Using MySQL for Big Data Advantage
Integrate for Insight

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Agenda

- The rise of Big Data & Hadoop
- MySQL in the Big Data Lifecycle
- MySQL Solutions for Big Data
- Q&A
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DRIVING MySQL INNOVATION

MySQL Enterprise Monitor 2.2
MySQL Cluster 7.1
MySQL Cluster Manager 1.0
MySQL Workbench 5.2
MySQL Database 5.5
MySQL Enterprise Backup 3.5
MySQL Enterprise Monitor 2.3
MySQL Cluster Manager 1.1

All GA!

2010

MySQL Enterprise Backup 3.7
Oracle VM Template for MySQL Enterprise Edition
MySQL Enterprise Oracle Certifications
MySQL Windows Installer
MySQL Enterprise Security
MySQL Enterprise Scalability

All GA!

MySQL Database 5.6 DMR*
MySQL Cluster 7.2 DMR
MySQL Labs!
(“early and often”)

2011

MySQL Cluster 7.2
MySQL Cluster Manager 1.4
MySQL Utilities 1.0.6
MySQL Migration Wizard
MySQL Enterprise Backup 3.9
MySQL Enterprise Audit
MySQL Database 5.6
MySQL Cluster 7.3

All GA!

MySQL Database 5.7.2 DMR

A BETTER MySQL

2012-13
Pluggable Storage Engines Architecture

MySQL Server
Clients and Apps

Enterprise Management Services and Utilities
Backup & Recovery
Security
Replication
Cluster
Partitioning
Instance Manager
Information Schema
MySQL Workbench

Connectors
Native C API, JDBC, ODBC, .Net, PHP, Ruby, Python, VB, Perl

Connection Pool
Authentication – Thread Reuse – Connection Limits – Check Memory – Caches

SQL Interface
DDL, DML, Stored Procedures, Views, Triggers, Etc.

Parser
Query Translation, Object Privileges

Optimizer
Access Paths, Statistics

Caches
Global and Engine Specific Caches and Buffers

Pluggable Storage Engines
Memory, Index and Storage Management

InnoDB
MyISAM
Cluster
Etc...

Files
Redo, Undo, Data, Index, Binary, Error, Query and Slow

Partners
Community
More..
Industry Leaders Rely on MySQL

Web & Enterprise

OEM & ISVs

Cloud
MySQL 5.6: In Summary

**IMPROVED PERFORMANCE AND SCALABILITY**
- Scales to 48 CPU Threads
- Up to 230% performance gain over MySQL 5.5

**IMPROVED INNODB**
- Better transactional throughput and availability

**IMPROVED OPTIMIZER**
- Better query exec times and diagnostics for query tuning and debugging

**IMPROVED REPLICATION**
- Higher performance, availability and data integrity

**IMPROVED PERFORMANCE SCHEMA**
- Better Instrumentation, User/Application level statistics and monitoring

**New! NoSQL ACCESS TO INNODB**
- Fast, Key Value access with full ACID compliance, better developer agility
Leading Use-Case, On-Line Retail

Users

Browsing

Recommendations

Social media updates
Preferences
Brands “Liked”

MySQL

Profile, Purchase History

Recommendations

Web Logs:
Pages Viewed
Comments Posted

Telephony Stream

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MySQL in the Big Data Lifecycle

- ACQUIRE
  - MySQL
- ORGANIZE
  - MySQL Applier
- ANALYZE
  - MySQL
- DECIDE
  - BI Solutions
MySQL + Hadoop: Unlocking the Power of Big Data

50% of our users integrate with MySQL*

Download the MySQL Guide to Big Data:

*Leading Hadoop Vendor
MySQL in the Big Data Lifecycle

NoSQL Interfaces for
MySQL Database
MySQL Cluster
MySQL NoSQL Interface

Design Goals: Fast, Flexible and Safe

Blazing Fast Key / Value Queries

Fully transactional / ACID

NoSQL + SQL across same Data Set

Combined with Schema Flexibility: Online DDL
Memcached is in-memory key-value store for small data.

- It is one of the most widely used In-Memory cache implementations for social network websites.
- Memcached has a simple and open protocol as opposed to a rich client bound to a specific language, and implementation makes it portable across a wide variety of languages and environments.

**Diagram Description:**
- **Client:** Connects to Memcached.
- **Memcached:** Stores and retrieves data.
- **MySQL:** Provides SQL queries.
- **Simple protocol:** Set/get/add/delete commands.
- **Save/retrieve copy:** Data synchronization between client and Memcached.
InnoDB as a Key Value store

- Combine the best of the NoSQL world and SQL world
- Memcached listens on specific ports as the front end, directs requests directly to InnoDB
- Simple commands, much smaller network transmit packages
- Persistent storage from InnoDB
- Index on the key column
- Full ACID compliance
- Bypass Optimizer and QP layer of MySQL and directly access the storage engine
- Dual access of data (SQL and Memcached)
MySQL 5.6: NoSQL Interface to InnoDB

- **Memcached API**

  - Key-value access to InnoDB
  - Bypasses SQL parsing
  - Implemented via:
    - Memcached plug-in to mysqld
    - Memcached mapped to native InnoDB API
    - Use existing Memcached clients
    - Shared process for ultra-low latency

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Performance

MySQL 5.6: NoSQL Benchmarking

Up to 9x Higher “SET / INSERT” Throughput
MySQL Cluster: Multiple NoSQL Interfaces

Mix & Match

Clients and Applications

NoSQL

Native
memcached
JavaScript
Java

SQL

JDBC / ODBC
PHP / PERL
Python / Ruby

NDB API

MySQL Cluster Data Nodes
• NoSQL C++ API, flexaSynch benchmark
• 30 x Intel E5-2600 Intel Servers, 2 socket, 64GB
• ACID Transactions, with Synchronous Replication
MySQL in the Big Data Lifecycle

Import Data
Apache Sqoop
MySQL Hadoop Applier
Apache Sqoop

- Apache TLP, part of Hadoop project
  - Developed by Cloudera
- Bulk data import and export
  - Between Hadoop (HDFS) and external data stores
- JDBC Connector architecture
  - Supports plug-ins for specific functionality
- “Fast Path” Connector developed for MySQL
Importing Data

Gather Metadata

Sqoop Import

Transactional Data

Submit Map Only Job

Sqoop Job

HDFS Storage

Map

Map

Map

Map

Hadoop Cluster

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MySQL Applier for Hadoop

Real-Time Event Streaming
MySQL to HDFS
Hadoop Applier: Design

- Uses MySQL replication techniques for real time integration
- Binlog API uses Binary Log to rapidly fetch new data from a running server via the replication protocol
- MySQL Binlog comprised of events, each event represents a database change
- Hadoop Applier receives the events using the Binlog API, and writes the changes into a file in Hadoop Distributed File System
- Other tools in Hadoop Ecosystem, such as Apache Hive, can then consume this data
New Tool: MySQL Applier for Hadoop

- Binlog API
  - Decode Row
  - libhdfs
    - Timestamp
    - Primary Key
    - Data
      - HDFS
Hadoop Applier: Implementation

- Replicates rows inserted into a table in MySQL to Hadoop Distributed File System
- Uses an API provided by libhdfs, a C library to manipulate files in HDFS
- The library comes pre-compiled with Hadoop Distributions
- Connects to the MySQL master (or reads the binary log generated by MySQL) to:
  - Fetch the row insert events occurring on the master
  - Decode these events, extracting data inserted into each field of the row
  - Separate the data by the desired field delimiters and row delimiters
  - Use content handlers to get it in the format required
  - Append it to a text file in HDFS
Integration with HIVE

- Hive runs on top of Hadoop. Install HIVE on the hadoop master node
- Set the default datawarehouse directory same as the base directory into which Hadoop Applier writes
- Create similar schema's on both MySQL & Hive
- Timestamps are inserted as first field in HDFS files
- Data is stored in 'datafile1.txt' by default
- The working directory is base_dir/db_name.db/tb_name

### SQL Query

<table>
<thead>
<tr>
<th>SQL Query</th>
<th>Hive QL</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>CREATE TABLE t (i INT);</code></td>
<td><code>CREATE TABLE t (time_stamp INT, i INT) [ROW FORMAT DELIMITED] STORED AS TEXTFILE;</code></td>
</tr>
</tbody>
</table>
Mapping Between MySQL and HDFS Schema

MySQL

<table>
<thead>
<tr>
<th>col1</th>
<th>col2</th>
<th>....</th>
</tr>
</thead>
<tbody>
<tr>
<td>data1</td>
<td>data2</td>
<td>....</td>
</tr>
<tr>
<td>data3</td>
<td>data4</td>
<td>....</td>
</tr>
</tbody>
</table>

HIVE

datafile1.txt
table1/datafile1.txt

ts1, data1, data2, ...
ts2, data3, data4, ...
....
ts = timestamp

Data warehouse directory

- database1.db
  - table1
  - table2
  - datafile1.txt
- database2.db
  - table3
  - table4
  - datafile1.txt
MySQL in the Big Data Lifecycle

Analyze
Export Data
Decide

ANALYZE
DECIDE
Analyze Big Data
Export Data

Submit Map Only Job

Squoop Export

Gather Metadata

MySQL

Transactional & Analytics Data

Squoop Job

HDFS Storage

Hadoop Cluster
MySQL Reporting Database for BI
MySQL Operational Database for Web
Data Analysis: MySQL Enterprise Edition

Highest Levels of Security, Performance and Availability

- Oracle Premier Lifetime Support
- Oracle Product Certifications/Integrations
- MySQL Enterprise Security
- MySQL Enterprise Monitor/Query Analyzer
- MySQL Enterprise Backup
- MySQL Workbench
- MySQL Enterprise Audit
- MySQL Enterprise Scalability
- MySQL Enterprise High Availability
- MySQL Enterprise Edition

Data Analysis: Highest Levels of Security, Performance and Availability
MySQL Enterprise Monitor with Query Analyzer

Tune Analytical Queries

Enhance DevOps Agility

Replication Monitoring

<table>
<thead>
<tr>
<th>Server</th>
<th>Type</th>
<th>Slave IO</th>
<th>Slave SQL</th>
<th>Seconds Behind</th>
</tr>
</thead>
<tbody>
<tr>
<td>master:10101</td>
<td>TREE</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>slave:10101</td>
<td>master</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>Ringlet:2</td>
<td>RING</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>Yang:10120</td>
<td>master/slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>Yin:10121</td>
<td>master/slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>RingSpoke:4</td>
<td>MIXED</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>ring1:10183</td>
<td>master/slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>ring2:10182</td>
<td>master/slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>ring3:10181</td>
<td>master/slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>ring3slave:10180</td>
<td>slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>Tree 3:5</td>
<td>TREE</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>master:10153</td>
<td>master</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>slave1:10150</td>
<td>slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>slave2:master:10152</td>
<td>master/slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>slave2:slave:10151</td>
<td>slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
<tr>
<td>slave3:slave:10154</td>
<td>slave</td>
<td>Running</td>
<td>Running</td>
<td>0:00:00:00</td>
</tr>
</tbody>
</table>

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Scaling, Security and Data Protection

- MySQL Enterprise Scalability
- MySQL Enterprise Security
- MySQL Enterprise Audit
- MySQL Enterprise Backup
MySQL Enterprise Backup

- Online Backup for InnoDB
- Full, Incremental, Partial Backups (scriptable interface)
- Compression
- Point in Time, Full, Partial Recovery options
- Metadata on status, progress, history
- Unlimited Database Size
- Cross-Platform
  - Windows, Linux, Unix
- Certified with Oracle Secure Backup

Ensures quick, online backup and recovery of your MySQL apps.
MySQL Enterprise Security

MySQL External Authentication

- PAM (Pluggable Authentication Modules)
  - Access external authentication methods
  - Standard interface (Unix, LDAP, others)
  - proxied and non-proxied users
- Windows
  - Access native Windows services
  - Authenticate users already logged into Windows (Windows Active Directory)

- Pluggable Authentication API
  Integrates MySQL with existing security infrastructures and SOPs
5.5 MySQL Enterprise Scalability

MySQL default thread-handling – excellent performance, can limit scalability as connections grow
MySQL Thread Pool improves sustained performance/scale as user connections grow.

Diagram showing external and internal clients connecting to thread pools and execution threads established.
Thread Pool

MySQL 5.6 Sysbench OLTP Read/Write

Simultaneous Database Connections

Transactions Per Second

MySQL Enterprise Edition
With Thread Pool

MySQL Community Server
Without Thread Pool
MySQL Enterprise Audit
Policy-based Auditing for MySQL Applications

- Out-of-the-box logging of connections, logins, query activity across all or specific MySQL servers
- User defined policies, filtering and log rotation
- Dynamically enabled, disabled: no server restart
- XML-based audit stream per Oracle audit specification
- Easily implemented via MySQL 5.5 Audit API
- MySQL 5.5.28 and higher

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• MySQL Maintenance Releases
• MySQL Support in 29 Languages
• 24/7/365
• Unlimited Incidents
• Knowledge Base
• MySQL Consultative Support

"The MySQL support service has been essential in helping us with troubleshooting and providing recommendations for the production cluster, Thanks."

-- Carlos Morales – Playfulplay.com

Only From Oracle
Summary

• MySQL + Hadoop: widely deployed solution
• “Best of both worlds” SQL + NoSQL Access
• Tools and expertise to support you
• End to end Oracle solutions for Big Data

Integrate for Insight
Next Steps

**Download the Guide**

**Try Out MySQL 5.6**
http://www.mysql.com/downloads/mysql/

**Engage MySQL Consulting**
http://www.mysql.com/consulting/
Thank you!
Hardware and Software
Engineered to Work Together