Issues and Challenges of Data Transaction Management in Cloud Environment

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Abstract - *Cloud Computing is one of the most important areas in the current IT industries. It provides different type of services (SaaS, PaaS, and IaaS)* ***depending on the customers' requirements. Instead of*** *owning, installing and maintaining software in IT industries can use Cloud computing. In this paper, needs of ACID properties for cloud databases, advantages and limitations of cloud databases are discussed. It also portrait the major issues and challenges of Database Architectures and Data Transaction Management in Cloud Environment. There are different procedures used to handle the data, but each one of them has its own limitations in cloud environment. Finally this paper provides an exhaustive study on Transaction Processing System, Cloud DataBase as a Service (DBaaS), Cloud RDBMS and Cloud data storages in order to design a novel architecture for cloud databases with the support of traditional ACID properties.*

Keywords: Cloud database Architecture, Data Transaction Management, Issues and Challenges, ACID properties.

1. INTRODUCTION

Cloud computing is a new technology used to provide different services. Cloud is divided into two major models namely, service model and deployment model. The main three service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The recent four cloud deployment models are private cloud, community cloud, public cloud and hybrid cloud [1]. Certain major challenges in cloud computing are Security, Cost and Service level agreement [1]. Data Transaction Management (DTM) is one of the challengeable events in cloud computing. IaaS is basic to manage the cloud transaction management. The data are maintained in the database –as- a-service (DaaS) model. It hosts databases in cloud environment and provide features such as data definition, data storage and data retrieval. The leading cloud computing providers like Amazon, Google, IBM, Oracle and Microsoft provide database –as- a-service with their cloud DaaS solutions[2]. In Cloud resources are typically elastic, with infinite amount of compute power and storage available on demand and pay-only-for-what-you-use. In this paper the overall issues and challenges in cloud data transaction management has been discussed.

2. NEED OF ACID PROPERTIES FOR CLOUD TPS

During the data transaction management data are stored at third-party and replicated from large geographic distance [4]. It is also hard to maintain the ACID (Atomicity, Consistency, Isolation and Durability) guarantees. Cloud platform providers provide databases for developers to maintain the data and each one of them has their own advantages and limitations. For example Amazon SimpleDB and Google's Big table provide good databases for vendors with different features [3].

The important concept of transaction is a sequence of database events (reads/writes).

- DBMS entrust *atomicity* (all-or-nothing property) even if system crash in the central point of a transaction.
- Each transaction is executed entirely and it must take the database between *consistent* states or must not run at all.
- DBMS entrust that concurrent transactions emerge to run in *isolation*.
- DBMS entrust *durability* of committed transactions even if system smashes.

When a transaction completes successfully in Transaction Processing System (TPS) database changes are said to be committed and it should satisfy the ACID properties [8].

3. ADVANTAGES AND LIMITATIONS IN CLOUD DATABASES

A suitable cloud database is needed to execute a successful transaction in cloud TPS. Cloud uses different database architectures for TPS and maintains the presentation, application, database and data storage layers. Such a database-as-a-service (DBaaS) is attractive for two reasons. First, due to economies of scale, the hardware and energy costs incurred by users are likely to be much lower when they are paying for a share of a service rather than running everything themselves. Second, the costs incurred in a well-designed DBaaS will be proportional to actual usage ("pay-per-use")—this applies to both software licensing and administrative costs. The latter are often a significant expense because of the specialized expertise required to extract good performance from commodity DBMSs. By centralizing and automating many database management tasks, a DBaaS can substantially reduce operational costs and perform well. The advantages and limitations of various database architectures are listed below [7].

TABLE -1: ADVANTAGES AND LIMITATIONS IN CLOUD DB

Cloud DB	Advantages	Limitations
Classic	Scalability and elasticity in the web and application layers.	Potential bottleneck in the database server.
		Limitations in Cost.
Partitioning	Partitioning is transparent to the application programmer.	Add or remove machines in order to workload it must involve repartition.
Replication	ROWA (read once write all) based on master copy.	For Update-intensive workloads the master becomes bottle neck.
	Cheap hardware can be used to run the DB server.	
	Scale – out and scale-down nicely with the work load.	
	Add or remove satellite server depends on the work load.	
	Increase scalability and reliability	
Distributed	Provide full scalability and elasticity.	Not possible to achieve consistency and availability.
	Cheap hardware can be used in all tiers.	Weak to achieve the atomicity.
Caching	Increase scalability and reduce the cost.	Complex design
	Add or remove memory cache machine is trival.	

4. ISSUES RELATED TO CLOUD TPS

Cloud computing is a resource delivery and usage model. It gets resource through network "On-demand" and "at scale" in a cloud environment. The different types of issues related to Cloud Transaction Processing System [TPS] are [5]:

TABLE -2: ISSUES RELATED TO CLOUD TPS

Technical Issues	Security
	Hardware and Software expertise
	Non-technical Issues
	Financial Issues
Operational and Organizational Issues	Distributed Business Level
	Complexity of application
	Cost
Security and Reliability Issues	Consumer Requirements
	Service Compared and tested
	Integrity and Infrastructure
	Portability
	High quality and Low price
	Interface with business process
	Speed change

All the cloud services are cost effective but they have lot of issues regarding the security and backup [6]. So the cloud environment needs a secure Transaction Processing System to maintain the ACID properties.

5. CHALLENGES OF CLOUD TPS AND DATABASES

5.1. *Cloud TPS*

5.1.1) Performance:
Industries are challenging with the difficulty of ensuring the online transaction applications. It has many performance necessities including transaction speed and near real-time responsiveness.

5.1.2) ACID guarantees:
It is hard to maintain ACID guarantees in the face of data replication over huge geographic distances [8]. If a transaction committed successfully in cloud transaction processing system that means it satisfied all the ACID properties.

5.1.3) Security:
There are massive risks in storing transactional data on third party host. Service providers must make the proper investments in providing; proving and ensuring appropriate levels of security over time. Malicious users can utilize weak spot in the data security model to increase unauthorized access to data. The security of the enterprise data stored at the vendor is validating through the subsequent assessments test.

- Cross-site scripting [XSS]
- Access control weaknesses
- OS and SQL injection flaws
- Cross-site request forgery[CSRF]
- Cookie manipulation
- Hidden field manipulation
- Insecure storage
- Insecure configuration.

Whichever vulnerability detected during these tests can be oppressed to gain access to responsive enterprise data and it may leads to a financial failure [13].

5.2. *Cloud Databases*

5.2.1) Performance:
Companies encounter many performance challenges when dealing with multiple nodes and multiple databases required for mission-critical transactions.

5.2.2) Bottlenecks:
One of the key challenges they face in moving to the cloud is due to the bottlenecks that occur within their data architecture. In cloud TPS every transaction is an update process, so challenging to design database to avoid bottlenecks in database layer.

5.2.3) Data Security:
In cloud computing security of data stored at the Cloud Service Provider (CSP) is a major concern. In traditional application data are stored on the computer which is reside at the customer premises. The physical and logical security should be provided by the customer. In the cloud computing environment the data are stored on shared environment which is not under the control of user. Data security and privacy cannot be guaranteed by physical boundaries of machines or networks.

5.2.4) Data Privacy:
Privacy is one of the major factor in cloud TPS. It provide the facility of an individual or group to seclude themselves or information about themselves and there by revels themselves selectively. The data privacy is also a matter of concern in the cloud computing. Companies need to setup a group of employee to look into the privacy concern of data. Data in the cloud may be distributed across geographical border and may not be satisfying privacy law of the concerned region, in India Information Technology Act, 2000("IT Act") and its various sub section governs the data security and privacy related issues.

5.2.5) Scalability:
Challenge to keep the scalability because traditional databases do not scale effectively to number of nodes being deployed in online transaction applications. Scalability advantages are not without their own complexities. While we can scale on demand, applications need to be able to scale with the environment. Every component whether it is processors, servers, storage or load-balancers that is to be scaled need some kind of management overhead. During scaling, it is important to note what percentage of resource is actually scalable. It is called as scalability factor [12].

6. CLOUD TRANSACTION PROCESSING SYSTEM

Data transaction management applications are the potential candidates for deployment in cloud. Each cloud providers give set of virtual machines to the cloud computing vendors and they can install their own software for transaction processing system.

Elements of Transaction Processing System

- Client
- Cloud Service Providers
- Nodes
- Transaction Managers
- Two Phase Commit Protocol
- RDBMS
- Data storage Architecture

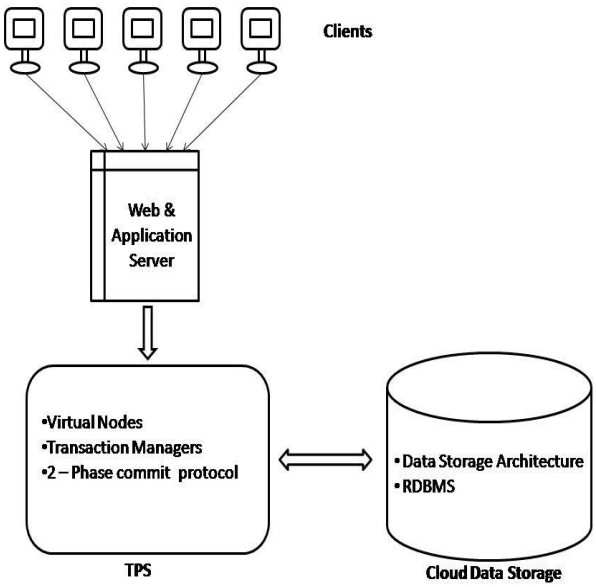

Fig -1: Cloud TPS

The clients send request to the web and application server. Application server sends it to the transaction processing system (TPS). Number of virtual nodes (machines) is constructed in the TPS. The data entered in to TPS is called a transaction. A single transaction is divided in to multiple processes and sends it to sufficient number of nodes. One of the involved nodes in the particular transaction acts as Transaction Manager (TM) and it is responsible for other nodes involved in the transaction. Two phase commit protocol is used to maintain the ACID properties [10]. Cloud data storage is used to store the data. It is hard to maintain ACID properties and security in Cloud RDBMS and Cloud Data Storage.

7. DATABASE AS A SERVICE

Database as a Service (DBaaS), a form of Platform as a Service (PaaS), is currently found in the public marketplace in three broad capabilities - online general relational databases, non-relational databases, and the ability to operate virtual machine images loaded with common open source databases such as MySQL or similar commercial databases. These three approaches provide Government IT leadership with a wide range of capabilities and potential complexities.

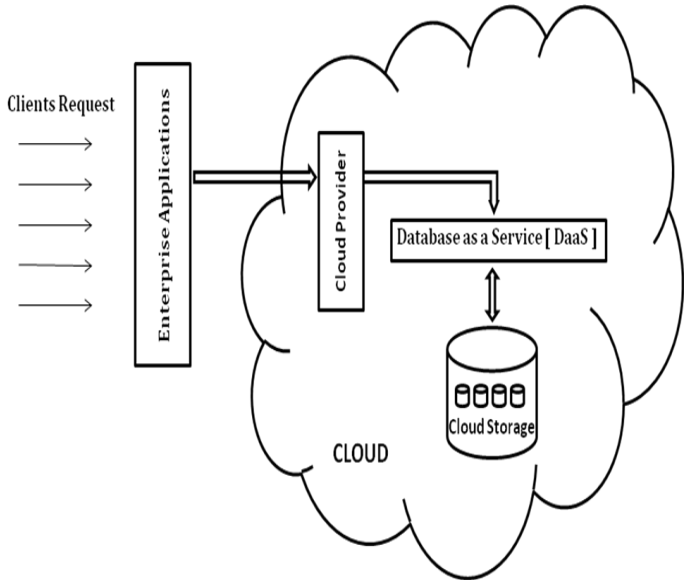

Fig -2: Database as a Service

The client send request to the enterprise applications. Cloud providers offer databases and storage space for enterprises are called Database as a Service (DBaaS) [2]. The enterprise applications send client data to database through cloud provider. Data fetched from the cloud storage area and update the data. Virtual machines are involving to maintain the Cloud databases and storages.

8. OVERVIEW OF CLOUD RDBMS AND CLOUD DATA STORAGE

Cloud providers provide different RDBMS for database management and Data Storage to maintain data. Cost factor for some of the leading cloud providers are as follows:

TABLE -3: COST FACTOR FOR CLOUD PROVIDERS

Cloud Providers	RDBMS	Price per hour	Storage	Price per GB
Amazon	Amazon RDS	$0.017	Amazon S3	$0.0300
Amazon	-------	-------	Amazon EBS	$0.125

Google	Cloud SQL	$0.025	Cloud Storage	$0.026
Microsoft Azure	SQL Database	$0.0067	Storage	$0.024
Rackspace	Cloud Databases	$0.05	Block Storage	$0.000164

8.1. Amazon

8.1.1) Amazon RDS:
Amazon Relational Database Service (Amazon RDS) is a web service that makes it simple to set up, function, and scale a relational database in the cloud environment. Amazon RDS offers cost-efficient and resizable capacity while managing time-consuming database management responsibilities, release up to focus on the applications and business [14]. Amazon RDS furnishes online access to the capabilities of a familiar MySQL, Oracle, Microsoft SQL Server, or PostgreSQL relational database management systems.

8.1.2) Amazon S3:
Amazon S3 is a cloud storage system for the Internet. It is designed to make web-scale computing easier for developers. It provides an easy web-services interface that can be used to store and retrieve any quantity of data, at every time, from anywhere on the web. It gives any developer access to the same highly scalable, reliable, secure, fast, low-priced infrastructure that Amazon uses to run its own universal network of web sites [14]. The service aims to maximize benefits of scale and to pass those benefits on to developers.

8.1.3) Amazon EBS:
Amazon EBS (Elastic Block Store) provides block level storage volumes for use with Amazon EC2 instances. Amazon EBS volumes are off-instance storage that persists separately from the life of an instance. Amazon EBS volumes offer consistent and low-latency act needed to run the user's workloads. With Amazon EBS, one can scale his usage up or down within minutes [14].

8.2. Google

8.2.1) Cloud SQL:
Cloud SQL stores and manages data using a fully-managed, relational MySQL database. Replication, patch management and database management to ensure availability and performance is handled by Google. MySQL databases are deployed in the cloud without a fuss. Google Cloud Platform provides powerful databases that run fast. [15].

8.2.2) Cloud Storage:
Google Cloud Storage provides developers and IT associations durable and highly available object storage. Google created three simple product options to help and improve the performance of applications while keeping the costs low. These three product options use the same API, providing with a simple and consistent method of access [15].

8.3 . Microsoft Azure

8.3.1) SQL Database:
SQL Database is a relational database-as-a-service offering with built-in mission-critical capabilities. It supports existing SQL Server libraries and APIs, permitting to reuse code and scripts. It can stand up a SQL Database on Azure in seconds, without having to manage virtual machines or infrastructure [16].

8.3.2) Storage:
Azure has four types of storage-blob, file (preview), table, and queue. The total cost depends on how much quantity is stored, the volume of storage transactions and outbound data transfers, and which data redundancy options are choosen [16].

8.4. Rackspace

8.4.1) Cloud Databases:
Cloud databases provide fast, scalable, fully managed MySQL database service. It offers a performance-optimized database for the applications. Cloud Databases give a simple, on-demand provisioning and open APIs. So, it can deploy MySQL, Percona Server, or MariaDB with minimal effort [17].

8.4.2) Block Storage:
Cloud Block Storage offers reliable, high-performance, on-demand storage for applications hosted on Cloud Servers. Even the most resource-eager workloads run faultlessly, therefore users can always count on the application to perform consistently [17].

9. CONCLUSION

Comfortable ACID guaranty is needed for perfect transaction management system. Unfortunately, the cloud environment is not fully reliable to maintain ACID properties. It requires a better architecture to process the data transaction

management and cloud storage system. Security is an important factor to consider the transactional data. Because, data are stored in the third party and replicated from large geographic distance. The next step is to implement new architecture to completely maintain ACID properties and strengthen the security for data transaction management in cloud environment.

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