Managing Large Scale Transactional Data in The Cloud

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The Big Data Eco–System in the Cloud
Inside a Data Center
MaaT: Distributed Transaction Processing

- **Pessimistic locking**
  - Less aborts compared to OCC
  - Blocking limits throughput

- **Optimistic Concurrency Control (OCC)**
  - High Throughput
  - More aborts with contention
Maat Design Principles

High Throughput

Conflict resolution at **fine granularity**

Avoid blocking transactions

Resolve conflict with **less aborts**

Scalability

**Distributed** verification

Only involve the **nodes accessed**

A  B  C
Data Center Data Management: MaaT

Calculate timestamp ranges where Txn can commit

Commit if an intersection exist
Catastrophic Failures: Geo-Replication
Google Spanner

- Global-scale data infrastructure
- Data is partitioned within data center
- Replication across data centers using Paxos
- Transactions execute on data using 2-phase commit
Communication Overhead
Replicated commit (VLDB 2013)

- Execute communication expensive transactions within a data center.
- Fault-tolerance across data centers using Paxos
- Consistency within data center using 2PC
- Significant reduction in communication costs.
Data Variety

Country Table

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND</td>
<td>India</td>
</tr>
<tr>
<td>USA</td>
<td>United States</td>
</tr>
</tbody>
</table>

Currency Table

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INR</td>
<td>India Rupees</td>
</tr>
<tr>
<td>USD</td>
<td>Dollars</td>
</tr>
</tbody>
</table>

Keys

- 13a1
- 13a2
- 13a3

Values

- Apple iPod Nano 32 GB
- Apple iPod Nano 18 GB
- Apple iPod Nano 08 GB

Graphical representation of data variety.
System Architecture

OLAP Client

Column Store

ETL/ Data Pipeline

OLTP Client

Row Store

ETL/ Data Pipeline

Graph analytics Client

Graph Engine
Replication Driven Solution

OLAP Client

OLTP Client

Graph analytics Client

Operation Processing Layer

Query Analyzer

Update Manager

Column Store

Row Store

Graph Engine
Privacy-Preserving Data Services In the Cloud

- Data security and privacy in the cloud vulnerable to:
  - Curious/Snooping system administrators
  - Hackers with illegal access

- **GOAL**: Functionality and performance of database systems while preserving data privacy and security.
Cloud for Privacy-Preserving Data Storage

Secure data storage requires encryption before outsourcing the data
- More space is required to store
- Data is transferred encrypted

- Efficient I/O
- Larger volumes

- Bandwidth Intensive
- Low communication overhead among geographically dispersed data centers

NSF Cloud Workshop 2014
Experimental Setup

- **Single DataCenter**
  - Servers, Racks and Clusters
  - Different Compute, Memory and Network configs

- **Multi DataCenter**
  - Datacenters in physically different locations

- Virtual Machine Access as given by Amazon EC2, Microsoft Azure
Evaluation Workloads

- **TPC-C**: Evaluating Single partitions and distributed Transactional Processing
- **Transactional YCSB**: Geo-Replication
- **TPC-H** and **Graph Workloads** - Variety

Evaluation Scenarios

- Contention
- Throughput Evaluation
- Scale-Out
- Handling Failures - Node and Data Centers
VM Placement Control

Beyond the Virtual Machine Statistics:
  ◦ NW Utilization
  ◦ Physical Machine Utilization
  ◦ Disc Utilization

Infrastructure for Benchmark Generation

Overall, EC2 + more control and statistics.