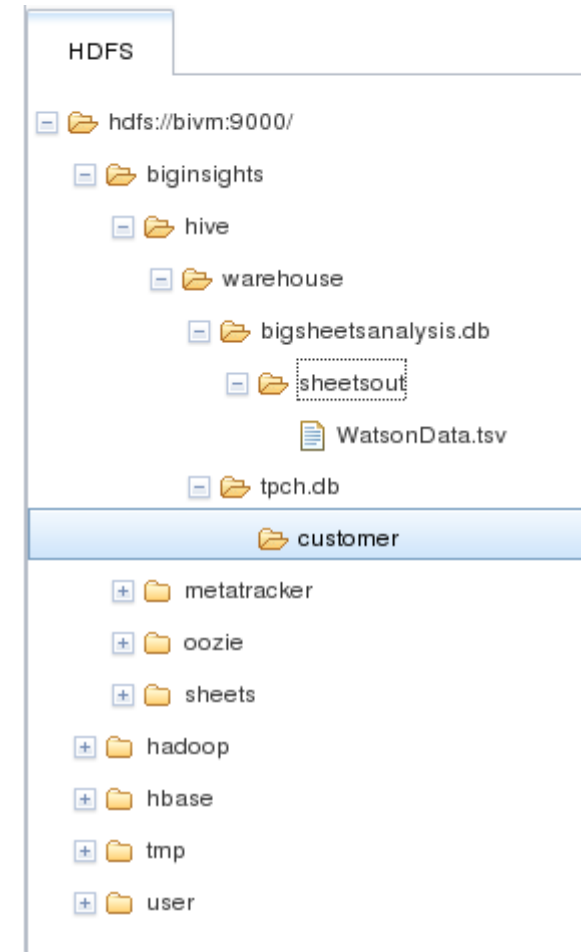
- Subdirectory created in warehouse directory
`/biginsights/hive/warehouse/tablename/`
- **External** tables may have their data stored anywhere in the DFS
- Populated tables contain 1 or more data files

■ Schema (or database)

- Tables may be organized by schemas
- Schema is just a collection of tables
- Creating a schema creates a subdirectory in the warehouse to hold the tables

`/biginsights/hive/warehouse/schema.db/tablename/`

■ Catalog data (more later)



Big SQL Extensions to CREATE TABLE

- **Additional data types: BINARY(N), VARCHAR(N), DECIMAL(P,S)**
- **NULL/NOT NULL indicators**
 - These are advisory only – not enforced
 - Big SQL query re-write software takes advantage of this info
- **Table hints**
 - Certain optimizer hints can be attached to tables
 - Hint will automatically apply when the table is used in a query

```
create table offices
(
  office_id int          not null,
  name      string       not null
)
...
with hints (tablesize='small')
```

- **Explicit syntax for HBase tables (column mappings, column family options, . . .)**

Populating Tables

- **Data can be LOADED from . . .**

- Local file system
- Distributed file system
- Netezza, DB2, Oracle, Informix, MS-SQL, Teradata
- Example

```
CREATE TABLE EMPLOYEE (EMPNO INT, NAME STRING, AGE INT) . . . ;
```

```
// Overwrite any existing data with new data from a local file
```

```
LOAD HIVE DATA LOCAL INPATH '/home/user1/employee.data' OVERWRITE INTO TABLE EMPLOYEE;
```

```
// Append new data from a file in HDFS to the table
```

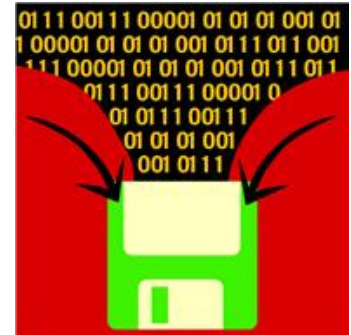
```
LOAD HIVE DATA INPATH '/user/biadmin/employee.data' INTO TABLE EMPLOYEE;
```

- **What LOAD does:**

- Copies or moves the data, but doesn't manipulate it
- Format of the input file must match the format of the table

- **HBase notes:**

- Similar LOAD syntax (LOAD HBASE). Composite keys, indexes, column encoding handled.
- A single row INSERT may be used against HBase table



Querying data: Overview of SQL Support

- **Projection**

```
SELECT col1, col2 FROM t1
```

- **Restriction**

```
SELECT * FROM t1 WHERE col1 > 5
```

- **Union**

```
SELECT EMPNO FROM EMPLOYEE WHERE WORKDEPT LIKE 'E%'
UNION
SELECT EMPNO FROM ACTIVITIES WHERE PROJNO IN('MA2100', 'MA2110', 'MA2112')
```

- **Difference (EXCEPT)**

```
(SELECT * FROM T1) EXCEPT ALL (SELECT * FROM T2)
```

- **Intersection**

```
(SELECT * FROM T1) INTERSECT (SELECT * FROM T2)
```

- **Joins**

- **Subqueries**

- **Built-in functions**

SQL Support - Joins

- **Big SQL supports both common and ANSI / ISO join syntax**



```
select ... from tpch.orders,  
tpch.lineitem  
where o_orderkey = l_orderkey
```



```
select ... from tpch.orders  
join tpch.lineitem  
on o_orderkey = l_orderkey
```

SQL Support – Subqueries

- Big SQL supports subqueries in **SELECT** and **WHERE** clauses



```
select c1, (select  
    count(*) from t2)  
from t1  
where ...
```



```
select c1  
from t1  
where c2 > (select ...)
```

SQL Support – Aggregates

- **Big SQL supports windowed aggregates**



```
SELECT EXTRACT(YEAR FROM CAST(CAST (order_day_key AS  
varchar(100)) AS timestamp)) AS year,  
SUM (sale_total) AS total_sales,  
RANK () OVER (ORDER BY SUM (sale_total) DESC) AS ranked_sales  
FROM gosalesdw.sls_sales_fact  
GROUP BY EXTRACT(YEAR FROM CAST(CAST (order_day_key AS  
varchar(100)) AS timestamp))
```

year	total_sales	ranked_sales
2006	1495891100.90	1
2005	1159195590.16	2
2007	1117336274.07	3
2004	914352803.72	4

SQL Support – Functions (partial list)

- **Numeric**

abs	ceil	floor	ln	log10
mod	power	sqrt	sign	width_bucket

- **Trigonometric**

cos	sin	tan	acos	asin
atan	cosh	sinh	tanh	

- **String**

char_length	bit_length	octet_length	upper	lower
substring	position	index	translate	trim
json_get_object				

- **Aggregates, etc.**

Catalog Tables (HCatalog)

```
[localhost][foo] 1> select * from syscat.tables where tablename='users';
```

schemaname	tablename
default	users

```
1 row in results(first row: 0.14s; total: 0.15s)
```

```
[localhost][foo] 1> select * from syscat.columns where tablename='users';
```

schemaname	tablename	name	type	precision	scale
default	users	id	INT	10	0
default	users	office_id	INT	10	0
default	users	name	STRING	0	0
default	users	children	ARRAY	0	0

```
4 rows in results(first row: 0.19s; total: 0.21s)
```

Other BigInsights catalog tables track index and schema information

BigSheets and Big SQL

IBM InfoSphere BigInsights Quick Start Edition (for Non-Production Environm)

Welcome biadmin | Log out | About | Help IBM.

Welcome | Dashboard | Cluster Status | Files | Applications | Application Status | **BigSheets**

Workbooks > View Results

WatsonBlogs-Revised

Edit Delete Add chart WatsonBlogs > WatsonBlogs-R... Build new workbook

Ready Refresh Fit column(s) Create Table Export data Run Stop 100%

	Country	FeedInfo	Language	SubjectHtml
1		{"Title":"Fern Halper's data makes	English	Are you ready for <Key
2		{"Title":"","Id":"27788189","ExtKey	English	<Keyword>IBM Watson<
3		{"Title":"Medical Quack","Id":"233	English	<Keyword>IBM Watson<
4		{"Title":"Flying like a banana blog	English	<Keyword>IBM Watson<
5		{"Title":"IMasters -","Id":"3230361	Portuguese	Processamento de lingu
6	DE	{"Title":"Rudi2019s ruk Blog","Id	German	Off Bank profit Einsatz
7		{"Title":"Medical Quack","Id":"233	English	

Target Schema: sheets
Target Table: blogs
Confirm Cancel

Task Launcher for Big Data *Test.sql

Connection: Big SQL JDBC

```
-- test script
create view myview
as select feedinfo from sheets.blogs;
select * from myview limit 10;
```

Problems Console SQL Results

Type query expression here	Status	Operation	Date	Connection Profile	Result
create view	Success	create view	2/7/14 3:32 F	Big SQL JDBC	feedinfo
select * from	Success	select * from	2/7/14 3:32 F	Big SQL JDBC	1 [{"Title":"Fern Halper's data makes the world go 'round","Id"
drop view my	Success	drop view my	2/7/14 3:34 F	Big SQL JDBC	2 [{"Title":"","Id":"27788189","ExtKey":"2fe4441ca88258772333b0
create view r	Success	create view r	2/7/14 4:31 F	Big SQL JDBC	3 [{"Title":"Medical Quack","Id":"23369637","ExtKey":"d4abe748d
select * from	Success	select * from	2/7/14 4:31 F	Big SQL JDBC	4 [{"Title":"Flying like a banana blog","Id":"41844757","ExtKey
					5 [{"Title":"IMasters -","Id":"32303613","ExtKey":"aebc21db7f16
					6 [{"Title":"Rudi2019s ruk Blog","Id":"39980009","ExtKey":"e8
					7 [{"Title":"Medical Quack","Id":"23369637","ExtKey":"d4abe748d

Total 10 records shown

DFS File Catalog Table

Table: sheets.blogs

HCatalog Reader Save as Master Workbook

	country	feedinfo	language	postsize	published	subje
1		{"Title":"Fern H English	English	10118	2012-02-13 14	Are you
2		{"Title":"","Id":"10628	English	10628	2012-03-22 16	<Keyw

Using Existing Standard SQL Tools: Eclipse

The screenshot displays the Eclipse IDE interface with the following components:

- Editor Window:** Shows a SQL script named `*Script10.sql` with the following content:


```

1 SELECT
2   L_RETURNFLAG,
3   L_LINESTATUS,
4   SUM(L_QUANTITY) AS SUM_QTY,
5   SUM(L_EXTENDEDPRICE) AS SUM_BASE_PRICE,
6   SUM(L_EXTENDEDPRICE*(1-L_DISCOUNT)) AS SUM_DISC_PRICE,
7   SUM(L_EXTENDEDPRICE*(1-L_DISCOUNT)*(1+L_TAX)) AS SUM_CHARGE,
8   AVG(L_QUANTITY) AS AVG_QTY,
9   AVG(L_EXTENDEDPRICE) AS AVG_PRICE,
10  AVG(L_DISCOUNT) AS AVG_DISC,
11  COUNT(*) AS COUNT_ORDER
12 FROM LINEITEM
13 WHERE L_SHIPDATE <= '1998-09-02'
14 GROUP BY L_RETURNFLAG, L_LINESTATUS
15 ORDER BY L_RETURNFLAG, L_LINESTATUS
16

```
- BigInsights Servers View:** Located on the left, it shows a tree structure with 'BigInsights Servers'.
- Data Source Explorer View:** Located on the right, it shows a tree structure with 'Big SQL - bdvm072.svl.ibm.com' and 'BigSQL - 170.224.193.37 (IBM Big SQL)'. Under 'BigSQL', there is a 'default' schema and several other schemas like 'gosales', 'gosalesdw', 'gosaleshr', 'gosalesmr', and 'gosalesrt'.
- Properties for BigSQL - 170.224.193.37 Dialog:** A modal dialog box titled 'Big SQL JDBC Connection Properties' is open. It contains the following fields:
 - Drivers:** IBM Big SQL JDBC Driver 2.0 Default
 - General Tab:**
 - Catalog: default
 - Host: 170.224.193.37
 - Port number: 7052
 - User name: biadmin
 - Password: (masked with dots)
 - ☒ Save password
 - Connection URL: jdbc:bigsql://170.224.193.37:7052/default
 - Optional Tab:** (Currently selected)
 - Buttons:** Test Connection, OK, Cancel



Using Existing Standard SQL Tools: SQuirreL SQL

SQuirreL SQL Client Version 3.4.0

Connect to: BigSQL vm... Active Session: 1 - BigSQL vm072 () as biadmin

SQL

```
SELECT L_RETURNFLAG, L_LINESTATUS, SUM(L_QUANTITY) AS SUM_QTY, SUM(L_EXTENDEDPRICE) AS SUM_BASE_PRICE, SUM(L_EXTENDEDPRICE * (1 - L_DISCOUNT)) AS SUM_DISC_PRICE, SUM(L_EXTENDEDPRICE * (1 - L_DISCOUNT) * (1 + L_TAX)) AS SUM_CHARGE, AVG(L_QUANTITY) AS AVG_QTY, AVG(L_EXTENDEDPRICE) AS AVG_PRICE, AVG(L_DISCOUNT) AS AVG_DISC, COUNT(*) AS COUNT_ORDER FROM tpch.LINEITEM WHERE L_SHIPDATE <= '1998-09-02' GROUP BY L_RETURNFLAG, L_LINESTATUS ORDER BY L_RETURNFLAG, L_LINESTATUS;
```

Limit rows: 100

select count(*) SELECT_L_RETURN

Rows 4: SELECT L_RETURNFLAG, L_LINESTATUS, SUM(L_QUANTITY) AS SUM_QTY, SUM(L_EXTENDEDPRICE) AS SUM_BASE_PRICE, SUM(L_EXTENDEDPRICE * (1 - L_DISCOUNT)) AS SUM_DISC_PRICE, SUM(L_EXTENDEDPRICE * (1 - L_DISCOUNT) * (1 + L_TAX)) AS SUM_CHARGE, AVG(L_QUANTITY) AS AVG_QTY, AVG(L_EXTENDEDPRICE) AS AVG_PRICE, AVG(L_DISCOUNT) AS AVG_DISC, COUNT(*) AS COUNT_ORDER

L_returnflag	L_linestatus	SUM_QTY	SUM_BASE_PRICE	SUM_DISC_PRICE	SUM_CHARGE	AVG_QTY	AVG_PRICE	AVG_DISC	COUNT_ORDER
A	F	380,456	532,348,211.54083	505,821,179.8	534,594,445.51434	8,971	12,384,801.3941	11,798	507.99
N	F	8,971	12,384,801.3941	11,798	534,594,445.51434	380,456	532,348,211.54083	505,821,179.8	507.99
N	O	742,802	1,041,502,841.74463	989.73	1,041,502,841.74463	381,449	534,594,445.51434	507.99	507.99
R	F	381,449	534,594,445.51434	507.99	534,594,445.51434	380,456	532,348,211.54083	505,821,179.8	507.99

Add Alias

Add Alias

Name: BigSQL on bdvm072.svl.ibm.com

Driver: ☒ IBM Big SQL JDBC Driver 2.0 Default

URL: jdbc:bigsql://bdvm072.svl.ibm.com:7052/default

User Name: biadmin

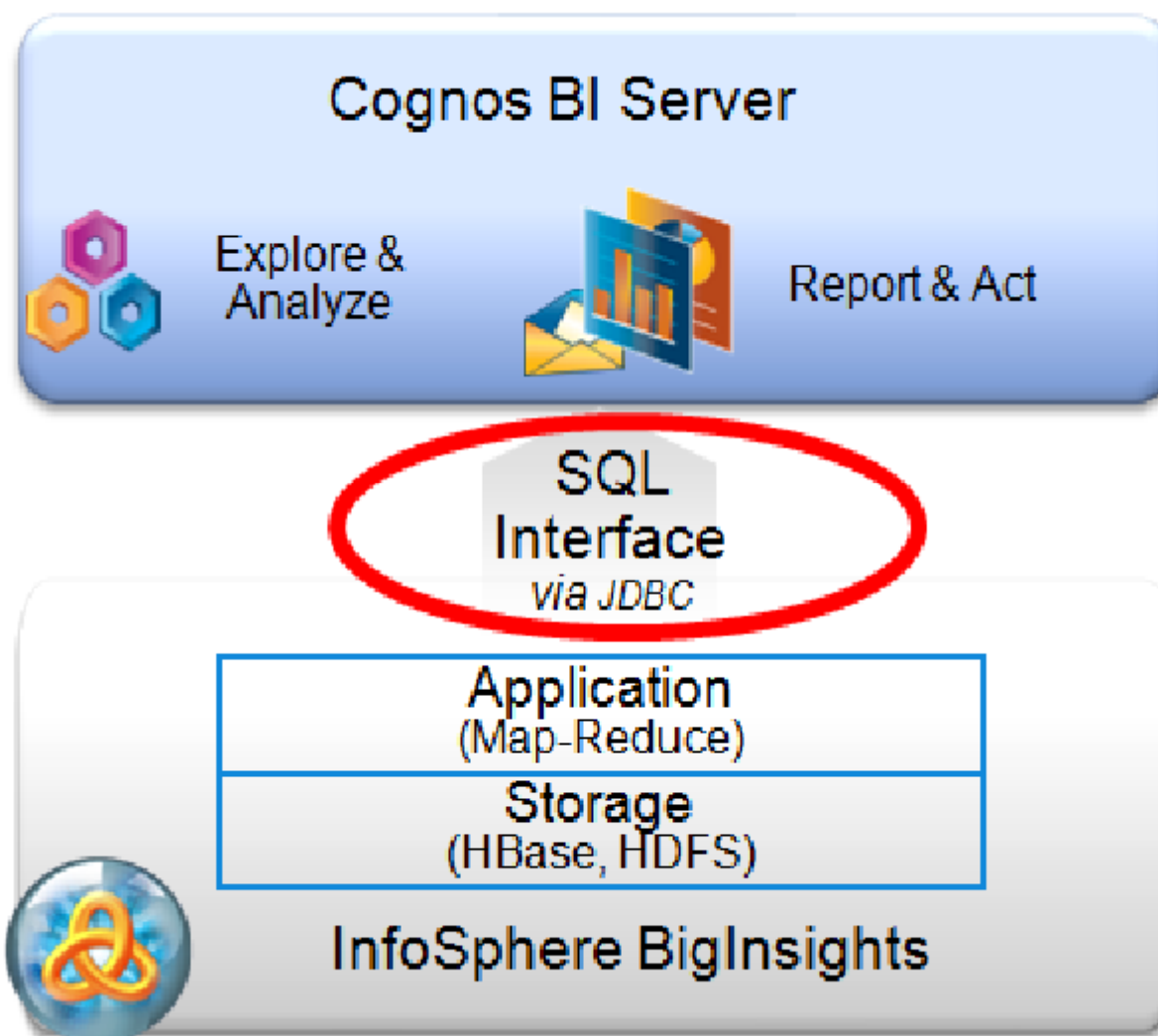
Password:

☐ Auto login ☐ Connect at Startup

Warning - Passwords are saved in clear text

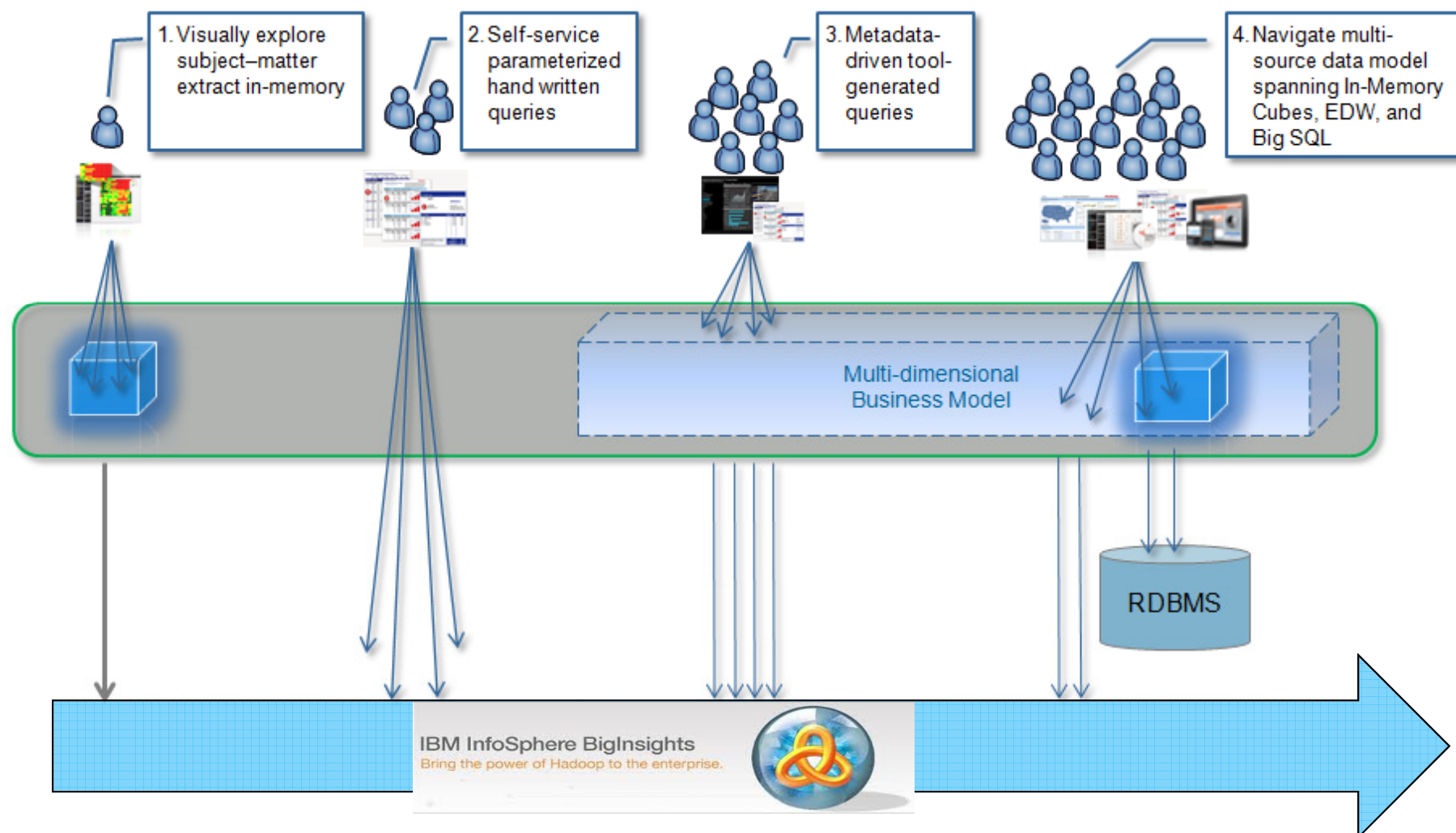


Cognos Business Intelligence



MicroStrategy use of Big SQL

MicroStrategy



MS Excel: Big SQL integration via ODBC

The screenshot illustrates the process of integrating MS Excel with Big SQL via ODBC. It shows three main components:

- IBM Big SQL ODBC Client Setup:** A window for configuring the ODBC driver. It includes fields for Database (default), Host (sdsvm691013.svl.ibm.com), Port (7052), User ID (biadmin), and Password (masked).
- Microsoft Excel - Book1:** The Excel application window with the Data menu open. The 'Import External Data' option is highlighted, leading to the 'Import Data...' dialog box.
- Data Connection Wizard:** A dialog box for selecting a database and table. It shows a list of tables in the 'gosalesdw' schema, including 'go_org_name_lookup', 'go_region_dim', 'go_satisfaction_dim', 'go_time_dim', 'go_time_quarter_lookup', 'media_test', 'media_test_a', 'media_ts', 'mrk_activity_status_dim', 'mrk_adv_fact', 'mrk_bundle_group_lookup', 'mrk_campaign_lookup', 'mrk_prod_survey_targ_fact', 'mrk_product_survey_dim', 'mrk_product_survey_fact', 'mrk_promotion_dim', 'mrk_promotion_fact', 'mrk_promotion_plan_fact', 'mrk_rt_survey_dim', 'mrk_rt_survey_fact', 'mrk_rt_survey_targ_fact', 'myprod_brand', and 'myprod_brand1'.



A word about . . . SerDes

- **Custom serializers / deserializers (SerDes)**

- Read / write complex or “unusual” data formats (e.g., JSON)
- Commonly used with Hive, HBase
- Developed by user or available from open source community

- **Using SerDes with Big SQL**

- Add the SerDe .jar file to \$BIGSQL_HOME/userlib and \$HIVE_HOME/lib
- Stop / restart Big SQL service
- Specify SerDe class name (not .jar file name) when creating table

- **Example**

```
-- Create a table for JSON data. Use open source hive-json-serde-0.2.jar SerDe
create table socialmedia-json (Country String, FeedInfo String, . . . )
row format serde 'org.apache.hadoop.hive.contrib.serde2.JsonSerde'
stored as textfile;
```

```
load hive data inpath '</hdfs_path>/WatsonBlogsData.json' overwrite into table
  socialmedia-json;
```

```
select * from socialmedia-json;
```

Sample JSON input for previous example

```
[biadmin@bdvm327 twitter]$ cat WatsonNewsBlogsData.json|more

[{"PostSize":5775,"ThreadId":"4f129a8be","Crawled":"2012-01-15 09:21:15","FeedInfo":{"Title\":"www.ibm.comnews\","Id\":"44032787\","ExtKey\":"879cd3257c296614160914c3d96f9b85\","Url\":"http://www-03.ibm.com\"},"Published":"2012-01-15 09:21:15","Url":"http://www.ibm.com/innovation/us/watson/?lnk=ftpl","Country":"US","SubjectHtml":"<Keyword>IBM</Keyword> - <Keyword>Watson</Keyword>","Inserted":"2012-05-29 00:52:57","Language":"English","TextHtml":"<![CDATA[<Keyword>IBM</Keyword> - <Keyword>Watson</Keyword>\n\n      Call to find out how Watson's capabilities could benefit your business.\n      1-800-426-7630\n      \nRelated content\nDesigning the Computer for a Smarter Planet\nThere\u2019s an enormous amount of science included when <Keyword>Watson</Keyword> answers a single Jeopardy! question, how does it all work together?\nExplore <Keyword>Watson</Keyword>\nBeyond Jeopardy! The Business Implications of <Keyword>Watson</Keyword>\n<Keyword>IBM</Keyword> <Keyword>Watson</Keyword> passed its first test on\u2019 Jeopardy!\u2019 in February 2011, but the real test will be in applying the underlying systems, data management and analytics technology in business and across different industries. Watch the webcast now and learn about the present and future business implications of Deep QA and the other technologies behind <Keyword>Watson</Keyword> from David Ferrucci and other <Keyword>IBM</Keyword> executives.\nRegister now\nBetter Bu
```

JSON-based social media data to load into Big SQL Table *socialmedia-json* defined with SerDe

Sample Big SQL query output for JSON data

authorinfo	country	crawled	feedinfo	id	inserted	published
{ "Nick": "", "Id": "", "Name": "", "Url": "" }	US	2012-04-11 03:31:47	{ "Title": " www.ibm.co mnews", "Id ": "4403278 7", "ExtKey ": "879cd32 57c2966141 60914c3d96 f9b85", "Ur l": "http:/ /www-03.ib m.com" }	31859312 32	2012-05-23 20:18:08	2012-04-11 03:31:47
{ "Nick": "", "Id": "", "Name": "", "Url": "" }	US	2012-02-22 23:50:14	{ "Title": " www.ibm.co mnews", "Id ": "4403278 7", "ExtKey ": "879cd32 57c2966141 60914c3d96 f9b85", "Ur l": "http:/ /www-03.ib m.com" }	32535948 48	2012-05-26 05:21:06	2012-02-22 23:50:14

Sample output: Select * from socialmedia-json

A word about . . . performance

■ Tuning options

- Table design (e.g., storage formats for Hive, key & column family definitions for HBase)
- Hints in queries, table definitions
- ANALYZE TABLE ... COMPUTE STATISTICS command
- Secondary indexes (HBase tables only)
- MapReduce job properties
- . . .

■ Query hints provided in comments: `/*+ name=value [, ...] +*/` `select * from foo /*+ accessmode='local' +*/ where c1 < 1000;`

■ Access mode hint

- Causes query to be executed in the Big SQL server
- HBase indexed queries can return extremely rapidly
- Local access can be forced on for your entire session



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- **What RDBMS professionals should know about Big SQL** ✓



Big SQL – what RDBMS experts should know

- **Big SQL provides industry-standard query support for Hadoop-based storage managers**
 - Exploits Hadoop environment
 - Includes Hadoop-specific extensions
 - Introduces Hadoop-specific concepts
 - Copes with “unconventional” data structures and formats (e.g., JSON) via SerDes, other features
- **RDBMS = more than query & storage management**
 - Transaction management
 - Stored procedures
 - INSERT / UPDATE / DELETE
 - GRANT / REVOKE
 - 3GL language support (e.g., COBOL)
 - Rich catalog statistics and decades of cost-based optimization development
- **Bottom line: Big SQL provides SQL experts with on-ramp to Hadoop, but doesn't turn Hadoop into one big relational database**

Want to learn more?

- **Big SQL tutorial (product Information Center)**
- **Videos , articles, downloads, etc.**
 - Technical portal at <http://tinyurl.com/biginsights>

InfoSphere BigInsights Tutorials



Manage

Within minutes, dive into the world of big data with robust, browser-based control.



Import

Collect and import data for exploration and analysis that helps you make sense of seemingly unrelated data.



Analyze

Delve into BigSheets, an intuitive spreadsheet-like tool, to create analytic queries without any previous programming experience.



Develop

Easily develop your first big data application by using the InfoSphere BigInsights Eclipse plugin.



Query

Quickly master the intricacies of SQL queries for Hadoop with IBM Big SQL.



Extract

Discover the power of Text Analytics by creating extractors to derive valuable insights from text documents.



BigInsights Technical Enablement Wiki



Get up to speed on InfoSphere BigInsights, IBM's software platform designed to help firms store, manage, and analyze "big data".

Technical materials

- Articles, white papers, and books
- BigInsights InfoCenter

Videos and Demos

- Video guide

Downloads

- BigInsights Basic Edition (free)
- Karmasphere Studio Community Edition Virtual Appliance with BigInsights (free)
- Fix packs for BigInsights Enterprise Edition (licensed)

Discussion Forum

- BigInsights forum on IBM developerWorks

