SPARK SUMMIT 2017

OAP: Optimized Analytics Package for Spark Platform

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About me

Daoyuan Wang

- developer@Intel
- Focuses on Spark optimization
- An active Spark contributor since 2014

Yuanjian Li

- Baidu INF distributed computation
- Apache Spark contributor
- Baidu Spark team leader

Agenda

- Background for OAP
- Key features
- Benchmark
- OAP and Spark in Baidu
- Future plans

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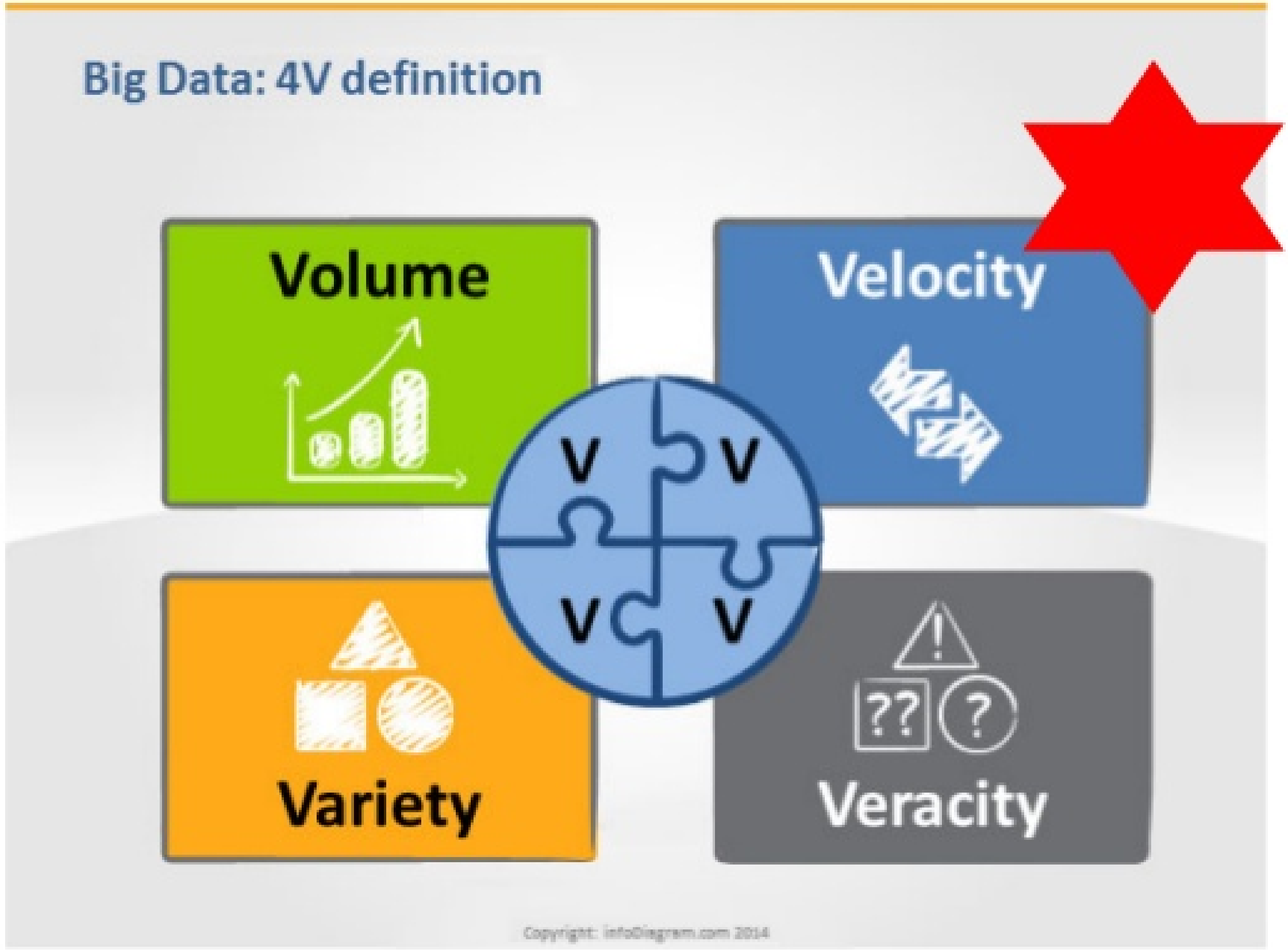
Data Analytics in Big Data Definition



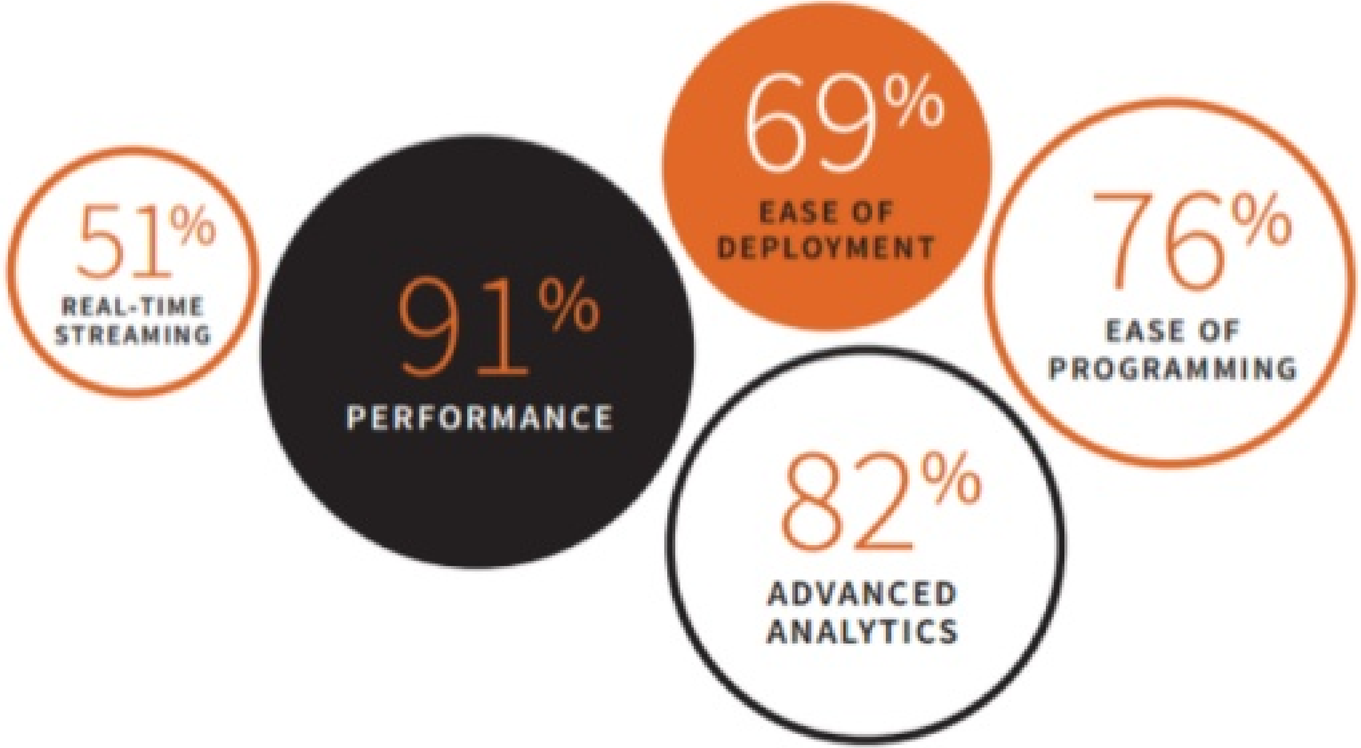
Copyright: infoDiagram.com 2014

- People wants OLAP against large dataset **as fast as possible**.
- People wants extract information from new coming data **as soon as possible**.

Data Analytics Acceleration is Required by Spark Users

FEATURES USERS CONSIDER IMPORTANT

Respondents were allowed to select more than one feature.



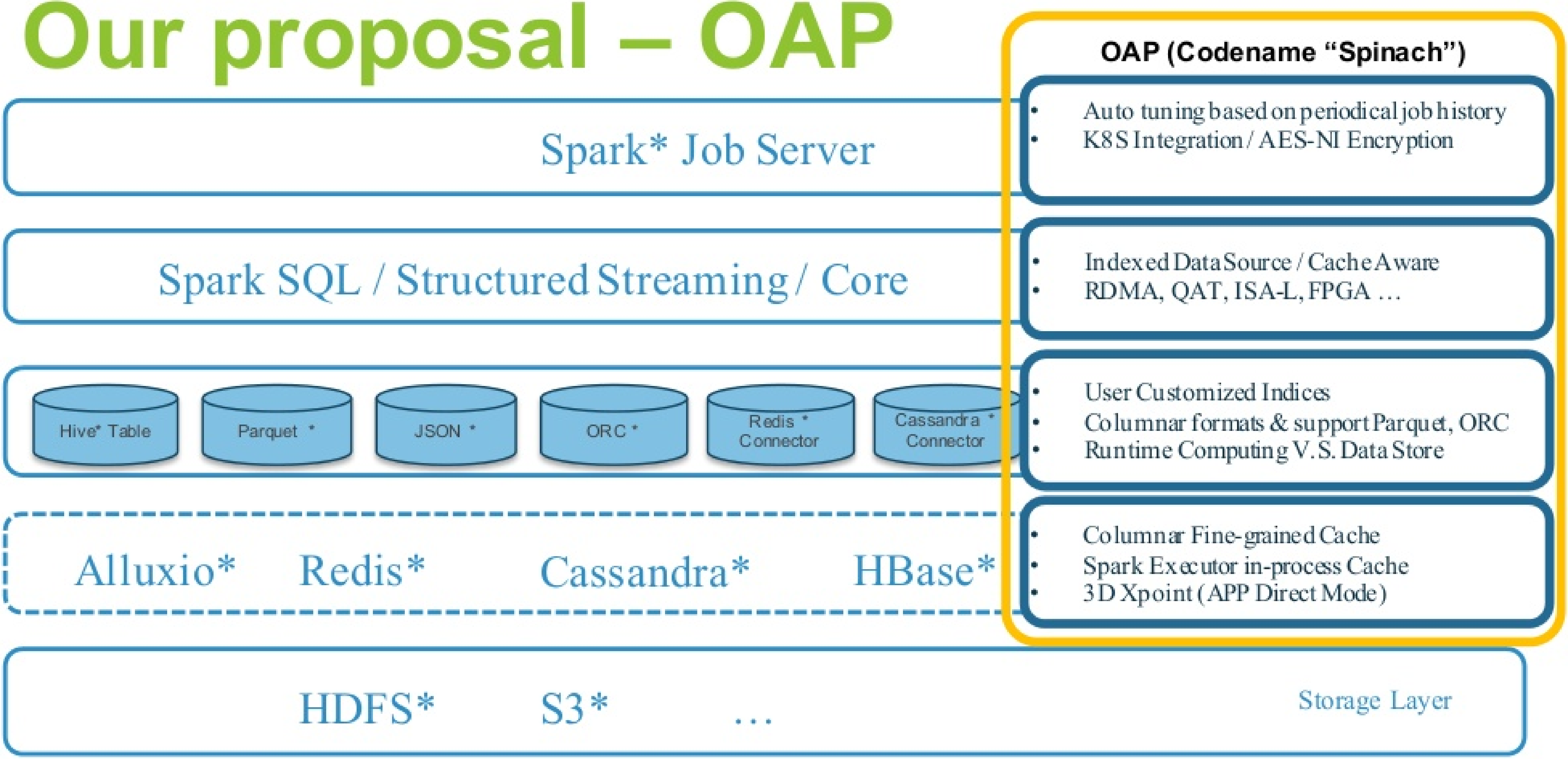
http://cdn2.hubspot.net/hubfs/438089/DataBricks_Surveys_-_Content/2016_Spark_Survey/2016_Spark_Infographic.pdf

Emerging hardware technology

Intel® Optane™ Technology
Data Center Solutions

Accelerate applications for fast caching and storage, reduce transaction costs for latency-sensitive workloads and increase scale per server. Intel® Optane™ technology allows data centers to deploy bigger and more affordable datasets to gain new insights from large memory pools.

Our proposal – OAP



Spark* Job Server

Spark SQL / Structured Streaming / Core

Hive* Table

Parquet *

JSON *

ORC *

Redis * Connector

Cassandra * Connector

Alluxio* Redis* Cassandra* HBase*

HDFS* S3* …

Storage Layer

OAP (Codename "Spinach")

- Auto tuning based on periodical job history
- K8S Integration / AES-NI Encryption

- Indexed DataSource / Cache Aware
- RDMA, QAT, ISA-L, FPGA …

- User Customized Indices
- Columnar formats & support Parquet, ORC
- Runtime Computing V.S. Data Store

- Columnar Fine-grained Cache
- Spark Executor in-process Cache
- 3D Xpoint (APP Direct Mode)

Why OAP

Low cost

- Makes full use of existing hardware
- Open source

Good Performance

- Index just like traditional database
- Up to 5x boost in real-world

Easy to Use

- Easy to deploy
- Easy to maintain
- Easy to learn

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A Simple Example

1. Run with OAP

```
    $SPARK_HOME/sbin/start-thriftserver --package oap.jar;
```

2. Create a OAP table

```
    beeline> CREATE TABLE src(a: Int, b: String) USING spn;
```

3. Create a single column B+ Tree index

```
    beeline> CREATE SINDEX idx_1 ON src (a) USING BTREE;
```

4. Insert data

```
    beeline> INSERT INTO TABLE src SELECT key, value FROM xxx;
```

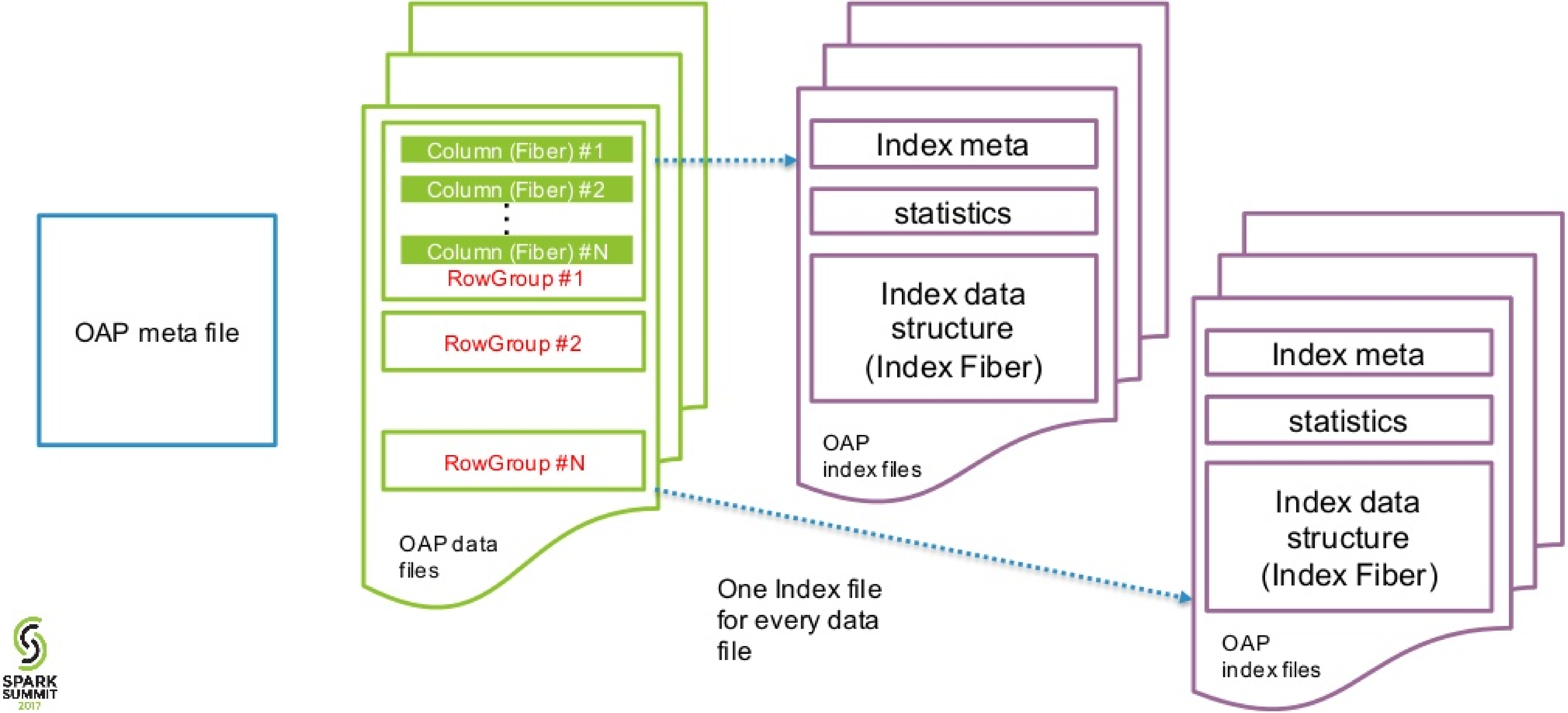
5. Refresh index

```
    beeline> REFRESH SINDEX on src;
```

6. Execution would automatically utilize index

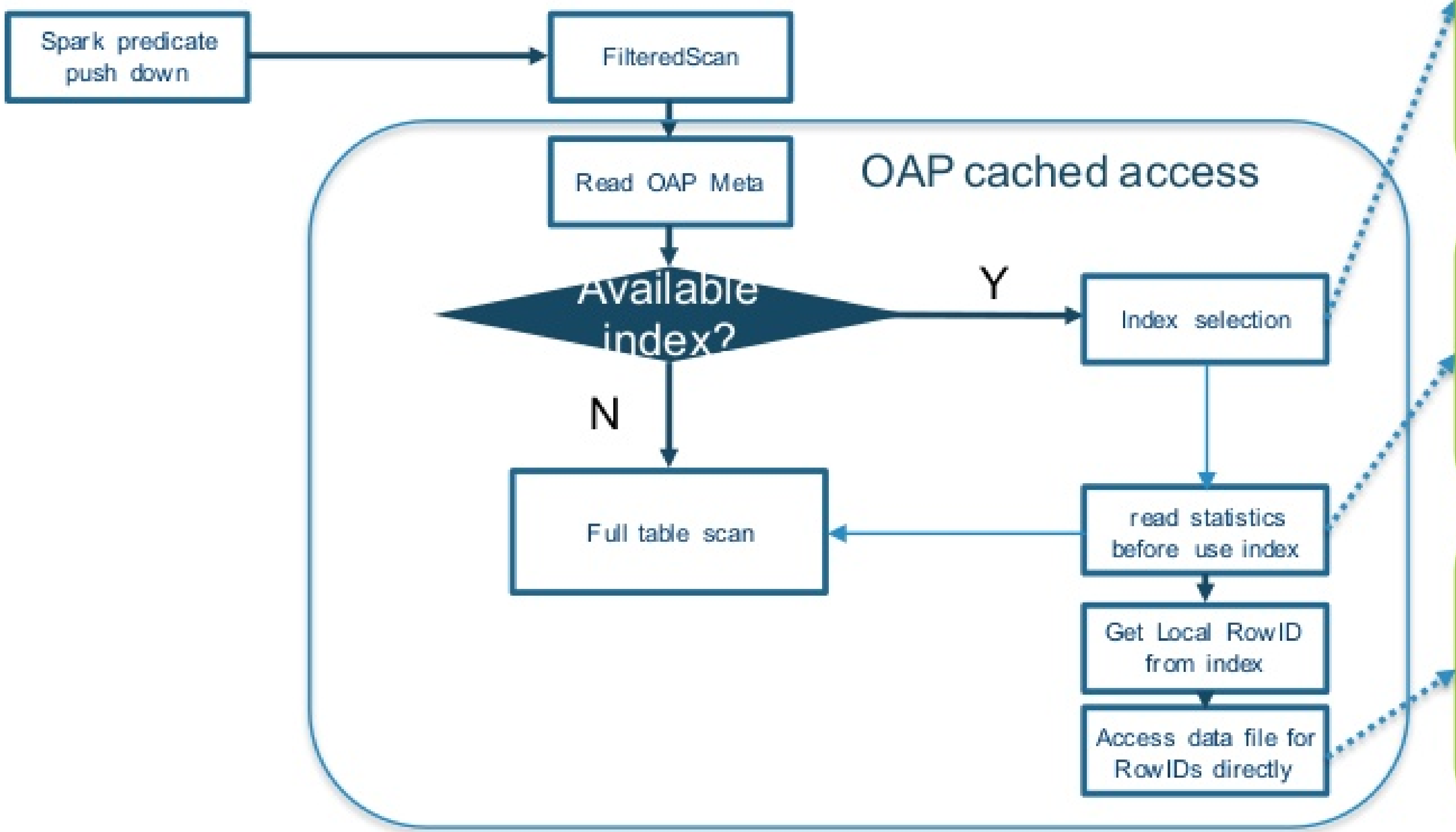
```
    beeline> SELECT MAX(value), MIN(value) FROM src WHERE a > 100 and a <
1000;
```

OAP Files and Fibers



One Index file for every data file

OAP Internals - index

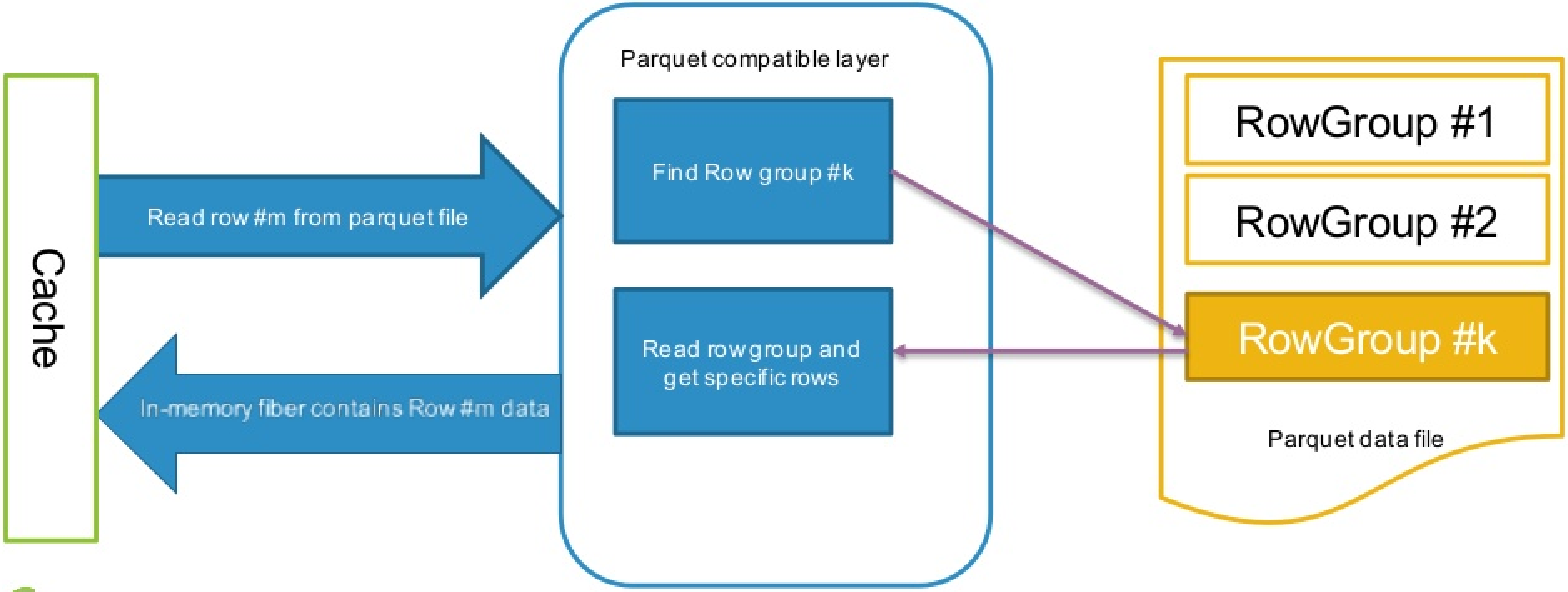

Spark predicate push down
FilteredScan
OAP cached access
Read OAP Meta
Available index?
Y
N
Index selection
Full table scan
read statistics before use index
Get Local RowID from index
Access data file for RowIDs directly

Supports Btree Index and BitMap Index, find best match among all created indices

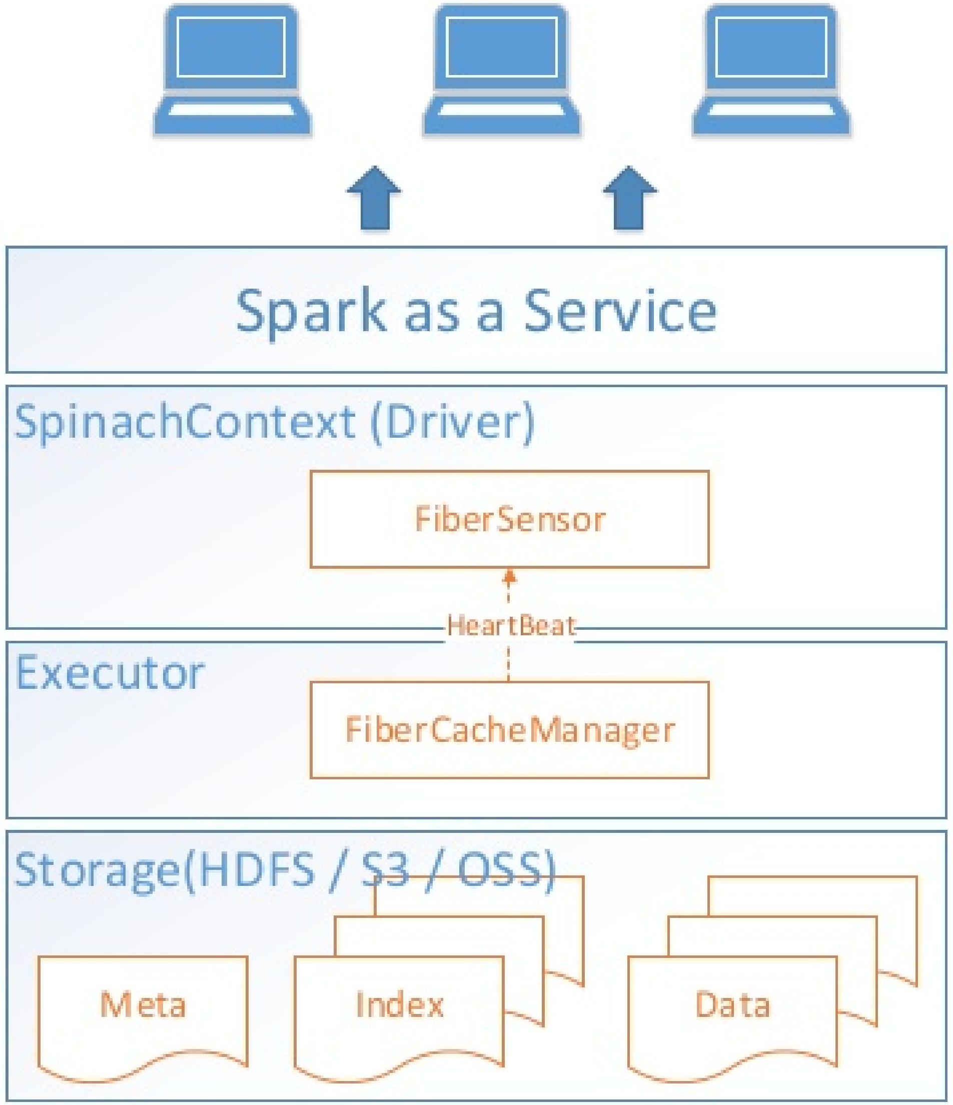
Supports statistics such as MinMax, PartbyValue, Sample, BloomFilter

Only reads data fibers we need and puts those fibers into cache (in-memory fiber)

OAP compatible layer


Cache
Read row #m from parquet file
In-memory fiber contains Row #m data
Parquet compatible layer
Find Row group #k
Read rowgroup and get specific rows
RowGroup #1
RowGroup #2
RowGroup #k
Parquet data file

OAP Data locality



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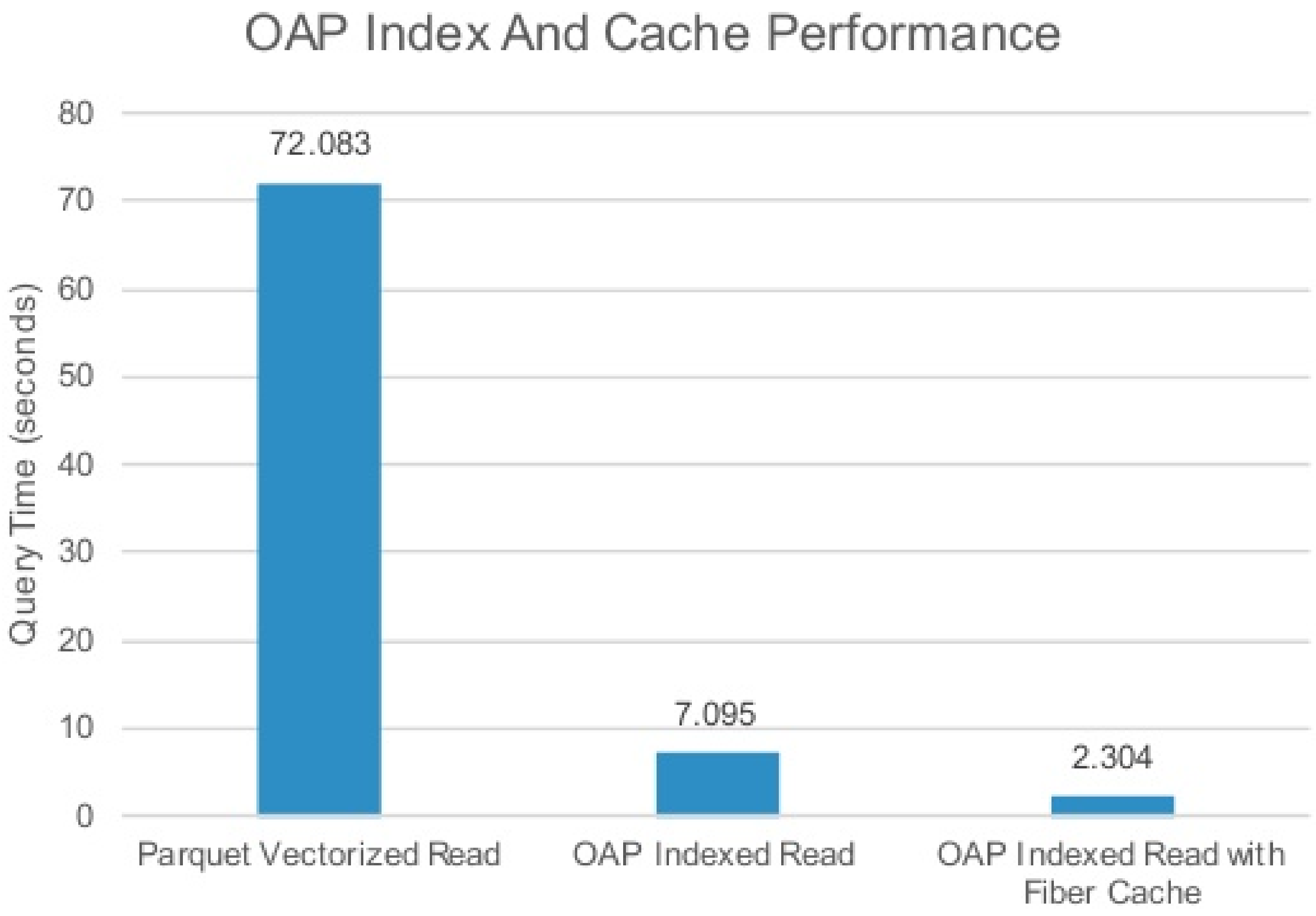
Performance

Cluster:
1 Master + 2 Slaves

Hardware:
CPU – 2x E5-2699 v4
RAM – 256 GB
Storage – S3610 1.6TB

Data:
300GB (Compressed Parquet)
2 Billion Records



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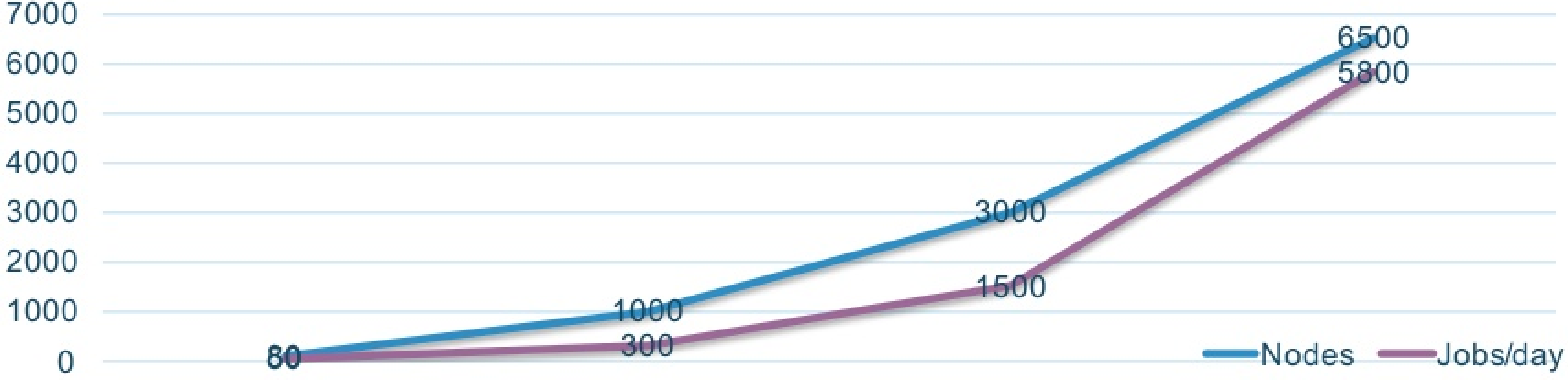
Spark In Baidu



2014

- Spark import to Baidu
- Version: 0.8

2015

- Build standalone cluster
- Integrate with in-house FS\Pub-Sub\DW
- Version: 1.4

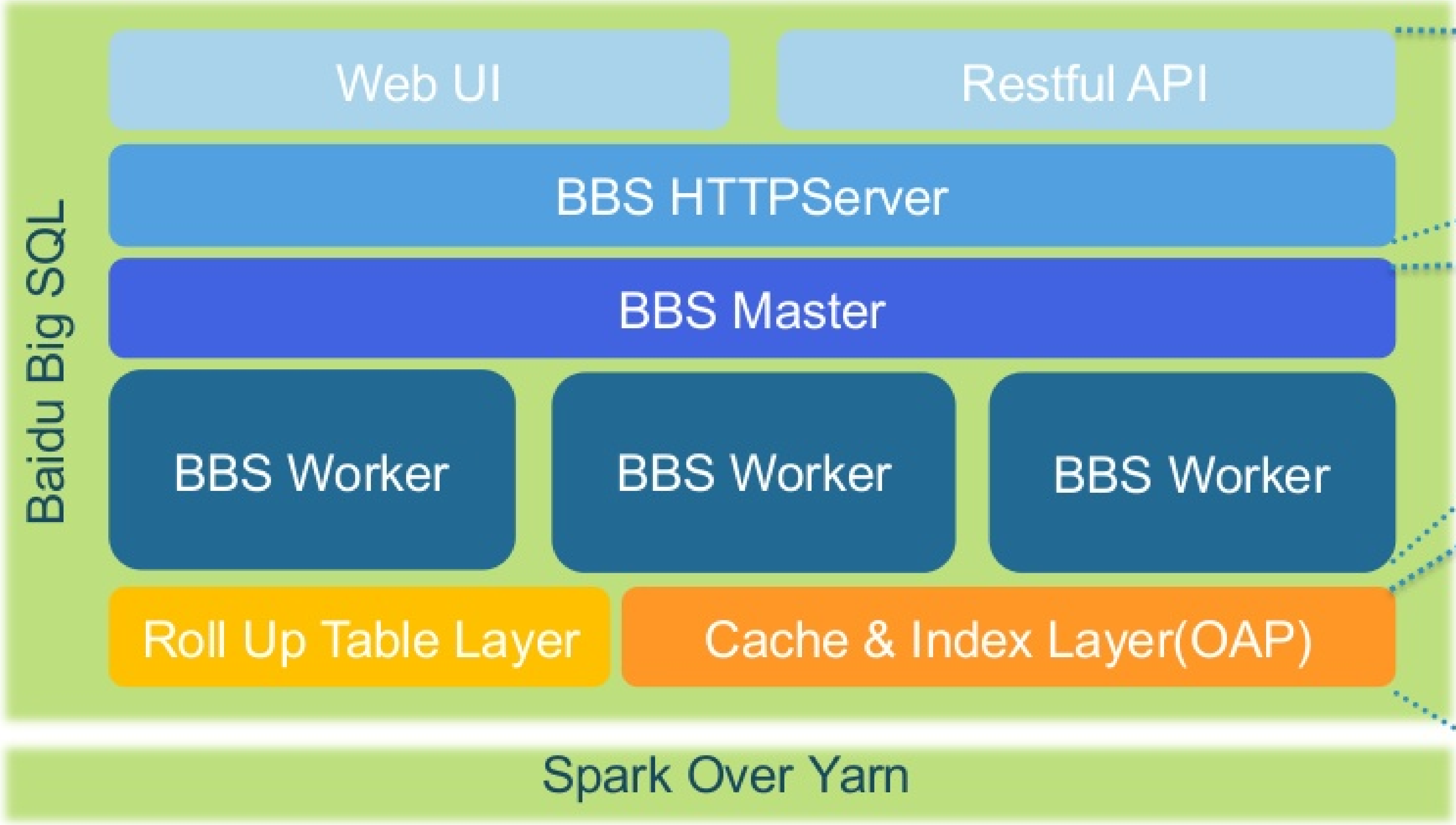
2016

- Build Cluster over YARN
- Integrate with in-house Resource Scheduler System
- Version: 1.6

2017

- SQL\Graph Service over Spark
- OAP
- Version: 2.1

Baidu Big SQL



API Layer:

- Meta Control API
- Job API:

Load\Export\Query\Index Control

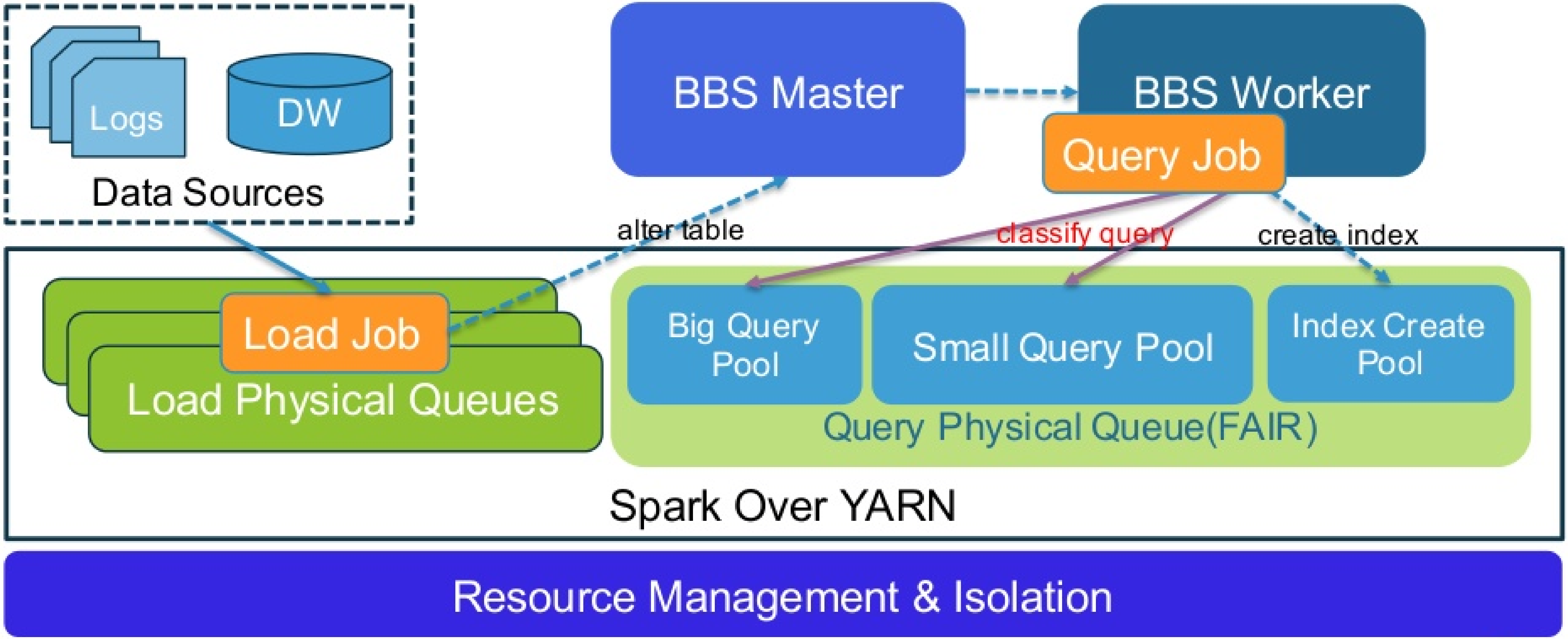
Control Layer:

- Meta Control
- Job Scheduler
- Spark Driver
- Query Classification

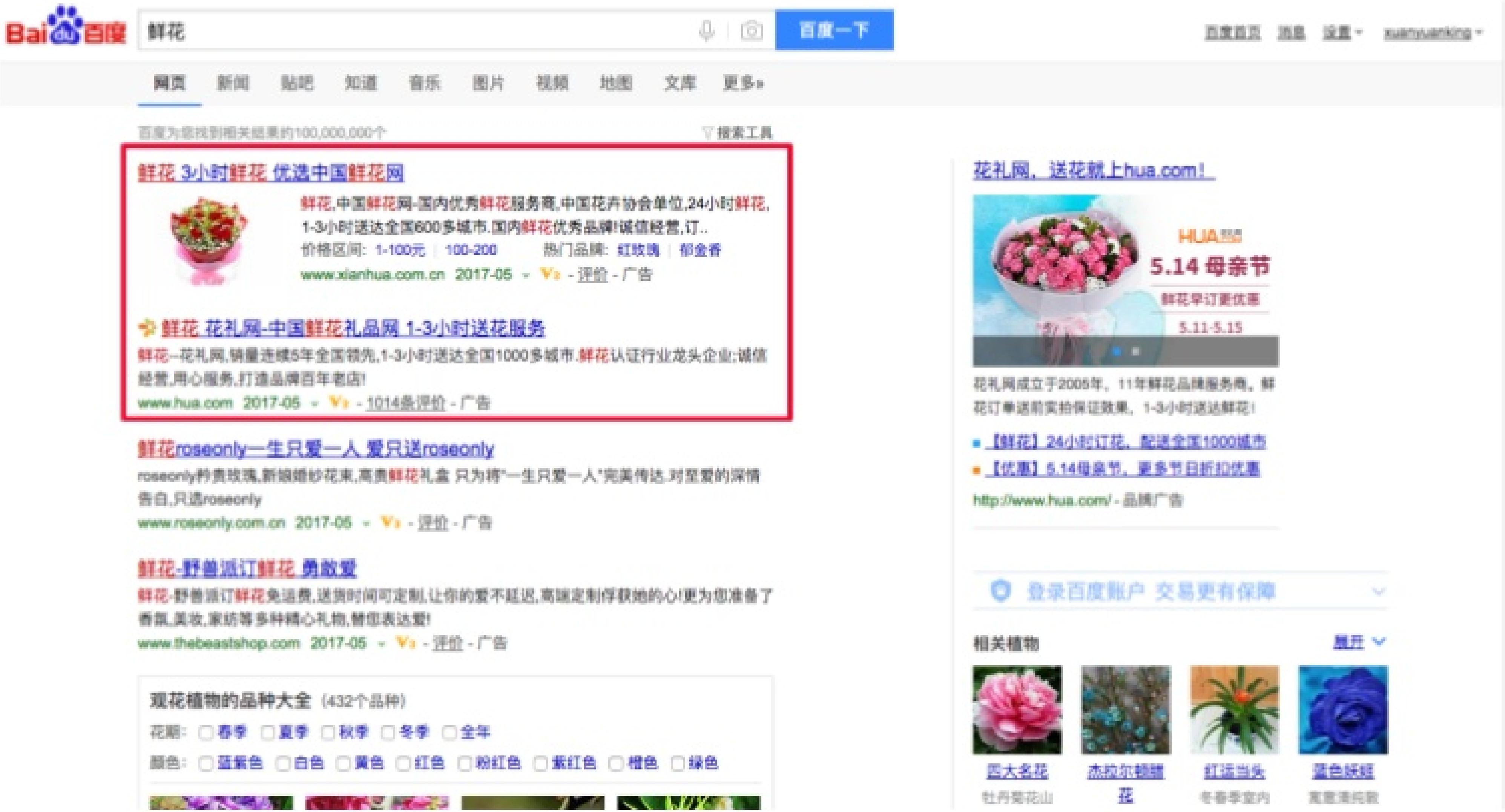
Boosting Layer:

- Roll Up Table Management
- Roll Up Query Change
- Index Create\Update
- Cache Hit

Baidu Big SQL



Introductory Story



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颜色: □蓝紫色 □白色 □黄色 □红色 □粉红色 □紫红色 □橙色 □绿色

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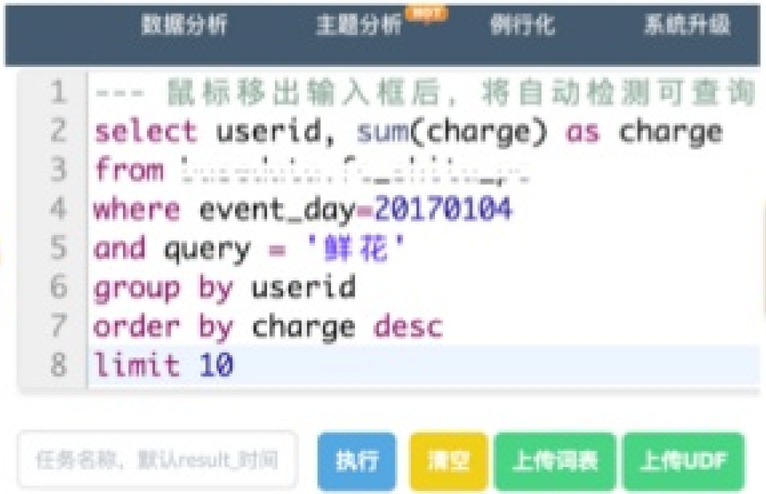
四大名花	杰拉尔顿蜡花	红运当头	蓝色妖姬
牡丹菊花山		冬春季室内	寓意清纯脱

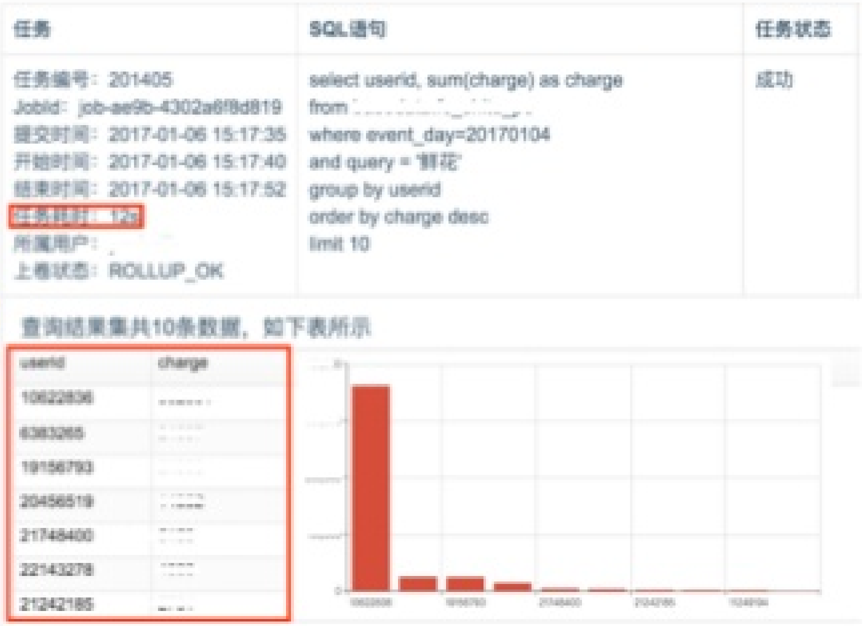
Introductory Story

Get the top 10 charge sum and correspond advertiser which triggered by the query word ‘flower’



```
--- 鼠标移出输入框后，将自动检测可查询
select userid, sum(charge) as charge
from [redacted]
where event_day=20170104
and query = '鲜花'
group by userid
order by charge desc
limit 10
```

- Create index on ‘userid’ column
- Various index types to choose for different fields types



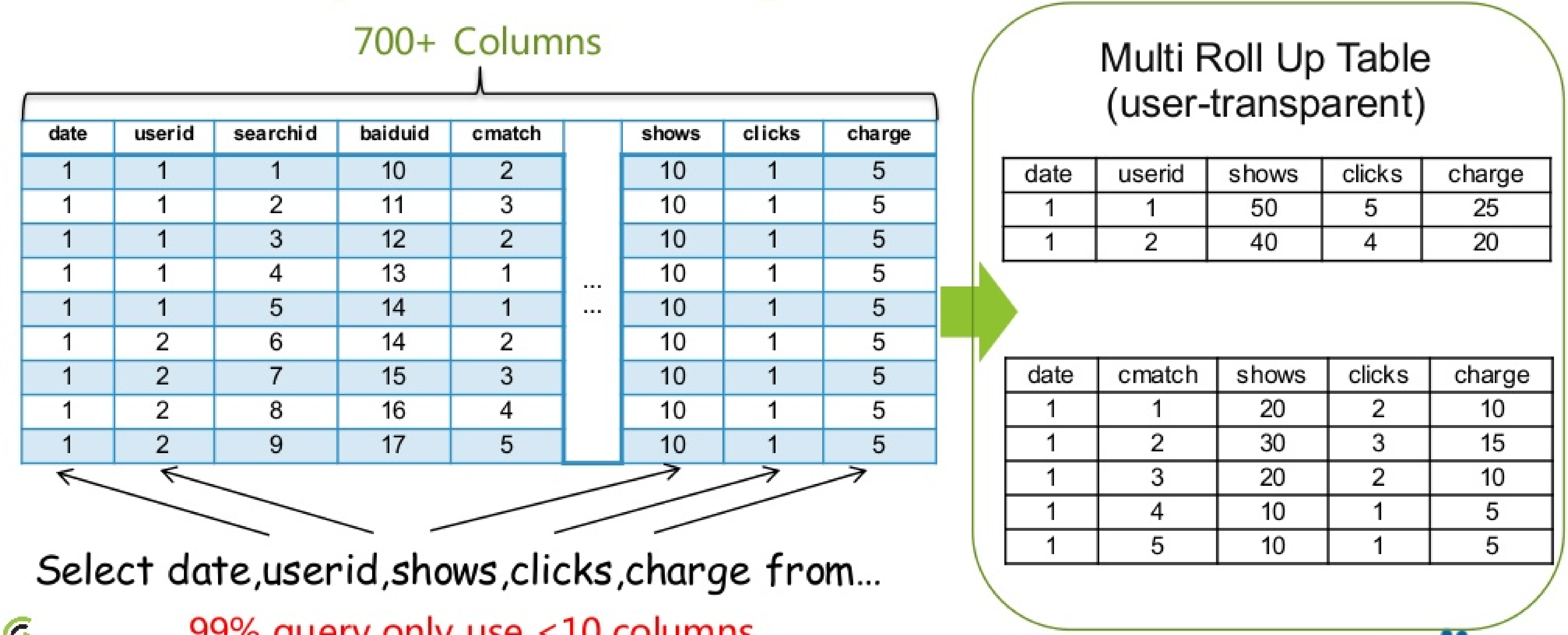
任务	SQL语句	任务状态
任务编号：201405 JobId：job-ae9b-4302a6f8d819 提交时间：2017-01-06 15:17:35 开始时间：2017-01-06 15:17:40 结束时间：2017-01-06 15:17:52 任务耗时：12s 所属用户：[redacted] 上卷状态：ROLLUP_OK	select userid, sum(charge) as charge from [redacted] where event_day=20170104 and query = '鲜花' group by userid order by charge desc limit 10	成功

查询结果集共10条数据，如下表所示

userid	charge
10622836	[redacted]
6383265	[redacted]
19156793	[redacted]
20456519	[redacted]
21748400	[redacted]
22143278	[redacted]
21242185	[redacted]

- ×5 speed boosting than native spark sql, ×80 than MR Job
- 3 day baidu charging log, 4TB data,70000+ files, query time in 10~15s

Roll Up Table Layer



700+ Columns

date	userid	searchid	baiduid	cmatch		shows	clicks	charge
1	1	1	10	2		10	1	5
1	1	2	11	3		10	1	5
1	1	3	12	2		10	1	5
1	1	4	13	1	…	10	1	5
1	1	5	14	1	…	10	1	5
1	2	6	14	2		10	1	5
1	2	7	15	3		10	1	5
1	2	8	16	4		10	1	5
1	2	9	17	5		10	1	5

Select date,userid,shows,clicks,charge from…

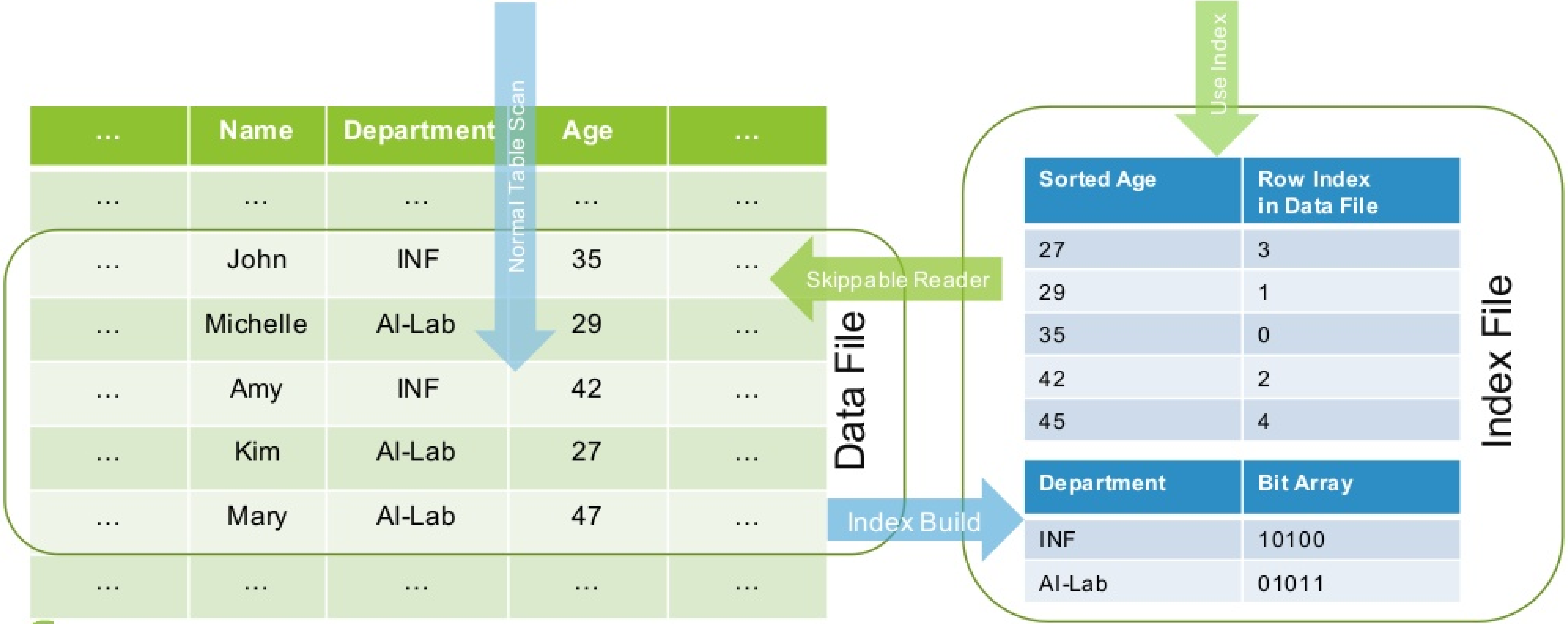
Multi Roll Up Table
(user-transparent)

date	userid	shows	clicks	charge
1	1	50	5	25
1	2	40	4	20

date	cmatch	shows	clicks	charge
1	1	20	2	10
1	2	30	3	15
1	3	20	2	10
1	4	10	1	5
1	5	10	1	5

99% query only use <10 columns

OAP In BigSQL



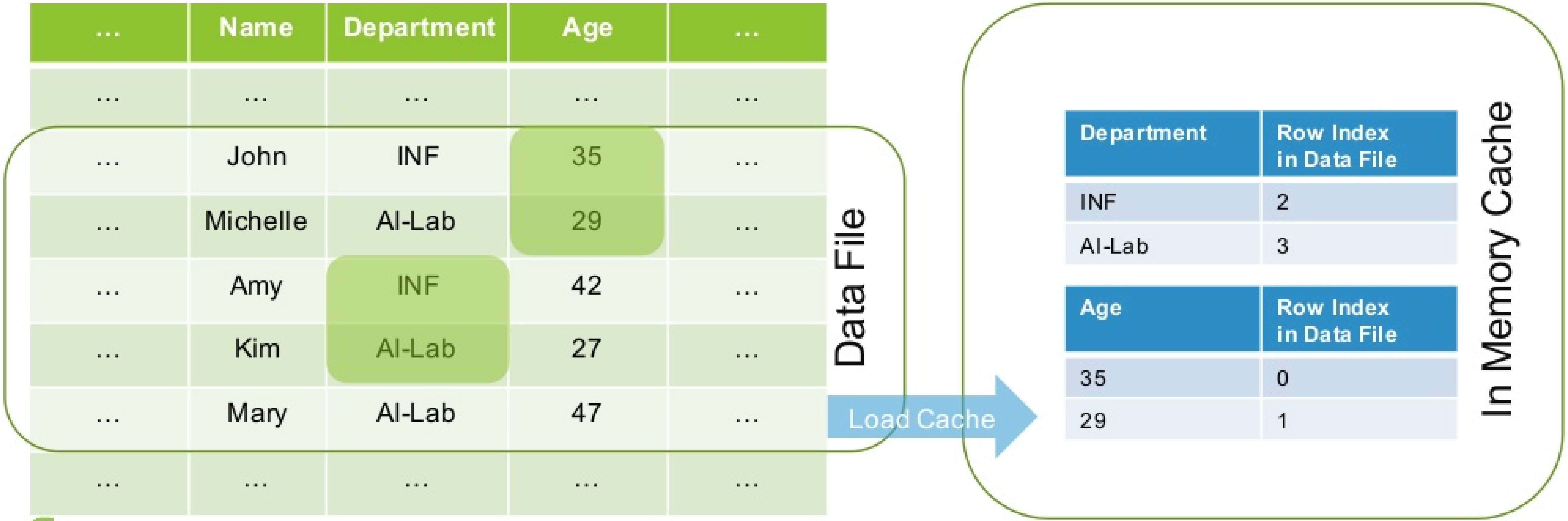
…	Name	Department	Age	…
…	…	…	…	…
…	John	INF	35	…
…	Michelle	AI-Lab	29	…
…	Amy	INF	42	…
…	Kim	AI-Lab	27	…
…	Mary	AI-Lab	47	…
…	…	…	…	…

Sorted Age	Row Index in Data File
27	3
29	1
35	0
42	2
45	4

Department	Bit Array
INF	10100
AI-Lab	01011

Select xxx from xxx where age > 29 and department in (INF, AI-Lab)

OAP In BigSQL



…	Name	Department	Age	…
…	…	…	…	…
…	John	INF	35	…
…	Michelle	AI-Lab	29	…
…	Amy	INF	42	…
…	Kim	AI-Lab	27	…
…	Mary	AI-Lab	47	…
…	…	…	…	…

Department	Row Index in Data File
INF	2
AI-Lab	3

Age	Row Index in Data File
35	0
29	1

BBS’s Contribute to Spark

- Spark-4502

Spark SQL reads unneccesary nested fields from Parquet

- Spark-18700

getCached in HiveMetastoreCatalog not thread safe cause driver OOM

- Spark-20408

Get glob path in parallel to reduce resolve relation time

- …

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Future plans

- Compatible with more data formats
- Explicit cache and cache management
- Optimize SQL operators (join, aggregate) with index
- Integrate with structured streaming
- Utilize Latest hardware technology, such as Intel QAT or 3D XPoint.
- Welcome to contribute!

https://github.com/Intel-bigdata/OAP

WOMEN IN BIG DATA

Connect
Inspire
Build
Cultivate
Create
Grow
Embrace
Educate
Lead

WOMEN IN BIG DATA NETWORKING LUNCHEON

The Women in Big Data team invites you to join us for lunch, network with your peers and hear from a dynamic panel of experts. Come learn what career & growth opportunities are available in the field of big data analytics.

Agenda:

12.20PM	Grab Lunch & Networking
12:30PM-12:40PM	Women in Big Data Overview with Soumya Guptha, Marketing Manager, Intel
12:40PM-12:45PM	My journey in Data Analytics & Artificial Intelligence with Ziya Ma, Intel VP & Director, Big Data Technologies
12:50PM-01:40PM	Panel: Making The Best Out Of The Fast Paced Data World!

Panel: Making The Best Out Of The Fast Paced Data World!

Gayle Sheppard, VP, New Technology Group, Intel | Ritika Gunnar, Global VP of IBM Cloud and Cognitive, IBM | Eva Tse, Director of Big Data Services, Netflix | Jennifer Shin, CEO 8 path solutions | Soumya Guptha, Marketing Manager, Software and Solutions Group, Intel

Join us for a networking luncheon to hear from industry experts from leading companies such as IBM, Intel and others on their investments in Big Data technologies such as Spark, Machine Learning, Artificial Intelligence.

www.womeninbigdata.org/ | @DataWomen | Women in Big Data Forum | www.meetup.com/Women-in-Big-Data-Meetup/

GRASSROOTS COMMUNITY CHAMPIONING WOMEN'S LEADERSHIP AND SUCCESS IN BIG DATA

SPARK SUMMIT 2017

Thank You.

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