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Analyzing Service Level Agreements for Optimal Quality of Service in Cloud Computing

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Abstract: The several factors that aid in the formation of Service Level Agreements (SLAs) between service providers and users determine the management and establishment of SLAs in the cloud. Both the generation of SLA metrics and the providing of services are determined by these criteria. Companies and consumers alike must settle on a method for selecting a service provider. Researching and comparing the top providers on the market today under the same circumstances is an intensive procedure that is necessary when picking the proper service for every customer. The biggest problem for clients when choosing an IaaS provider is the lack of openness and standardisation in the industry. When making a scientifically-based preference for one service over another within the same category or supplier, this study is crucial. After a year of testing VNS and SSaaS, this study compared Amazon and Microsoft Azure's SLA quality of service across two major providers using identical tools, server settings, geographic region, time, and factors. When comparing the two firms' SLAs from the user's point of view, we found that their network factors and performance variations were very comparable. when a consequence of the virtualization technology they employ, AWS provides better values when the number of client connections increases. AWS surpassed Azure in terms of service credit, free tier account providing, and Linux usability.

Keywords: *- cloud, computing, Service*

INTRODUCTION

One of the main distributed computing technologies, cloud computing aims to make computers more scalable and flexible by making available various resources and standard services over the Internet, which also helps keep costs down. Additionally, cloud computing offers a wide variety of deployment strategies to cater to different consumer requirements. Because of this, cloud computing is thought to have a huge impact, as it allows small businesses to expand globally with ease and at a cheap cost while maintaining good quality.

Cloud computing relies on Service Level Agreements (SLAs) to provide the highest possible QoS. Providers and consumers of cloud services enter into these agreements to spell out the parameters of performance and availability that need to be met. Uptime assurances, response times, data redundancy, and security measures are some of the characteristics that are evaluated when SLAs are analysed. In order to select cloud services that meet their operational needs, organisations can benefit from conducting thorough SLA analyses, which aid in detecting any gaps and dangers. To improve reliability, performance, and user happiness, organisations should carefully evaluate SLAs to make sure their cloud infrastructure meets their demands. A strong and efficient cloud environment can only be achieved through this procedure, which is essential for reducing the likelihood of downtime, protecting data, and meeting regulatory requirements.

The ever-changing nature of cloud computing also means that SLAs need constant monitoring and adjustment to stay up with corporate expectations and technological improvements. The agreed-upon quality-of-service indicators are regularly satisfied and any deviations are swiftly rectified through this ongoing assessment. Standard Terms and Conditions (STCs) include not only technical requirements but also financial and legal considerations, such as remedies for disagreements and fines for noncompliance. In order for service providers and consumers to continue to have a mutually beneficial relationship, it is vital that they fully comprehend and analyse SLAs.

Improving service level agreements (SLAs) gives cloud providers an edge by showing customers they care about providing top-notch services and earning their confidence. Consumers may make well-informed decisions about their IT infrastructure's resilience, scalability, and ability to serve important business processes with the help of thorough SLA analysis. Ultimately, the effective deployment and administration of cloud services are driven by a methodology that incorporates technical, legal, and strategic factors when analysing SLAs for optimal QoS in cloud computing.

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The significance of service level agreements (SLAs) in preserving service quality is paramount as cloud computing develops further. With the growing dependence on cloud services for essential business functions, service level analysis (SLA) has become an integral part of IT strategies for many organisations. As part of this study, you'll need to familiarise yourself with the baseline metrics and evaluate the adaptability and scalability of the SLA conditions to meet the demands of future expansion.

Additionally, SLA frameworks are being impacted by new technologies like AI and ML, which are offering sophisticated capabilities for tracking and forecasting service performance. In order to avoid service interruptions and achieve SLA requirements, these solutions provide proactive control of cloud resources. As an added bonus, the monitoring process is made even easier with the integration of automated SLA management solutions. These tools provide real-time insights and notifications for suspected SLA breaches.

Service providers and customers must communicate clearly for SLA management to be effective. The parameters of the SLA and the processes for reporting and resolving concerns must be understood by all parties. To keep it current and relevant to the business's requirements and expectations, the SLA should be reviewed and updated on a regular basis.

In order to keep cloud services of high quality, it is vital to analyse and improve Service Level Agreements continuously. Organisations may guarantee dependable, scalable, and goal-aligned cloud services by utilising cutting-edge innovation and encouraging open communication. By taking this preventative measure, we may improve the cloud computing ecosystem for future development and innovation while also improving the user experience.

Because cloud computing often runs in an ever-changing setting, it needs lightweight, real-time decision-supporting parameters and functions to serve an unpredictable and diversified group of entities. In order to construct and establish the functions, SLA parameters are also required. The administration process was simplified by focusing solely on performance with traditional IT and web-based business application deployment. However, things have changed drastically since the advent of the cloud.

Service Level Agreements (SLAs) are necessary in cloud environments for all parties involved, including providers, customers, and the relationship between providers and customers. SLAs are legally binding contracts that members enter into to guarantee:

a) The standards for Quality of Service (QoS) are fulfilled, and in the event that one party breaches the conditions of the SLA, the negligent party will be held financially accountable as outlined in the SLA.

b) Listed here are the potential earnings for the service provider at various service levels,

c) If the agreed-upon performance is not fulfilled, the service provider is required to pay a penalty.

d) Various SLAs exist, each with its own set of metrics and ways of measurement (e.g., measured per client or per query).

e) Service customers and providers create a Service Level Agreement (SLA) that specifies the metrics, anticipated quality of service (QoS), and penalties for service delivery.

Users at the front end, providers and internationally distributed servers at the back end, and the network are the main components of cloud architecture, as outlined by the Service Level Agreement (SLA) paradigm. Service level agreements (SLAs) are based on the many elements and conditions between providers and consumers. Users can tailor their requests for cloud services to their own needs. With the assistance of a broker or auditor, the supplier satisfies the need.

The providers negotiate, allocate, and manage the SLA in accordance with the demand. You can see the whole procedure in the image below.

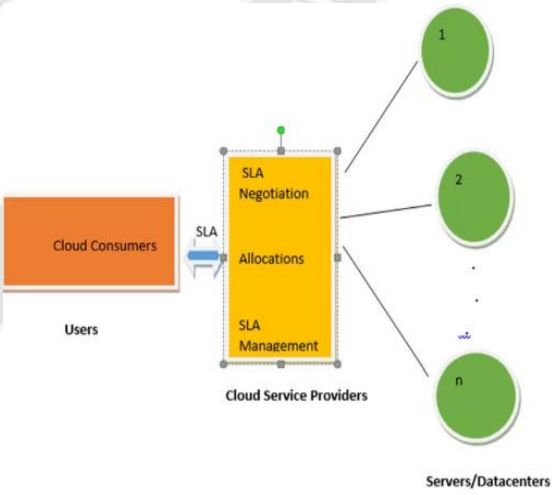

Fig.1: SLA Model

Not only does the SLA model aid consumers in choosing a better service, but it also determines the template criteria for providers and users that utilise various cloud service signing contracts. A combination of provider and user evaluations is

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the basis of the SLA model-based evaluation approach. A high-grade service, by definition, provides a high-quality service.

Objective

1. To Evaluate and Compare the Quality of Service (QoS) Metrics
2. To Provide a Scientific Basis for Choosing Cloud Service Providers

Methodology

Evaluation of QoS in Cloud Computing Environment

We painstakingly evaluated and tracked the following performance parameters to assess the virtual server providers' ability to meet user demands and rate their service quality:

1. Response time
2. Processing time
3. Transfer rate (Throughput)
4. Bandwidth
5. Latency
6. Jitter
7. Data loss

Cloud infrastructure as a service evaluation followed a straightforward, lengthy, and sequential methodology. Iperf3, Netperf, MTR, WinSCP, and Putty were all part of the package. It covered two time zones (Tokyo and Canada) and three server kinds (general purpose, memory optimise, and compute optimise) with wildly varying user configurations (10,50,100). Comparable to the two businesses operating in tandem with the two service suppliers. Figure 2 depicts the assessment cycle:

Figure 2. Empirical Evaluation Lifecycle

These steps are illustrated in Figure 3

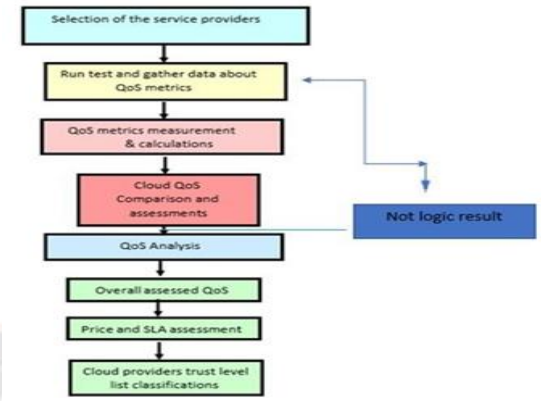

Figure 3: Flowchart of QoS Evaluation

APPROACH

VM Performance

Fast CPU, OS, processor type, RAM, and underlying virtualization are only a few of the numerous variables that affect a virtual machine's performance.

We benchmarked three distinct types of virtual machines (VMs) using diverse settings, including varying amounts of sessions across the two providers, different times of day (both peak and off-peak), and different settings.

In order to test the internal network performance using benchmark tools, we established two identical virtual machines (VMs), with one VM serving as a server and the other as a client. deployed across two regions' data centres (Tokyo and Canada) across both providers, Putty allowed for remote SSH server access.

VM type were classified as shown:

-Type 1: General purpose Balanced CPU-to-memory ratio

-Type 2: Memory optimized also called High memory-to-core ratio

-Type 3: Compute optimized also called High CPU-to-memory ratio.

Measurement Tools

Table 1: Measurement Tool and factor

Tool	Used for
Iperf3	Bandwidth
Iperf3	Transfer rate
Iperf3	Data loss
Iperf3 / MTR	Jitter
Linux command (time) + Iperf3 /Vmstat /WinSCP	Processing time
MTR / httperf / Htop	Response time
netperf	Latency

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SLA Discussion Performance Variability

Performance varies from one instance of a public cloud service to another. Varying workloads, virtualization overhead, unpredictable networks, and shared use of resources and time are just a few of the elements that might affect performance.

One easy way to quantify the relative unpredictability of performance is to utilise the standard deviation, a popular statistical tool for measuring performance variability. For the purpose of calculating standard deviation, the following equation was used:

Table 2: (AWS, Azure) Performance Variation

Factors	AWS			Azure		
	VM1	VM2	VM3	VM1	VM2	VM3
Bandwidth	0.66	0.00	0.11	0.00	0.00	0.66
Transfer rate	0.02	0.00	0.002	0.002	0.001	0.002
Jitter	1.3	0.10	0.4	0.6	0.20	0.6
Data loss	0.20	0.38	0.32	0.25	0.61	0.43
Latency	0.13	0.13	0.14	0.14	0.14	0.14
Process time	0.002	0.011	0.80	0.30	0.030	0.82
Response time	1	1	0.9	2	2	1

By averaging the results from four day sessions and four night sessions, we were able to produce a variation sample for the 100 customers whose values are displayed in the table. In order to conduct load testing, the number of parallel connections between the client VM (located in Tokyo, Japan) and the server VM (also in Tokyo, Japan) was increased by 10, 50, and 100. Both providers' results showed unstable performance fluctuation, with values ranging from 0 to 2.

1. VMs bandwidth performance variation

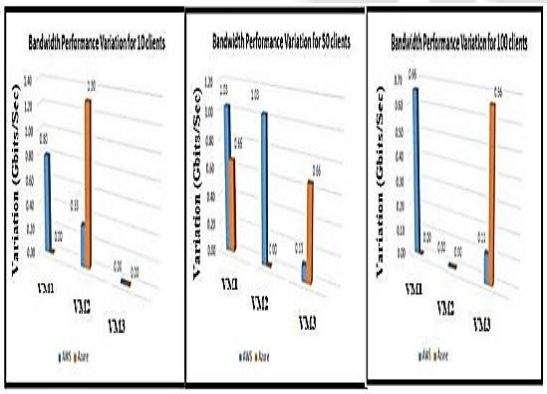

Figure 4. Demonstrated inconsistent bandwidth use across VM types for both service providers.

2. VMs transfer rate performance variation

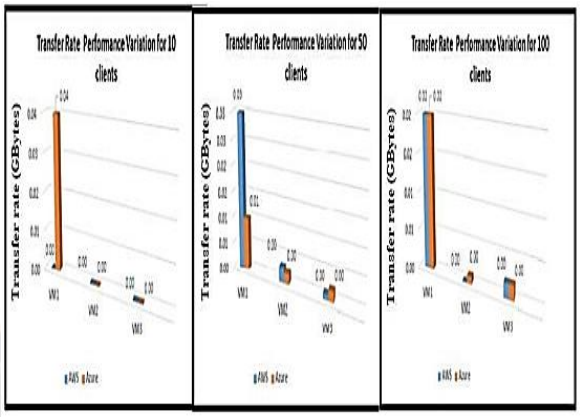

Figure 5. Displays the transfer rate fluctuation between different types of virtual machines, with VM2 and VM3 showing essentially constant rates across all providers.

3. VMs jitter performance variation

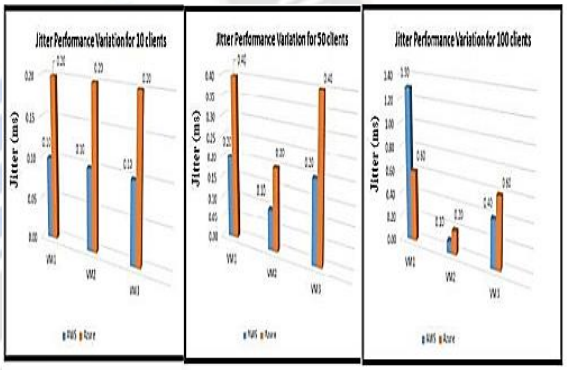

Figure 6. That AWS exhibits reduced variance across all VMS for connections from 10 and 50 clients, as well as for VM2 and VM3 of the 100 clients. This means that depending on the MTR tool, AWS has smaller jitter fluctuations than Azure.

4. VMs data lost performance variation

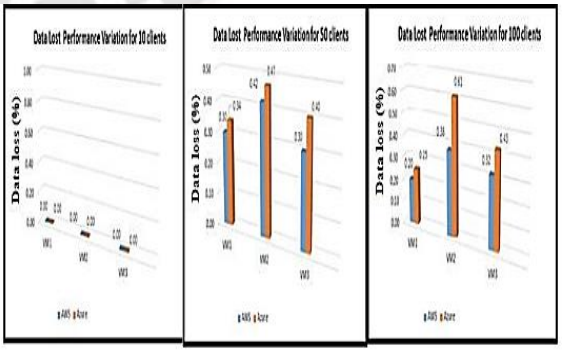

Figure 7. Displays data loss variation for virtual machines; all three virtual machines (VMs) perform best with ten customers; data loss increases with rising connection numbers across all providers.

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5. VMs latency performance variation

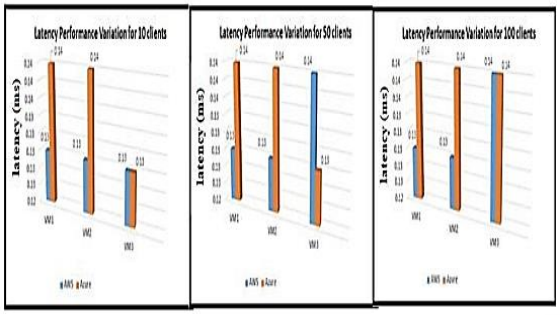

Figure 8. Found no variations in latency values between VM1 and VM2 for 10 and 50 connections, regardless of the kind of virtual machine. VM3 results demonstrated that all 10, 50, and 100 connections had different latency values.

6. VMs process time performance variation

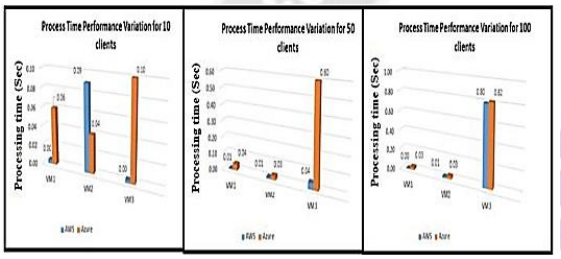

Figure 9. Shown that the process time variance among the three types of virtual machines was not consistent for 10, 50, and 100 customers, with VM3 exhibiting the most problematic variation on Azure.

7. VMs response time variation

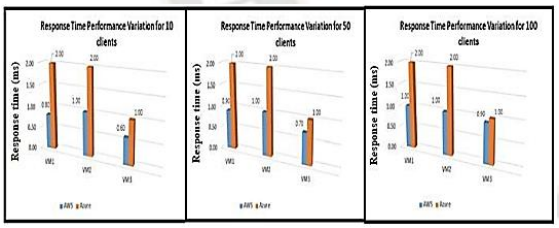

Figure 10. Shown that the three types of VMs did not exhibit steady response time variation for 10, 50, and 100 clients. While Amazon's variation grows with the number of customers, Azure's variation over VM types is the biggest.

8. Free account

An essential component that allows consumers to use their expertise with cloud services is the cloud tier account. Furthermore, consumers are able to test out various cloud service providers and their offerings risk-free, whether that's in terms of financial or legal commitments. The trial periods and the features supplied by each platform (AWS, Azure) are what set them apart.

Level of Azure account: Each user pays $200 once for a one-month tier account on Microsoft Azure, with the option to attach a credit card in case the amount goes beyond $200; students pay $100 each month. Up to ten virtual CPUs running different operating systems and a virtual network are all part of this account's virtual machine services. The free tier time ends or the $200 is nearly depleted, whichever comes first, and the account is terminated.

Tier account in AWS: Users of AWS and Azure have access to the same services, but with AWS, you can get a 12-month tier account for just $1. You can even attach your credit card to your account so you may use it to run virtual machines (VMs) that aren't compatible with the free account. Even if the 12-month period has ended, AWS does not immediately delete the account; customers have a grace period to access their data whenever they need it.

Azure and AWS both provide a plethora of services to assist customers in finding the right infrastructure for their needs. Nevertheless, compared to Azure, AWS is better as it offers a 12-month free trial instead of only one month. An additional perk of the AWS free tier is that data is not instantly deleted when users decide to unsubscribe; it remains accessible for future re-opening.

Table 3 Some free services provided by (AWS, Azure) (Amazon Cloud Docs .2021), (Azure Cloud Docs.2021)

AWS	Azure
750 hours per month ofLinux	Not limited by hour only by account charge
Expires 12 months aftersign-up	Expired after completed account given charge
Up to 10 VCPU	UP to 10 VCPU
5 GB of StandardStorage	8TB of storage for amonth
up 50 free virtualnetworks.	Up 50 free virtualnetworks.
Limited regions	Limited regions
Limited VM types	Limited VM types

9. VM SLA

Guaranteed service, duration of guarantee, correctness of warranty, exclusions of warranty, service credit, violation, reporting of service abuse, and service credit are common elements of service level agreements (SLAs). Building upon the formula:

Monthly Uptime % = (Maximum Available Minutes-Downtime) / Maximum Available Minutes X 100 (Azure Cloud Docs.2021), (AWS Cloud Docs.2021).

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Controlling user-Azure modification during VM instance use is the responsibility of the Virtual Machine Service Level Agreement (VM SLA) in Azure. When it comes to external connection, Azure has you covered 99.99% of the time. At each stage of service reduction, the client receives a percentage of the entire paid value as service credit: 10% for services dropped to less than 99.99, 25% for services decreased to less than 99%, and 100% for services decreased to fewer than 95%. The service identified an incident that impacts the health of the virtual machine, and it will be marked as unavailable.

Virtual Machine Service Level Agreements (VMSLAs) in Amazon Web Services (AWS) govern the procedures by which users and Amazon manage EC2 virtual machines. The uptime percentage is guaranteed by AWS at 99.99% per month. In contrast, the customer can redeem 10% of the Service credit when the service is reduced to the percentage range of 99.99% to 99%. But if the service drops below 99.0% to 95%, the client can get 30% of the service credit back. as well as 100% in the event that the service drops below 95%. When a virtual machine (VM) in AWS Elastic Compute Cloud (EC2) is unavailable, it indicates it is not communicating with the outside world (Amazon Cloud Docs.2021).

The service level agreement (SLA) for virtual machines (VMs) on AWS and Azure is 99.99%. There is a 5% gap between AWS and Azure in terms of credit service.

RESULT

The results of quality-of-service (QoS) tests for network diagnostic parameters reveal that various IaaS cloud systems perform significantly differently. Noisy neighbours, hardware heterogeneity, and the kind or overhead of virtualization were external factors that affected performance and explained the observed difference.

Since customers of cloud services do not have physical control over the assets, they must rely on providers to guarantee the services' dependability, usefulness, transparency, and efficiency. Ensuring a trustworthy connection between the supplier and the consumer in cloud computing is crucial for an acceptable SLA, and quality of service is a critical component in this regard. Ensures that the service provider delivers on their promises and meets the customer's needs in accordance with the terms and conditions agreed upon, fostering a relationship of trust between the parties. In particular, consumers have a hard time comprehending and evaluating SLA papers due to the vagueness of the agreement language. Since every service provider has their own unique SLA nomenclature, these difficulties become much more significant when a customer employs services from more than one supplier. Establishing a paper outlining the key ideas, negotiating and defining the SLA, and covering all other stages of the SLA life cycle are all necessary for an effective SLA. The service is evaluated and any SLA violations are detected through monitoring. There is a big issue with providers writing SLA documents in complex language and then expecting consumers to analyse and monitor availability, violation, response time, throughput, error rates, and performance without proper tools.

Table 4: (AWS, Azure) trust level classification

Classification Terms		Best Provider
Performance factors	Bandwidth	AWS
	Transfer rate	AWS
	Jitter	AWS=Azure
	Data loss	AWS=Azure
	Latency	AWS
	Processing time	AWS
	Response time	AWS
Price		AWS
Workload factor		AWS
Tier account		AWS
Ease of use		AWS
SLA		AWS

Based on account utilisation over one year, Linux OS usage, virtual machine construction, and SLA service credit, AWS provides better, easier-to-use services.

CONCLUSION

There are a number of factors that allow service providers and customers to construct SLA metrics, which are crucial to the administration and setup of SLAs in cloud computing. In order to determine the supply of services, these characteristics are necessary. If businesses and consumers want to make educated choices, they need to do their homework and compare services scientifically. Infrastructure as a Service (IaaS) presents a formidable obstacle for clients when choosing a provider due to the absence of transparency and standardisation. Findings from this study stress the significance of using evidence-based preferences when selecting a service or provider. Over the course of a year, this research compared Amazon Web Services' and Microsoft Azure's SLA quality of service using the same tools, server settings, geographic location, time, and characteristics. Both businesses' networks performed similarly, but AWS's virtualization technology allowed them to handle more client connections with ease. In this study, AWS was shown to be the best option because to its user-friendly interface, greater free tier account options, and 5% larger service credit difference compared to

Azure. Additionally, AWS was found to be easier to use with Linux.

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