Moving Databases into Cloud

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Overview

• Little about me

• Fairy Tale: Once upon a time, there were database clusters...
  – What is PowerDB?

• Everything (computers, storage, network etc.) has become virtual
  – Virtualization is the driving force for cloud computing

• We are moving everything (including databases) to cloud until the next wave comes
About Me

• 1974, Born.

• 1996, B.Sc., H.U. Computer Engineering Department

• 2000, M.Sc., H.U. Computer Engineering Department
  – Information Retrieval

• 2007, PhD, ETH Zurich
  – Database Replication in Clusters

• Worked as Data Architect in the Life Sciences domain for the last 6 years

• Little more can be found here:
  – http://yunus.hacettepe.edu.tr/~akal/
PowerDB View of Database Clusters

• Cluster of databases
  – Cluster of off-the-shelf PCs
  – Each PC runs an RDBMS
  – Ethernet Connection

• Middleware Architecture
  – Clients access the cluster over the middleware only
  – Distinguished cluster into two parts
    • Update and read-only nodes
  – Lazy replication management
    • Eager from user’s perspective

• The “Scale-out” vision
  – Adding new nodes for higher performance
  – More nodes allow to increase parallelism
The Early Approach to PowerDB Replication

- Relies on full replication
- Queries execute where they are initiated
- Users may specify their freshness needs
  - How much the accessed data may deviate from up-to-date data
  - Freshness at the database level
- Read-only nodes are maintained by means of decoupled refresh transactions
Systems evolve... So did PowerDB...

- Customized node groups for certain query types
  - Support for arbitrary physical data design

- Queries may span over many nodes

- Users may still specify their freshness needs
  - Freshness at the database object level

- Fast query processing even with the higher update rates and freshness requirements
  - Read-only nodes must be kept as up-to-date as possible

PowerDB Middleware

Update Transactions ➔ Read-only Transactions (Queries)

Continuous Update Propagation to Read-only Nodes

Update Nodes ➔ Read-only Nodes

T₁: w(a), a,b,c,d
T₂: r(a), a,b,c,d
T₃: r(b), a,b,c,d
T₄: r(d), a,b,c,d
Have You Detected Research Problems?

• How to handle more than one update nodes?
• How to distribute data?
• How to avoid data skew?
• How to handle node failures?
• How to determine node freshness?
• How to route queries?
• How to classify queries?
• How to create custom nodes?
Before That... Little About Virtualization

- Technique of abstracting hardware

- Enables creation of multiple virtual machines (VMs), each running an OS and application
  - VM is a logical entity that looks and behaves like physical machine

- Virtualization layer resides between hardware and VMs
  - Also known as hypervisor

- VMs are provided with standardized hardware resources
PC Cluster of 128 nodes mounted in 9 cabinets (2002)

Yahoo’s Hadoop cluster of ~42K nodes (2011)
What Virtualization Puts on the Table?

• Researching on database clusters used to require a cluster at hand.
  – It is very expensive although commodity components are available.

• Creating customized nodes to satisfy any possible incoming query requires several nodes.

• Having a large cluster of virtual computers (cloud database) is not as expensive as before.
  – You can simply order from Amazon
Customizing Node Groups
- Organize as node groups (NG)
- Freely design every NG
Designing a Database

How can we automate these steps?
Automating Database Design

- Workload
  - Index Wizard (e.g., Index Tuning Wizard of Microsoft)
  - Index Recommendations
  - Candidate Index (or MW) Selection
  - Configuration Enumeration
  - Configuration Simulation and Cost Estimation Module
  - MS SQL Server
Tune for a Query or a Workload?

- 50% of queries benefit from customized (tuned for query) design
- 37% of queries find their optimal indexes in fixed (tuned for workload) design
- Troublesome queries: Index wizards are not perfect
Automating Cloud Database Design

- Workload

  - Cloud Utilization Wizard
    - Determine required number of nodes
    - Determine proper nodes to create schema

- Index Wizard

- Index Recommendations

- Recommended Cloud DB Design
More Research Problems Arise

• How to determine optimal number of nodes to evaluate a query?
• How to determine optimal number of node groups?
• How to monitor the cluster and the workload?
• When to initiate reevaluation of the design?
• How to automate redistribution of data?
• ...
Thank You!

• If you are interested in these stuff, you can always approach me.

• I am always looking for eager graduate students to work with.