Integration of Oracle and Hadoop: hybrid databases affordable at scale

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Advantages of integrating Oracle and Hadoop

• Best of two worlds:
  • Oracle, optimized for Online Transactional System
  • Hadoop, scalable distributed data processing platform

• Hybrid systems:
  • Move (read-only) data from Oracle to Hadoop
  • Query Hadoop data from Oracle (using Oracle APIs)
  • Also possible: query Oracle from Hadoop

• Increase scalability and lower ratio cost/performance
  • Hadoop data formats and engines for high performance analytics
  • ....without need of changing the end-user apps connecting to Oracle
Oracle optimized for OLTP, Hadoop affordable at scale

Example of Oracle RAC deployed with shared storage

The shared nothing architecture allows to scale for high capacity and throughput on commodity HW
The Hadoop ecosystem is heterogeneous and evolving

Main Hadoop components at the CERN-IT Hadoop service (2016):

- HDFS: Hadoop Distributed File System
- MapReduce
- YARN: Cluster resource manager
- Zookeeper: Coordination
- Flume: data collector
- Impala: SQL
- Spark: Large scale data processing
- Sqoop: Data exchange with RDBMS
- Pig: Scripting
- Hive: SQL
- HBase: NoSql columnar store
Hadoop data formats and data ingestion

- Hadoop data formats
  - Are an important dimension to the architecture
  - Compression and encoding for analytic workloads
  - Columnar formats (Parquet)

- Data ingestion also very important
  - Sqoop to transfer from databases
  - Kafka, very successful for message-oriented ingestion
Examples from CERN and HEP

- ATLAS DDM for reports
- FCC reliability studies
- Accelerator and industrial controls at CERN
- Archive and reporting use cases to be explored

Example:
- Speedup of a reporting query from CERN Network experts
- Running in Oracle in 12 hours (no parallel query allowed in prod)
- Moved to Hadoop and run in parallel in minutes (throw HW to the problem)
The biggest (RDBMS) database at CERN

- **CERN Accelerator Logging System**
  - An archive system for metrics from most of devices and systems installed and used by LHC
  - **500 TB** in Oracle
  - **500 GB produced per day** (15 billion data points)

- **Offloaded to Hadoop with Apache Sqoop**
  - Daily export with 10 parallel streams, duration 3 hours (40 MB/s)
  - **Parquet** format with Snappy compression: factor 3.3
  - Size on HDFS: **140 TB**
Techniques for integrating Oracle and Hadoop

- Export data from Oracle to HDFS
  - **Sqoop** good enough for most cases
  - Other options possible (custom ingestion, Oracle DataPump, streaming, ..)

- Query Hadoop from Oracle
  - Access tables in Hadoop engines using **DB links** in Oracle
  - Build hybrid views: transparently combine data in Oracle and Hadoop

- Use Hadoop frameworks to process data in Oracle DBs
  - Use Hadoop engines (Impala, Spark) to process **data exported** from Oracle
  - Read data in a RDBMS **directly** from Spark SQL with JDBC
Offloading from Oracle to Hadoop

• Step 1: Offload data to Hadoop
  - Oracle database → Table data export → Hadoop cluster
  - Apache Sqoop
  - Data formats: Parquet, Avro

• Step 2: Offload queries to Hadoop
  - Oracle → Offloaded SQL
  - Offload interface: DB LINK, External table
  - Hadoop
  - SQL engines: Impala, Hive
How to access Hadoop from an Oracle query

• Query Apache Hive/Impala tables from Oracle using a database link

```
cREATE DATABASE LINK my_hadoop USING 'impala-gateway';
SELECT * FROM big_table@my_hadoop WHERE col1 = :val1;
```

• Query offloaded via ODBC gateway to Impala (or Hive)

• SQL operations that can be offloaded
  • Filtering predicates are pushed to Hadoop
  • Problem: grouping aggregates are not pushed
• There are techniques to work around this problem
  • Create aggregation with views in Hive/Impala
  • DBMS_HS_PASSTHROUGH – to push exact SQL statement to Hadoop
Making data sources transparent to end-user

• Hybrid views on Oracle
  • Recent (read-write) data in Oracle
  • Archive data in Hadoop
  • Advantages: Hadoop performance with unchanged applications (Oracle APIs)

```
create view hybrid_view as
select * from online_table where date > '2016-10-01'
union all
select * from archival_table@hadoop where date <= '2016-10-01'
```
Specialized products for hybrid DB and offloading

- **Oracle BigData SQL**
  - Custom engine to query Hadoop from Oracle
  - Based on Oracle external tables (predicate pushing)

- **Gluent Inc**
  - Similar functionality to BigData SQL
  - Uses Apache Impala to process data on Hadoop
  - Leverages *hybrid* views on Oracle for data integrity
  - Predicate pushing and partition pruning
  - Data retrieval >10x faster than ODBC gateway
Query Oracle from Apache Spark

- Spark SQL using JDBC to query Oracle directly
  - To access metadata and/or lookup tables
  - Use to retrieve metadata that can quickly become stale

- Example code to query Oracle into a Spark DataFrame (Python):

```python
df = sqlContext.read.format('jdbc').options(
    url="jdbc:oracle:thin:@ORACLE_DB/orcl.cern.ch",
    user="myuser",
    password="mypass",
    fetchSize=1000,
    dbtable="(select id, payload from my_oracle_table) df",
    driver="oracle.jdbc.driver.OracleDriver"
).load()
```
Conclusions

- Hadoop performs at scale, excellent for data analytics
- Oracle proven for concurrent transactional workloads
- Solutions are available to integrate Oracle and Hadoop

- There is value in hybrid systems (Oracle + Hadoop):
  - Oracle APIs for legacy applications and OLTP workloads
  - Scalability on commodity HW for analytic workloads
Hadoop Service at CERN

- Service provided by CERN-IT for Experiments and CERN users
- Projects ongoing with Experiments, Accelerators sector and IT
- Hadoop Users Forum for open discussions: subscribe to egroup it-analytics-wg
- Getting started material: Hadoop tutorials https://indico.cern.ch/event/546000/

- Related talks/posters at CHEP 2016:
  - First results from a combined analysis of CERN computing infrastructure metrics, talk on Tuesday at 12:00
  - A study of data representations in Hadoop to optimize data storage and search performance of the ATLAS EventIndex, poster on Tuesday 16:30
  - Big Data Analytics for the Future Circular Collider Reliability and Availability Studies, talk on Thursday at 14:15
  - Hadoop and friends - first experience at CERN with a new platform for high throughput analysis steps, talk on Thursday at 14:45
  - Developing and optimizing applications for the Hadoop environment, talk on Thursday at 15:15