Apache Kylin

OLAP on Hadoop

DTCC

2015中国数据库技术大会

DATABASE TECHNOLOGY CONFERENCE CHINA 2015

大数据技术探索和价值发现

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Agenda

- What's Apache Kylin?
- Tech Highlights
- Performance
- Roadmap
- Q & A

What's Kylin

kylin / ˈkiːˈlɪn / 麒麟

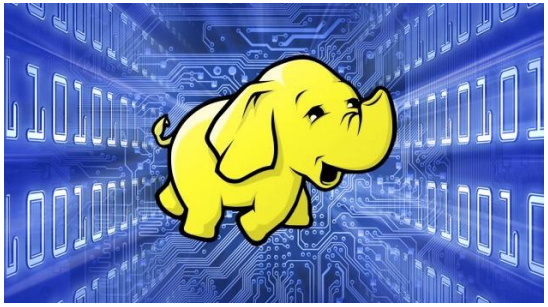
--n. (in Chinese art) a mythical animal of composite form

Extreme OLAP Engine for Big Data

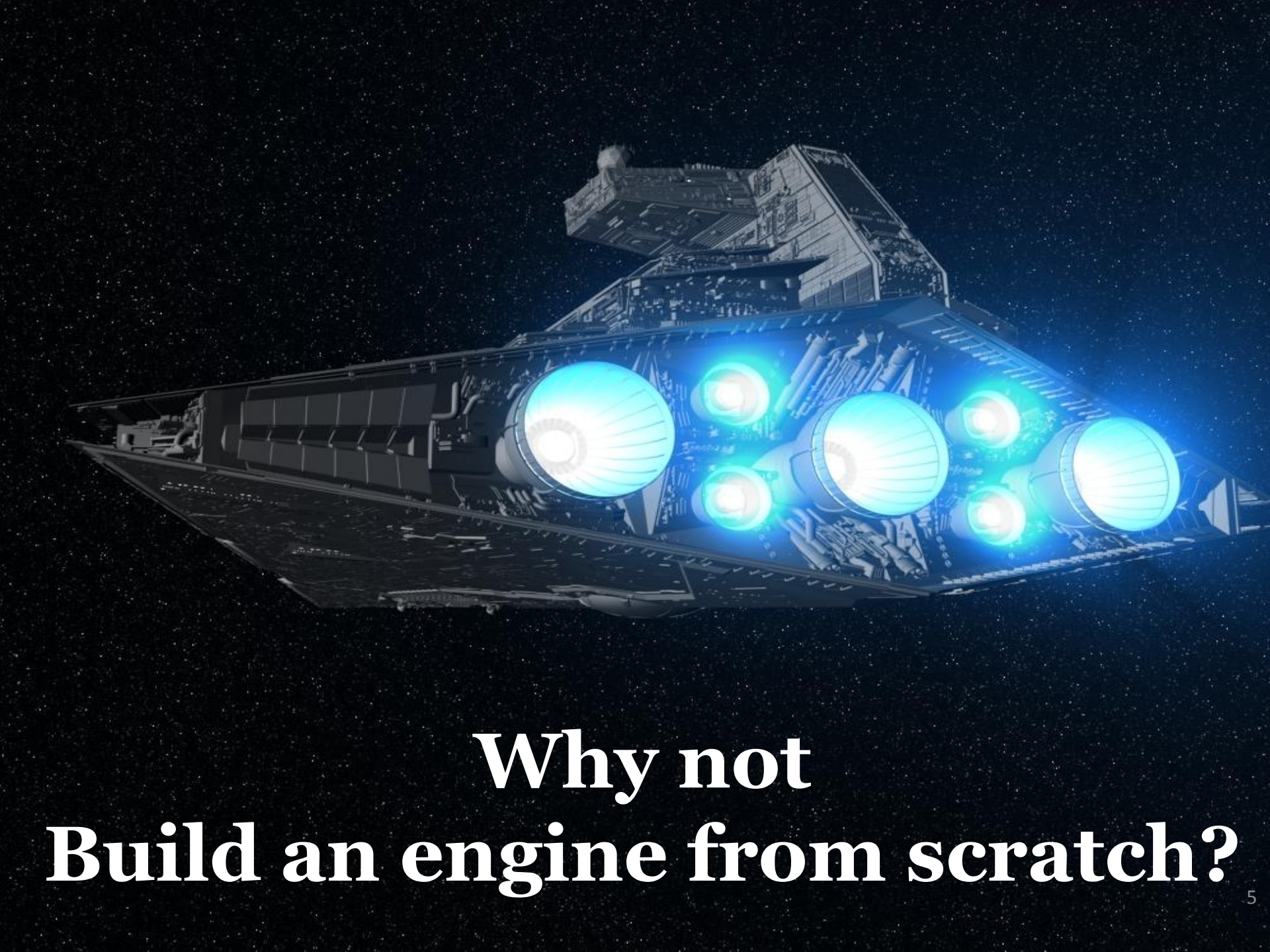
Kylin is an open source Distributed Analytics Engine from eBay that provides SQL interface and multi-dimensional analysis (OLAP) on Hadoop supporting extremely large datasets

- Open Sourced on Oct 1st, 2014
- Be accepted as Apache Incubator Project on Nov 25th, 2014

Big Data Era



- More and more data becoming available on Hadoop
- Limitations in existing Business Intelligence (BI) Tools
  - Limited support for Hadoop
  - Data size growing exponentially
  - High latency of interactive queries
  - Scale-Up architecture
- Challenges to adopt Hadoop as interactive analysis system
  - Majority of analyst groups are SQL savvy
  - No mature SQL interface on Hadoop
  - OLAP capability on Hadoop ecosystem not ready yet



Why not
Build an engine from scratch?

Features Highlights

- **Extreme Scale OLAP Engine**

Kylin is designed to query 10+ billions of rows on Hadoop

- **ANSI SQL Interface on Hadoop**

Kylin offers ANSI SQL on Hadoop and supports most ANSI SQL query functions

- **Seamless Integration with BI Tools**

Kylin currently offers integration capability with BI Tools like Tableau.

- **Interactive Query Capability**

Users can interact with Hive tables at sub-second latency

- **MOLAP Cube**

Define a data model from Hive tables and pre-build in Kylin

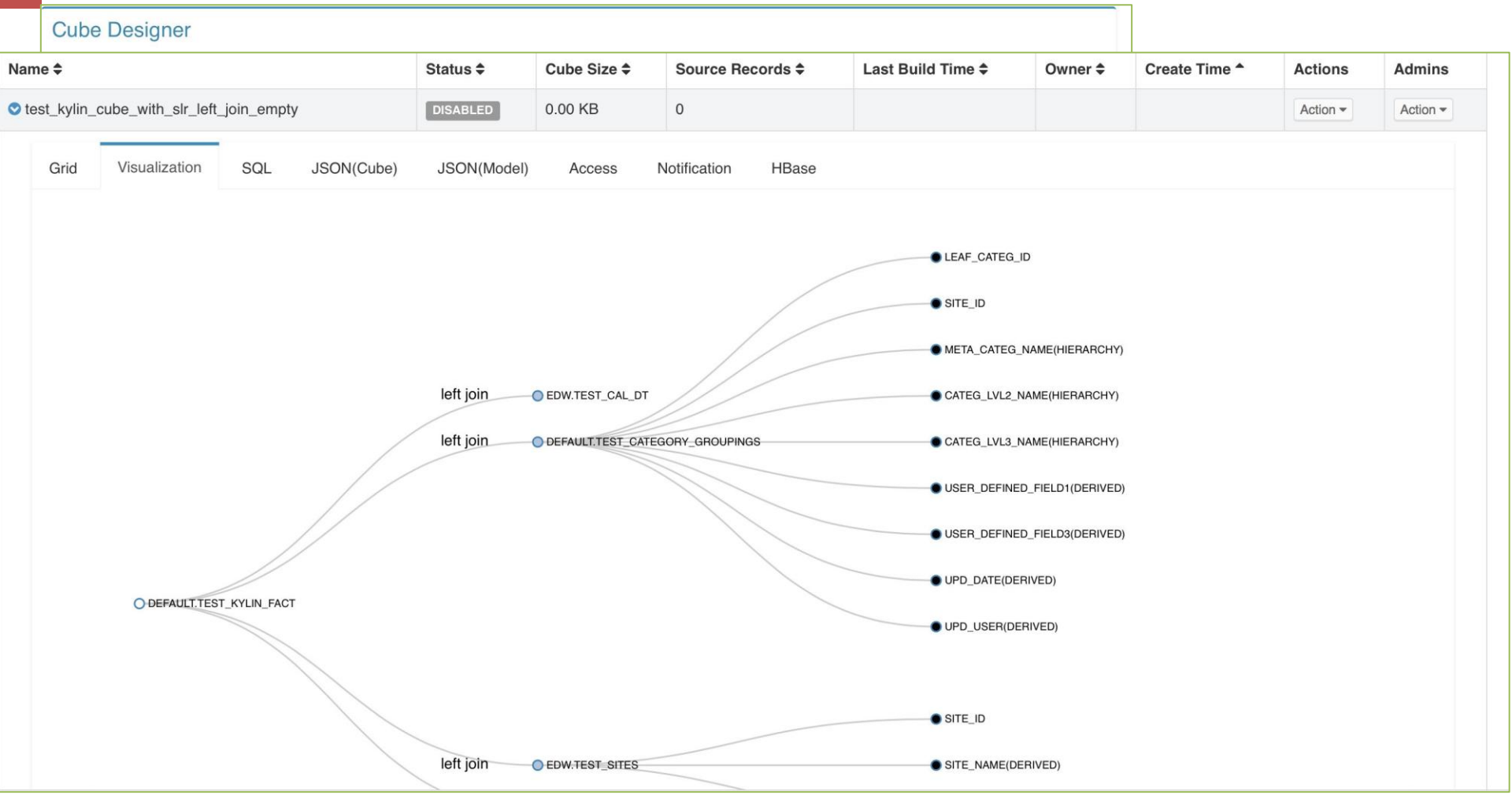
- **Scale Out Architecture**

Query server cluster supports thousands concurrent users and provide high availability

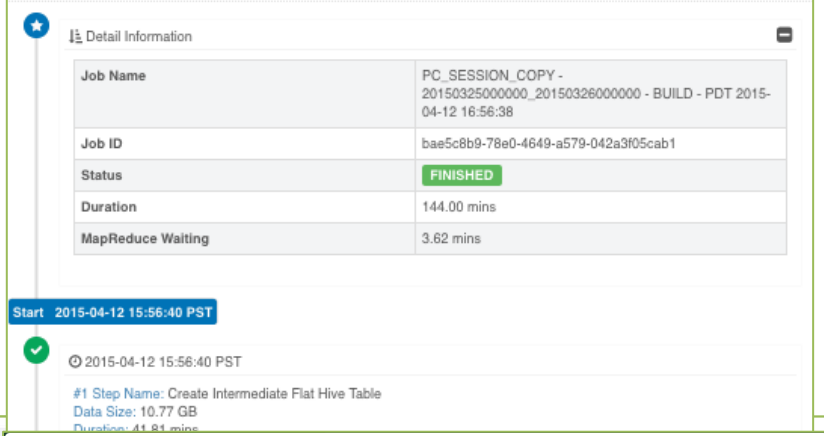
Features Highlights…

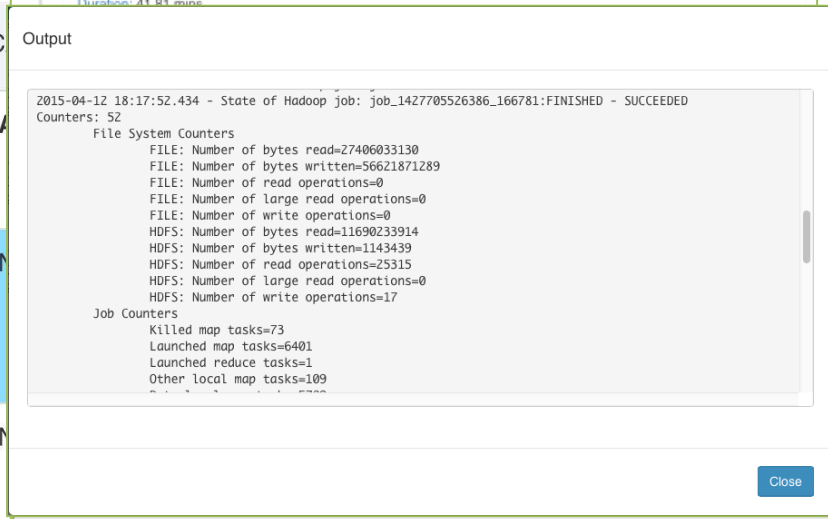
- Compression and Encoding Support
- Incremental Refresh of Cubes
- Approximate Query Capability for distinct count (HyperLogLog)
- Leverage HBase Coprocessor for query latency
- Job Management and Monitoring
- Easy Web interface to manage, build, monitor and query cubes
- Security capability to set ACL at Cube/Project Level
- Support LDAP Integration

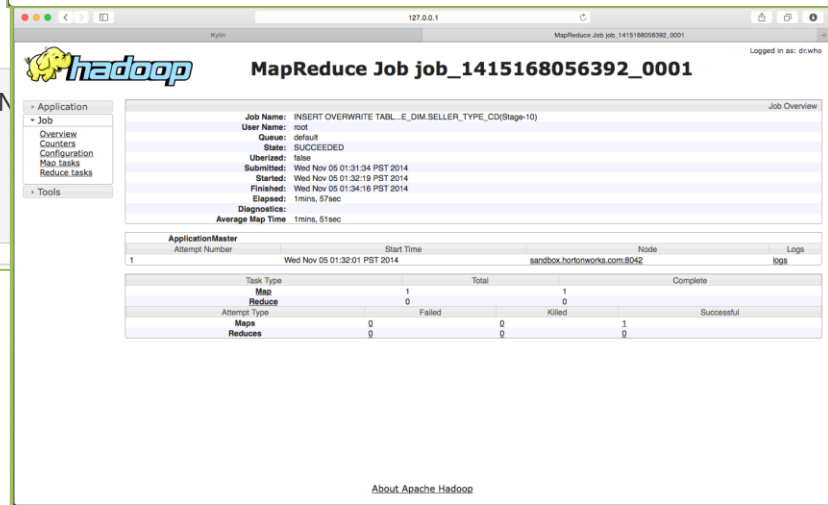
Cube Designer



Job Management







Jobs NEW PENDING RUNNING FINISHED ERROR DISC

Job Name	Cube	Progress	Last Modified Time	Duration	A
PC_SESSION_COPY - 20150325000000_20150326000000 - BUILD - PDT 2015-04-12 16:56:38	PC_SESSION_COPY	100%	2015-04-12 18:20:41 PST	144.00 mins	N
PC_SESSION_COPY - 20150324000000_20150325000000 - BUILD - PDT 2015-04-12 06:49:57	PC_SESSION_COPY	100%	2015-04-12 09:07:41 PST	197.00 mins	N
PC_SESSION_COPY - 20150323000000_20150324000000 - BUILD - PDT 2015-04-09 22:34:08	PC_SESSION_COPY	100%	2015-04-09 23:57:09 PST	143.00 mins	N

Query and Visualization

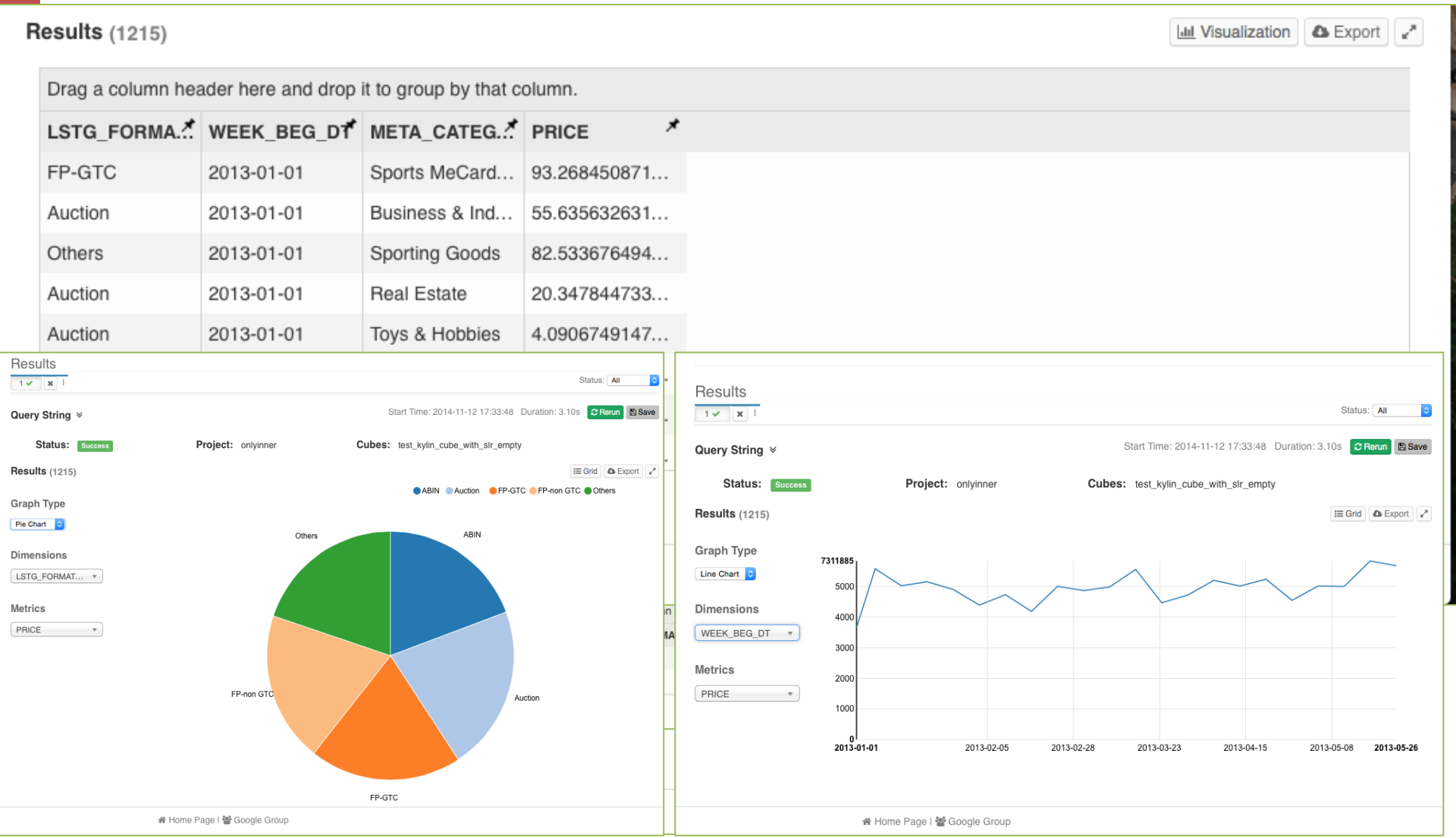
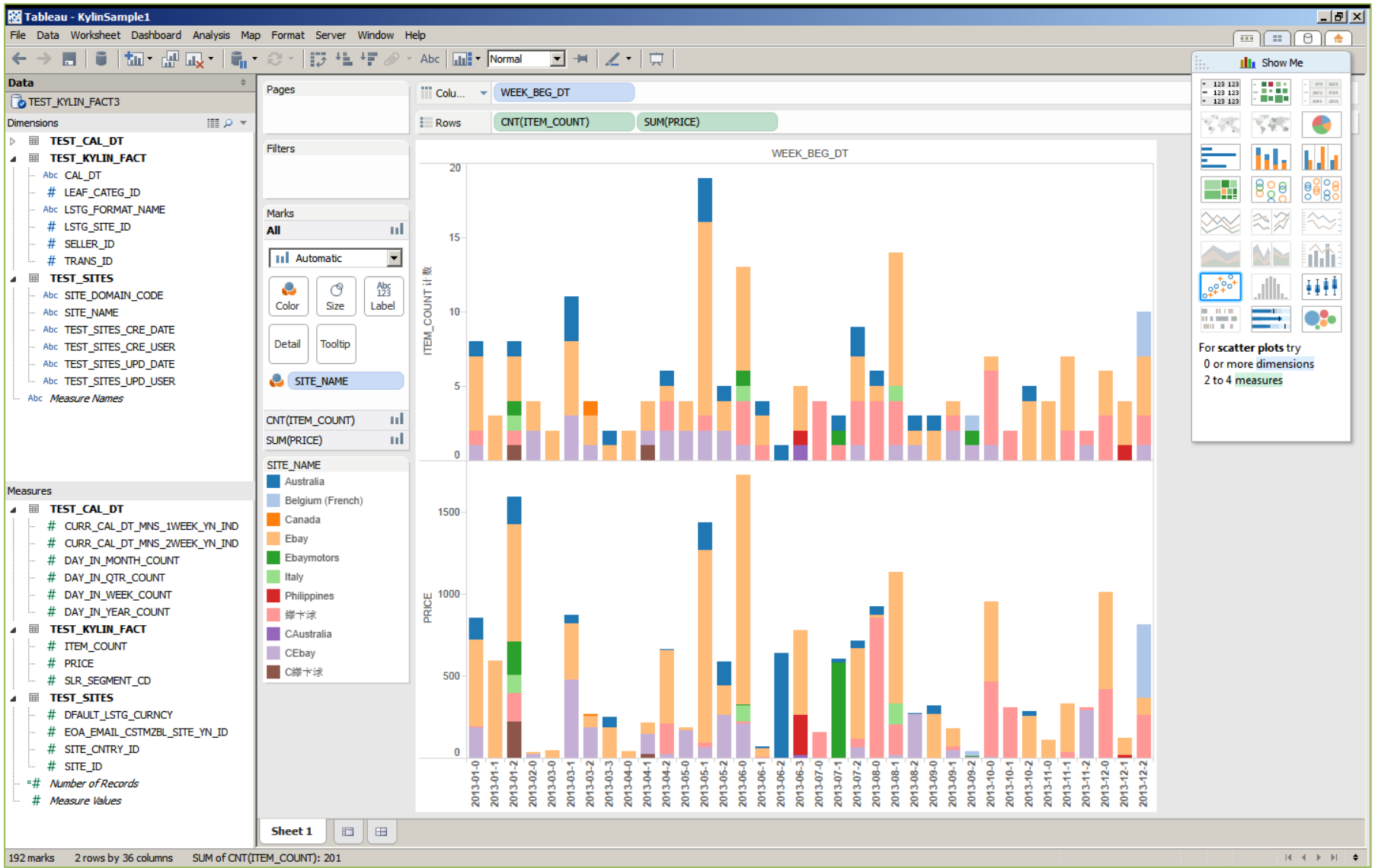


Tableau Integration



Who are using Kylin

- eBay
  - 90% query < 5 seconds

Case	Cube Size	Raw Records
User Session Analysis	26 TB	28+ billion rows
Classified Traffic Analysis	21 TB	20+ billion rows
GeoX Behavior Analysis	560 GB	1.2+ billion rows

- Baidu
  - Baidu Map internal analysis
- Many other Proof of Concepts
  - Bloomberg Law, British GAS, JD, Microsoft, StubHub, Tableau …

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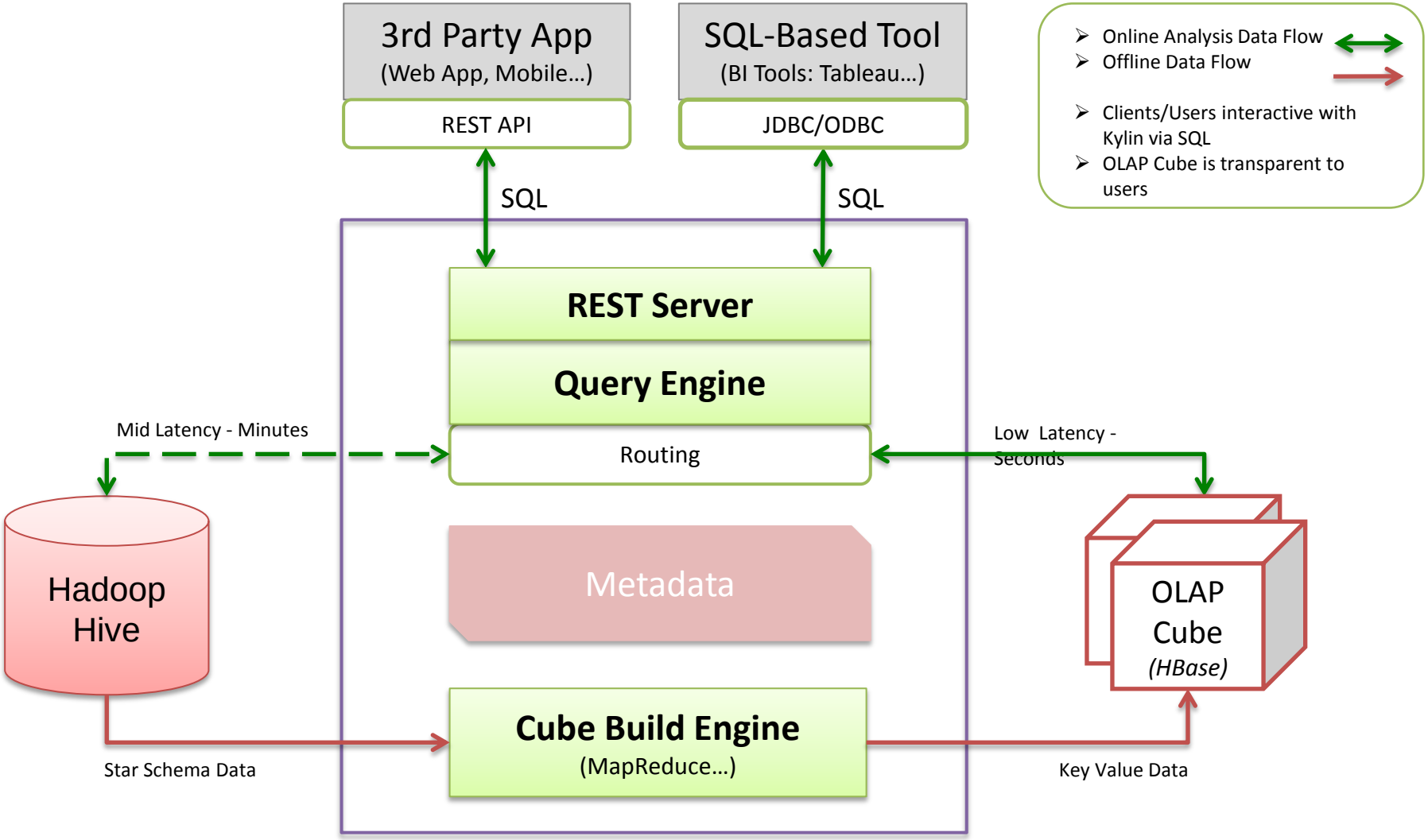
Kylin Architecture Overview

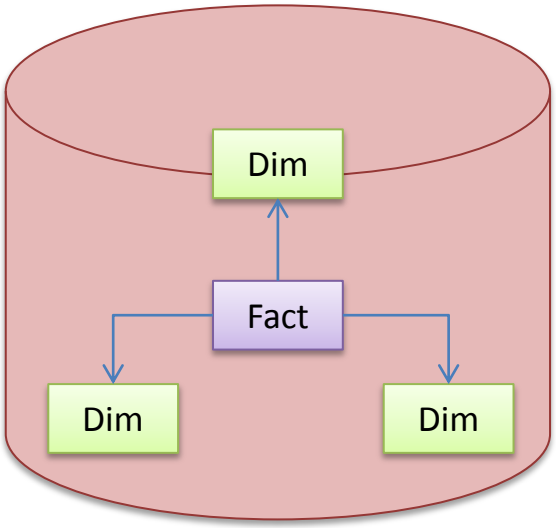


Data Modeling

End User

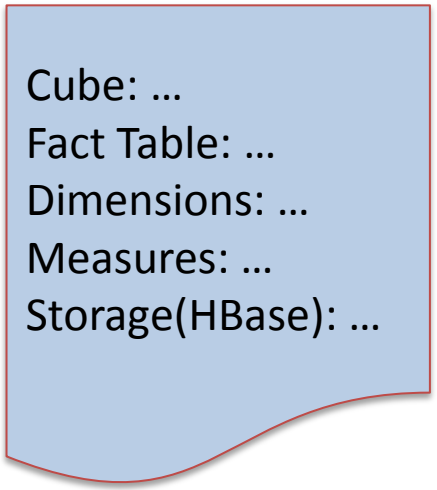
Cube Modeler

Admin



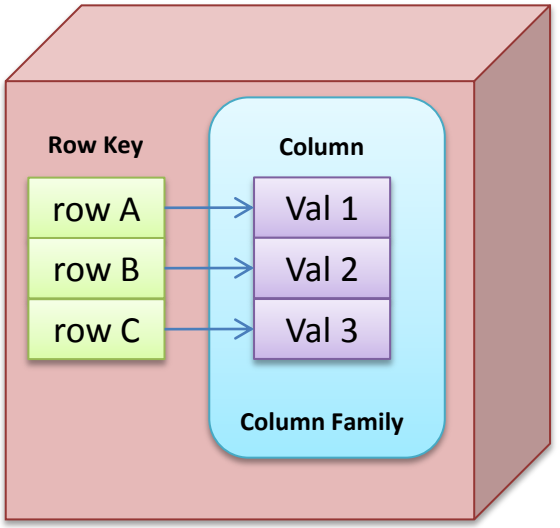
Source

Star Schema



Mapping

Cube Metadata

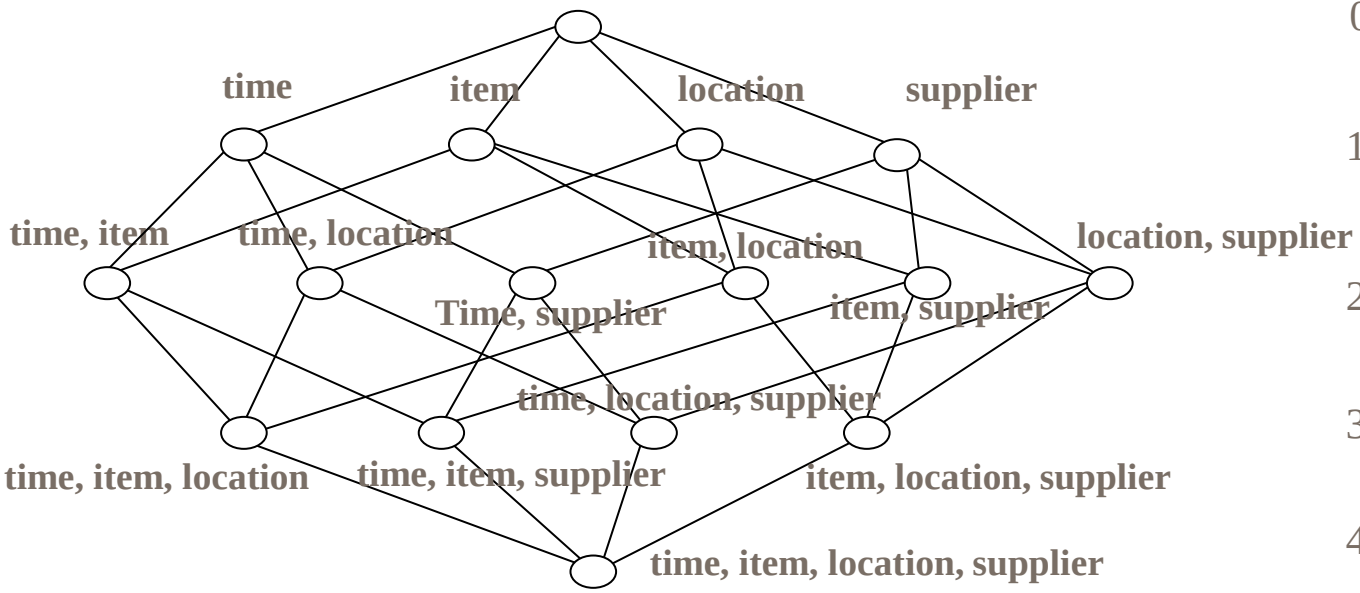


Target

HBase Storage

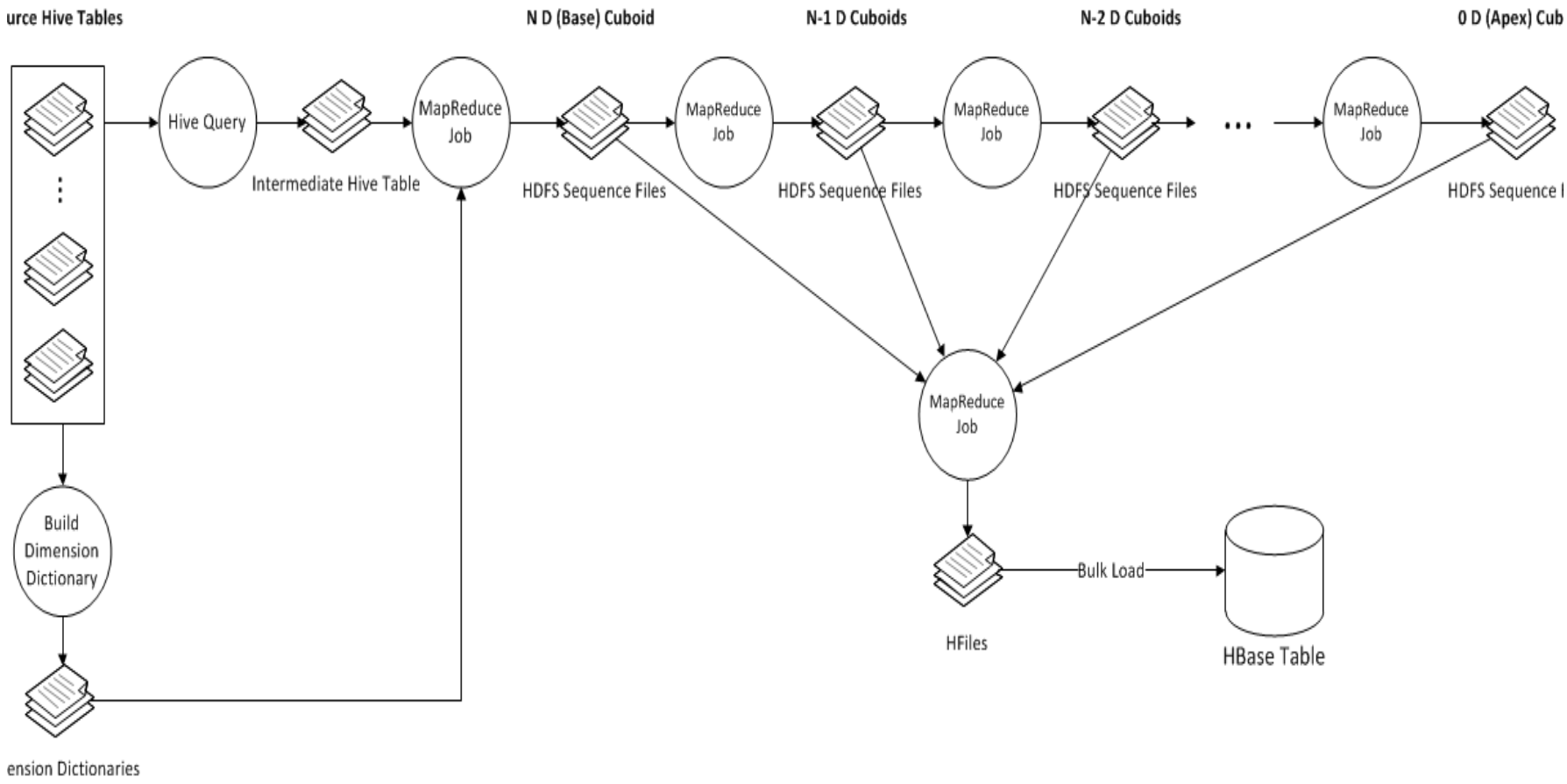
OLAP Cube – Balance between Space and Time

- Cuboid = one combination of dimensions
- Cube = all combination of dimensions (all cuboids)

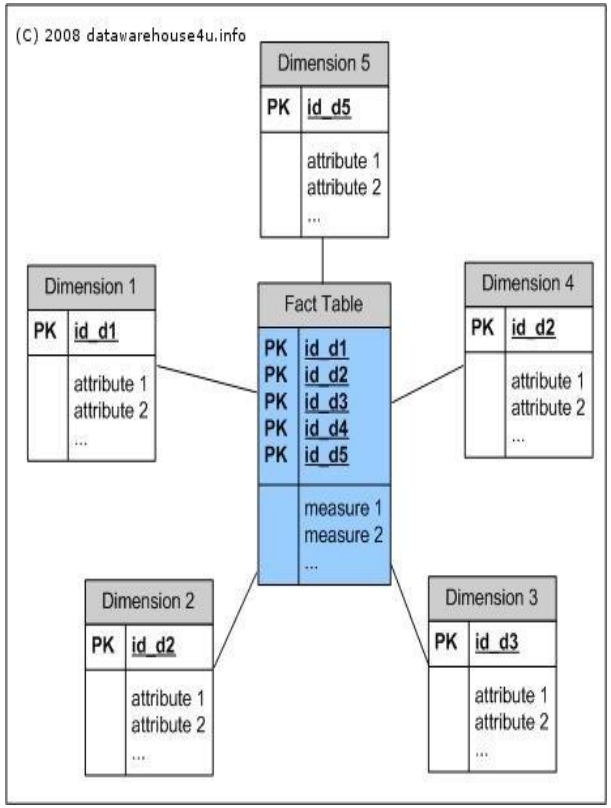


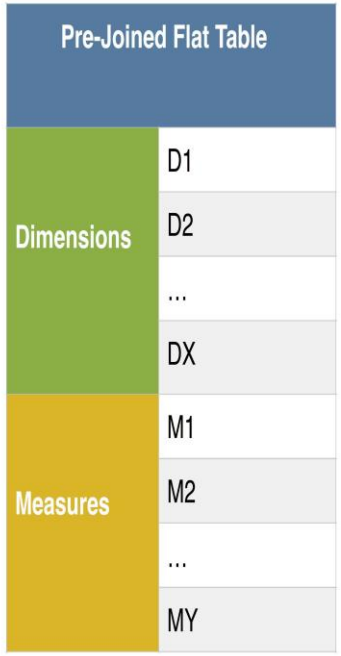
- Base vs. aggregate cells; ancestor vs. descendant cells; parent vs. child cells
  1. (9/15, milk, Urbana, Dairy_land) - **<time, item, location, supplier>**
  2. (9/15, milk, Urbana, *) - **<time, item, location>**
  3. (*, milk, Urbana, *) - **<item, location>**
  4. (*, milk, Chicago, *) - **<item, location>**
  5. (*, milk, *, *) - **<item>**

Cube Build Job Flow



How To Store Cube? – HBase Schema



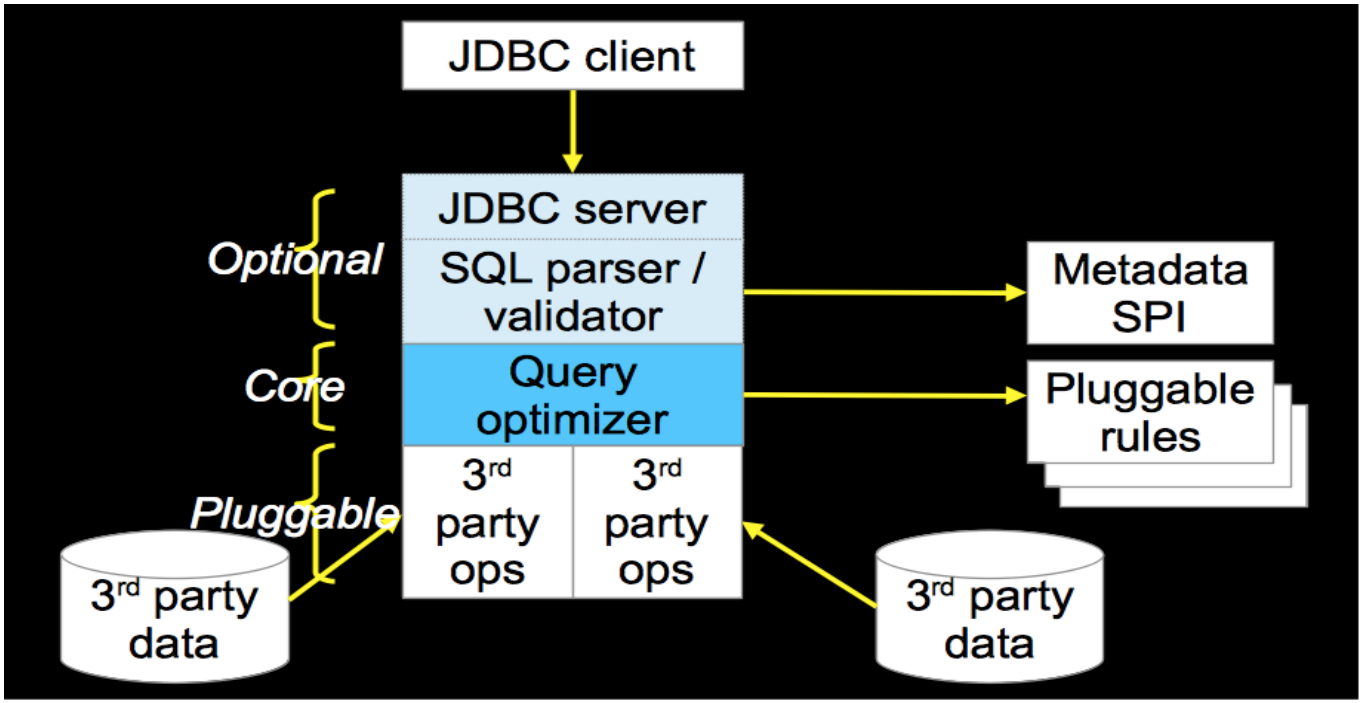


Row Key = Cuboid ID+Dimensions

Row Value = Measures

Query Engine – Calcite

- Dynamic data management framework.
- Formerly known as Optiq, Calcite is an Apache incubator project, used by Apache Drill and Apache Hive, among others.
- http://optiq.incubator.apache.org



Kylin Extensions on Calcite

- **Metadata SPI**
  - Provide table schema from Kylin metadata
- **Optimize Rule**
  - Translate the logic operator into Kylin operator
- **Relational Operator**
  - Find right cube
  - Translate SQL into storage engine API call
  - Generate physical execute plan by linq4j java implementation
- **Result Enumerator**
  - Translate storage engine result into java implementation result.
- **SQL Function**
  - Add HyperLogLog for distinct count
  - Implement date time related functions (i.e. Quarter)

Query Engine – Kylin Explain Plan

```
SELECT test_cal_dt.week_beg_dt, test_category.category_name, test_category.lvl2_name, test_category.lvl3_name,
test_kylin_fact.lstg_format_name,  test_sites.site_name, SUM(test_kylin_fact.price) AS GMV, COUNT(*) AS TRANS_CNT
FROM  test_kylin_fact
 LEFT JOIN test_cal_dt ON test_kylin_fact.cal_dt = test_cal_dt.cal_dt
 LEFT JOIN test_category ON test_kylin_fact.leaf_categ_id = test_category.leaf_categ_id  AND test_kylin_fact.lstg_site_id =
test_category.site_id
 LEFT JOIN test_sites ON test_kylin_fact.lstg_site_id = test_sites.site_id
WHERE test_kylin_fact.seller_id = 123456OR test_kylin_fact.lstg_format_name = 'New'
GROUP BY test_cal_dt.week_beg_dt, test_category.category_name, test_category.lvl2_name, test_category.lvl3_name,
test_kylin_fact.lstg_format_name,test_sites.site_name
```

```
OLAPToEnumerableConverter
  OLAPProjectRel(WEEK_BEG_DT=[$0], category_name=[$1], CATEG_LVL2_NAME=[$2], CATEG_LVL3_NAME=[$3],
LSTG_FORMAT_NAME=[$4], SITE_NAME=[$5], GMV=[CASE(=($7, 0), null, $6)], TRANS_CNT=[$8])
    OLAPAggregateRel(group=[{0, 1, 2, 3, 4, 5}], agg#0=[$SUM0($6)], agg#1=[COUNT($6)], TRANS_CNT=[COUNT()])
      OLAPProjectRel(WEEK_BEG_DT=[$13], category_name=[$21], CATEG_LVL2_NAME=[$15], CATEG_LVL3_NAME=[$14],
LSTG_FORMAT_NAME=[$5], SITE_NAME=[$23], PRICE=[$0])
        OLAPFilterRel(condition=[OR(=($3, 123456), =($5, 'New'))])
          OLAPJoinRel(condition=[=($2, $25)], joinType=[left])
            OLAPJoinRel(condition=[AND(=($6, $22), =($2, $17))], joinType=[left])
              OLAPJoinRel(condition=[=($4, $12)], joinType=[left])
                OLAPTableScan(table=[[DEFAULT, TEST_KYLIN_FACT]], fields=[[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]])
                OLAPTableScan(table=[[DEFAULT, TEST_CAL_DT]], fields=[[0, 1]])
              OLAPTableScan(table=[[DEFAULT, test_category]], fields=[[0, 1, 2, 3, 4, 5, 6, 7, 8]])
            OLAPTableScan(table=[[DEFAULT, TEST_SITES]], fields=[[0, 1, 2]])
```

Storage Engine

- **Plugin-able storage engine**
  - Common iterator interface for storage engine
  - Isolate query engine from underline storage
- **Translate cube query into HBase table scan**
  - Columns, Groups → Cuboid ID
  - Filters -> Scan Range (Row Key)
  - Aggregations -> Measure Columns (Row Values)
- **Scan HBase table and translate HBase result into cube result**
  - HBase Result (key + value) -> Cube Result (dimensions + measures)

Cube Optimization

- Curse of dimensionality: N dimension cube has 2^N cuboid
  - Full Cube vs. Partial Cube
- Hugh data volume
  - Dictionary Encoding
  - Incremental Building

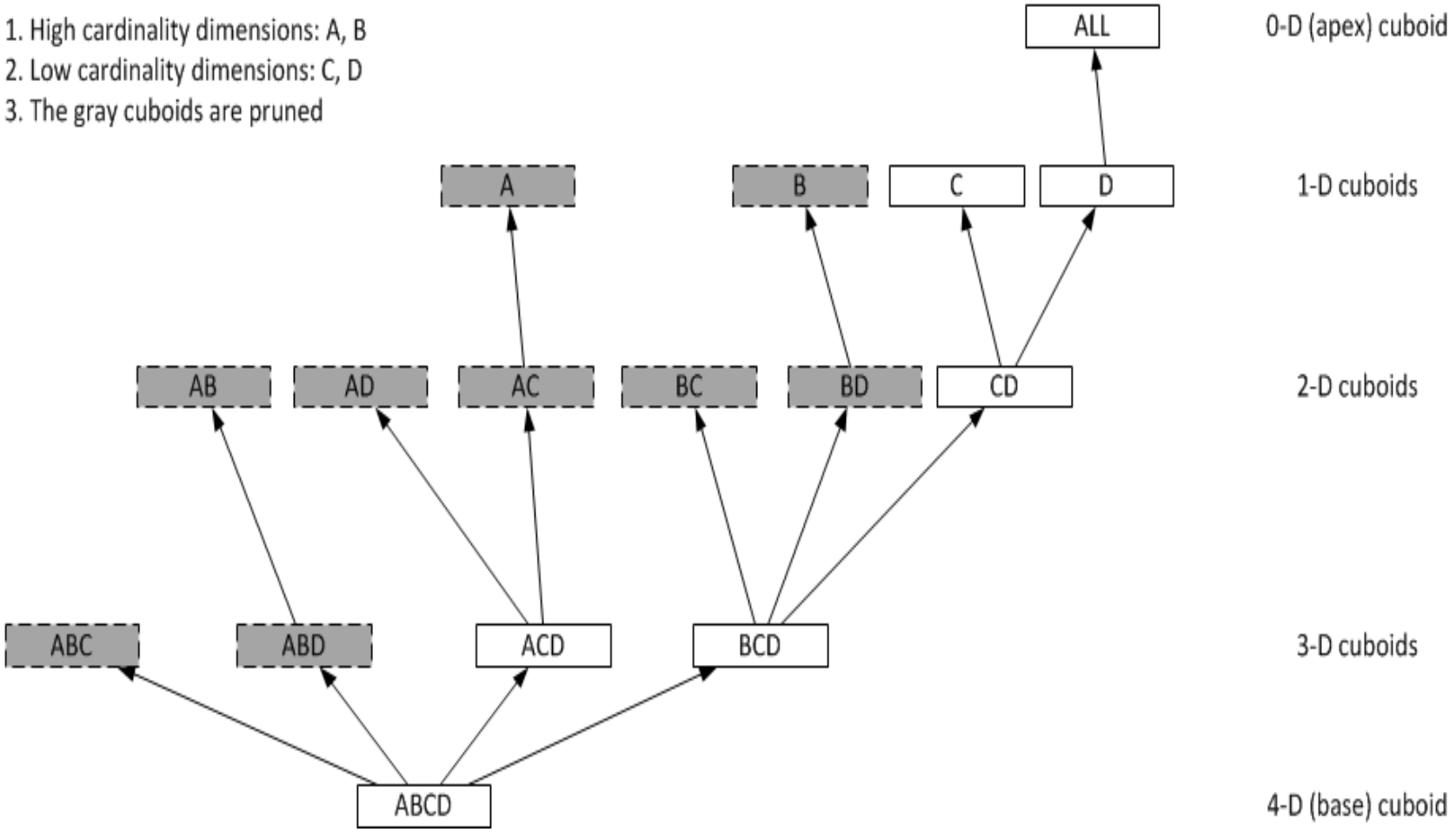
Full Cube vs. Partial Cube

- **Full Cube**
  - Pre-aggregate all dimension combinations
  - "Curse of dimensionality": N dimension cube has 2^N cuboid.

- **Partial Cube**
  - To avoid dimension explosion, we divide the dimensions into different aggregation groups
    - $2^{N+M+L} \rightarrow 2^N + 2^M + 2^L$
  - For cube with 30 dimensions, if we divide these dimensions into 3 group, the cuboid number will reduce from 1 Billion to 3 Thousands
    - $2^{30} \rightarrow 2^{10} + 2^{10} + 2^{10}$
  - Tradeoff between online aggregation and offline pre-aggregation

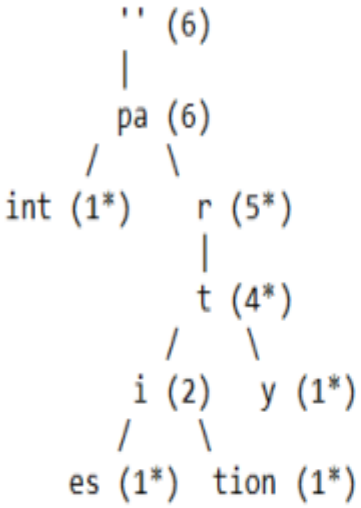
Partial Cube

1. High cardinality dimensions: A, B
2. Low cardinality dimensions: C, D
3. The gray cuboids are pruned



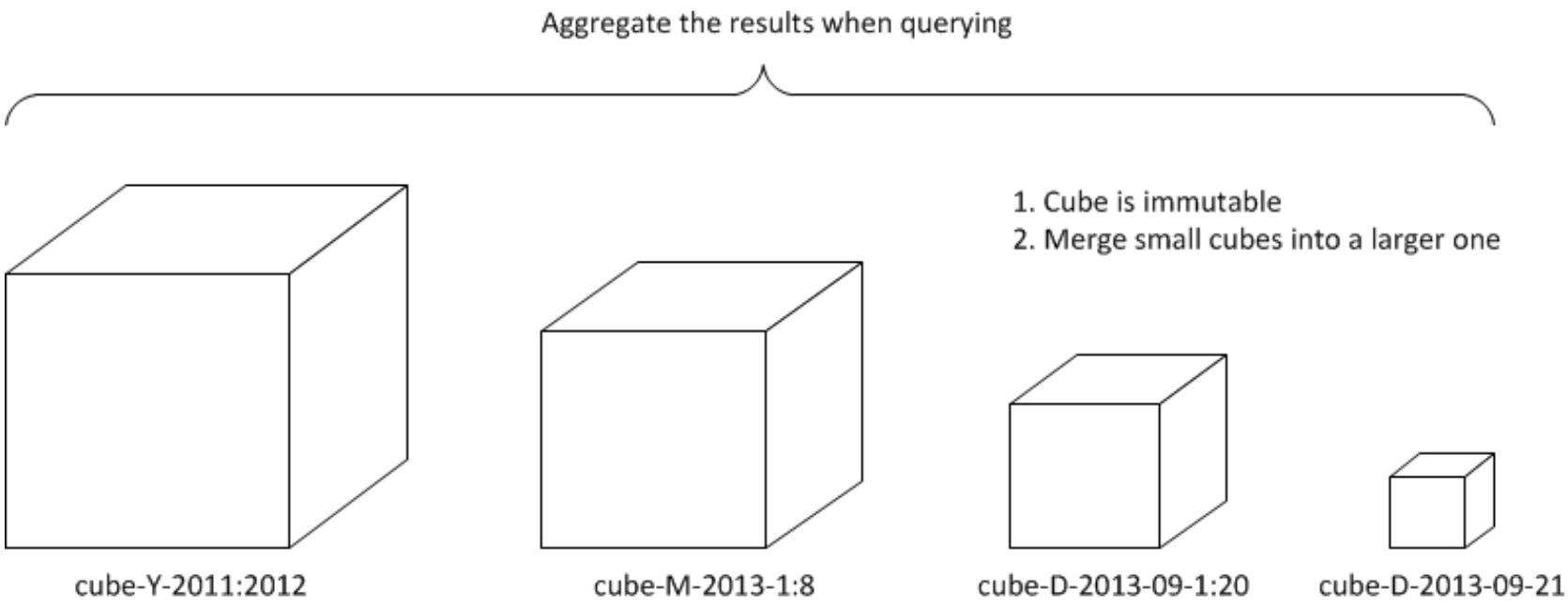
Dictionary Encoding

- Data cube has lost of duplicated dimension values
- Dictionary maps dimension values into IDs that will reduce the memory and storage footprint.
- Dictionary is based on Trie



[value]		[seq no]
par	->	1
part	->	2
party	->	5
parties	->	3
partition	->	4
paint	->	0

Incremental Build



Streaming, ongoing effort

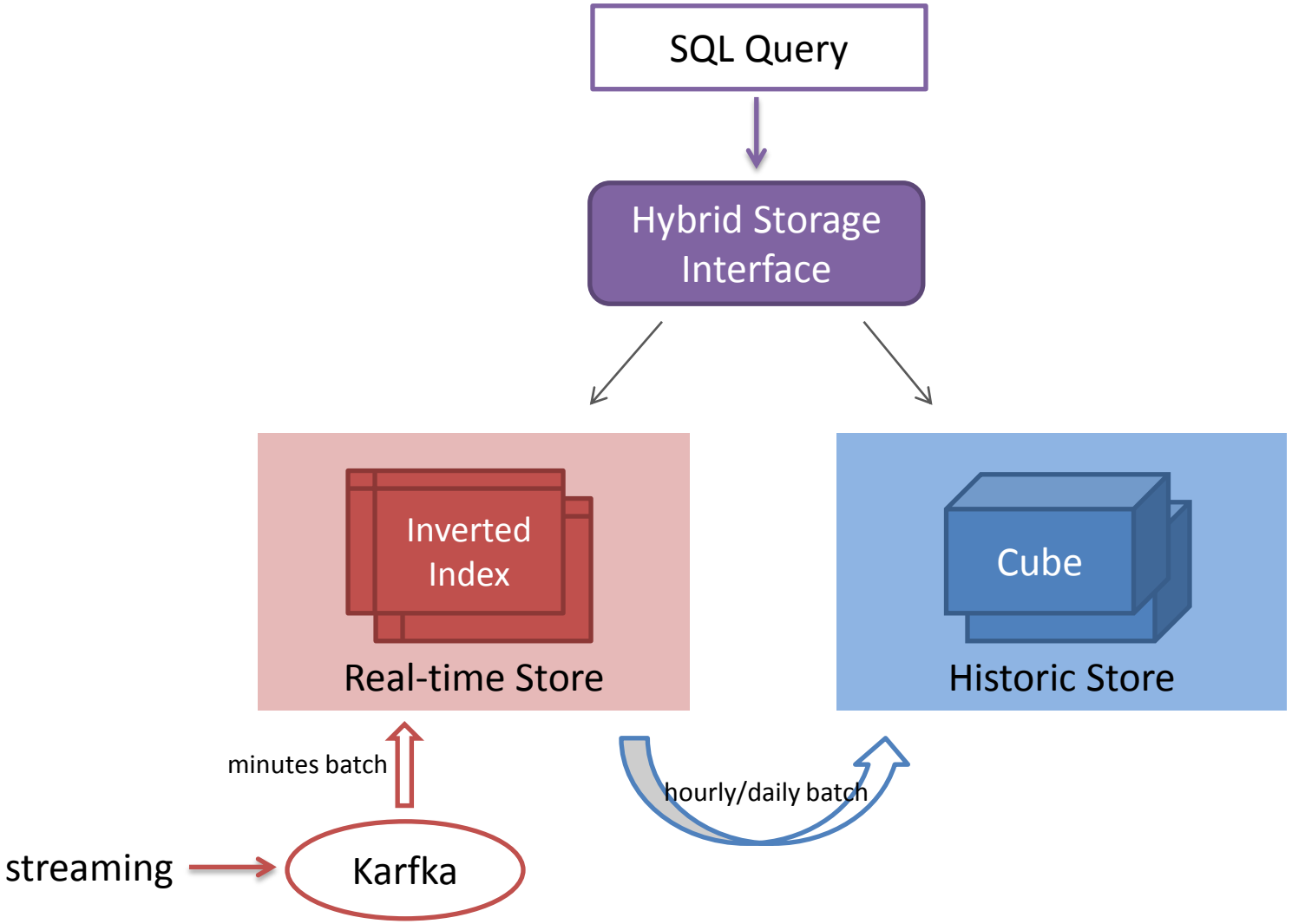
- Cube is great, but…
  - Sometimes we want to drill down to row level information
  - Cube takes time to build, how about real-time analysis?

- Streaming with inverted index

Complements

	Cube	Inverted Index
Storage format	Pre-aggregated cuboids	Sharding, columnar storage, with inverted index on row blocks
Query method	Cuboid scanning	Massive parallel processing
Strength	Pre-aggregate huge historic data to small summaries	Swift response to real-time data
Weakness	Take time to build	Slow at scanning large data volume

Kylin 0.8, Lambda Architecture



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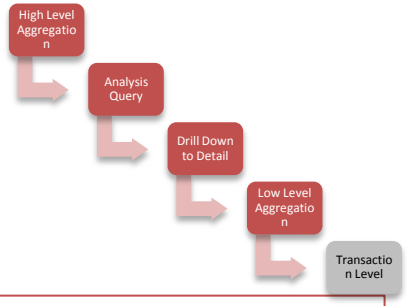
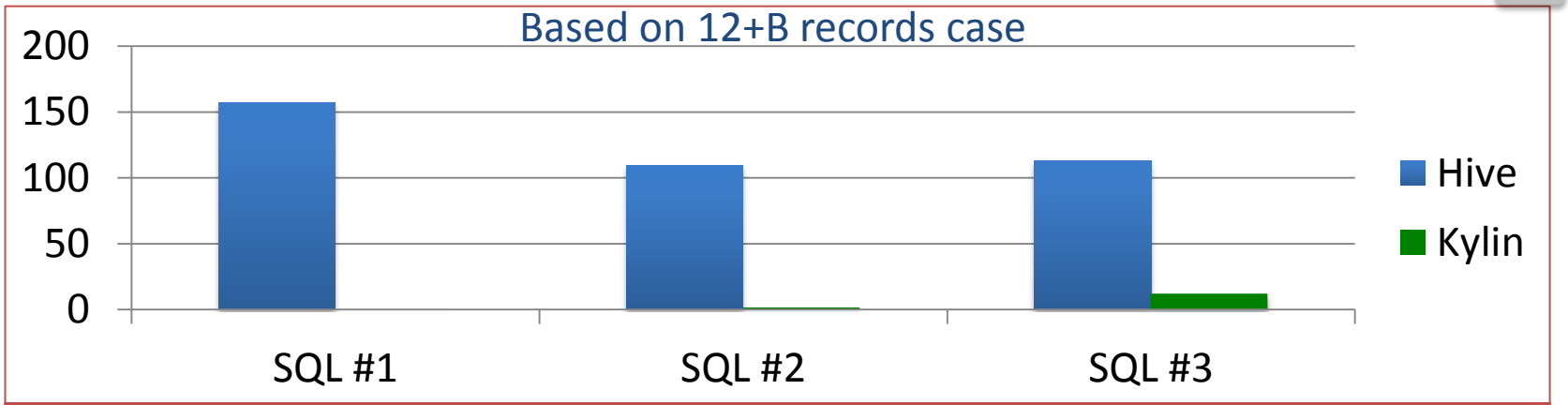
Kylin vs. Hive



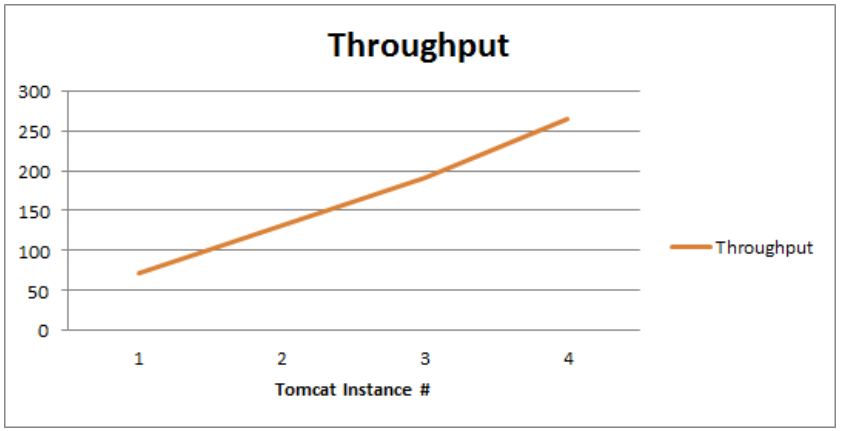


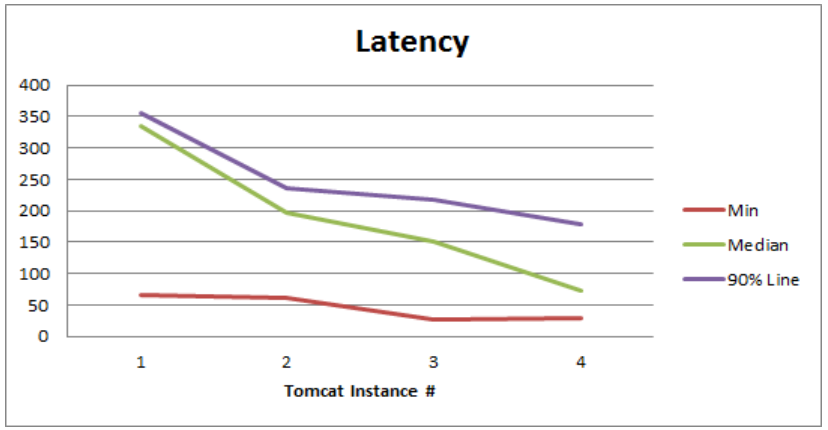
#	Query Type	Return Dataset	Query On Kylin (s)	Query On Hive (s)	Comments
1	High Level Aggregation	4	0.129	157.437	1,217 times
2	Analysis Query	22,669	1.615	109.206	68 times
3	Drill Down to Detail	325,029	12.058	113.123	9 times
4	Drill Down to Detail	524,780	22.42	6383.21	278 times
5	Data Dump	972,002	49.054	N/A	

Performance -- Concurrency

Single Tomcat Instance on a Single Machine

	Parallel Thread #	Data			Latency (ms)				Throughput
		Raw Recors	HBase Scan	Return	Min	Max	Median	90% Line	
High Level Aggregation Query	30	1,940,304,293	5	5	67	1809	334	355	72.5/sec
Detail Level Query (with Seller ID)	30	13,683,834,542	43934	7283	1758	4534	2182	3171	9.7/sec

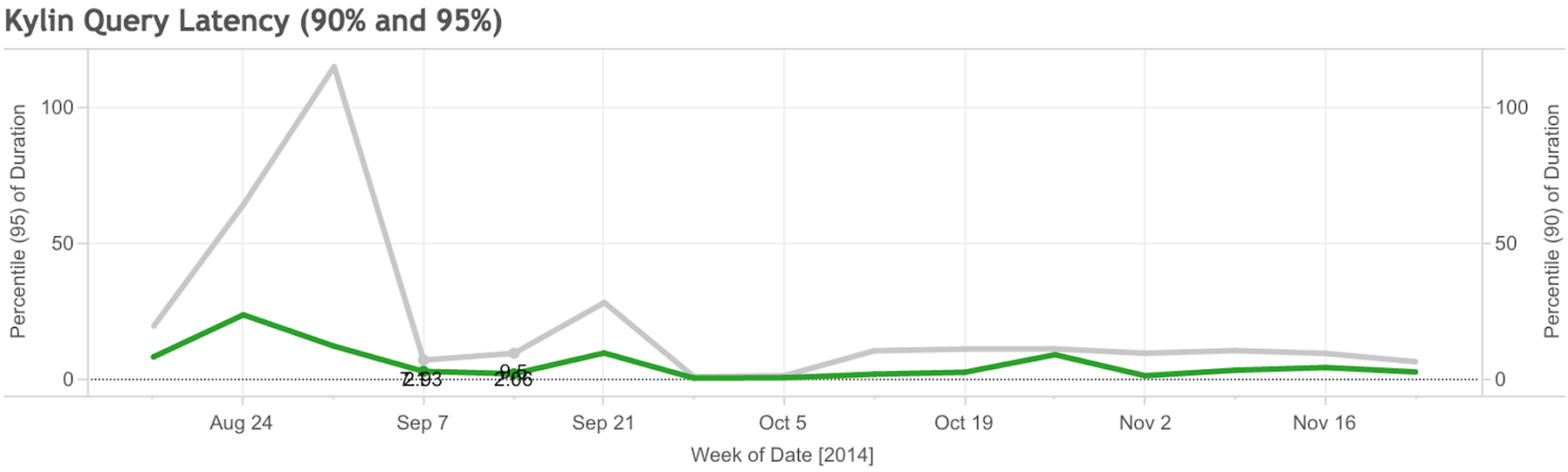




Linear scale out with more nodes

Performance - Query Latency

90% queries <5s



Green Line: 90%tile queries
Gray Line: 95%tile queries

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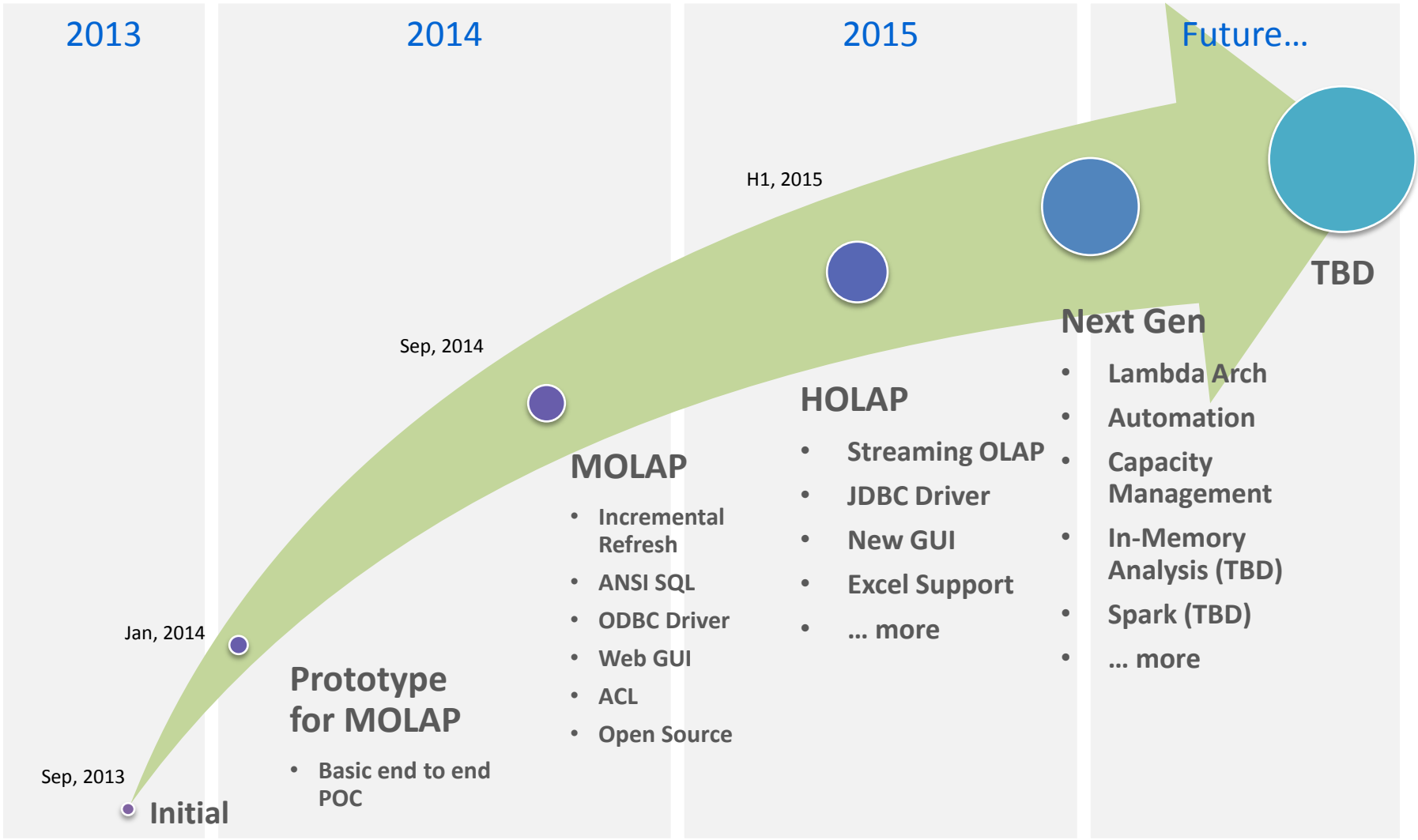
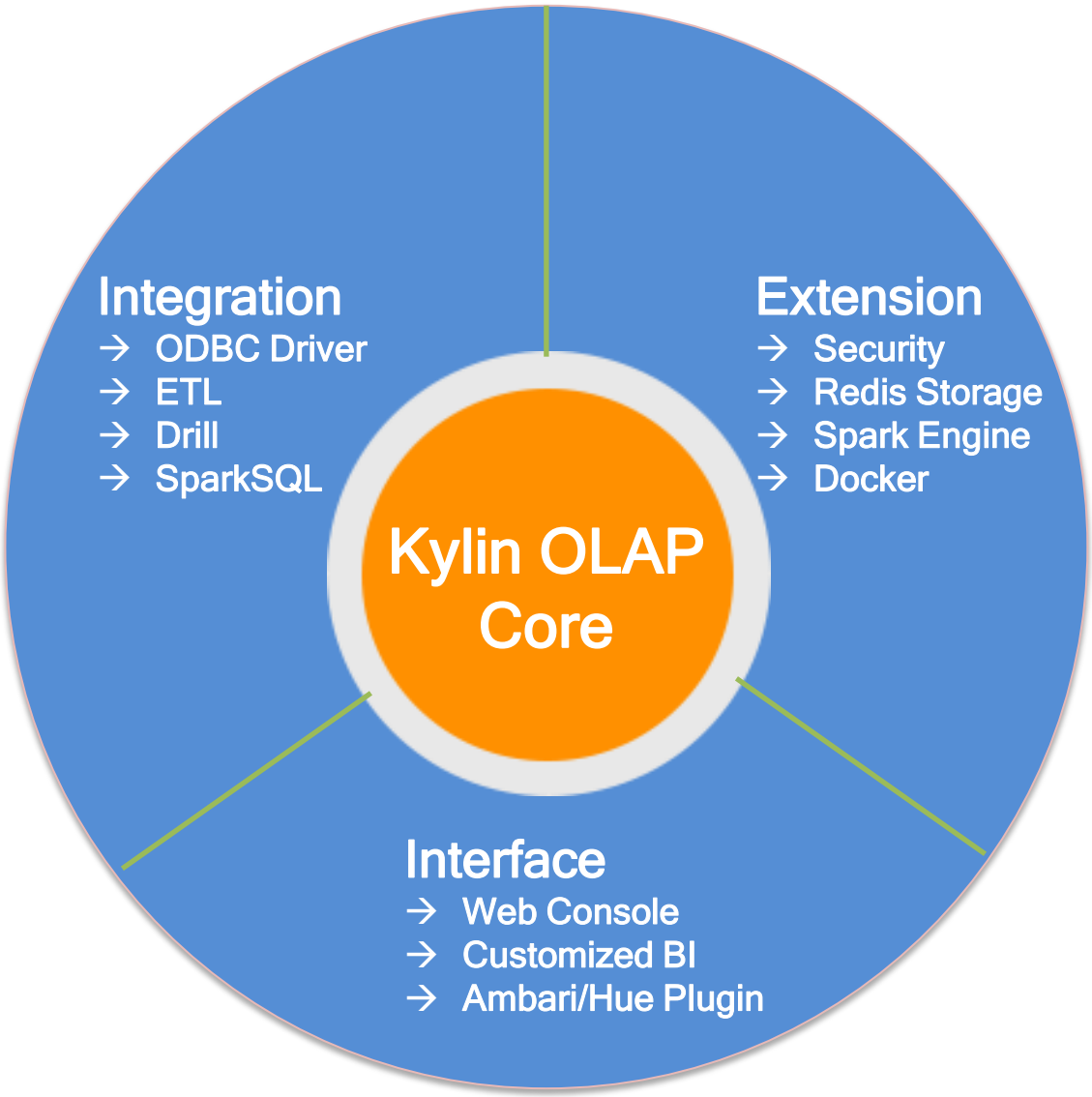
Kylin Evolution Roadmap



Kylin Ecosystem

- Kylin Core
  - Fundamental framework of Kylin OLAP Engine
- Extension
  - Plugins to support for additional functions and features
- Integration
  - Lifecycle Management Support to integrate with other applications
- Interface
  - Allows for third party users to build more features via user-interface atop Kylin core
- Driver
  - ODBC and JDBC Drivers



Apache Kylin

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