Hive - A Warehousing Solution Over a Map-Reduce Framework

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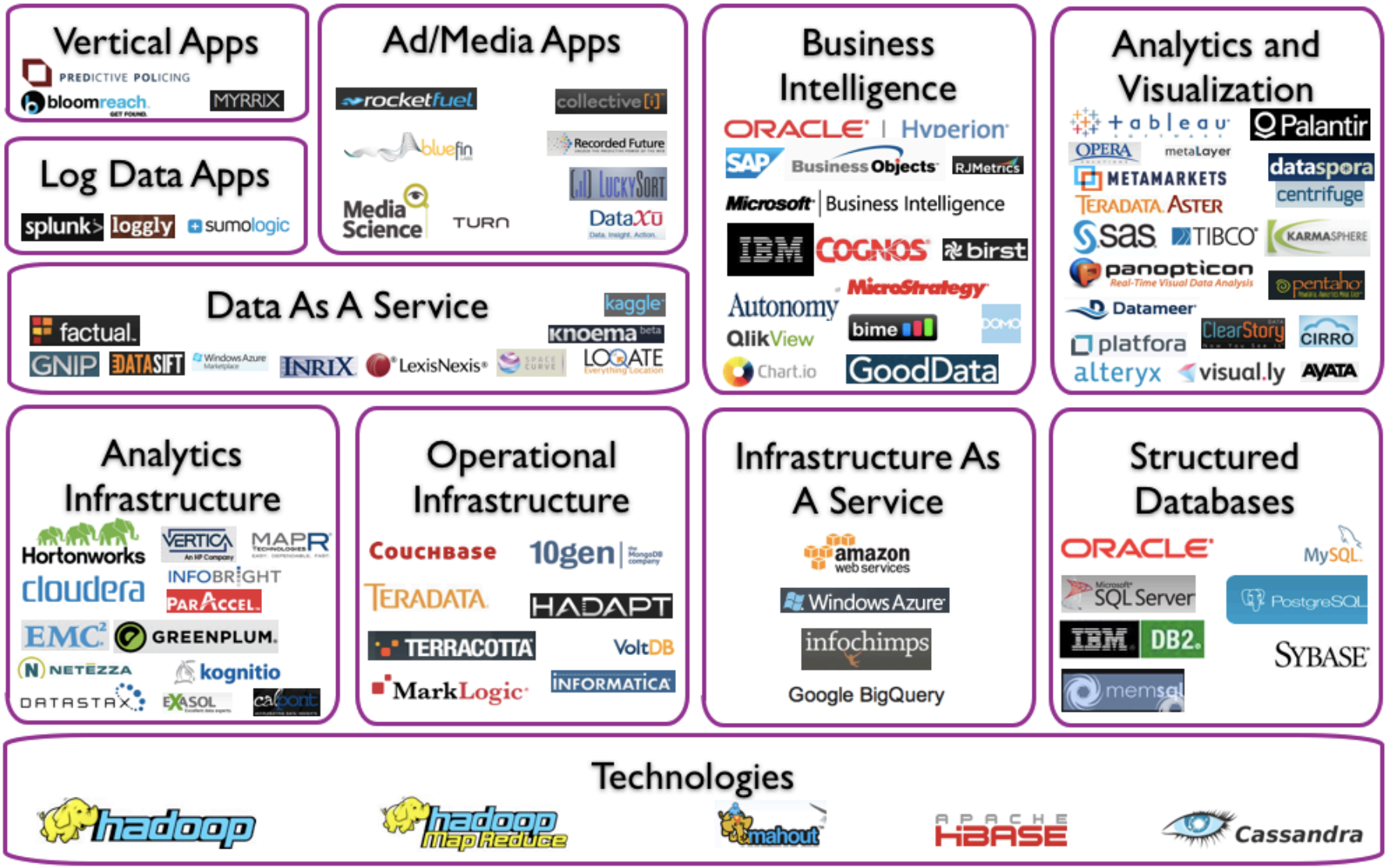
SQL at Facebook: Emergence of Apache Hive

- Developed Hive to address traditional RDBMS limitations.
- 300+ PB of data under management[(1)].
- 600+ TB of data loaded daily.
- 60,000+ Hive queries per day[(2)].
- More than 1,000 users per day.
- Initial Apache release in April 2009.

Big Data Landscape



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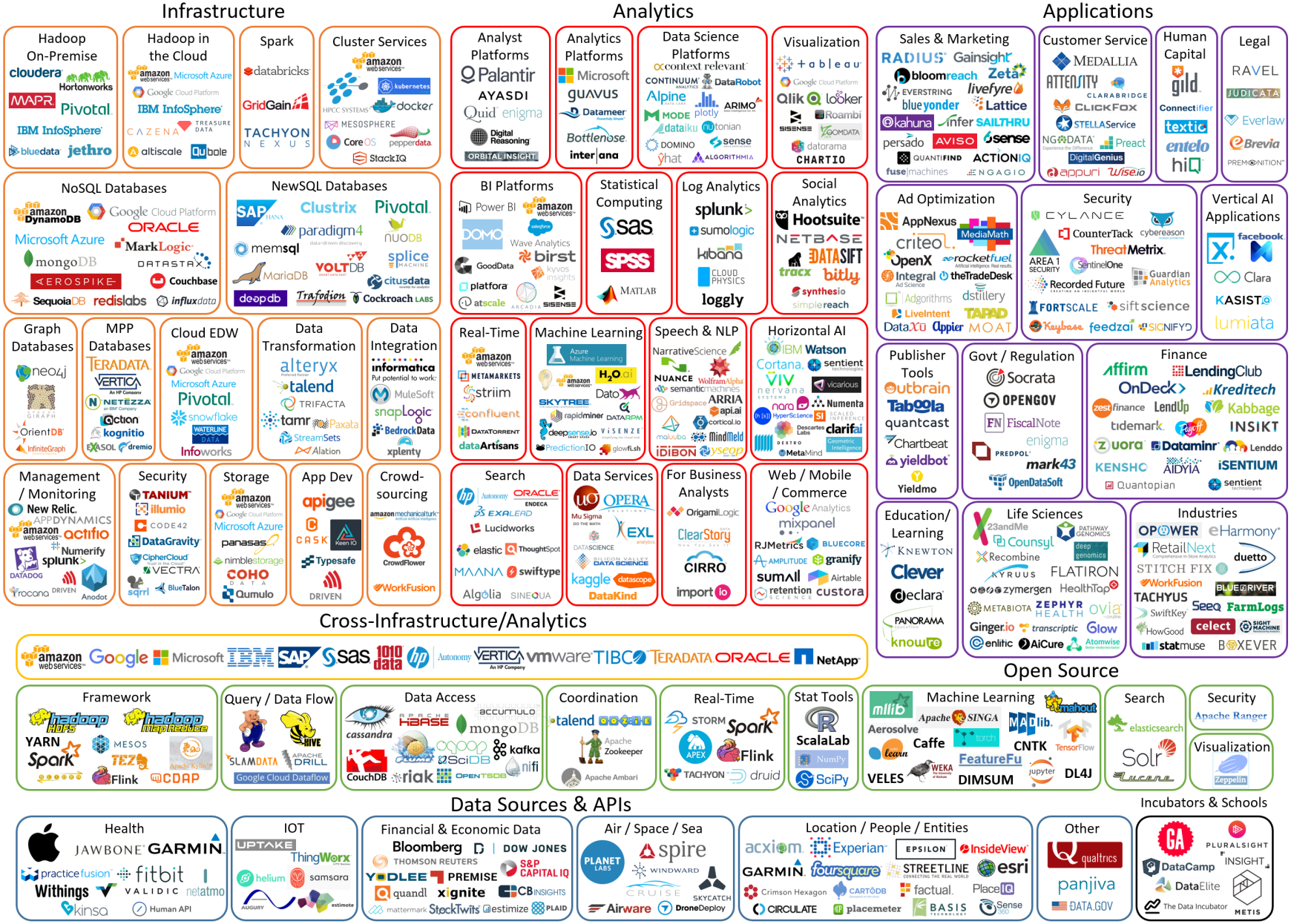
Big Data Landscape 2016 (Version 3.0)



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FIRSTMARK

Hive Classic: Strengths and Challenges

Traditional SQL Workloads Needed Higher Performance!

Challenges that Data Analysts faced

- Data Explosion

  - TBs of data generated everyday

Solution – HDFS to store data and Hadoop Map-Reduce framework to parallelize processing of Data

What is the catch?

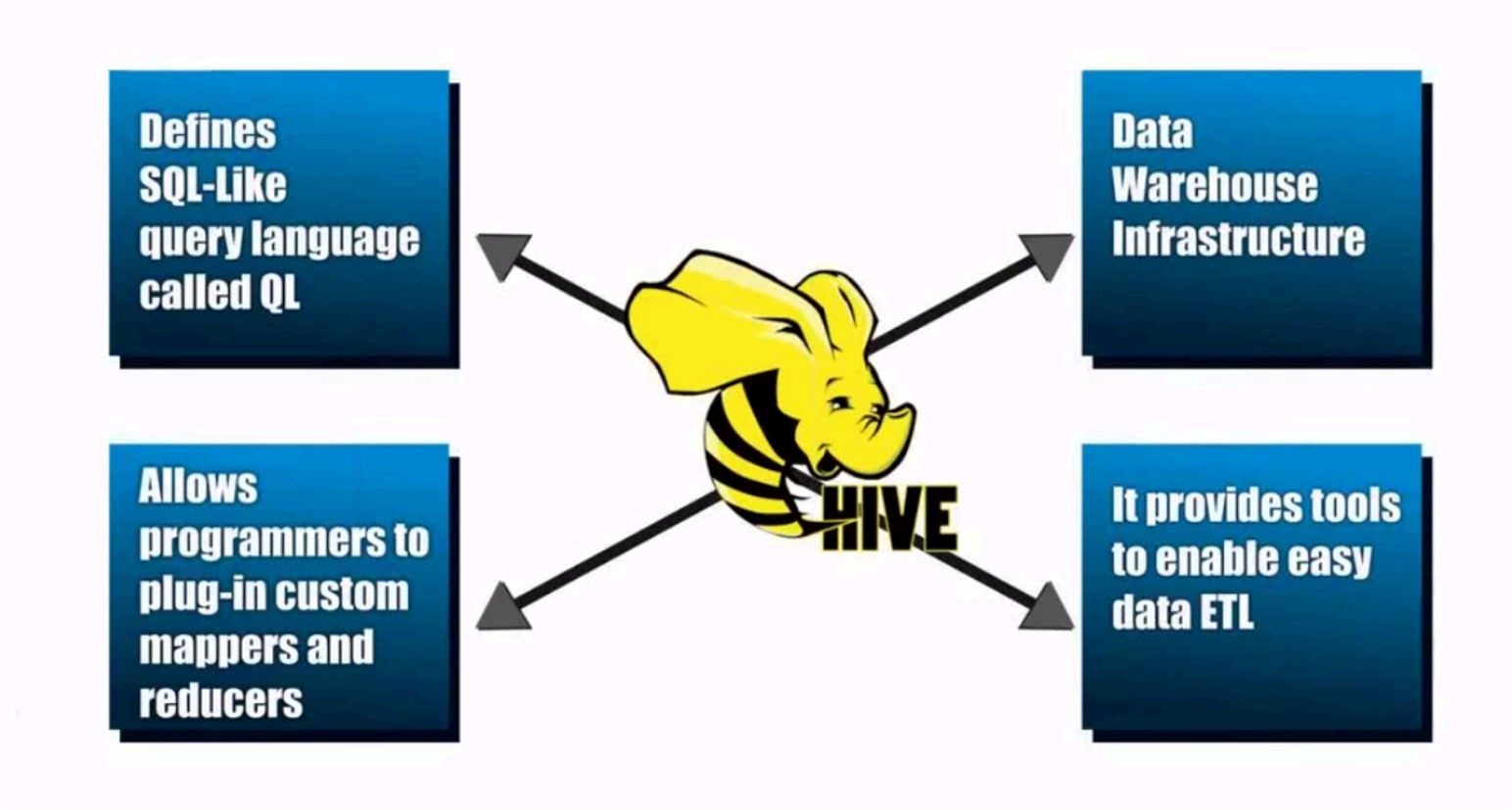
- Hadoop Map Reduce is Java intensive
- Thinking in Map Reduce paradigm can get tricky

What is HIVE?

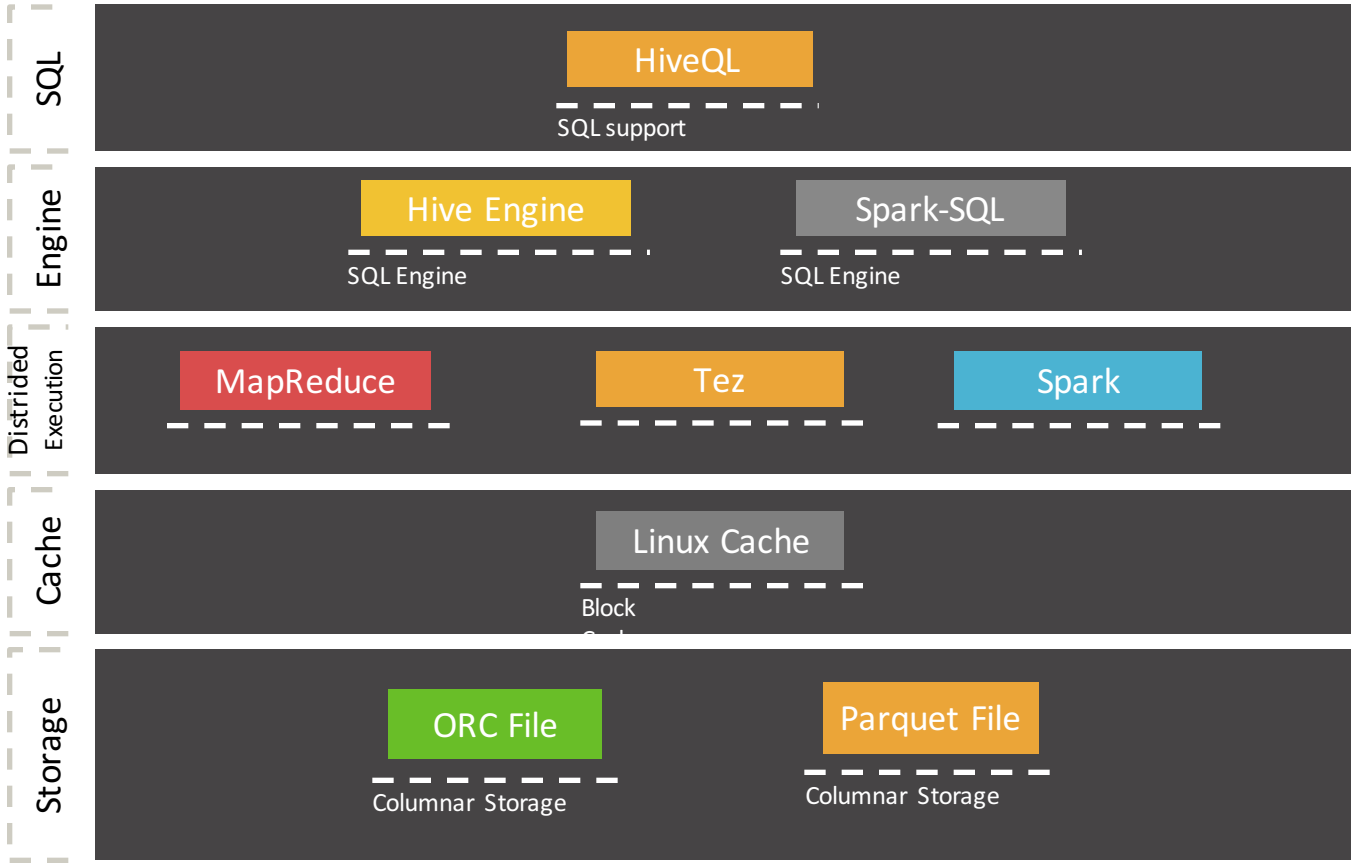
- A system for querying and managing structured data built on top of Hadoop
  - Uses Map-Reduce for execution
  - HDFS for storage – but any system that implements Hadoop FS API

- Key Building Principles:
  - Structured data with rich data types (structs, lists and maps)
  - Directly query data from different formats (text/binary) and file formats (Flat/Sequence)
  - SQL as a familiar programming tool and for standard analytics
  - Allow embedded scripts for extensibility and for non standard applications

Hive Key Principles



Query processing in Hadoop

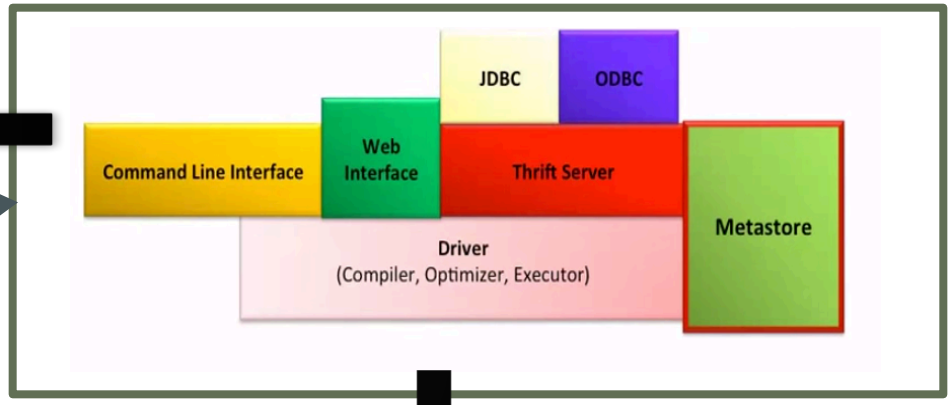


HiveQL to MapReduce

Hive Framework

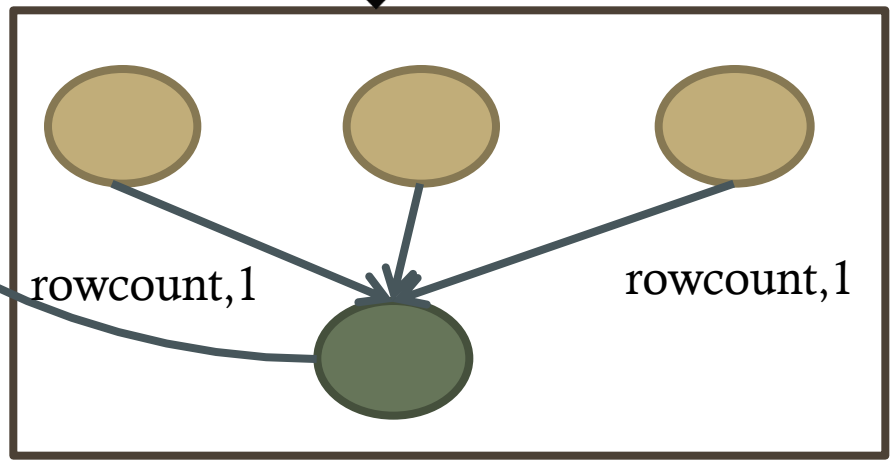
Data Analyst

N



SELECT COUNT(1) FROM Sales;

rowcount, N



Sales: Hive table

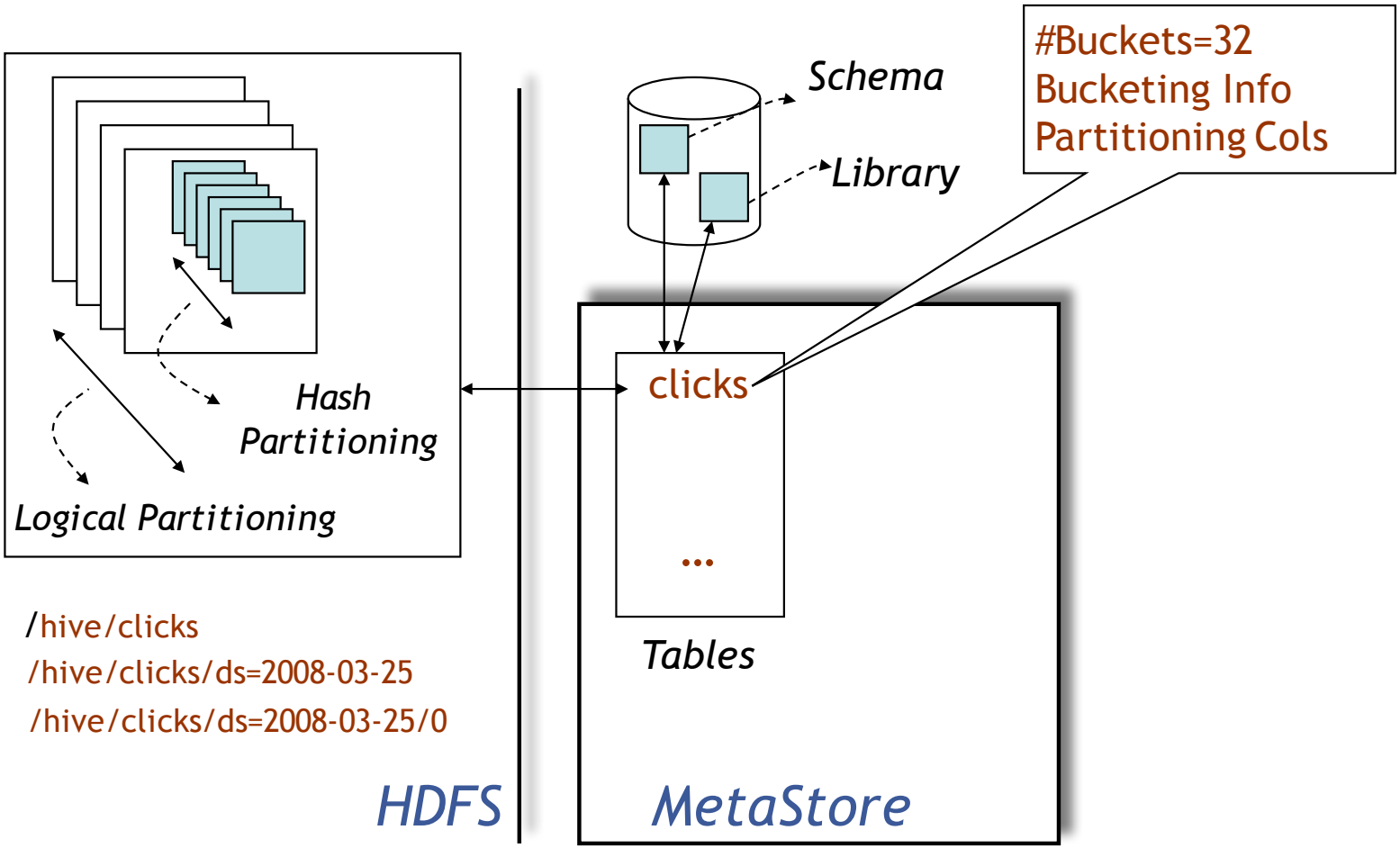
MR JOB Instance

Hive Data Model

Data in Hive organized into :

- Tables
- Partitions
- Buckets

Hive Data Model



Hive Data Model Contd.

- Tables

- Analogous to relational tables

- Each table has a corresponding directory in HDFS

- Data serialized and stored as files within that directory

- Hive has default serialization built in which supports compression and lazy deserialization

- Users can specify custom serialization –deserialization schemes (**SerDe's**)

Hive Data Model Contd.

- Partitions

- Each table can be broken into partitions
- Partitions determine distribution of data within subdirectories

Example -

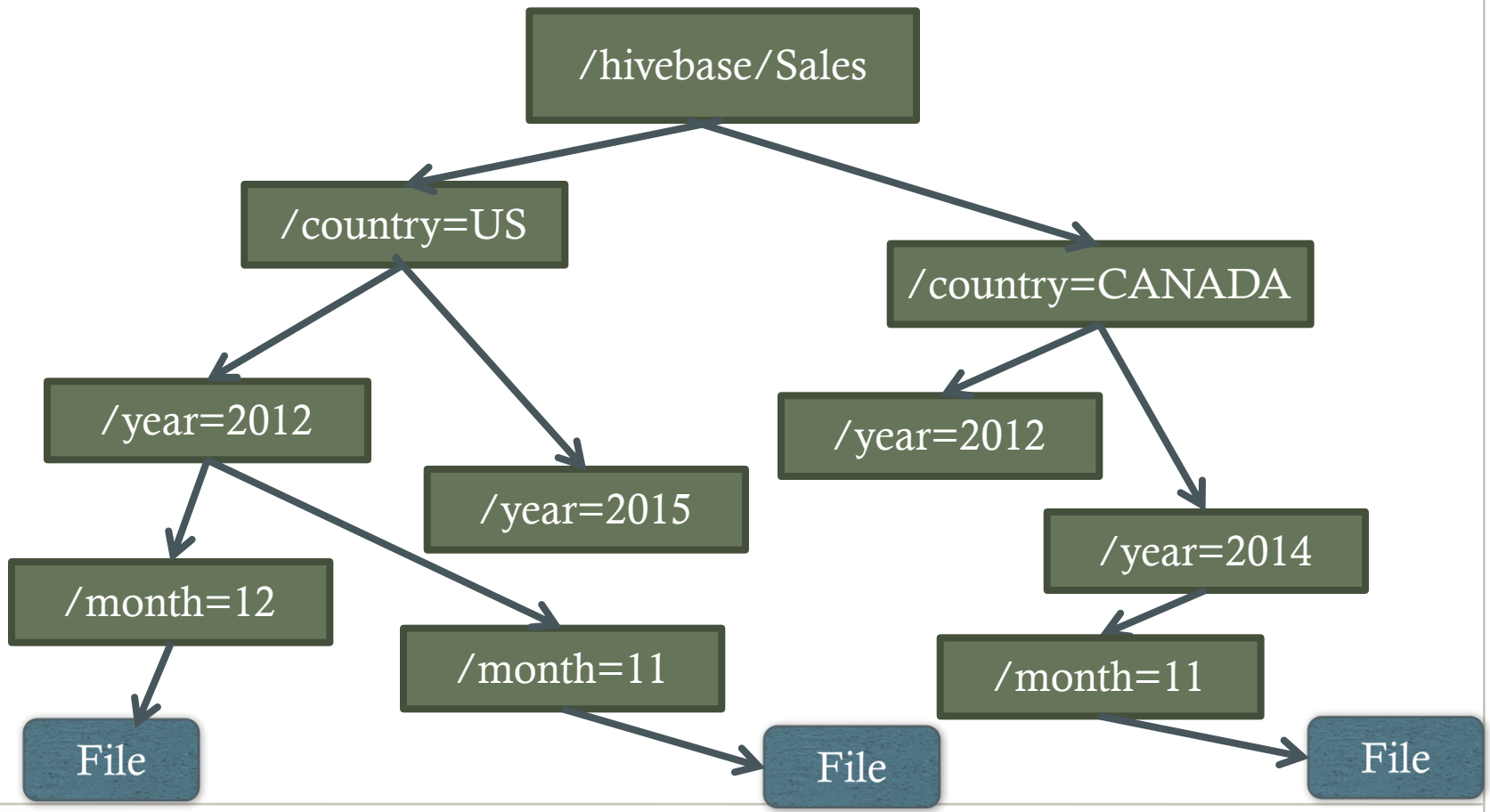
CREATE_TABLE Sales (sale_id INT, amount FLOAT)

PARTITIONED BY (country STRING, year INT, month INT)

So each partition will be split out into different folders like

Sales/country=US/year=2012/month=12

Hierarchy of Hive Partitions



Hive Data Model Contd.

- Buckets

- Data in each partition divided into buckets
- Based on a hash function of the column
- **H(column) mod NumBuckets = bucket number**
- Each bucket is stored as a file in partition directory

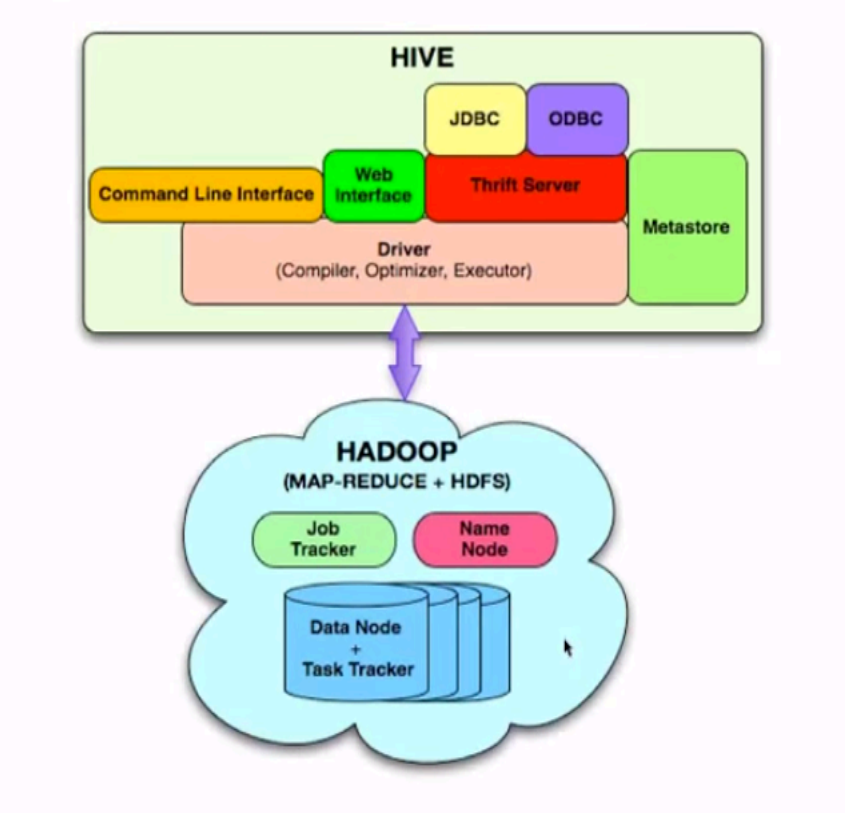
Architecture

Externel Interfaces- CLI, WebUI, JDBC, ODBC programming interfaces

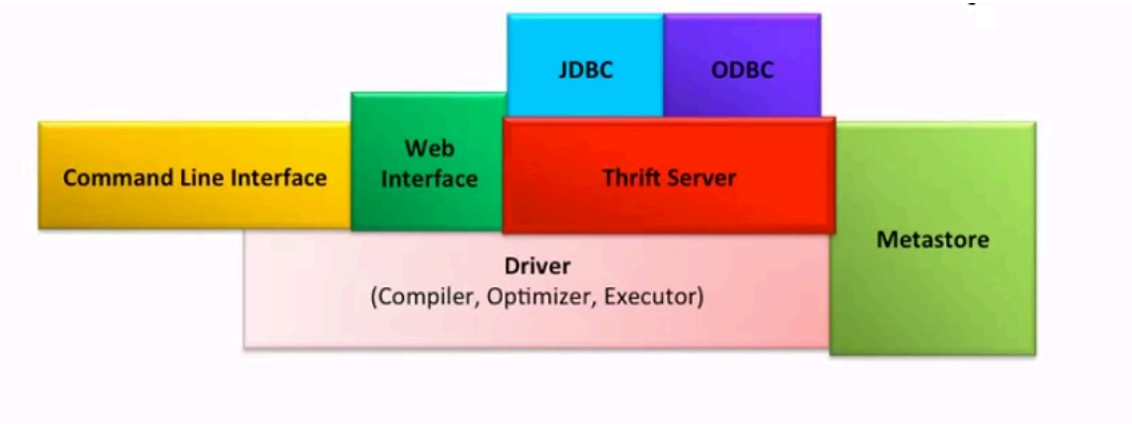
Thrift Server – Cross Language service framework .

Metastore - Meta data about the Hive tables, partitions

Driver - Brain of Hive! Compiler, Optimizer and Execution engine

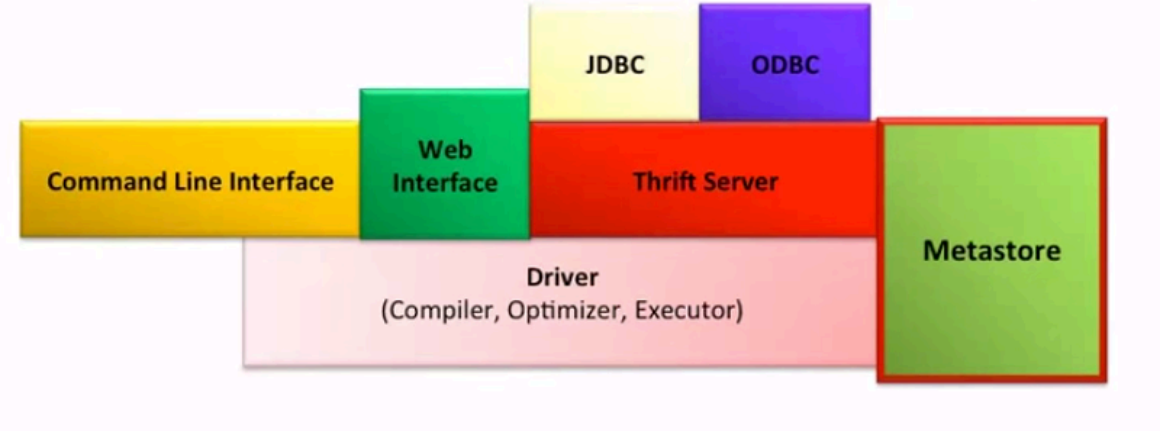


Hive Thrift Server



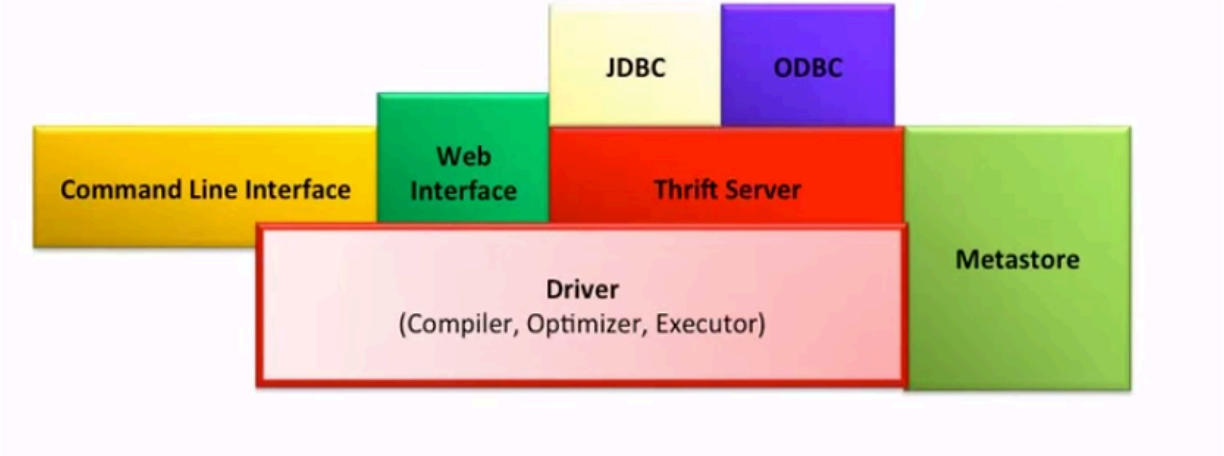
- Framework for cross language services
- Server written in Java
- Support for clients written in different languages
  - JDBC(java), ODBC(c++), php, perl, python scripts

Metastore



- System catalog which contains metadata about the Hive tables
- Stored in RDBMS/local fs. HDFS too slow(not optimized for random access)
- Objects of Metastore
  - Database - Namespace of tables
  - Table - list of columns, types, owner, storage, SerDes
  - Partition – Partition specific column, Serdes and storage

Hive Driver



- **Driver** - Maintains the lifecycle of HiveQL statement
- **Query Compiler** – Compiles HiveQL in a DAG of map reduce tasks
- **Executor** - Executes the tasks plan generated by the compiler in proper dependency order. Interacts with the underlying Hadoop instance

Compiler

- Converts the HiveQL into a plan for execution
- Plans can

    - Metadata operations for DDL statements e.g. CREATE

    - HDFS operations e.g. LOAD

- Semantic Analyzer – checks schema information, type checking, implicit type conversion, column verification
- Optimizer – Finding the best logical plan e.g. Combines multiple joins in a way to reduce the number of map reduce jobs, Prune columns early to minimize data transfer
- Physical plan generator – creates the DAG of map-reduce jobs

Hive Query Language

- Basic SQL
  - From clause subquery
  - ANSI JOIN (equi-join only)
  - Multi-table Insert
  - Multi group-by
  - Sampling
  - Objects traversal
- Extensibility
  - Pluggable Map-reduce scripts using TRANSFORM

HiveQL

DDL :

- CREATE DATABASE
- CREATE TABLE
- ALTER TABLE
- SHOW TABLE
- DESCRIBE

DML:

- LOAD TABLE
- INSERT

QUERY:

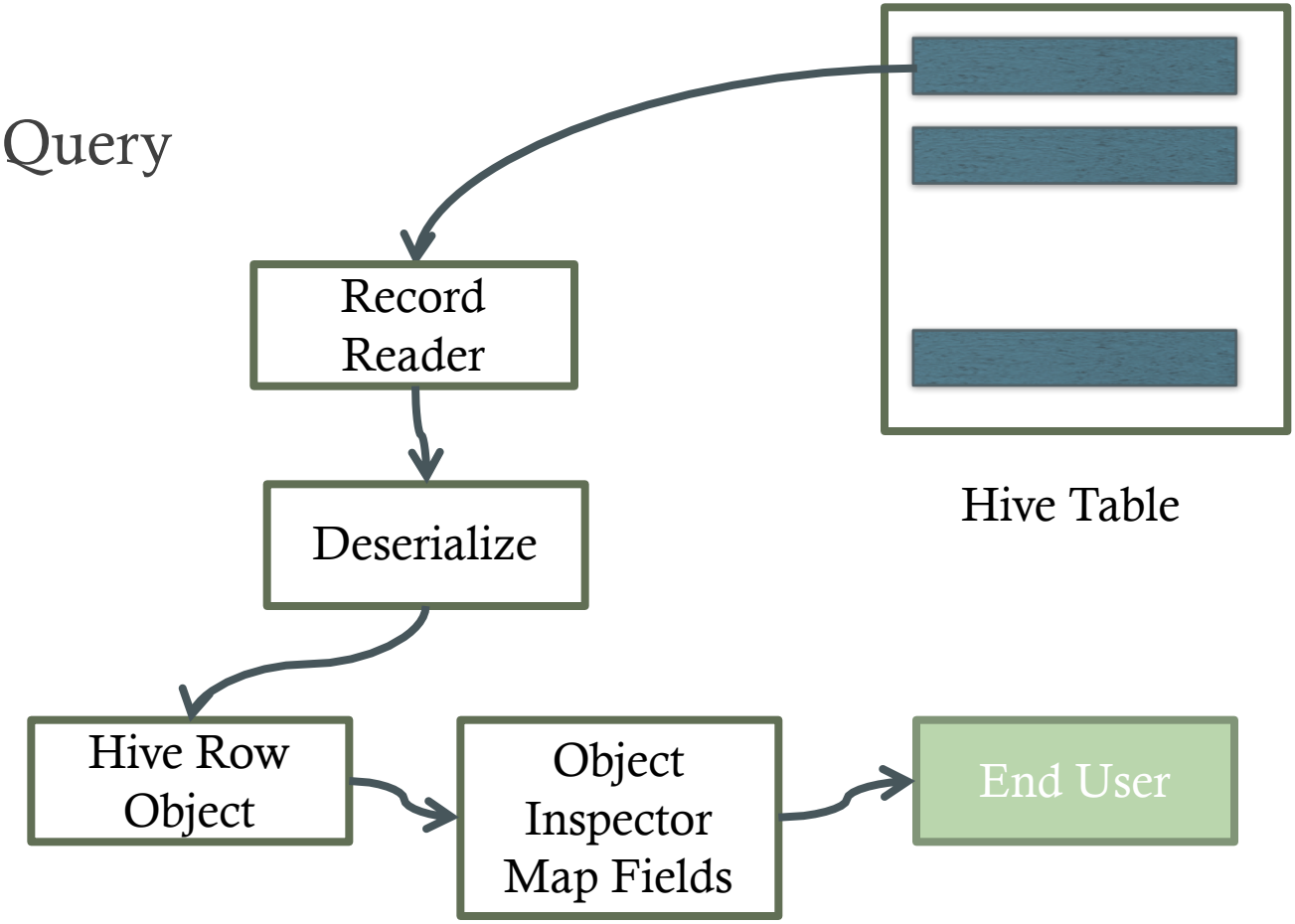
- SELECT
- GROUP BY
- JOIN
- MULTI TABLE INSERT

Hive SerDe

- SELECT Query

- Hive built in Serde: Avro, ORC, Regex etc

- Can use Custom SerDe's (e.g. for unstructured data like audio/video data, semistructured XML data)



Good Things

- Suitable for Data Analysts
- Easy Learning curve
- Completely transparent to underlying Map-Reduce
- Partitions(speed!)
- Flexibility to load data from localFS/HDFS into Hive Tables

Cons and Possible Improvements

- Extending the SQL queries support(Updates, Deletes)
- Parallelize firing independent jobs from the work DAG
- Table Statistics in Metastore
- Explore methods for multi query optimization
- Perform N- way generic joins in a single map reduce job
- Better debug support in shell

Hive v/s Pig

Similarities:

- Both High level Languages which work on top of map reduce framework
- Can coexist since both use the under lying HDFS and map reduce

Differences:

- **Language**
  - Pig is a procedural ; (A = load ‘mydata’; dump A)
  - Hive is Declarative (select * from A)

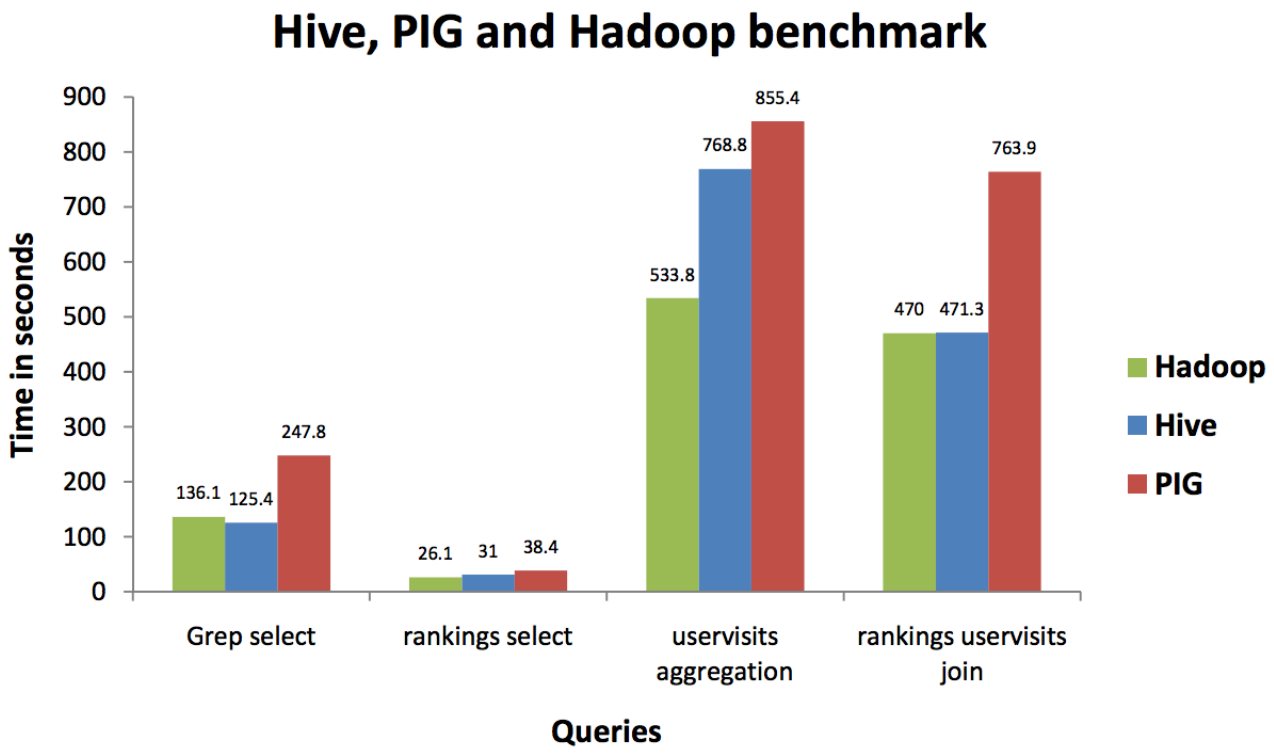
- **Work Type**
  - Pig more suited for adhoc analysis (on demand analysis of click stream search logs)
  - Hive a reporting tool (e.g. weekly BI reporting)

Hive v/s Pig

Differences:

- **Users**
  - Pig – Researchers, Programmers (build complex data pipelines, machine learning)
  - Hive – Business Analysts
- **Integration**
  - Pig - Doesn't have a thrift server(i.e no/limited cross language support)
  - Hive - Thrift server
- **User's need**
  - Pig – Better dev environments, debuggers expected
  - Hive - Better integration with technologies expected(e.g JDBC, ODBC)

Head-to-Head
(the bee, the pig, the elephant)



Version: Hadoop – 0.18x, Pig:786346, Hive:786346

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