Experimental Evaluation of Cloud Database Management Systems

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Abstract

Nowadays, most of the organizations create more data in electronic format; storage room is turning out to be progressively imperative. Thus, organizations are facing the challenges of managing, sharing, and updating data among the management. Cloud storage is the answer for all. The Cloud computing is the best stage for the enormous Database. From database point of view response time is also important, how quickly your database is responding?

In paper, we present a study of Database management system (DBMS) in cloud computing. We analyze the performance of different CDBMS (cloud database management systems). We have compared two cloud services to analyze the performance in terms of query response time. We used SQL Management Studio software for analysis. We have done the performance evaluation of two cloud services (i.e., Windows azur, and Amazon) using different query operations and DML (Data manipulation language) like SELECT, INSERT, UPDATE, DELETE. Results illustrates that the Azure cloud database is taking less time when using just SELECT statement while with rest of the statements, Amazon's cloud database performance is far better than Azure cloud database.

1. Introduction

Cloud computing is a buzz phrasing that means different things to different people. It is capable to provide shared resources and on demand services to its user. Cloud computing is providing the storage solutions which allows the users and enterprises to store their data in third party's data center. Because of the advantages i.e. low-cost of services, scalability, high performance, availability, high computing power cloud computing has become demanded.

With the growing popularity of the "Cloud computing" worldview, numerous applications are moving to the cloud. The flexible way of assets and the pay as you go model have broken the foundation hindrance for new applications which can be effortlessly tried out without the requirement for enormous forthright speculations. The sporadic burden attributes of these applications, combined with expanding interest for data storage while ensuring round the clock accessibility, and changing degrees of consistency necessities posture new difficulties for data management in the cloud. These current application requests call for frameworks fit for giving adaptable and predictable data management as a service in the cloud. Amazon's Simple DB is an initial phase in this bearing, yet is composed along the key's lines worth stores like big table and consequently does not give steady access to different articles. [1]

Cloud computing is providing advantages for data storage. There are two obvious advantages to store information in Cloud Servers: 1) The information proprietors spare themselves out from the inconvenience of purchasing additional data storage servers and procuring server administration engineers; 2) It is less demanding for the information proprietor to impart their information to planned beneficiaries when the information is put away in the cloud [2].

Furthermore, putting the substantial information records on the remote servers, the customers can be diminished of the weight of capacity and calculation [3]. As customers no more have their information provincially, it is of basic significance for the customers to guarantee that their information are by and large accurately put away and kept up. As perseverance of right data storage is important for that reason data analysis is additionally essential. Basically database is the logical collection of data and database management system (DBMS) is a software for data creation, editing and deleting.. Thus in cloud world, Cloud Database (CDB) is likewise utilized for capacity and numerous PC researcher trusts that database in cloud is utilized as a service as cloud has services that can be scaled bigger or littler [4]. With increase in data size, the cloud data base management becomes more difficult.

1.1 Research Objectives

Two different research objectives are set to perform the research
1. Theoretical Analysis(what are some difficulties to get access on cloud services)
2. Experimental analysis of the performance of cloud server vs cloud server in terms of query Response time using of multiple DML statements (SELECT, SELECT with Clauses (WHERE and ORDER BY) and UPDATE).

Section 2 presents the related work. Section 3 describes the proposed work. Section 4 discusses the results. Section 5 concludes the paper with highlighting possible future work.

2. Related Work

Alhamad et al. [6] have discussed the use of cloud services. It is important to understand the performance of the cloud infrastructure provided by clouds. They evaluate EC2 instances as example to examine the stability of most types of VMs, provided by Amazon. They conclude with the performance of large CPU, which shows that it has the best stability of performance. However they keep their work limited by only using CPU as their main parameter.

Divyakant Agrawal et al. [7] have discussed the problem of data storage. They proposed to overcome with increasing demand of data storage there should be scalable & elastic system that provide data management as a service.

Pengcheng Xiong et al. [8] have presented SmartSLA, a cost aware resource management system, to address the issue of intelligently manage the resources in a shared cloud database system.

Mohammed A. AlZain el al. [9] proposed (MCDB) which is based on Multi-clouds service providers. They compare MCDB with AWS. This comparison shows that multi-clouds model is superior then single cloud model in addressing the security issues in cloud computing. However they keep their work limited by just comparing this model with only one cloud (AWS).

Kaushik Donkena and Subbarayudu Gannamani [10] have done performance evaluation between cloud(Windows Azure) and traditional databases while retrieving the data and finally analyze the results. However, their work was limited by considering only SELECT statement. In our work we are using Select, Where Clause, Order by and Update Statements.

Changqing Ji et al. [11] have proposed Big Data Processing in Cloud Computing Environments. Authors found that big data encounters three major problems while processing i.e. big data storage and management, big data analysis and big data security.

Mansaf Alam and Kashish Ara Shakil [12] have proposed an architecture for management of data in cloud termed as "Cloud Database Management System Architecture" to full filled the requirements of scalability, availability along with stringent security and user authentication needs.

Shangguang Wang el al have proposed an evaluation approach of QoCS. The simulation results demonstrate that proposed approach can perform an accurate evaluation of QoCS in service-oriented cloud computing [13].

Kaiping Xue and Peilin Hong have discussed the advantages of cloud computing for data storage. They highlighted two main advantages (i.e. cloud provides additional data storage and to take access of stored data from cloud any time) [14].

Ylber Januzaja el al have proposed Database-as-a-service (DaaS) in cloud computing. In their research work they use SCALE DB, storage engine in cloud storage and finalized their results with conclusion that database is working as a service in cloud computing [15].

Baby Marina et al have analyzed the quality of response time for traditional database, remote database, and cloud database by using different DML Statements [16].

Ritu Aggarwal have discussed some strategies related to how we can multiplex virtual resource allocation to physical resource allocation effectively based on the fluctuating demand. They also use skewness metric to determine different resource characteristics appropriately so that the capacities of servers are well utilized [17].

3. Proposed Work

In this research, we set two research objectives. 1st objective was achieved through theoretical analysis and 2nd objective was achieved through experimental analysis.

3.1 Theoretical analysis

In theoretical analysis we are discussing about difficulties faced by researcher for getting access on a database of a cloud:

- ➢ Search for a cloud
- ➢ Get access on a database of cloud
- ➢ Difficulties for getting access

3.1.1 Search for a cloud

Firstly, we have to decide on which cloud we want an access. There are many cloud's which are allowing an access to their database services e.g Amazon web service, Microsoft Azure, Alibaba, Oracle cloud, Google cloud platform etc. In our research we got access on Amazon web service(AWS) and Microsoft Azure.

3.1.2 Get access on database of cloud:

After choosing a particular cloud we have to create an account with that cloud for getting access and for creating an account we need to have either:

- Credit card
- Debit card
- Visa card
- Master card
- Paypal

When I started to create an account I make sure that internet transaction service must be activated for the credit card so for that to contact with your bank or card issuer to confirm that your card is active or whether it is enable for

international transaction or not because there will be small transaction of $2.00 for authorization purpose without this you cannot process further. Standard chartered credit cards are by default active for online payments.

If you have a card of Bank Alfalah then they will ask you for how long you want the card to permit online payments. You can tell them for 15 minutes, 1 week, or you can tell them to keep it active for infinite time.

Banks like HBL, Silk Bank, Faysal Bank, Askari Bank keep this service active only for small time period. That means before you go ahead for online transaction you would have to call customer service and tell them to open online payment for small window (10 minutes to half an hour), then it will be up to you to make your payment within that time period.

You have to provide your credit or debit card information(name, billing address, credit or debit card number, cvv code, issue date, expiration date phone number) exactly what's printed on card. Despite providing the correct information you might get error due to some issues with your bank service as shown in below figure3.1.
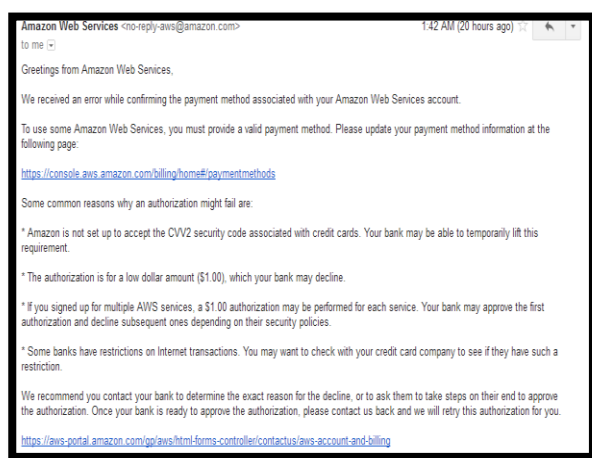

Fig. 3.1 Error while confirming payment method

Once you have done with all the requirements that are needed for an account you will be notified by an email for successfully getting access on that particular cloud.

3.1.3 Difficulties for getting access

If you want to get an access on a cloud you must have a credit card.

First of all being a student it's difficult to have a credit or debit card. We cannot use any prepaid card such as ATM card for this process and this one is the biggest problem. ATM or debit card means when you use a debit card or ATM card the money will be deducted from your checking account but with a credit card you are borrowing money to be paid latter and it's like a loan. So by using credit card

when we activate online transaction service for paying to cloud service provider to get access on their cloud services its totally on their hands how much they are going to deduct, so it's somehow risky whatever amount has been deducted you have to pay latter on.

Some cloud service provider claims that there will be a transaction of $1.00 but they are doing transaction of $2.00 such as Amazon Web Service.

3.2 Experimental Analysis

In this section, we compare two cloud databases (i.e., Windows Azure and Amazon Web Services) through experimental analysis. Performance of databases is evaluated through the query response time (QRT) by increasing the number of entries.

To measure the query response time a database which have been used is 'Adventure Works Sample Database' and SQL Server 2014 Management Studio software is chosen to run the database.

Data manipulation language (DML) statements used to find out the QRT into two different servers including SELECT statement, SELECT with Clauses (WHERE and ORDER BY) and UPDATE statement. Our target was to measure the QRT by increasing the number of entries.

3.3 Windows Azure (Cloud Server)

To analyze the performance of Windows azure cloud server in terms of query response time experiment is performed.

Windows Azure is providing the SQL server and the database 'Adventure Works Sample Database' is easily available in windows azure is used. Windows azure is used on web page via internet connection.

To measure the QRT number of entries increased and multiple Data Manipulation Language (DML) statements are used i.e SELECT, SELECT with clauses (WHERE and ORDER BY) and UPDATE. Firstly we only used SELECT statement and total no. of entries is 296 then gradually we increase the no. of entries to 543, 848, 12096 and 97537. Average value of the query response time is measured. Each and every query is repeated for 30 times and then average response time is taken.

The hardware configurations of the Cloud suppliers are unrevealed.

3.4 Amazon Web Services (cloud Server)

Amazon web services (AWS) server is another server used to perform the experiment. AWS is also used on web page via internet connection.

Same software is used for AWS and same DML statements which are used in Windows Azure are used in AWS to perform experiment. No. of entries are also the same and query statement is again the same as Windows Azure.

4. Results and Discussion

In this section, we discuss the results of two different research objectives as described in previous section.

4.1 Theoretical Results

This section discusses few difficulties which were faced by researcher

4.1.1 Account Creation

As we working on Amazon Web Services (AWS) and Microsoft Azure cloud, so to get the access on their databases it is necessary to register ourselves with them by creating an account.

4.1.2 Payment Method

To create an account it's obligatory that one must have Credit card/PayPal/Debit card because service providers will do the small amount of transaction after you provide your card number during registration time, initially this transaction will be made only for the authorization purposes.

4.1.3 Prepaid card and security

For payment method or account creation process one cannot use his prepaid card (ATM card). It's a biggest problem that we cannot use ATM or prepaid card because they (service provider) were also asking to remove the CVV number from the card which is a card security number and it's a bit risky because using a credit card is like you are borrowing money to be paid latter and it's like a loan. ATM card means we can keep limited money in our account and can easily fulfill their (service provider) requirements. But as they are not allowing for prepaid card and we cannot totally relay on them so it's risky to remove the CVV number or use credit card.

4.1.4 Country Issue

As I was searching for another cloud which can fulfill my requirements I found Alibaba Express(cloud) but after providing the entire information regarding my card I got a message that my credit card is not supportable because

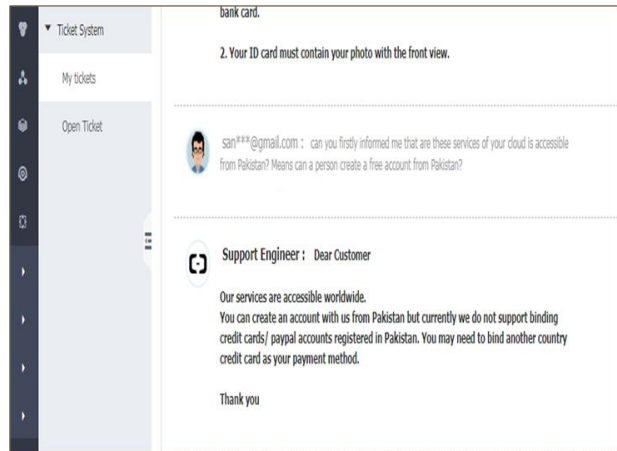they are not supporting binding credit cards from Pakistan.

Fig. 4.1 showing card binding issue

4.2. Experimental Results:

In this section, we discuss results of second objective
Performance of two different cloud databases is comparatively analyzed. QRT was measured with different DML statements. Each query was run for 100 times and then average query response time is calculated.
The average query response time of all the data entries (296, 504, 848, 12096, 97537) with different DML statements (SELECT, SELECT with clauses (WHERE and ORDER by) and UPDATE) are tabulated and also graphically plotted which indicates the time in milliseconds and number of entries.
Same database tables are run in two different servers with same queries. Multiple tables are also selected for increasing number of entries. When multiple clauses like WHERE and ORDER BY are applied then number of retrieved entries are found from total number of entries. Graphs are also plotted for each DML statement in which high response time is measured and it shows the response time with respect of number of entries.

Table 4.1 Average response time in milliseconds using SELECT Statement

Command	No. of entries	Amazon Cloud Server	Azure Cloud Server
SELECT*FROM[Adventure Works2012].[Production]. [Product];	296	20.7	11.767
SELECT*FROM[Adventure Works2012].[Sales]. [SalesOrderDetail];	504	21.7	12.73

Command	No.of entries	Retrieved entries	Amazon Cloud Server
SELECT*FROM[Adventure Works2012].[Sales].[Customer];	848	23	15.14
SELECT*FROM[Adventure Works2012].[Production].[Product],[AdventureWorks2012].[Production].[ProductCategory];	12096	777.5	702.53
SELECT*FROM[Adventure Works2012].[Production],[AdventureWorks2012].[ProductModel];	97537	1166.96	1017.43

4.2.1. SELECT Statement

Our target was to measure the QRT with increasing number of entries. For each number of entries different queries were performed. Therefore the average response time of different entries for two different databases by using only SELECT statement is given in table 4.1. And graphically representation of above mentioned results are:
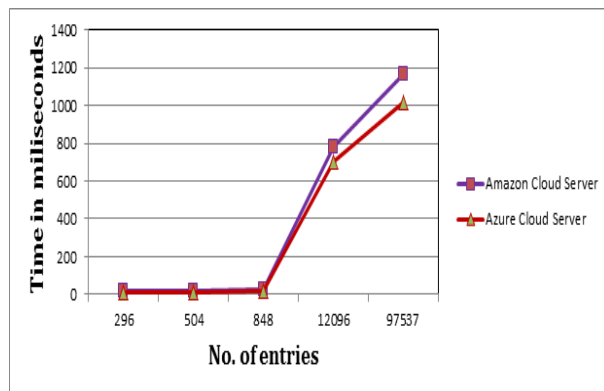

Fig. 4.1 Average response time using SELECT Statement

From the graph figure 4.1 and tabulated results shown in table 4.1 clearly indicated that there is extreme change between the performance of two different databases (Amazon database and Azure database). With increasing number of entries response time is also increasing in both servers. The results shows that Azure cloud is taking less time as compare to Amazon cloud database. In 296 no. of entries Amazon is taking 9 times higher response time as compare to Azure cloud. Same response time difference is noticed in all other mentioned number of entries.

4.2.2. SELECT with WHERE Clause Statement

When we run the SELECT query with WHERE clause then we retrieve different number of entries from total number of entries. For increasing number of entries each time different query is run with WHERE clause. Average response time of SELECT with WHERE clause in two different servers (Amazon and Azure) is tabulated as in table 4.2.

In table 4.2 retrieved entries are the number of entries which we fetched out from total number of entries after applying WHERE clause.

Table 4.2 Average response time in milliseconds using SELECT with WHERE CLAUSE

Command	No.of entries	Retrieved entries	Amazon Cloud Server	Azure Cloud Server
SELECT*FROM[AdventuresWork2012].[Production].[Product] WHERE ProductModelID > 20;	296	180	11.16	11.32
SELECT*FROM[AdventuresWork2012].[Sales].[SalesOrderDetail] WHERE ProductID> 800;	504	462	18.13	19.43
SELECT*FROM[Adventures Work2012].[Customer] WHERE Title = 'Mr.';	848	607	41.93	46.26
SELECT*FROM[AdventuresWork2012].[Production],[AdventuresWork2012].[ProductCategory] WHERE ProductModelID > 18;	12096	7914	243.33	274.1
SELECT*FROM[AdventuresWork2012].[ProductDescription],[AdventuresWork2012].[ProductModel] WHERE ProductDescriptionID> 1600;	97537	51329	1252.47	1802.2

When the results of above mentioned table are plotted graphically below, it shows that Amazon is taking less time than Azure cloud.
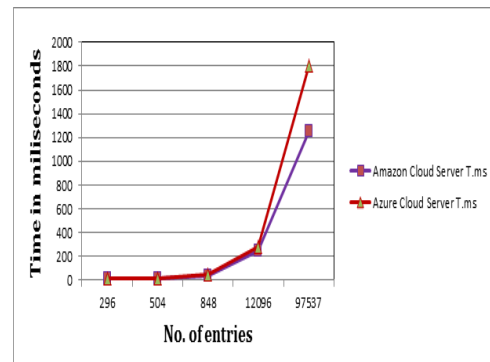

Fig. 4.2 Average response time using SELECT with WHERE Clause

In this result Amazon cloud server performance is far better as compare to Azure cloud server. In 462 retrieved entries from 504 total numbers of entries Azure cloud is taking 1 time higher response time as compare to Amazon. Then we gradually increased retrieved entries to 607 from total of 848 entries again Azure cloud is taking 5 times higher response time as compare to Amazon. In 7914 retrieved entries Azure cloud is taking 31 times higher response time as compare to Amazon cloud server. In 51329 retrieved entries again Azure cloud is taking much higher time than Amazon server.

4.2.3. SELECT with ORDER BY Clause Statement:

In SELECT with ORDER BY clause different numbers of entries retrieved with different response time. Average QRT for both servers (Amazon and Azure) by using SELECT with ORDER BY clause is tabulated in table 4.3.

Retrieved entries in table 4.3 are the number of entries which are recovered from the total number of entries.

Table 4.3 Average response time in milliseconds using SELECT with ORDER BY CLAUSE

Command	No. of entries	Retrieved entries	Amazon Cloud Server	Azure Cloud Server
SELECT*FROM[AdventuresWork20 12]. [Production].[Prod uct] WHERE ProductModelID> 20 ORDER BY ProductID DESC;	296	265	1.93	11.267
SELECT*FROM[AdventuresWork20 12]. [Sales].[SalesOrder Detail] WHERE ProductID> 800 ORDER BY DESC;	504	422	10.53	30.63
SELECT*FROM[AdventuresWork20 12]. [Customer] WHERE Title = 'Mr.', ORDER BY 'LAST NAME';	848	491	22.5	46.23
SELECT*FROM[AdventuresWork20 12]. [Product],[Adventu resWork2012]. [ProductCategory] WHERE ProductModelID> 18 ORDER BY DESC;	12096	10825	325.9	830
SELECT*FROM[AdventuresWork20 12]. [ProductDescriptio n],[AdventuresWor k2012].[ProductM odel]WHERE ProductDescription ID>1600 ORDER BY ProductDescription ID DESC;	97537	51329	1613.77	3378.13

Graphical representation of the above table is given below; this graph shows that Amazon server is taking less time than Azure server.
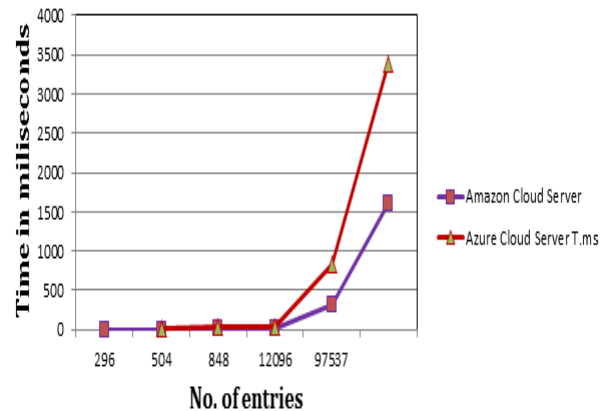

Fig. 4.3 Average response time in milliseconds using SELECT with ORDER BY CLAUSE

In SELECT with ORDER BY again Amazon's cloud performance is better. In 265 retrieved entries Azure cloud is taking 10 times higher response time than Amazon cloud. In 422 retrieved entries Azure cloud is taking 11 to 30.63 times greater response time. In 491 retrieved entries again Azure cloud is taking 23.5 to 46.23 higher time's as compare to Amazon cloud. In 10825 retrieved entries Azure is taking 500 times higher response time as compare to Amazon cloud. In 51329 retrieved entries again Azure cloud server is taking 1764.36 times greater response time from Amazon cloud.

4.2.4. UPDATE Statement:

While using UPDATE DML statement to measure the average Query Response Time(QRT) between two servers (Amazon,Azure) QRT was increasing when number of entries were increased. Average response time of UPDATE Statement is tabulated in table 4.4.

Table. 4.4 Average response time in milliseconds using UPDATE Statement

Commands	No.of entries	Retrieved data	Amazon Cloud Server	Azure Cloud Server
UPDATE[AdventureWorks2012].[Production].[Product]SET ReorderPoint = '1' WHERE ReorderPoint = '600';	296	25	1.05	2.67
UPDATE[AdventureWorks2012].[Production].[Product] SET Color = 'Black' WHERE Color = 'orange';	543	311	14.23	21.4
UPDATE[AdventureWorks2012].[Sales].[SalesOrderDetail] SET OrderQty='13' WHERE OrderQty> '2';	848	343	16.57	30.67
UPDATE[AdventureWorks2012].[Sales].[Customer] SET Title ='Mrs' WHERE Title = 'Ms';	12096	11240	224.03	943.05
UPDATE[AdventureWorks2012].[Sales].[CurrencyRate] SET FromCurrencyCode ='EUR' WHERE FromCurrencyCode = 'USD';	97537	14129	1814.81	4561.32

Graphically it has been plotted in figure:4.4. this graphically representation clearly showing that Azure cloud server is taking higher response time as compared to Amazon cloud server.
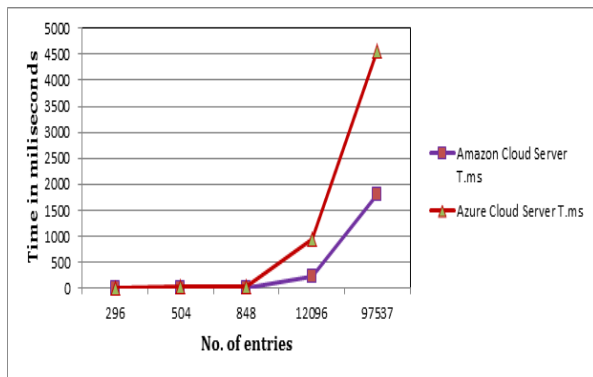

Fig. 4.4 Average response time in milliseconds using UPDATE Statement

In UPDATE statement performance of Amazon cloud server is again much better than Azure cloud server. We retrieved 25 number of entries from 296 number of entries in which Amazon and Azure cloud servers are much closer to each other in terms of response time but Azure is taking bit more response time. In 311 retrieved entries Azure cloud server is taking 7 times higher response time as compare to Amazon server. In 343 retrieved entries Azure cloud is taking 14 time's greater time as compare to Amazon server, rest of the entries also showing that Azure is taking higher response time as compared to Amazon cloud server.

4.3. Discussion:

The main aim of this research was to comparatively analyze the performance of two different cloud databases, Amazon cloud database and Azure cloud database in terms of query response. AdventureWorks sample database is selected to analyze the performance of two different servers. SQL Server 2014 is used which was laterally connected with both(Amazon, Azure) cloud databases. Multiple data manipulation language statements are used like SELECT, SELECT with clauses (WHERE and ORDER BY) and UPDATE. The average response time results are shown in both tabular and graphical representation. Results indicates that the Azure cloud database is taking less time when using just SELECT statement. While with rest of the statements, Amazon's cloud database performance is far better than Azure cloud database. Amazon is taking less response time as compared to Azure cloud database.

5. Conclusions And Future Work

5.1 Conclusions

For this whole research two different methods are used to meet two different research objectives. First research objective is theoretical analysis, in which we are discussing about the difficulties or things which are required to get access on almost all the cloud databases, what difficulties or things are required for access are mentioned in results chapter.

Secondly performance of two different cloud servers is evaluated in terms of query response time. Every time number of entries was increased, by doing this we got the results that by using only SELECT statement Amazon cloud is taking higher time than Azure cloud but rest of the results are showing that Azure is taking higher time than Amazon cloud.

5.2 Utilization of results:

Results of this research may help the new researchers about how to choose a cloud, which things are required to get access on a cloud. This may also help the owners of cloud

databases to find out the reason behind why a particular cloud is taking higher time to response.

5.3 Future Work:

In future, query response time can also be measured by using MariaDB, MySQL, Oracle or NoSQL database instead of SQL Server and more than two cloud can be compared for their performance analysis. For now in this research only SELECT and UPDATE DML statements are used, other DML statements such as INSERT and DELETE can also be used to evaluate the performance of two or more different cloud servers.

Acknowledgement

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