

# 云数据管理系统：挑战与机遇

陆嘉恒

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问题，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

Jiaheng Lu

Renmin Universtiy of China

---

1 / 29



## 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

---

2 / 29



## Outline

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

3 / 29



## Motivation: Internet Chatter



Death of RDBMS

Google 搜索 高级搜索 | 使用偏好

网页 搜索百宝箱

搜索 Death of RDBMS 获得大约 61,700 条查询结果，以下是第 1-10 条。

小提示: 只搜索中文(简体)查询结果, 可在 使用偏好 指定搜索语言

[Why does everything suck?: The Death of the Relational Database](#) - [ 翻译此页 ]

For your 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 ...  
[whydoeseverythingsuck.com/.../death-of-relational-database.html](#) - 网页快照 - 类似结果

[RDBMS: Reports of Its Death Exaggerated : Beyond Search](#) - [ 翻译此页 ]

RDBMS: Reports of Its Death Exaggerated. February 14, 2009. Tony Bain's "Is the Relational Database Doomed?" is an interesting article. ...  
[arnoldit.com/.../rdbms-reports-of-its-death-exaggerated/](#) - 网页快照 - 类似结果

[The Death of Row-Oriented RDBMS Technology. « Kevin Closson's ...](#) - [ 翻译此页 ]

10 Responses to "The Death of Row-Oriented RDBMS Technology." Feed for this Entry  
Trackback Address. 1 Noons September 13, 2007 at 4:01 am ...  
[kevinclosson.wordpress.com/.../the-death-of-row-oriented-rdbms-technology/](#) -  
网页快照 - 类似结果

[Death of the Relational Database ... ha!](#) - [ 翻译此页 ]

7 Sep 2007 ... Death of the Relational Database ... ha! ... In fact it caused RDBMs to adapt into the Object/Relational databases that appeared in the late ...  
[it.toolbox.com/.../death-of-the-relational-database-ha-18870](#) - 网页快照 - 类似结果

4 / 29



- **“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.
- 



- **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)
- 

7 / 29



## Why Now?

---

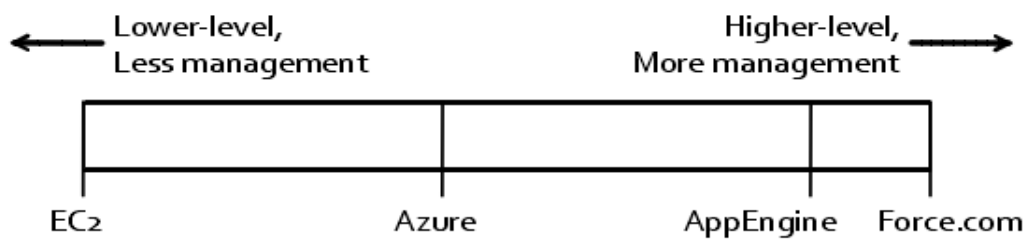
- **Experience with very large datacenters**
    - Unprecedented economies of scale
  
  - **Other factors**
    - Pervasive broadband internet
    - Pay-as-you-go billing model
- 

8 / 29



## Cloud Computing Spectrum

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



9 / 29



## Cloud Killer Apps

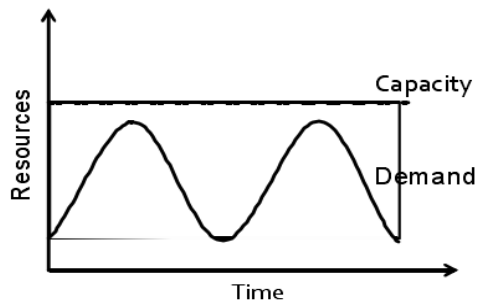
- Mobile and web applications
- Extensions of desktop software
  - Matlab, Mathematica
- Batch processing/MapReduce

10 / 29

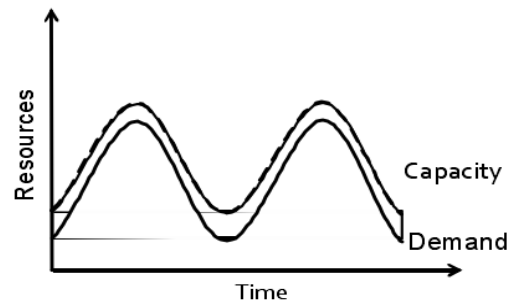


## Economics of Cloud Users


- Pay by use instead of provisioning for peak



Static data center



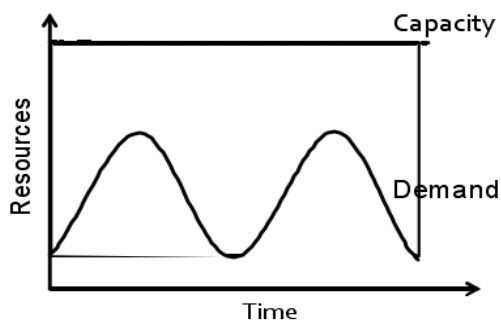
Data center in the cloud

 Unused resources



## Economics of Cloud Users

- Risk of over-provisioning: underutilization



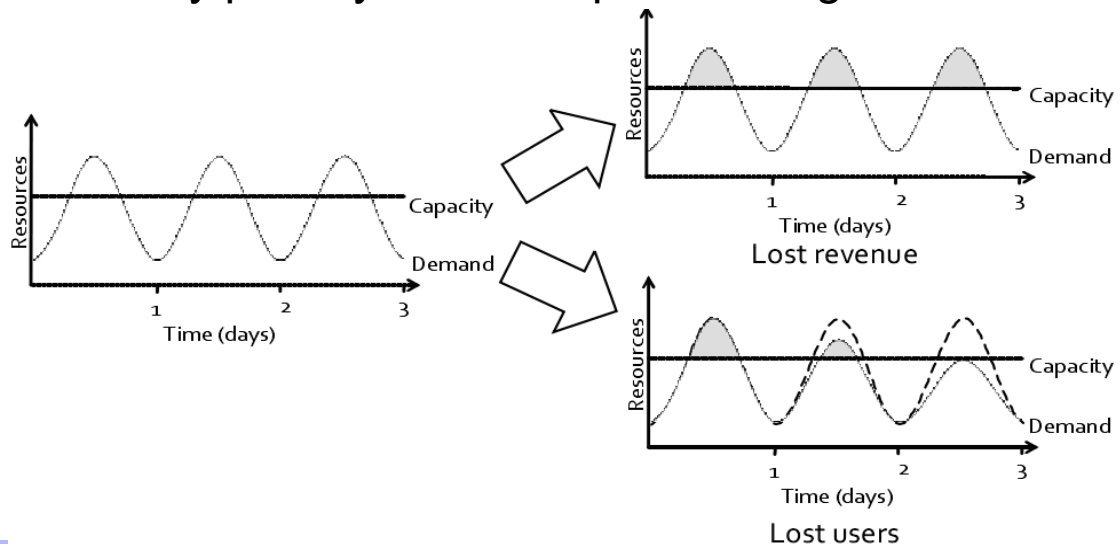
Static data center

 Unused resources



## Economics of Cloud Users

- Heavy penalty for under-provisioning



13 / 29



## Engineering Definition

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

14 / 29



## Business Definition

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

15 / 29



## Data Management in the Cloud?



16 / 29



## 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.

---

17 / 29



## Data and Networks: Attempt I

---

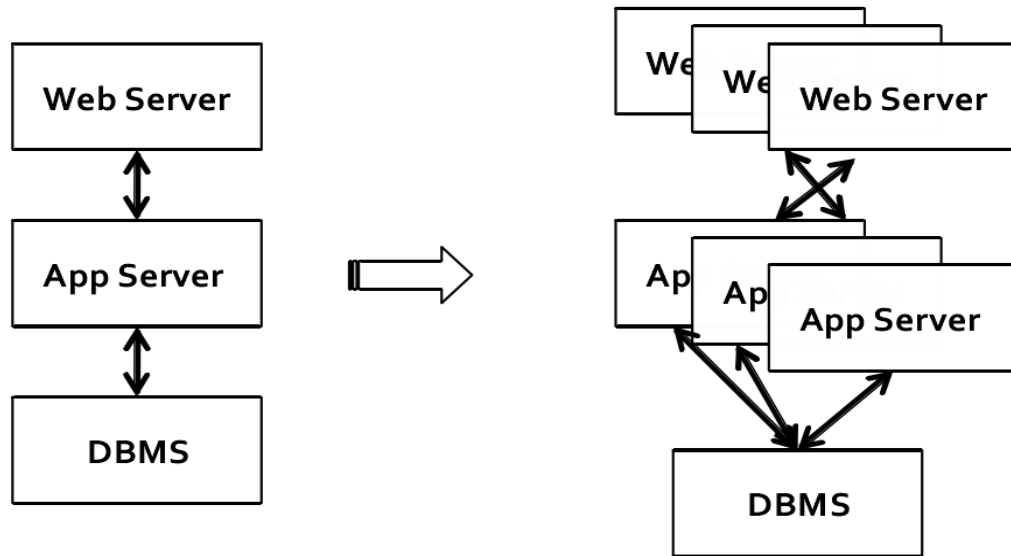
- Distributed Database (1980s):
  - Idealized view: unified access to distributed data
  - Prohibitively expensive: global synchronization
- Remained a laboratory prototype:
  - Associated technology widely in-use: 2PC

---

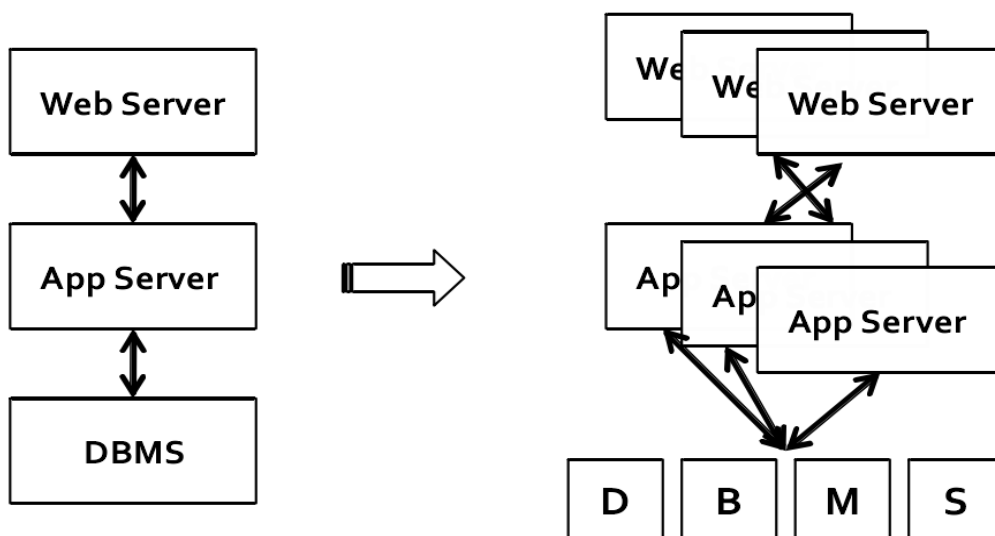
18 / 29



## Data and Networks: Attempt II



## Data and Networks: Pragmatics





## Database on S3: SIGMOD'08

---

- 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

---

21 / 29



## 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

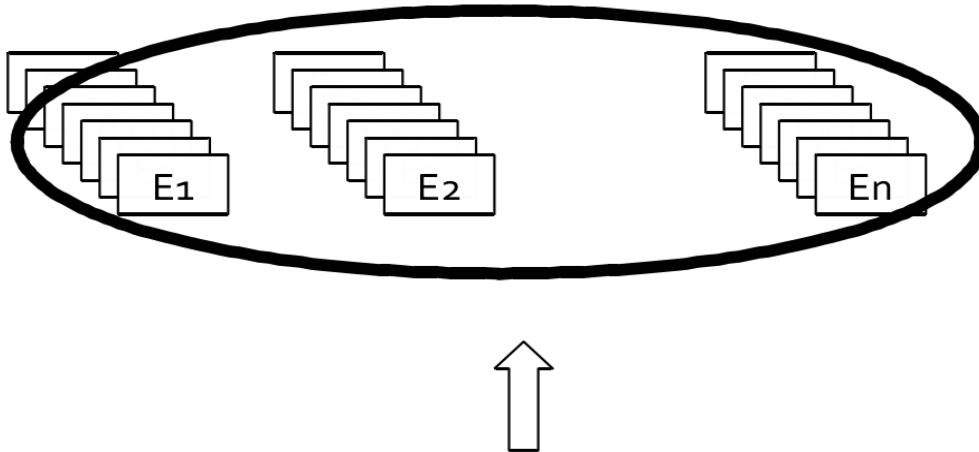
---

22 / 29



## Analytical Processing

---



### **Analysis Queries: Distributed Processing**

---

23 / 29



## 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.

---

24 / 29



## Underlying Principles: CIDR'2009

---

- **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
- 

25 / 29



## Data Security & Privacy

---

- 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
- 

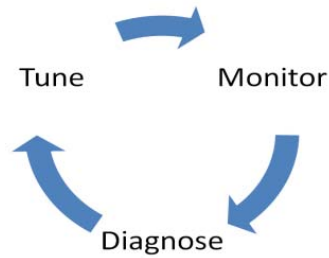
26 / 29



## Self management and self tuning in cloud-based data management

---

- Self management and self tuning



- Query optimization on thousands of nodes

---

27 / 29



## 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
- 

28 / 29



## References

---

- **Life Beyond Distributed Transactions: An Apostate's Opinion**  
by P.Helland, CIDR'07
  - **Building a Database on S3** M.Brantner, 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
  - **VLDB Database School (China) 2009**  
<http://www.sei.ecnu.edu.cn/~vldbsschool2009/VLDBSchool2009English.htm>
-