DATABASES IN THE CLOUD

@andy_pavlo
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OLTP vs. OLAP databases.

Source: https://www.flickr.com/photos/adesigna/3237575990
On-line Transaction Processing

- Fast operations that ingest new data and then update state using ACID transactions.
- Only access a small amount of data.
- **Volume**: 1k to 1mtxn/sec
- **Latency**: >1-50 ms
- **Database Size**: 100s GB to 10s TB
Example

• Maintain player’s state in an on-line game in the OLTP database.

Pre-computed model decides the next level the player is shown.
Example

- Maintain player’s state in an on-line game in the OLTP database.
Database Warehouses

• Complete history of OLTP databases.
• Complex queries that analyze large segments of fact tables and combine them with dimension tables.
• **Volume:** A couple queries per second
• **Latency:** 1-60 seconds
• **Database Size:** 100s TB to 10s PB
Example

• Compute model used to guide OLTP DBMS decisions from historical data.
OLTP vs. OLAP

• Storage Format:
  – **OLTP** → Row-oriented
  – **OLAP** → Column-oriented

• Primary Database Location:
  – **OLTP** → In-Memory
  – **OLAP** → Disks

• Workloads:
  – **OLTP** → Write-Heavy
  – **OLAP** → Read-Only
Things to consider with **databases** in the **cloud**. 

Source: https://www.flickr.com/photos/arvidnn/15285491335
Good Things

• Better Resource Utilization
• Elastic Scaling
• Database-as-a-Service Offerings
Better Resource Utilization

• Combine multiple silos onto overprovisioned resources.
• Public platform providers achieve better economies of scale.
• Database machines are (mostly) dead.
• Optimal multi-tenant placement is a difficult problem.
Elastic Scaling

- Automatically provision new resources on the fly as needed.
- Scaling up vs. Scaling out
- Difficult for OLTP DBMS to continue processing transactions while data migrates.
OLTP Scale-out Example

TPC-C Benchmark on H-Store (Fall 2014) Scaling from 3 to 4 nodes

E-Store: Fine-Grained Elastic Partitioning for Distributed Transaction Processing
Database-as-a-Service

• Cloud provider manages physical configuration of a DBMS.
• Ideal for applications that are co-located in the same provider’s compute platform.
• Combine private data with curated databases (i.e., data marts)
Bad Things

• I/O Virtualization
• File system Replication
• Security + Privacy Concerns
• Performance Variance
I/O Virtualization

• Distributed file system stores data transparently across multiple nodes.
• The data is not “local” to the DBMS.
• This causes a DBMS “pull data to query” rather than “push query to data”.
OLAP I/O Virtualization

SELECT YEAR(o_date) AS o_year, AVG(o_amount)
FROM orders
GROUP BY o_year
ORDER BY o_year ASC

Terabytes!
OLAP I/O Virtualization

\[ \text{SELECT} \ \text{YEAR}(o\_date) \ \text{AS} \ o\_year, \ \text{AVG}(o\_amount) \ \\
\text{FROM} \ \text{orders} \ \text{GROUP} \ \text{BY} \ o\_year \ \\
\text{ORDER} \ \text{BY} \ o\_year \ \text{ASC} \]
File System Replication

• The DBMS should not rely on file system replication for durability.
• OLTP systems maintain replicas in-memory.
• OLAP systems can store copies of tables in different ways on replica nodes.
OLAP Replication

Table 1:
- name

Table 2:
- name

Sort Order

Table 1:
- id

Table 2:
- id

Replica #1

Replica #2
OLAP Replication

Table 1:
- id

Table 2:
- id

Table 1:
- name

Table 2:
- name

Sort Order

Replica #1

Replica #2
Security + Privacy Concerns

- No truly encrypted solution exists.
- Many companies are unable to use public cloud platforms.
Performance Variance

- DBMSs are sensitive to changes in underlying hardware performance.
- “Noisy” neighbors on instances can cause large fluctuations in performance.
OLTP Performance Variance

YCSB on MySQL (Winter 2012)
Medium EC2 Instances

OLTP-Bench: An Extensible Testbed for Benchmarking Relational Databases
Djeliel Eddine Difallah, Andrew Pavlo, Carlo Curino, Philippe Cudre-Mauroux

35% Difference

Throughput (TPS)

Latency (msec)
Cloud database vendors.
Important Features

- Automatic Back-ups
- Geo-replication
- Elasticity / Live Reconfiguration
- Efficient Multi-Tenancy
- Workload Awareness
Cloud Database Vendors

• Cloud-friendly systems
• Database-as-a-Service (DBaaS)
Cloud-friendly DBMSs

• Most DBMS vendors make it easy to deploy on cloud platforms.
• Others provide support for easy scale-out in a cloud environment.
• More than just pre-configured instances.
OLTP DBaaS

- Amazon RDS / Aurora
- Microsoft Azure
- Google Cloud SQL
- Database.com
- ClearDB
- GenieDB
- Clustrix
OLAP DBaaS

- Amazon Redshift
- Google BigQuery
- Microsoft Azure
- Snowflake
Parting Thoughts

• The cloud does not magically make database problems go away.
• It’s easier to run an OLTP DBMS than a OLAP DBMS on the cloud.
• AFAIK, there is no truly autonomous DBMS as of yet.
CMU Database Group
Summer Internships
END

@andy_pavlo