云数据管理系统：挑战与机遇

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随着信息产业的发展，企业和公司产生的数据量快速增长，通常数据规模可以达到 TB 甚至 PB 级别。如何管理和分析海量数据是目前很多领域所面临的难题，例如在医疗、通信和互联网领域。传统的数据管理技术已经不能完全满足海量数据管理的需求，云计算技术的出现为海量数据管理带来了机遇，利用云平台来存储和管理海量数据是当前的研究热点之一。该 ppt 主要介绍了云数据管理方面的挑战和机遇，包括云数据管理的必要性和需求，数据管理的弱一致性研究，数据拷贝的一致性维护，数据的并发处理和版本模型等前沿数据库研究问题。
Cloud-based Data Management: Challenges & Opportunities

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Research experience and interesting

- **National University of Singapore PhD**
  - XML query processing and XML keyword search

- **University of California, Irvine Postdoc**
  - Approximate string processing
  - Data integration and data cleaning

- **Renmin University of China**
  - Cloud data management
  - XML data management
Outline

- Motivation: cloud data management

- Database Future and Challenges:
  - Large-scale Data management & transaction processing
  - Cloud-based data indexing and query optimization

Motivation: Internet Chatter

Google Search

- Why does everything suck? The Death of the Relational Database
  - [Click here]
  - For information, by not having RDBMS and RDF etc, we are able to use ... The "why relational databases suck" topic is pretty well beaten to death by ... whydoesthingsucks.com/.../death-of-relational-database.html - 阿企标签 - 电路板论坛

- RDBMS: Reports of its Death Evagerrated - Beyond Search
  - [Click here]
  - RDBMS Reports of its Death Evagerrated. February 14, 2009: Tony Blair's "Is the Relational Database Doomed?" is an interesting article ...
  - arnold.com/.../rdbms-reports-of-its-death-evagerrated - 阿企标签 - 电路板论坛

- The Death of Row Oriented RDBMS Technology « Kevin Closson's... - [Click here]
  - 10 Responses to "The Death of Row-Oriented RDBMS Technology" - Feed for this Entry
  - trackback address: 1 Nones September 13, 2007 at 4:01 am ...
  - kevinclisson.wordpress.com/.../the-death-of-row-oriented-rdbms-technology/

- Death of the Relational Database... - [Click here]
  - In fact, it caused RDBMSs to adapt into the Object/Relational databases that appeared in the late ...
  - ittoolbox.com/.../death-of-the-relational-database-he-18870 - 阿企标签 - 电路板论坛
“If you want vast, on-demand scalability, you need a non-relational database.” Since scalability requirements:
  • Can change very quickly and,
  • Can grow very rapidly.

Difficult to manage with a single in-house RDBMS server.

Although RDBMS scale well:
  • When limited to a single node.
  • Overwhelming complexity to scale on multiple sever nodes.

Current State

Most enterprise solutions are based on RDBMS technology.

Significant Operational Challenges:
  • Provisioning for Peak Demand
  • Resource under-utilization
  • Capacity planning: too many variables
  • Storage management: a massive challenge
  • System upgrades: extremely time-consuming
What is Cloud Computing?

- **Old idea: Software as a service (SaaS)**
  - Def: delivering applications over the internet

- **Recently: “[Hardware, infrastructure, Platform] as a service”**
  - Poorly defined so we avoid all “X as a service”

- **Utility Computing: pay-as-you-go computing**
  - Illusion of infinite resources
  - No up-front cost
  - Fine-grained billing (e.g. hourly)

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Why Now?

- **Experience with very large datacenters**
  - Unprecedented economies of scale

- **Other factors**
  - Pervasive broadband internet
  - Pay-as-you-go billing model
Cloud Computing Spectrum

- Instruction Set VM (Amazon EC2, 3Tera)
- Framework VM
  - Google AppEngine, Force.com

Cloud Killer Apps

- Mobile and web applications
- Extensions of desktop software
  - Matlab, Mathematica
- Batch processing/MapReduce
Economics of Cloud Users

- Pay by use instead of provisioning for peak

![Graph of Static data center vs. Data center in the cloud]

Risk of over-provisioning: underutilization

![Graph of Static data center]

Unused resources
Economics of Cloud Users

- Heavy penalty for under-provisioning

![Diagram showing resources, capacity, and demand over time with lost revenue and lost users](chart)

Engineering Definition

- Providing services on virtual machines allocated on top of a large physical machine pool.
Business Definition

- A method to address scalability and availability concerns for large scale applications.
The Vision

- **R&D Challenges at the macro level:**
  - Where and how does the DBMS fit into this model.

- **R&D Challenges at micro level:**
  - Specific technology components that must be developed to enable the migration of enterprise data into the clouds.

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Data and Networks: Attempt I

- **Distributed Database (1980s):**
  - Idealized view: unified access to distributed data
  - Prohibitively expensive: global synchronization

- **Remained a laboratory prototype:**
  - Associated technology widely in-use: 2PC
Data and Networks: Attempt II

Data and Networks: Pragmatics
Amazon’s Simple Storage Service (S3):
- Updates may not preserve initiation order
- No “force” writes
- Eventual guarantee

Proposed solution:
- Pending Update Queue
- Checkpoint protocol to ensure consistent ordering
- ACID: only Atomicity + Durability

Unbundling Txns in the Cloud

Research results:
- CIDR’09 proposal to unbundle Transactions Management for Cloud Infrastructures
- Attempts to refit the DBMS engine in the cloud storage and computing
Analytical Processing

Architectural and System Impacts

- **Current state:**
  - MapReduce Paradigm for data analysis

- **What is missing:**
  - Auxiliary structures and indexes for associative access to data (i.e., attribute-based access)
  - Caveat: inherent inconsistency and approximation

- **Future projection:**
  - Eventual merger of databases (ODSs) and data warehouses as we have learned to use and implement them.
Business data may not always reflect the state of the world or the business:
- Inherent lack of perfect information

Secondary data need not be updated with primary data:
- Inherent latency

Transactions/Events may temporarily violate integrity constraints:
- Referential integrity may need to be compromised

Data privacy remains a show-stopper in the context of database outsourcing.

Encryption-based solutions are too expensive and are projected to be so in the foreseeable future:
- Private Information Retrieval (Sion’2008)

Other approaches:
- Information-theoretic approaches that uses data-partitioning for security (Emekci’2007)
- Hardware-based solution for information security
Self management and self tuning in cloud-based data management

- Self management and self tuning
  \[ \text{Tune} \quad \text{Monitor} \quad \text{Diagnose} \]

- Query optimization on thousands of nodes

Remarks

- Data Management for Cloud Computing poses a fundamental challenge to database researchers:
  - Scalability
  - Reliability
  - Data Consistency

- Radically different approaches and solution are warranted to overcome this challenge:
  - Need to understand the nature of new applications
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- Building a Database on S3 M. Brartner, D. Florescu, D. Graf, D. Kossman, T. Kraska, SIGMOD’08
- Unbundling Transaction Services in the Cloud D. Lo, et, A. Fekete, G. Weikum, M. Zwilling, CIDR’09
- Principles of Inconsistency S. Finkelstein, R. Brendle, D. Jacobs, CIDR’09