成就直达号的大数据引擎技术专场

百度直达号　　　　　http://zhida.baidu.com/

百度开放服务平台　http://developer.baidu.com/

百度开放云　　　　　http://bce.baidu.com/

目录

- OLAP背景介绍
- Palo整体架构
- Palo关键技术
- Palo对外开放

什么是OLAP

- Online Analytical Processing

  - Analytical Processing vs. Transactional Processing
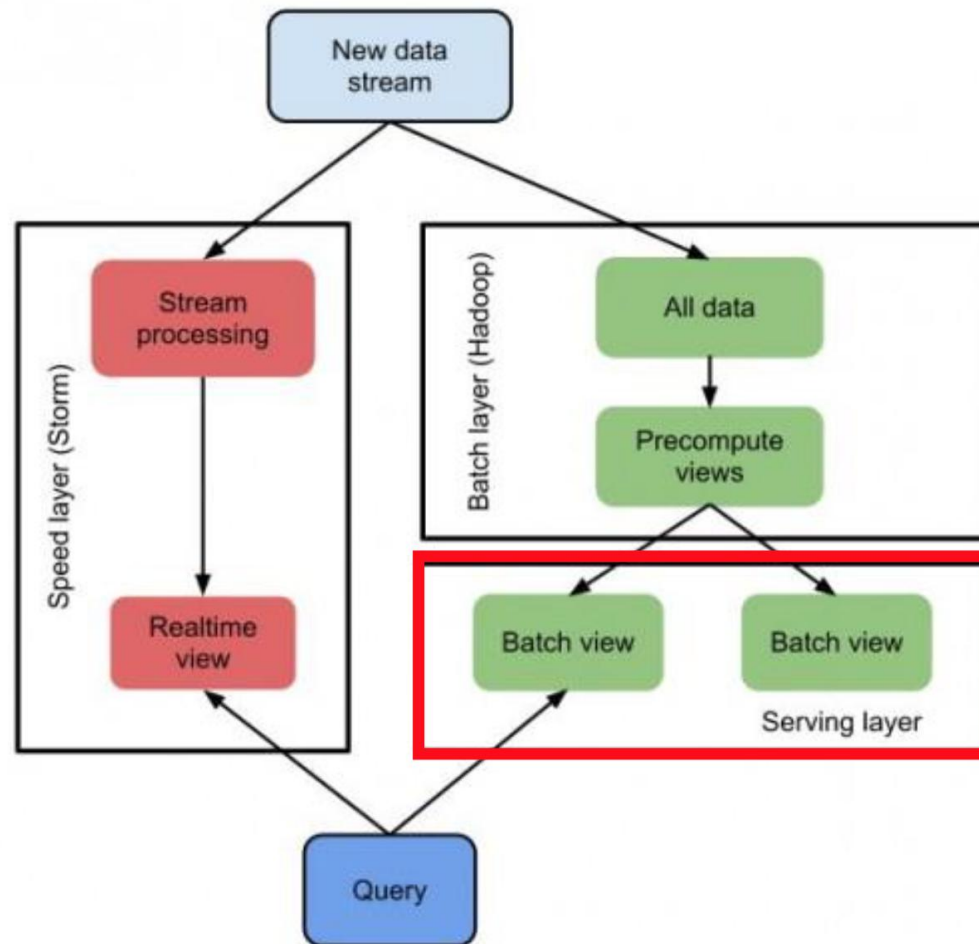
  - Online vs. Offline (Interactive vs. Batch)

OLTP vs. OLAP

	OLTP	**OLAP**
面向应用	日常交易处理	明细查询，分析决策
访问模式	简单小事务，操作少量数据	复杂聚合查询，可以过大量数据
数据	当前最新数据	历史数据
数据规模	GB	TB ~ PB
数据更新	实时更新	批量更新
数据组织	满足3NF	反范式，星型模型

Online vs. Offline

OLAP - Interactive Data Analysis

**结构化数据的
简单查询分析**

**文本数据的
简单查询分析**

**各类数据的
复杂分析**

Reporting

Multidimensional Analysis

Text Analysis

Data Mining

SQL DB
(PALO)

Search DB

Mining DB
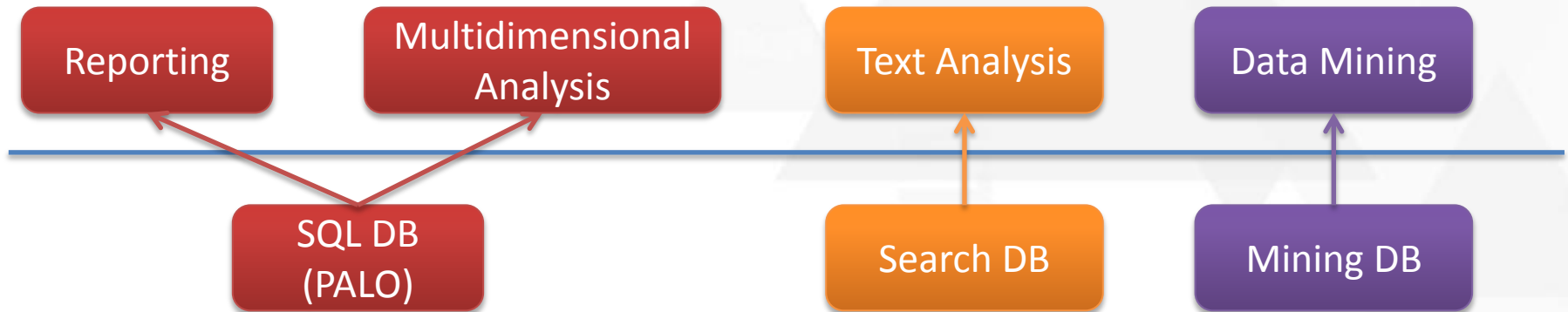
OLAP应用-在线报表
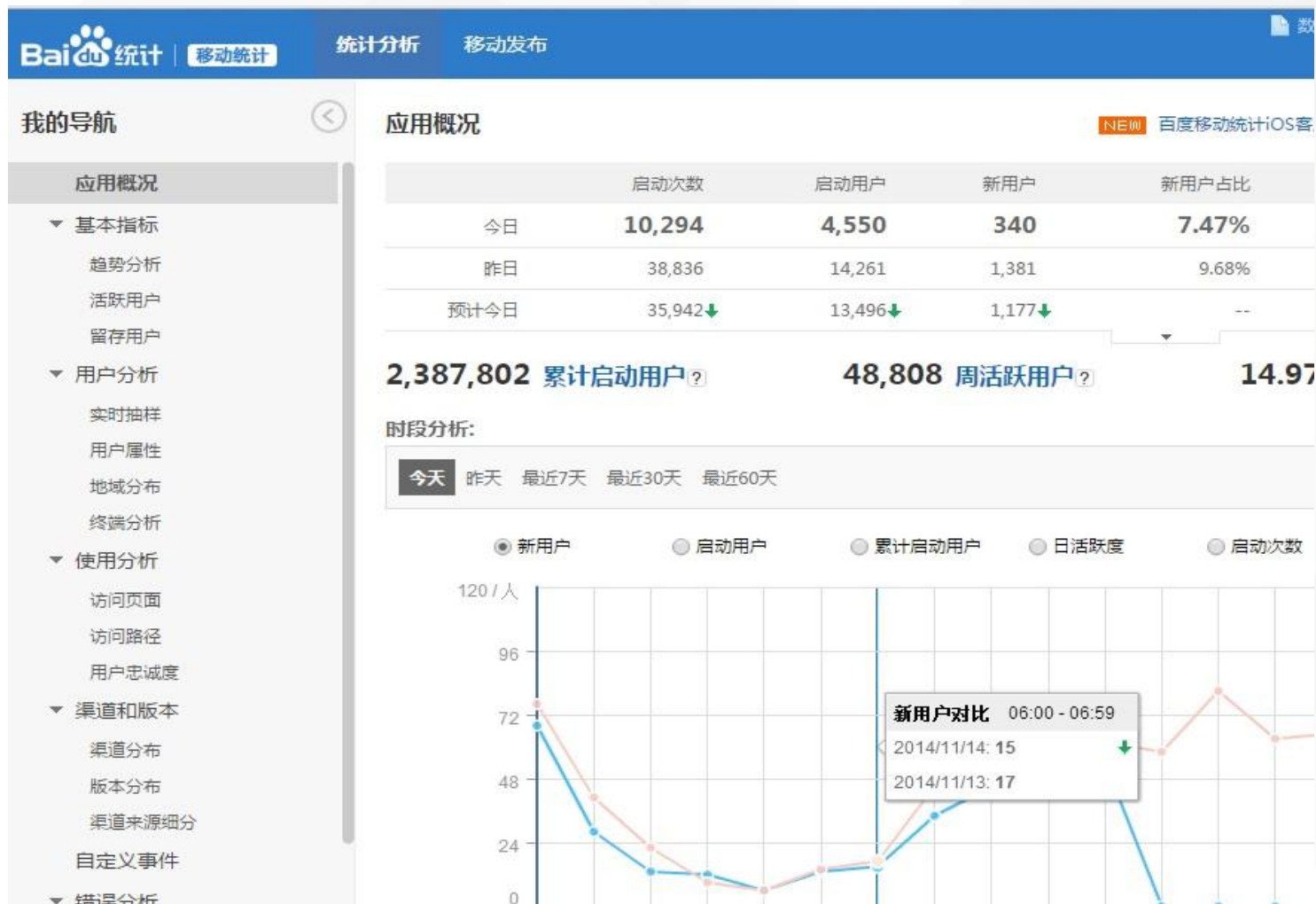
OLAP应用-多维分析
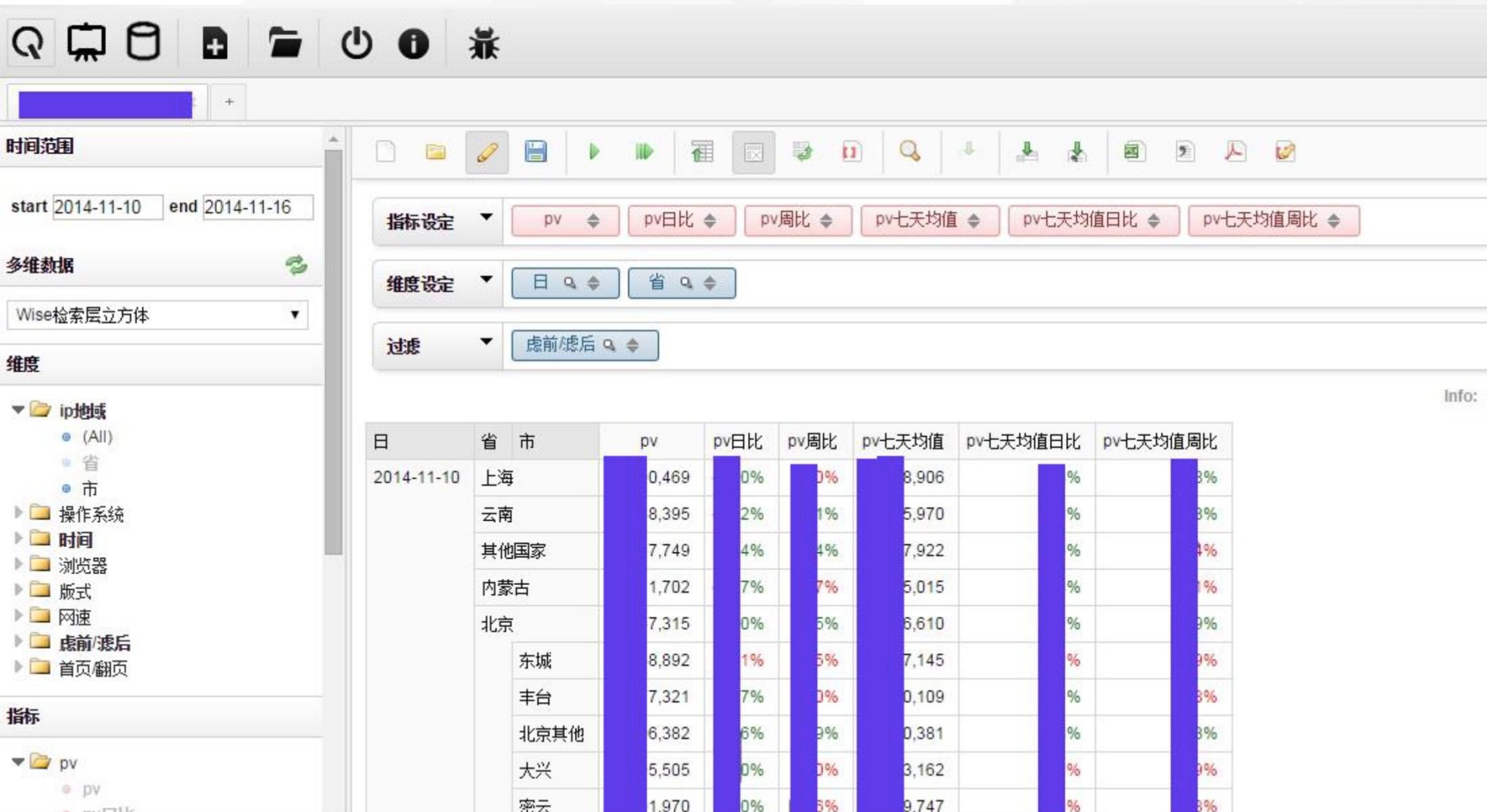
商业产品

产品	简介	技术特点	收购情况
Netezza	2000年在美国成立 Netezza TwinFin	✓ 软硬一体机 ✓ 采用FPGA数据过滤代替索引	2010年9月20日，IBM出资17.8亿美元收购
Greenplum	2003年在美国成立 Greenplum Database	✓ 行存 + 列存 ✓ Shared-Nothing集群	2010年7月6日，EMC出资3亿美元收购
Vertica	2005年在美国成立 Vertica Analytic Database	✓ 列存 ✓ Shared-Nothing集群	2011年2月，HP出资3.5亿美元收购
Aster Data	2005年在美国成立 nCluster	✓ SQL-MapReduce ✓ Shared-Nothing集群	2011年7月6日，Teradata出资2.63亿美元收购
ParAccel	2005年在美国成立 PADB	✓ 列存 + 自适应压缩 ✓ Shared-Nothing集群	2013年Actian出资1.5亿美元收购，Redshift宣称使用ParAccel

Vendor and Appliance	Memory (GB)	Total Cores	Compression	User Storage (TB, Compressed)	List Price
EMC Greenplum Data Computing Appliance	768	48	4 to 1	144	$2,000,000
IBM PureData System for Analytics N1001-010	n/a	112	4 to 1	128	$1,599,000
Microsoft SQL Server 2012 Parallel Data Warehouse[1]	2,304	144	5 to 1	340	$1,569,970
Oracle Exadata Database Machine X3-2	2,048	128	10 to 1	450	$13,580,000
Teradata Data Warehouse Appliance 2690	768	96	4 to 1	146	$1,168,000

开源社区和互联网企业

Hortonworks

Enterprise Hadoop   Products   Hadoop Training   Commu

The Stinger Initiative: Making Apache Hive 100 Times Faster
📅 February 20th, 2013   👤 Alan Gates

cloudera
Ask Bigger Questions

WHY CLOUDERA | PRODUCTS | SOLUTIONS | PARTNERS | RESOURCES | SUPPORT | ABOUT

Hadoop & Big Data

Cloudera Impala: Real-Time Queries in Apache Hadoop, For Real
by Marcel Kornacker & Justin Erickson | October 24, 2012 | 💬 14 comments | Tweet

Our Customers

Apache Drill Distributed system for interactive analysis.

Apache Drill (incubating) is a distributed system for interactive analysis of large-scale datasets, based on Google's Dremel. Its goal is to efficiently process nested data. It is a design goal to scale to 10,000 servers or more and to be able to process petabyes of data and trillions o records in seconds.

MemSQL, The Real-Time Analytics Platform.

MemSQL's real-time analytics platform is built on the world's fastest, most scalable in-memory database, capable of simultaneously handling real-time transactions and analytic workloads. MemSQL unleashes the full potential of Big Data by consuming and returning data instantly.

Spark SQL

Download | Libraries ▾ | Documentation ▾ | Examples | Community ▾ | FAQ

Spark SQL is Spark's module for working with structured data.

Search Images Maps Play YouTube News Gmail Documents More ▾   Andrew Brust ▾ ⚙

Google bigquery

COMPOSE QUERY ?

Query History
Job History

Compose Query ?   ✕

SELECT corpus, word_count FROM
publicdata:samples.shakespeare ORDER BY word_count DESC
LIMIT 200;

BigQuery Sandbox
▾ MyDataSet
  ⠿ NYBabyNames
  ⠿ NameData
  ⠿ WordCounts
▾ publicdata:samples
  ⠿ github_timeline
  ⠿ gsod
  ⠿ natality
  ⠿ shakespeare
  ⠿ trigrams
  ⠿ wikipedia

RUN QUERY   Query running (1.9s)...

Recent Queries

Query	Time
SELECT corpus, word_count FROM publicdata:samples.shakespeare ORDER BY word_count DESC LIMIT 200;	3:17pm
SELECT word, COUNT(word) AS wordcount FROM publicdata:samples.shakespeare WHERE word >= "A" AND word < "B" GROUP BY word HAVING COUNT(word) > 10 ORDER BY word LIMIT 10;	12:53pm
SELECT word, COUNT(word) AS wordcount FROM publicdata:samples.shakespeare WHERE word >= "A" AND word < "B" GROUP BY word HAVING COUNT(word) > 100 ORDER BY word LIMIT 10;	12:53pm

Introducing **Amazon Redshift**
A fast and powerful, fully managed petabyte-scale data warehouse service in the AWS Cloud.

< | >
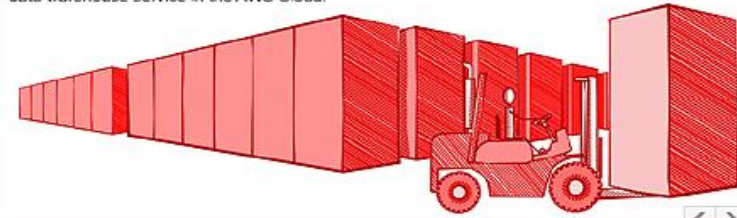
Mesa: Geo-Replicated, Near Real-Time, Scalable Data Warehousing

Ashish Gupta, Fan Yang, Jason Govig, Adam Kirsch, Kelvin Chan
Kevin Lai, Shuo Wu, Sandeep Govind Dhoot, Abhilash Rajesh Kumar, Ankur Agiwal
Sanjay Bhansali, Mingsheng Hong, Jamie Cameron, Masood Siddiqi, David Jones
Jeff Shute, Andrey Gubarev, Shivakumar Venkataraman, Divyakant Agrawal
Google, Inc.

🕐168.com   ⓤ ChinaUnix   ITPUB

ABSTRACT
Mesa is a highly scalable analytic data warehousing system that stores critical measurement data related to Google's

ness critical nature of this data result in unique technical and operational challenges for processing, storing, and querying. The requirements for such a data store are:
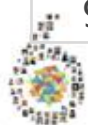
目录

- OLAP背景介绍
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- Palo对外开放

Palo

- *A **MPP-based** **Interactive Data Analysis** **SQL DB***

- A Google Mesa Clone, is simpler and better than Mesa

- **面向百TB~PB级别，结构化数据，毫秒/秒级分析**

- **百度大数据部OLAP团队研发**

- **第三代产品 Doris -> OlapStroageEngine -> Palo**

- **PALO意为"玩转OLAP"**
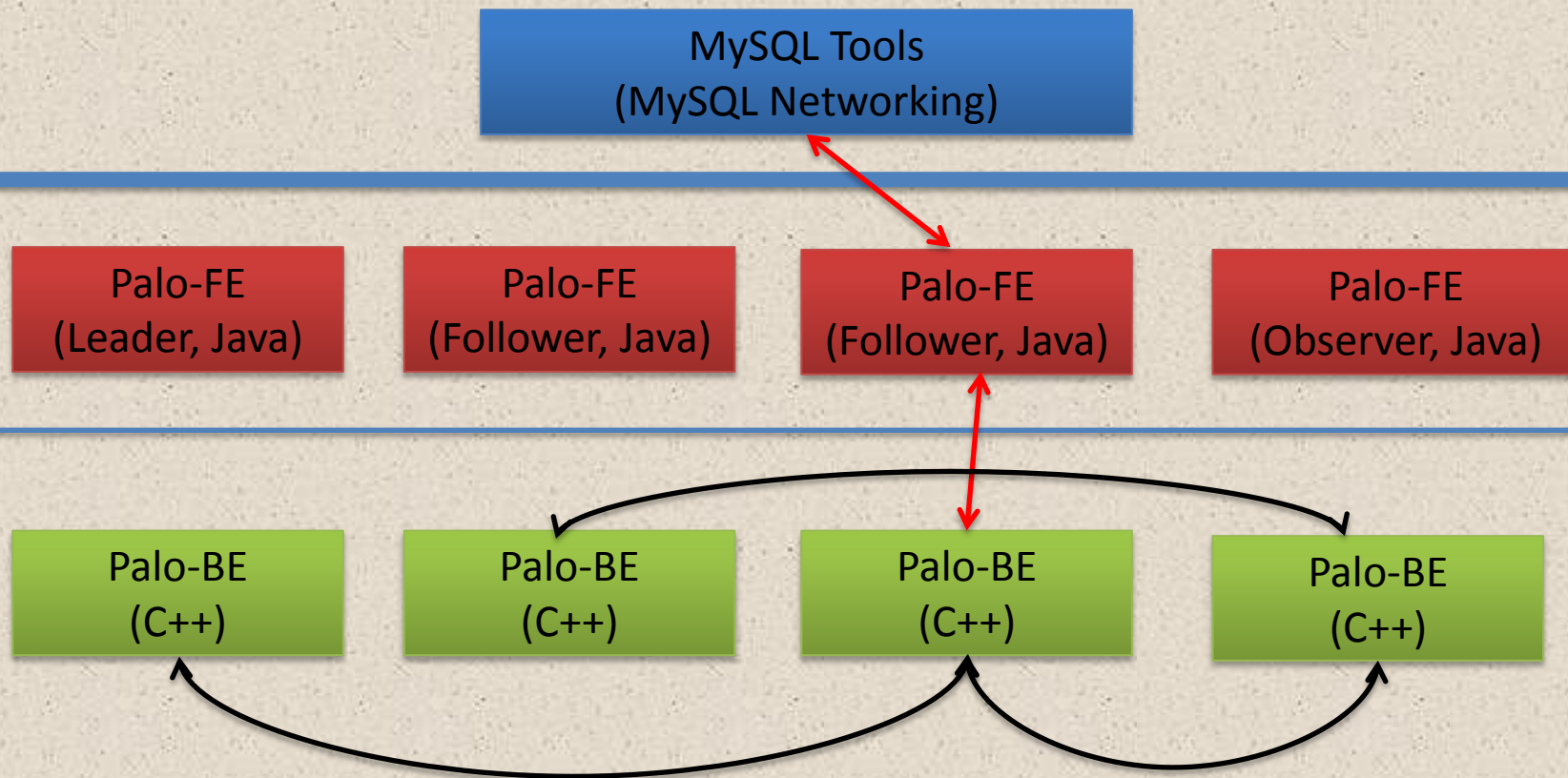
- **80+产品线使用，400+机器，单一业务最大百TB，15年预计部署1000台**

Palo设计原则和定位

- **简单可依赖**

| 低成本 | | 线性扩展 | | 支持云化部署 |

1/10 ~1/100 Cost   100~200节点 / 1000 TB

| 高可用 | | 高查询性能 | | 高加载性能 |

99.9999 % Uptime   10W QPS/ 100GB/s   10 TB / Hour

整体架构

MySQL Tools
(MySQL Networking)

Palo-FE
(Leader, Java)

Palo-FE
(Follower, Java)

Palo-FE
(Follower, Java)

Palo-FE
(Observer, Java)

Palo-BE
(C++)

Palo-BE
(C++)

Palo-BE
(C++)

Palo-BE
(C++)

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Frontend Metadata Management

- State Machine + Replicated Log

- 类似Raft协议思想
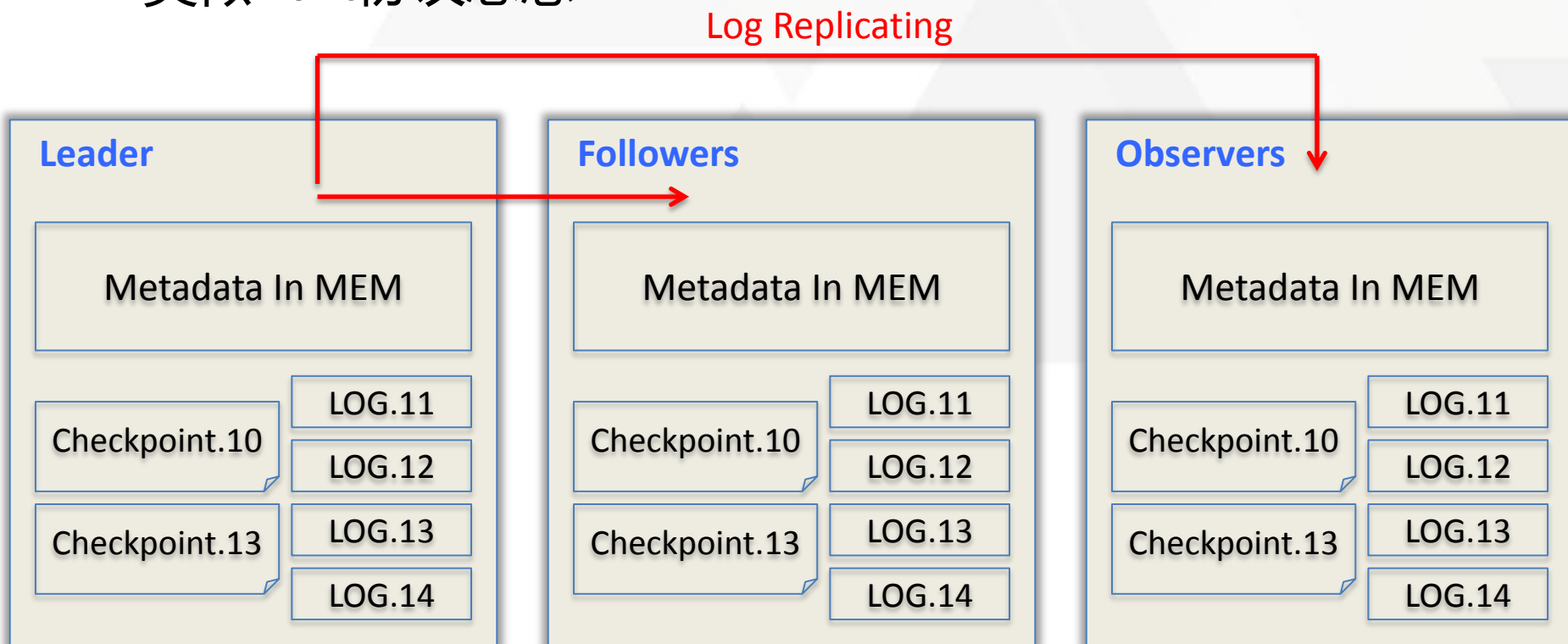
MySQL Networking Protocol
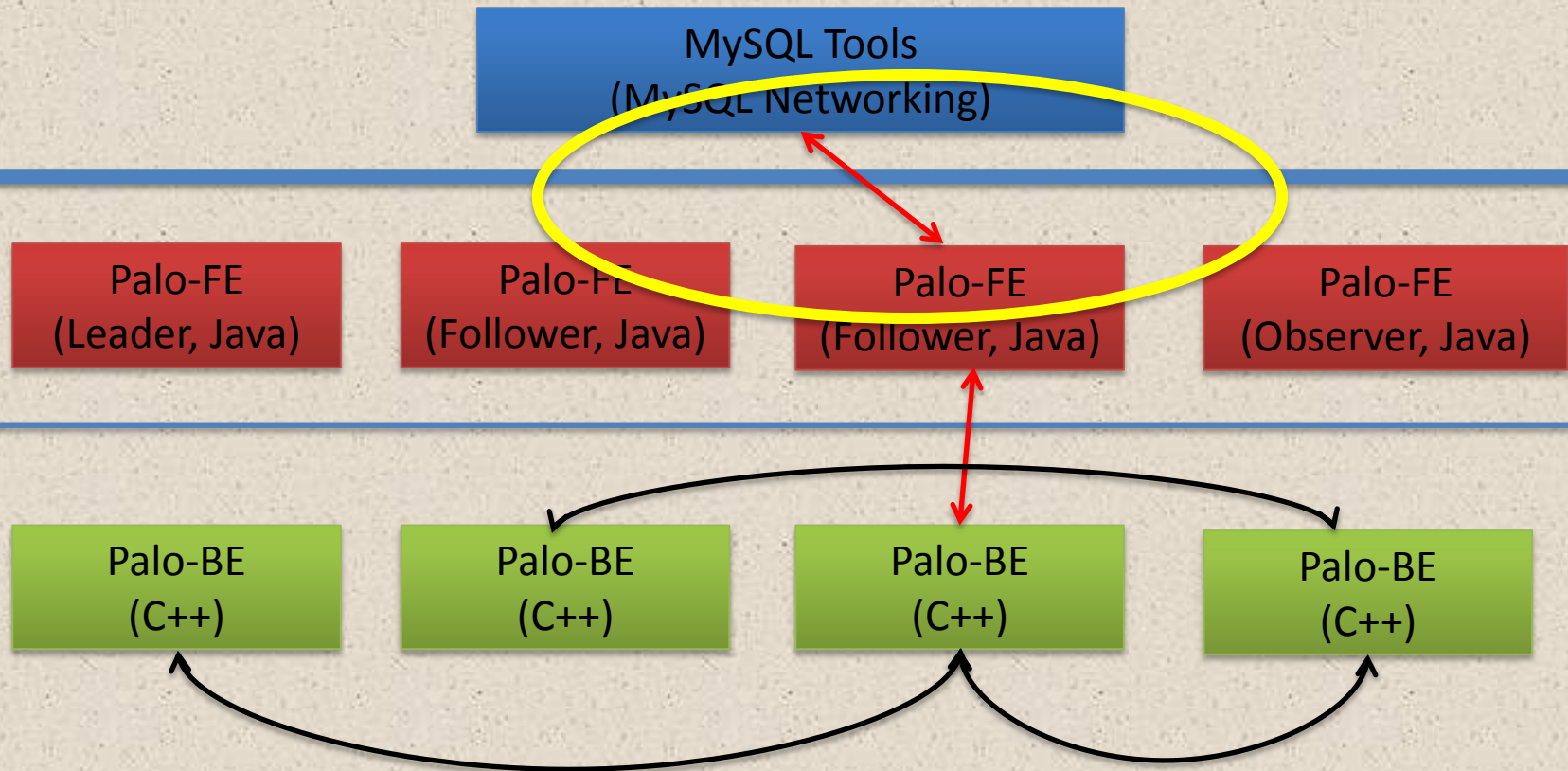
```
test@mry-laptop:~$
test@mry-laptop:~$ mysql -h tc-inf-devop01.tc.baidu.com -P 8276 -u maruyue
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 0
Server version: 4.1.2 (Powered by Palo 2.0 Beta)

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Oracle is a registered trademark of Oracle Corporation and/or its
affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> show databases;
+--------------------+
| Database           |
+--------------------+
| demo               |
| fc                 |
| information_schema |
| lbs                |
| searchbox          |
| test               |
+--------------------+
6 rows in set (0.01 sec)

mysql> use test;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
mysql> show tables;
+-----------------+
| Tables_in_test  |
+-----------------+
| fc_cmatch_fact  |
| tbldim_pn       |
| tbldim_querytrade |
| tbldim_region   |
| tbldim_wbws     |
| tbldim_wos      |
| tbldim_wpt      |
+-----------------+
7 rows in set (0.01 sec)
```
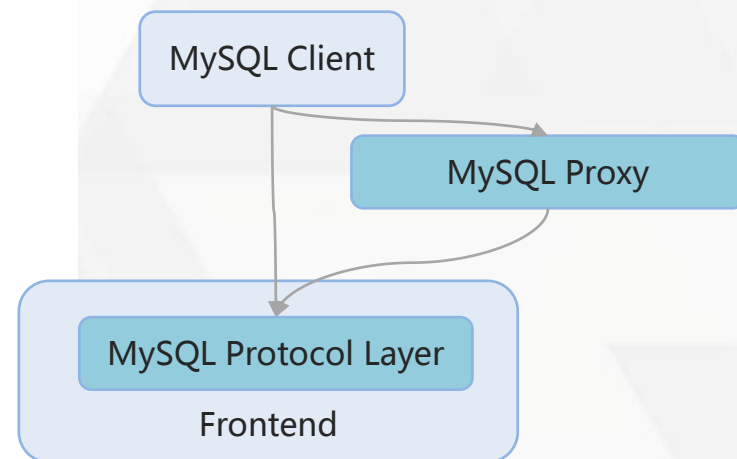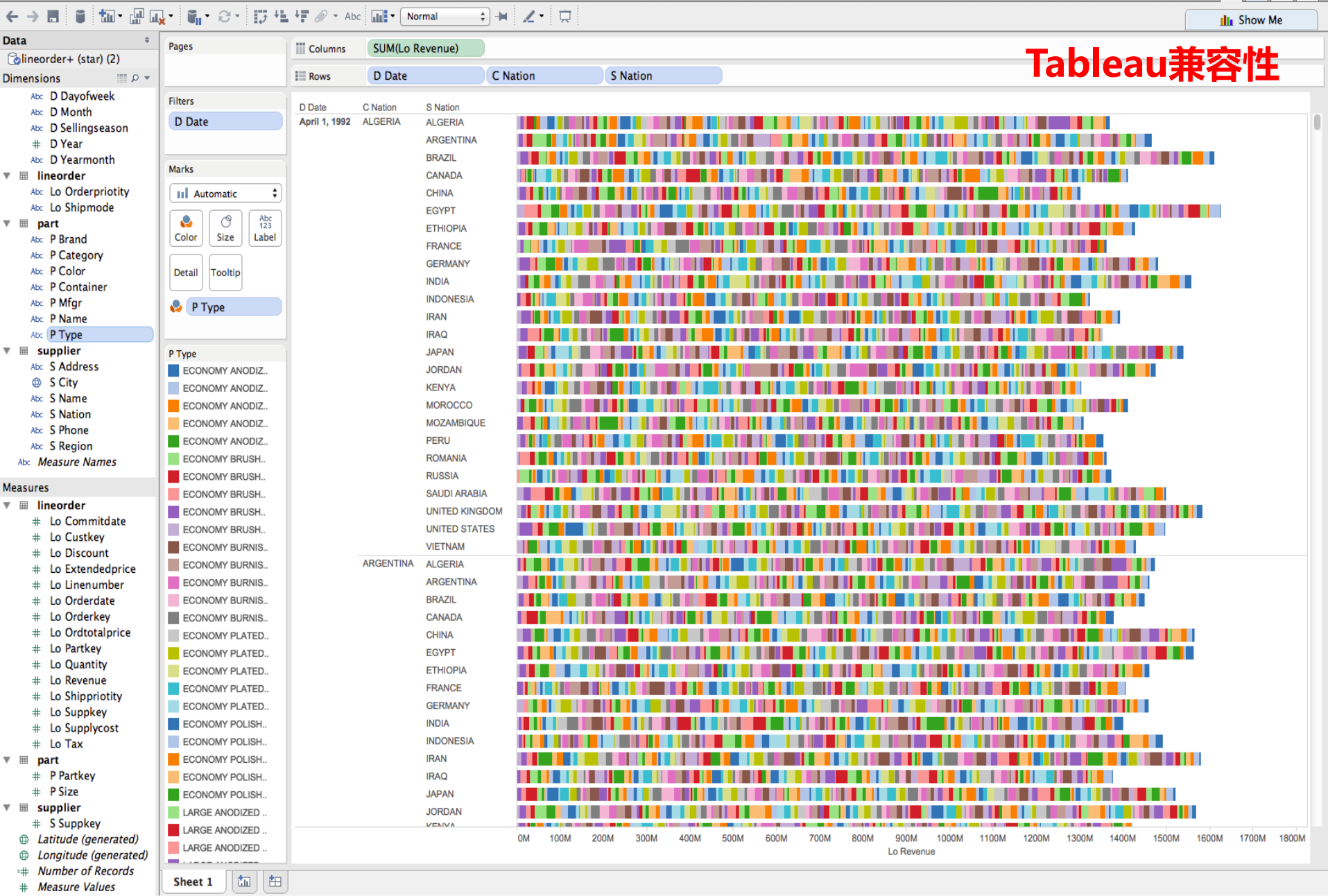

✓ 轻量级客户端

✓ 与上层应用兼容容易

✓ 学习曲线平缓，方便用户上手使用

✓ 利用MySQL相关工具，比如MySQL Proxy

Tableau兼容性

R语言兼容性

```
→ test_r R

R version 3.0.1 (2013-05-16) -- "Good Sport"
Copyright (C) 2013 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Previously saved workspace restored]

> library(RMySQL)
Loading required package: DBI
> con <- dbConnect(MySQL(), user="root", password="        ", dbname="demo", host="tc-inf-devop01.tc.baidu.com", port=8276)
> dbListTables(con)
[1] "cumulative_detail_test" "fc_cmatch_fact"         "tbldim_pn"
[4] "tbldim_querytrade"      "tbldim_region"          "tbldim_wbws"
[7] "tbldim_wos"             "tbldim_wpt"             "ud_test"
> rs <- dbSendQuery(con, "select * from tbldim_region")
> d1 <- fetch(rs, n = 10)
> d1
   pid cid province      city
1    1   0     北京   北京其他
2    2   0     上海   上海其他
3    3   0     天津   天津其他
4    4   0     广东   广东其他
5    5   0     福建   福建其他
6    8   0     海南   海南其他
7    9   0     安徽   安徽其他
8   10   0     贵州   贵州其他
9   11   0     甘肃   甘肃其他
10  12   0     广西   广西其他
>
```

存储模型

Keys

Values

Values聚合方式Sum, Replace

Date	PublisherId	Country	Clicks	Cost
2013/12/31	100	US	10	32
2014/01/01	100	US	205	103
2014/01/01	200	UK	100	50

(a) Mesa table A

Date	AdvertiserId	Country	Clicks	Cost
2013/12/31	1	US	10	32
2014/01/01	1	US	5	3
2014/01/01	2	UK	100	50
2014/01/01	2	US	200	100

(b) Mesa table B

Base表

AdvertiserId	Country	Clicks	Cost
1	US	15	35
2	UK	100	50
2	US	200	100

(c) Mesa table C

Rollup表

Figure 1: Three related Mesa tables

引自*Google Mesa Paper*

Date	PublisherId	Country	Clicks	Cost
2013/12/31	100	US	+10	+32
2014/01/01	100	US	+150	+80
2014/01/01	200	UK	+40	+20

(a) Update version 0 for Mesa table A

Date	AdvertiserId	Country	Clicks	Cost
2013/12/31	1	US	+10	+32
2014/01/01	2	UK	+40	+20
2014/01/01	2	US	+150	+80

(b) Update version 0 for Mesa table B

Delta更新

Date	PublisherId	Country	Clicks	Cost
2014/01/01	100	US	+55	+23
2014/01/01	200	UK	+60	+30

(c) Update version 1 for Mesa table A

Date	AdvertiserId	Country	Clicks	Cost
2013/01/01	1	US	+5	+3
2014/01/01	2	UK	+60	+30
2014/01/01	2	US	+50	+20

(d) Update version 1 for Mesa table B

Figure 2: Two Mesa updates
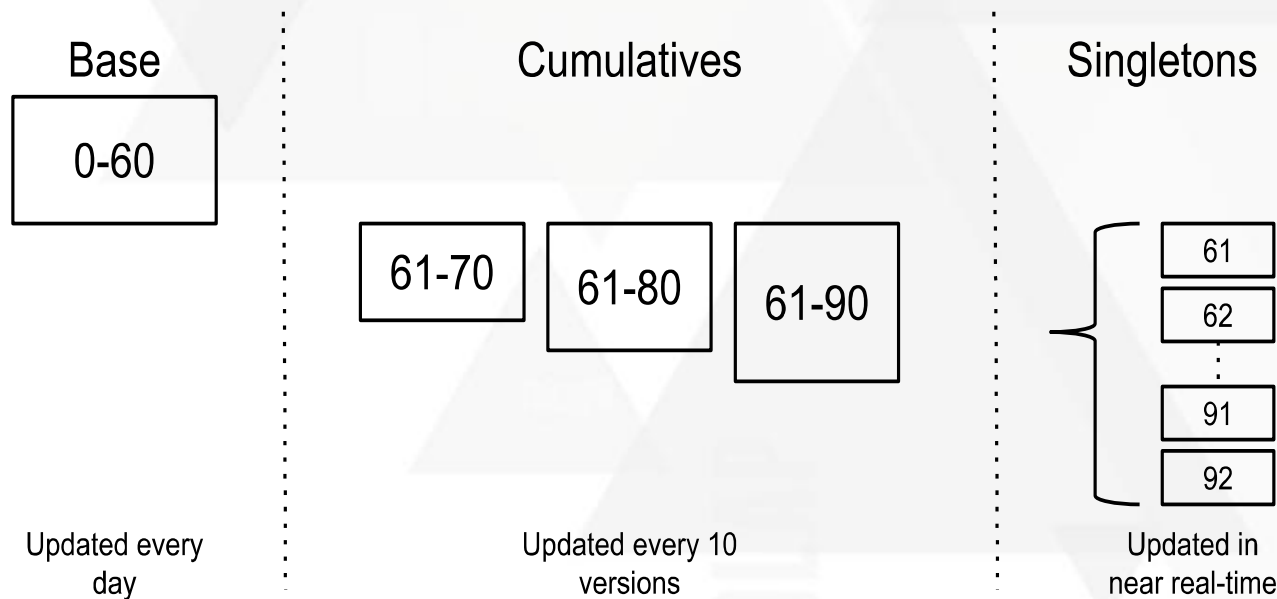
Compaction

Figure 3: A two level delta compaction policy

引自Google Mesa Paper

存储格式 – 行列存

- 数据块存储
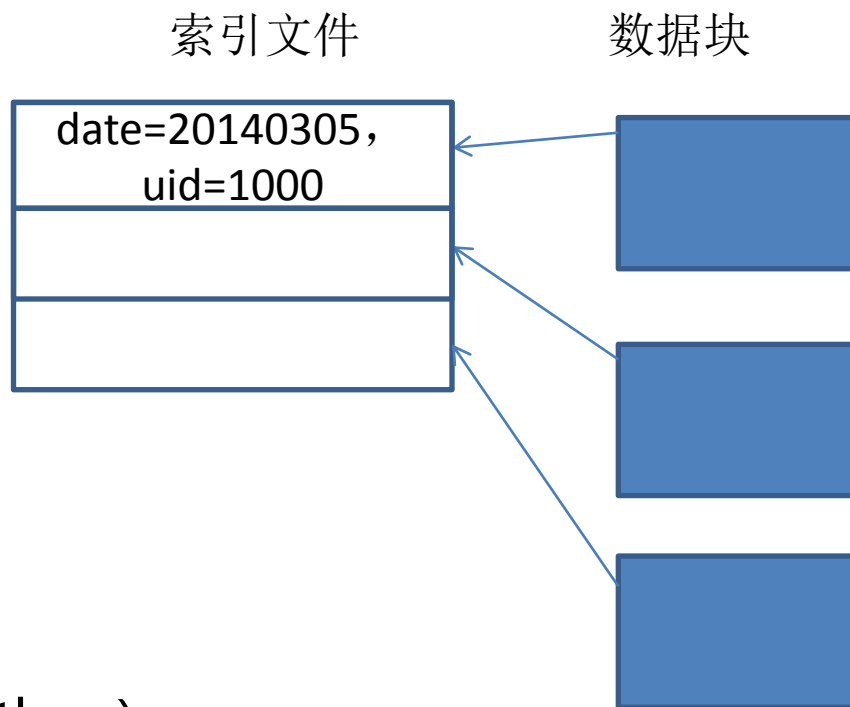 - 每个块包含256行
  - 块内按列存储
  - 块整体压缩

- 稀疏索引
  - 索引驻内存
  - 每个块一个索引项
  - 部分Key作为索引（Shortkey）

索引文件　　　　　数据块

date=20140305，uid=1000

存储格式 – 列存储

SSN	Name	Age	Addr	City	St
101259797	SMITH	88	899 FIRST ST	JUNO	AL
892375862	CHIN	37	16137 MAIN ST	POMONA	CA
318370701	HANDU	12	42 JUNE ST	CHICAGO	IL

101259797 | 892375862 | 318370701 | 468248180 | 378568310 | 231346875 | 317346551 | 770336528 | 277332171 | 455124598 | 735885647 | 387586301

Block 1

- ✓ 数据按列存储，每一列单独存放
- ✓ 只访问查询涉及的列，大量降低I/O
- ✓ 数据类型一致，方便压缩
- ✓ 数据包建索引，数据即索引
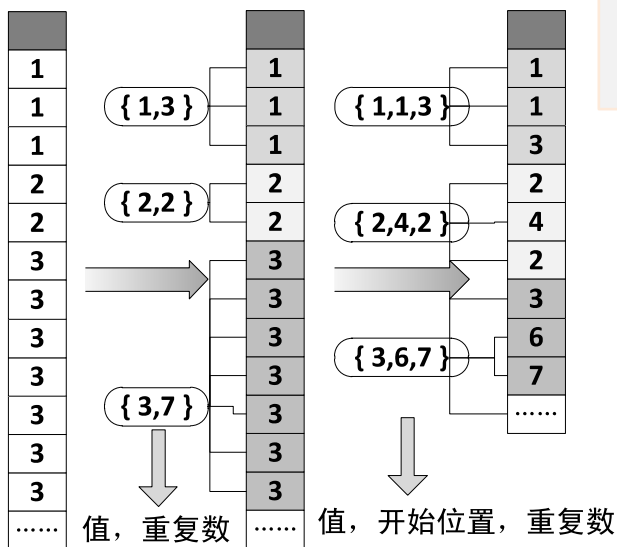
- ✓ Palo存储引擎利用原始过滤条件以及min、max和sum智能索引技术将数据集查询范围尽可能地缩小，可以大大减少I/O，提升查询性能

值，重复数   值，开始位置，重复数

数值类型的行程编码（RLE）压缩

a (date)	b (int)	c	d	e
100101	8, 10	...	...	...
100101, 100102	5, 25	...	...	...
100102	30, 50	...	...	...
100103	1, 5	...	...	...

True = 完全确定 → **必须读**取列数据

Possible = 有可能 → 可以进一步优化结合其它条件过滤后确定

False = 完全排除 → 不需要读取列数据

{min, max, sum, ...}

| 100101, 100101 | 8, 10, **600000** |
| 100101, 100102 | 5, 25, **1155261** |

600000 + **24351**

b列一个需要打开的数据包

```
select      a
            sum(b) as b
from        mytab
where       a<='100101'
group by    a
order by    b desc
```
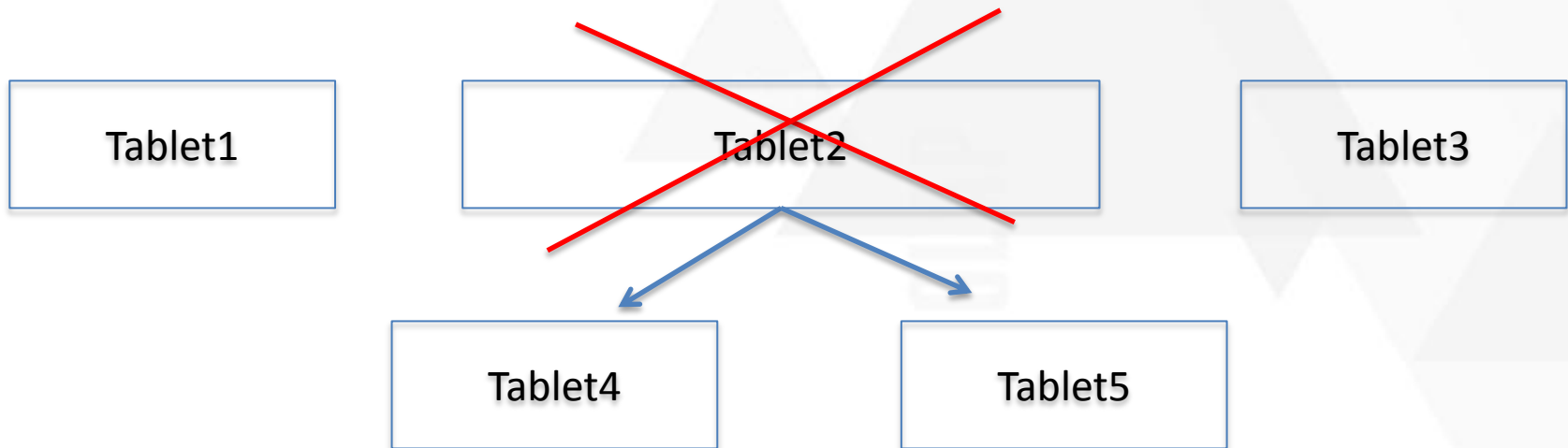
结果集
过滤条件I/O
基本算子

数据分区

- 单层分区

  - Hash Partition

  - Elastic Range Partition

数据分区

- ## 单层分区问题

  - 导入性能低，元数据更新频繁

  - 冷数据，会重复进行compaction，浪费资源

  - 冷热数据部方便进行异构存储介质优化（SSD/SATA）
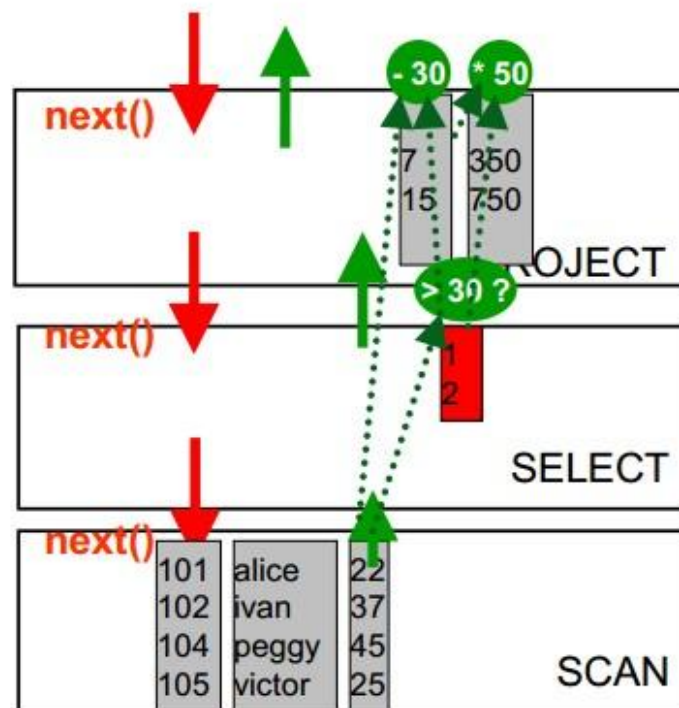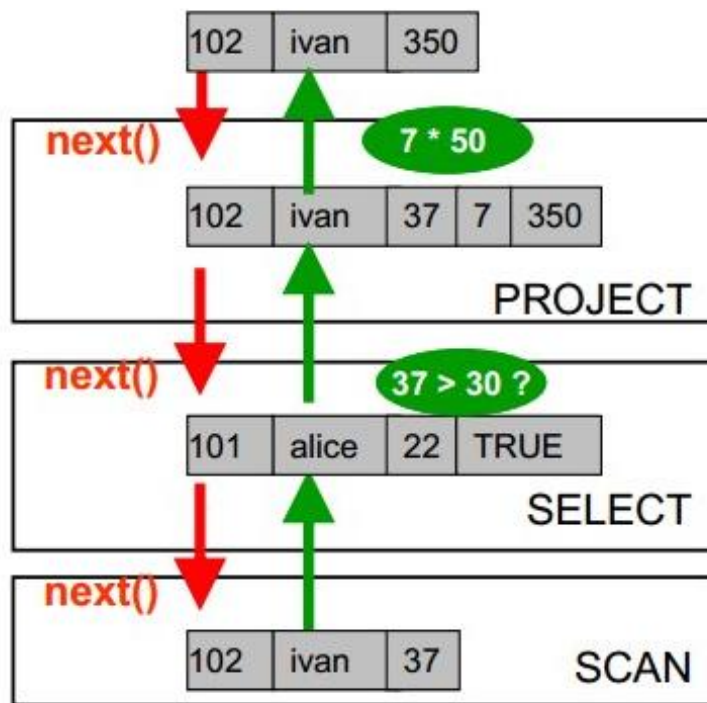
  - 数据删除比较低效

- ## 复合分区

  PARTITION BY *LIST*(date) (
       PARTITION 20150101 VALUES IN ("20150101"),
       PARTITION 20150102 VALUES IN ("20150102")
)
  SUBPARTITION BY *HASH*(user) PARTITIONS 16;

向量执行引擎

```
SELECT   id, name
         (age-30)*50 AS bonus
FROM     employee
WHERE    age > 30
```
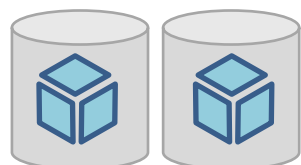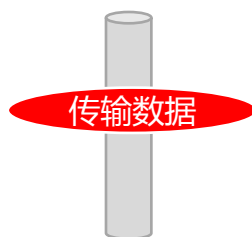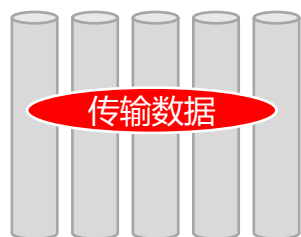
向量执行引擎

- 行式执行引擎的问题
  - 每行一次函数调用，打断CPU流水，不利于分支预测
  - 指令和数据的cache miss
  - 编译器不友好，不利于循环展开，SIMD
- 设计思路
  - 单条处理到批量处理
  - 行式处理到列式处理
- 效果
  - Star Scheme benchmark性能提升2~4倍

库内分析

time-stamp	userid
10:00:00	238909
00:58:24	7656
10:00:24	238909
02:30:33	7656
10:01:23	238909
10:02:40	238909

(a) Raw click data

time-stamp	userid	session
10:00:00	238909	0
10:00:24	238909	0
10:01:23	238909	0
10:02:40	238909	1
00:58:24	7656	0
02:30:33	7656	1

(b) Click data with session information

- UDF
- UDAF
- UDTF

```
SELECT ts, userid, session
FROM sessionize (
      ON clicks
      PARTITION BY userid
      ORDER BY ts
      TIMECOLUMN ('ts')
      TIMEOUT (60)
      );
```

Palo核心技术

- 存储引擎

  - 分布式存储引擎，单表容量可以到百TB~PB

  - 复合分区

  - 列存储，高效压缩和编码，智能索引

  - 小批量导入 + 批量原子提交，MVCC

  - 高效的分布式数据导入

  - 在线create rollup，schema change

  - 完善的分布式管理框架（自动副本均衡，副本修复）

Palo核心技术

- 查询引擎
  - 实现Mysql网络协议，易用，和各种BI工具无缝对接
  - **Share-noting MPP架构，可扩展性好**
  - 大表分布式join (shuffle和broadcast)
  - 谓词下推，复杂谓词下推
  - **Rollup表智能选择**
  - Partition pruning
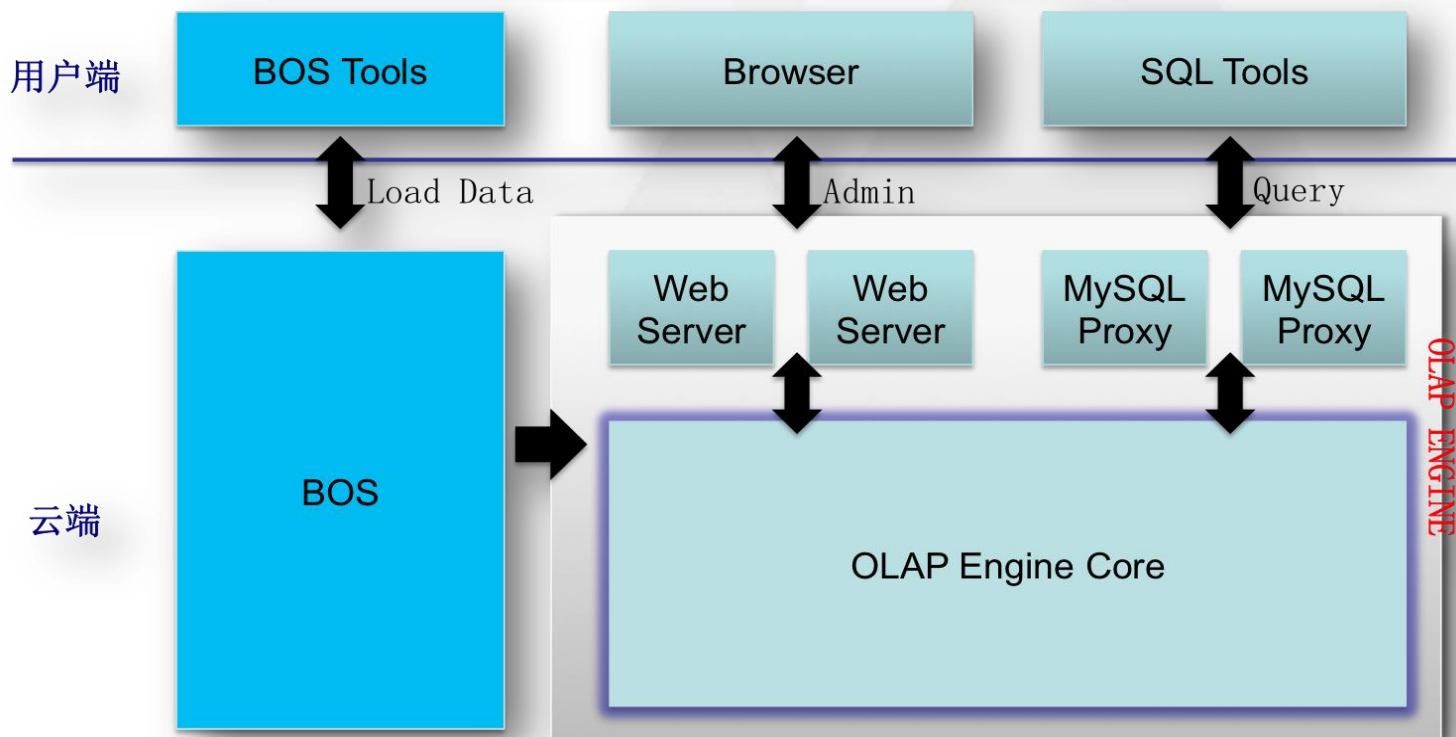 - 向量执行引擎
  - 库内分析
  - 丰富的SQL表达：窗口函数
  - 多租户资源隔离

目录
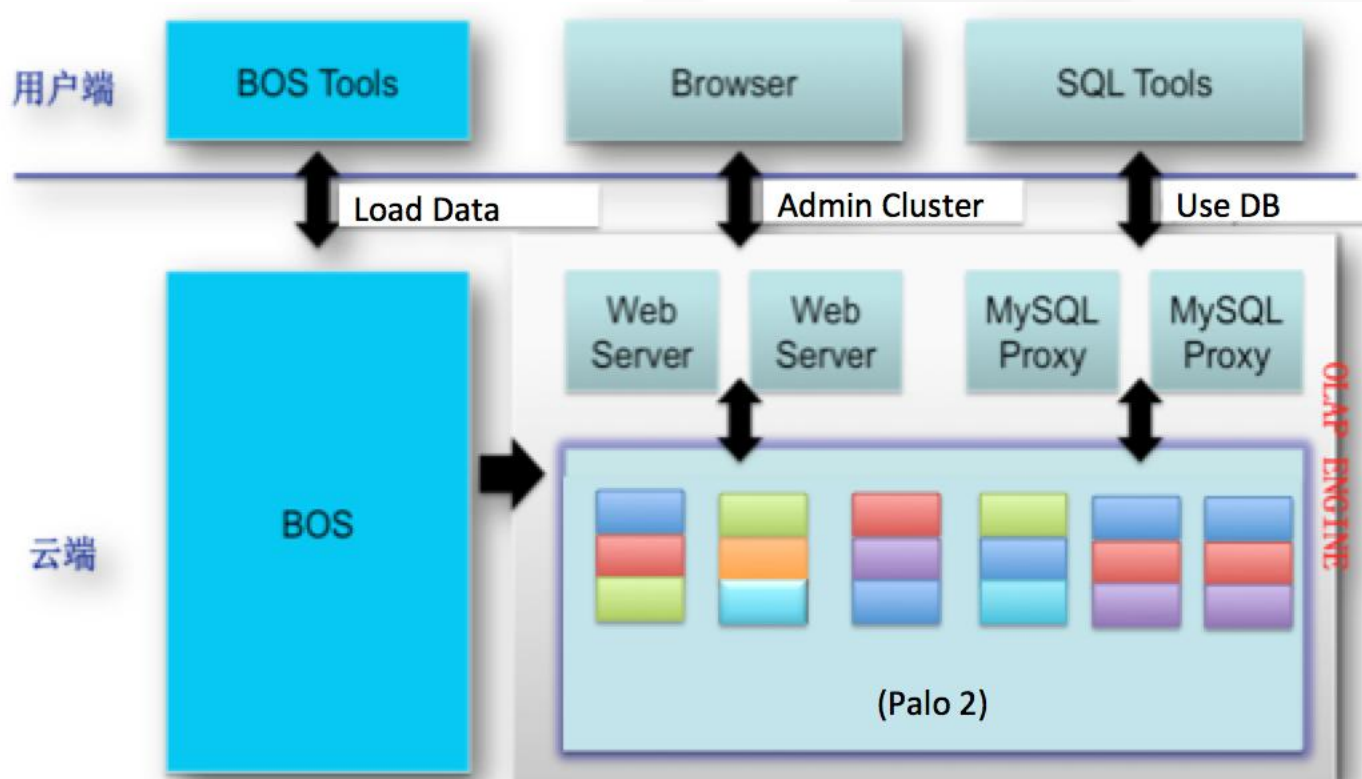
- OLAP背景介绍
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- Palo关键技术
- Palo对外开放

基于Palo的云分析 – OLAP Engine

- OLAP Engine Alpha 2014.9

- BigQuery 模式

基于Palo的云分析 – OLAP Engine

- OLAP Engine Beta 2015下半年，目前正在邀请用户测试

- Redshift模式

开源计划

- 2015下半年，10月左右，开源Palo

- 2016年开源云化框架

成就直达号的大数据引擎技术专场

百度直达号   http://zhida.baidu.com/

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