AVAILABILITY METRICS FOR CLOUD VIBRANT BEHAVIOUR WITH BENCHMARKS INFLUENCE ON DIVERSE FACETS

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ABSTRACT

Cloud computing is the record significant encroachment used in emergent industries and additional miniature and huge sized corporations, so the demand on accessing the quality of cloud considerably rising. The intricate vibrant behavior of many real time applications of cloud emboldens for estimating its quality in contrast with the different clouds. The applications deliver by the cloud will seize time to arrive at the client end and that time is a key reflection for the cloud performance. This paper addresses the problem of measuring the quality of cloud using cloud metrics based on the availability benchmarks. Diverse facets of availability of cloud are reflected and scrutinized by observing the impact of each facet on the prominent clouds and consequences of the proposed cloud metrics are used to compare the performance of the clouds. Cloud metric will be an evaluation in cloud computing which will brand the performance scheming of cloud precisely modest and a client then can effortlessly elect a cloud conferring to their respective requirements.

KEYWORDS

Availability Matrics, Cloude Vibrant Behavior, Diverse Facets, Cloud Computing, Application Delivery Controller

1. INTRODUCTION

Cloud computing means Internet ('Cloud') based development and use of computer technology (‘computing'). It is computing technology where IT-related capabilities are provided “as a service”, allowing users to access web based tools and application “in the cloud" without knowledge of, underlying technology infrastructure that supports them [17]. The cloud offers the disposal of hardware as well as software to the client virtually through the internet which makes the computing reasonable. It is a style of computing where scalable and elastic IT-enabled capabilities are delivered as a service to external customers using internet technologies [5]. Many different clients might be accessing the same back-end applications, and many provider such as Amazon, Google, IBM etc. are providing the cloud services has the expectation that their application will be properly delivered to users with maximum availability comparatively than the different clouds. It is essentially required to gather the information instantly without any delay in response and the gathered information should be related to each other according to the user's request. This related information provided by the cloud applications have to be consistent and stable [2] [4].

An Application Delivery Controller (ADC) [6] and Local Traffic Manager which virtualize the back-end systems were developed to ensure highest availability of requested resources. Cloud Services should be available maximum time [7] and must provide the full existence of applied applications. When clients have to choose the cloud for better quality services than the different clouds in the market than clients require some diverse facets by which they select the cloud according to their necessities. This particular requirement of the client is achieved by using a cloud metric. In this paper a cloud metric for availability is developed by keeping the cloud's quality attributes in cognizance.

The Six key Clouds like Amazon, Microsoft Azure cloud, Google application Engine [16], Sun Microsystems Cloud and Hadoop are selected and every cloud is scrutinized with different cloud availability metrics and the consequence is presented in the form of a chart. Cloud providers have to maintain the performance assessment testimony of their cloud to verify its quality and they have to keep a check on the quality of the clouds supplied by the different providers to compare the performance of their own cloud with the others that their own cloud is healthier than others or not. At the client end, the cloud quality estimation is also required to give the transparency of cloud's behavior. The cloud is estimated on purposed metrics for distinct scenarios and for each metric the impact of diverse facets are scrutinized and deliberated. These assessments given by the metrics are applied to a theorem. The final result shows the availability of each cloud and the level where they lies.

1.1 Diverse facets

Even short outages and response delays have an impact on usability. Rapid resumption after interruptions may be dependent on replicated databases whose synchronization is maintained in real- time [1]. The availability of the cloud applications leaves some impact on the cloud performance that impact depends on their relationship with availability facets. The diverse facets which are forces by the availability are:

1.1.1 Stability

The significant traits of cloud applications, that impact on the hazard of accidental significances as a result of amendments in any application.

1.1.2 Scalability

Scalability is a desirable property of a system, a network, or a process, which indicates its ability to either handle growing amounts of work in a graceful manner, or to be readily enlarged [3].

1.1.3 Consistency

Cloud services may be independent and of different nature. These self-directed services which are creating these applications always finish in consistent states regardless of any exceptional events.

1.1.4 Reliability

Reliability is the probability of success or the probability of a failure-free operation in a cloud. Cloud gets many requests concurrently and will also give the similar results for some requests in minimum time possible with full success.

1.1.5 Validity

Cloud services have to be valid according to the requests of the clients. The cloud actually delivers what it purports to deliver and if the availability is higher validity should also be higher.

1.1.6 Sensitivity

The cloud has to show variability in responses when it exists in the stimulus or situation. Cloud has to face many clients and their different requests at the same time, so it has to give response variably at that same time with higher availability.

1.1.7 Efficiency

Efficiency means the amount of computing resources and code required to perform a function. Cloud has to be so efficient so that to provide the higher availability it should require minimum resources and code to perform any function and to serve any request.

1.1.8 Case Study

The success for Clouds can be attributed to the ability to provide seemingly unlimited computing resources almost instantaneously and also to the pay-per-use pricing schemes [8]. The clouds Amazon, Google, Yahoo, Azure, Sun Microsystem's Cloud, and Hadoop (Figure 1) are taken and each metric has applied on each of them in their execution time for finding out their performance. Different clouds are introduced below:

Amazon Elastic Compute Cloud provides resizable compute capacity and designed to make web-scale computing easier for developers [9].

Figure 1: Famous cloud Providers

Google cloud provides, hosted and "software plus services" technologies, Google's multi-tenant, Internet-scale infrastructure offers faster access to innovation, superior reliability and security, and maximum economies of scale [10].

Windows Azure is the cloud platform that empowers you to develop and run applications with unbounded scalability and ease-of-use with flexible platform [11].

Yahoo! is building a set of scalable, highly-available data storage and processing services, and deploying them in a cloud model to make application development and ongoing maintenance significantly easier [12].

Sun support every facet, including the server, storage, network, and virtualization technology that drives cloud computing environments to the software that runs in virtual appliances that can be used to assemble applications in minimal time [13].

Hadoop [14] is a popular open source cloud computing with MapReduce framework offers transparent distribution of compute tasks and data with optimized data locality and task level fault tolerance [15].

2. DEFINITIONS AND TERMINOLOGY

This section covers all the terms and definitions used in the availability metrics for cloud. Terms denote for the diverse facets and some definition which defines the scenario which will calculate the availability of different clouds based on their diverse facets.

2.1 Definition: A scenario "z"

The dynamic behavior of cloud applications can be specified using a set of scenarios. A scenario, z from a number of applications n, is the interaction between client and the cloud's application.

2.2 Definition: A set "$C_A Z$"

Each execution scenario has certain positive diverse facets depending on the behavior of application. A set of application's probability for having positive diverse facets for different scenarios is denoted by "$C_A Z$".

2.3 Definition: A set "$C_B Z$"

Each execution scenario has certain negative diverse facets depending on the behavior of application. A set application's probability for having negative diverse facets for different scenario is denoted by "$C_B Z$".

2.4 Terms

$\mathbf{A_{N1}}, \mathbf{A_{N2}}, \mathbf{A_{N3}}, \mathbf{A_{N4}}, \mathbf{A_{N5}}, \mathbf{A_{N6}}, \mathbf{B_{N1}}, \mathbf{B_{N2}}, \mathbf{B_{N3}}, \mathbf{B_{N4}}, \mathbf{B_{N5}}, \mathbf{B_{N6}} \in I$

Where **I**= Set of Impact Factors.

3. CLOUD AVAIALABILITY METRICS

In this section, we define the availability metrics within a scenario scope i.e. measurements are calculated for the cloud application and their behavior during the execution. The cloud application metrics are proposed using the following stencil:

Context: The situation in which the metric is applicable i.e. at what state we can apply the metric.

Description: A textual description of the metric that explains the meaning of metric without overpowering systematic details.

Formula: A mathematical portrayal of the metric using the terminology defined. The formula is useful in automating the process of obtaining measurement using proposed metrics.
Impact: A discussion on the impact of the metric on one or more of the diverse facets.

3.1 ART

The section wraps the ART evaluation for the cloud with its effect on diverse facets which contributes to calculate the total quality of cloud.

3.1.1 Context

The time taken by the application from the instant of client's request up to the time to respond back with entire application to client is joined in the scenario for evaluating the ART.

3.1.2 Description

$T^{ARn}(z)$ is the time taken by the cloud to respond to the n number of requests which gives the three measurement entities during the execution of scenario z. $T^{ARn}(z)^{+}$ is the set of those diverse facets on which $T^{ARn}(z)$ behave positively. $T^{ARn}(z)^{-}$ is the set of those diverse facets on which $T^{ARn}(z)$ behave negatively.

3.1.3 Formula

$$T^{ARn}(z) = \begin{cases} T^{ARn}(z) = \frac{1}{n}\sum_{k=1}^{n} T^{ARk}(z) \\ T^{ARn}(z)^{+} = \{A_{N1}, A_{N2}, \dots\} \\ T^{ARn}(z)^{-} = \{B_{N1}, B_{N2}, \dots\} \end{cases}$$

3.1.4 Impact

ART is the Application Response Time which is the time in which client send the request to cloud and get the full adaptation response. The ART of a cloud should have to be low so that the client will get the services as early as possible. So it is important to find out the response time of a cloud for its quality measurement. ART can affect the following diverse facets:

3.1.5 Stability

If the application take larger response time than the system can never be constant. Stability can be achieved when the response time of application will be lesser.

3.1.6 Scalability

Cloud can scale variably if its ART is low and meet the growing amount of demands, because if ART will be low then the client will show more interest in that cloud.

3.1.7 Reliability

Reliability of a cloud depends on the ART, if the ART is low than the cloud will be more reliable and if the ART is high, the cloud will be less reliable.

3.1.8 Sensitivity

Cloud with minimum ART is more sensitive than others because if clouds give variable response for various requests simultaneously in minimum ART is highly sensitive.

3.1.9 Efficiency

Cloud which delivers the information in the minimum possible ART is said to be efficient. Because the lower the ART the lower the time to access the resources.

3.1.10 Case Study for ART

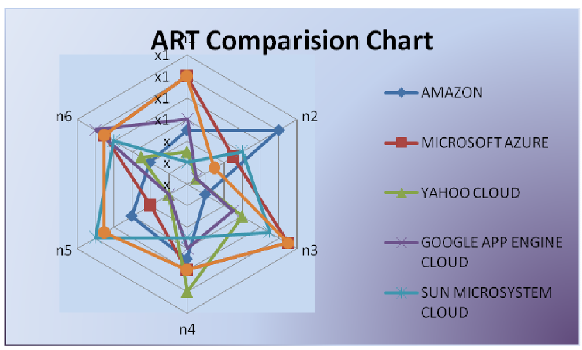

CHART 1: ART Comparision

The ART of six key clouds are compared and chart 1 has drawn with the results which shows that which cloud has given significant response time for different instants.

3.2 CRT

The section covers the CRT evaluation for the cloud with its effect on diverse facets which contributes to calculate the total quality of cloud.

3.2.1 Context

The response time gives fluctuations from first request/response to another and so on for a single application which is joined in the scenario for evaluating the CRT.

3.2.2 Description

$T^{CRn}(z)$ is the change in response time of a cloud to the n number of requests which gives the three measurement entities during the execution of scenario z. $T^{CRn}(z)^+$ is the set of those diverse facets on which $T^{CRn}(z)$ behave positively. $T^{CRn}(z)^-$ is the set of those diverse facets on which $T^{CRn}(z)$ behave negatively.

3.2.3 Formula

$$T^{CRn}(z) = \begin{cases} T^{CRn}(z) = \frac{1}{n}\sum_{k=1}^{n}\left(T^{CR(k+1)}(z) - T^{CR(k)}(z)\right) \\ T^{CRn}(z)^{+} = \{A_{N1}, A_{N2}, \ldots\} \\ T^{CRn}(z)^{-} = \{B_{N1}, B_{N2}, \ldots\} \end{cases}$$

3.2.4 Impact

CRT may vary according to the request in a cloud depending on the requests. Some requests take time for gathering the information related to the request. The retrieval of data from the database of cloud may produce change in the response time (CRT). CRT makes a big difference in the performance of a cloud and gives some possible impacts on cloud's quality. CRT can affect the following diverse facets:

3.2.5 Stability

Cloud is said to be stable if the CRT will be low but cloud is not constant if CRT will remain variable. Because if the cloud CRT gives variations than the cloud cannot be in a continual state.

3.2.6 Scalability

The cloud which have minimum CRT can scale more rapidly because even after the growing demands of clients the CRT will be lower and client will not have to wait any longer.

3.2.7 Consistency

If the CRT will be low the cloud will persists to be in consistent state because with higher CRT user will get time to send many requests for the same application simultaneously which may produce errors in the database. So, if user will not get that much time the cloud state will always be consistent.

3.2.8 Reliability

Cloud having less CRT is more reliable because even if it will get parallel requests for the same application the response will be same as for the single request so reliability will increase.

3.2.9 Sensitivity

Sensitivity of a cloud also relies on the CRT. For the immediate and variable response the CRT has to be lower. A cloud which takes longer CRT is not sensitive at all.

3.2.10 Efficiency

Less CRT will give a more efficient cloud because the lesser the CRT the time for accessing the extra resources and code will also be less, so cloud have to gather the best information in less time by using reduced amount of resources.

3.2.11 Case Study for CRT

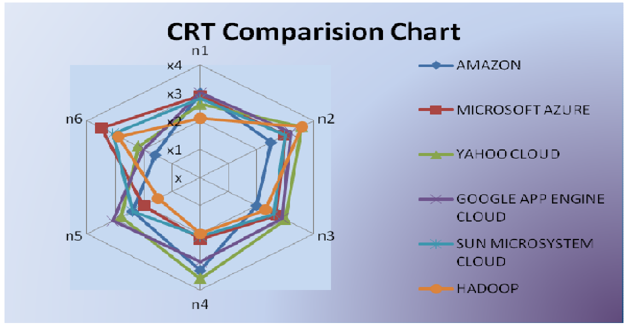

CHART 2: CRT Comparision

The CRT also affects the quality of a cloud which is compared for some of the different clouds and their comparison is shown in the chart 2 above. Each cloud had given some change in response time which differs for every instant.

3.3 NSR

The section wrap up the NSR evaluation for the cloud with its impact on quality attributes which contributes to calculate the total quality of cloud.

3.3.1 Context

The number of sessions requested by client for an application is joined in the scenario for evaluating the NSR.

3.3.2 Description

$N^{SRn}(z)$ is the n number of session requests of a cloud which gives the three measurement entities during the execution of scenario z. $N^{SRn}(z)^+$ is the set of those diverse facets on which $N^{SRn}(z)$ behave positively. $N^{SRn}(z)^-$ is the set of those diverse facets on which $N^{SRn}(z)$ behave negatively.

3.3.3 Formula

$$N^{SRn}(z) = \begin{cases} N^{SRn}(z) = \frac{1}{n}\sum_{k=1}^{n} N^{SRk}(z) \\ N^{SRn}(z)^+ = \{A_{N1}, A_{N2}, \dots\} \\ N^{SRn}(z)^- = \{B_{N1}, B_{N2}, \dots\} \end{cases}$$

3.3.4 Impact

NSR is number of session requests for an application given at a time. In cloud every application's session timings have maintained and the request/response have to be given at that time limit only. NSR also reflects the quality of a cloud and its effects on diverse facets are:

3.3.5 Stability

Cloud will be more stable if the NSR is high because the applications provided by that cloud are simple to use and any alteration will not cause inconvenience to the client.

3.3.6 Reliability

Cloud which provides higher NSR is more reliable because the information provided by it is easy to understand and provides the more suitable information.

3.3.7 Validity

When the NSR is high the validity is also high because he information of that cloud applications are valid and gives the recent and advance knowledge.

3.3.8 Sensitivity

The NSR increases, sensitivity will also increase because each session will give variability in responses for the requests based on the up to date information.

3.3.9 Efficiency

Cloud with low NSR will not be efficient because the cloud respond slowly for the session request and cause a limitation for its quality by acquiring many resources for a single request. So if the NSR will be high the efficiency will also be higher.

3.3.10 Case Study for NSR

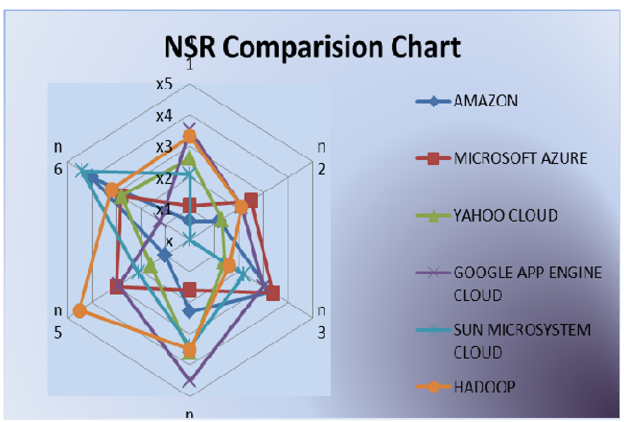

CHART 3: NSR Comparision

Session requests may increase instantly and this instant change in request reflects the quality of cloud. For some instants NSR is calculated and the chart 3 above shows the changes in response time according to change in request.

3.4 TVS

The section gives the TVS evaluation for the cloud with its impact on diverse facets which contributes to calculate the total quality of cloud.

3.4.1 Context

Total time a visitor devotes in a scrupulous application is joined in the scenario for evaluating the TVS.

3.4.2 Description

$T^{VSn}(z)$ is the time a visitor spends in the cloud which gives the three measurement entities during the execution of scenario z for n requests. $T^{VSn}(z)^{+}$ is the set of those diverse facets on which $T^{VSn}(z)$ behave positively. $T^{VSn}(z)^{-}$ is the set of those diverse facets on which $T^{VSn}(z)$ behave negatively.

3.4.3 Formula

$$T^{VSn}(z) = \begin{cases} T^{VSn}(z) = \frac{1}{n}\sum_{k=1}^{n} T^{VRk}(z) \\ T^{VSn}(z)^{+} = \{A_{N1}, A_{N2}, \ldots\} \\ T^{VSn}(z)^{-} = \{B_{N1}, B_{N2}, \ldots\} \end{cases}$$

3.4.4 Impact

TVS Amount of time visitors spend in the application. Quality of a cloud also depends on it because the clients spend slight time in an application or they may spend huge time in application, every client needs the full availability of cloud applications. TVS affect the following diverse facets:

3.4.5 Stability

If the TVS is higher than the cloud is more stable and prone to the recovery of any accidental hazard.

3.4.6 Scalability

If the TVS will be higher that means the cloud is more scalable because a client spending its precious time in an application it means that can handle the requests in very smooth fashion.

3.4.7 Consistency

When the TVS is higher in a cloud than the cloud will be more consistent because whenever the users will finish their access the cloud will remain in a consistent state so that the next time when the users again come for the access they will start from a consistent state without any variable result of last access.

3.4.8 Reliability

The TVS is higher the cloud is reliable too because if a user is devoting its most of the time to one application than its information must be more understandable and easily accessible.

3.4.9 Validity

When the TVS are higher the information provided by that application is valid and it is actually concerns with the actual request of the client.

3.4.10 Sensitivity

Cloud with the low TVS is not sensitive means it is not providing a variable response for the variable requests. So the cloud with high TVS is highly sensitive in giving the response according to the request changes.

3.4.11 Efficiency

Cloud with the high TVS is efficient because it gives better responses in less time by acquiring the minimum resources which will result in high availability.

3.4.12 Case Study for TVS

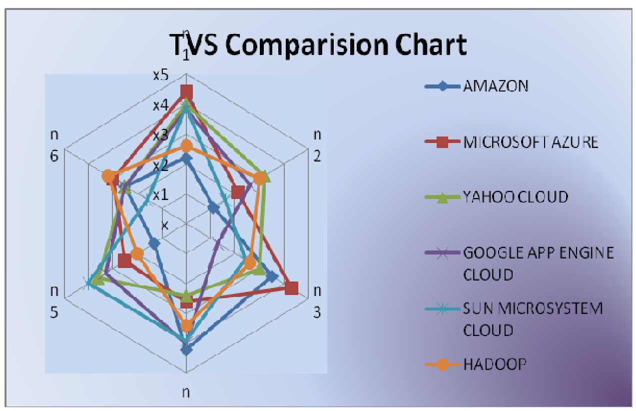

CHART 4: TVS Comparision

The time spend by the visitors may differ for different access. An application may accessed after many hours or in every second so TVS can cause the delay in availability. For some instant of time the availability changes has determined and shows in the chart 4.

3.5 NPR

The section covers the NPR evaluation for the cloud with its impact on quality attributes which contributes to calculate the total quality of cloud.

3.5.1 Context

Within a cloud application there are many pages which correspond to different requests which are joined in the scenario for evaluating the NPR.

3.5.2 Description

$N^{PRn}(z)$ is the n number of page requests which gives the three measurement entities during the execution of scenario z. $N^{PRn}(z)^{+}$ is the set of those diverse facets on which $N^{PRn}(z)$ behave positively. $N^{PRn}(z)^{-}$is the set of those diverse facets on which $N^{PRn}(z)$ behave negatively.

3.5.3 Formula

$$N^{PRn}(z) = \begin{cases} N^{PRn}(z) = \frac{1}{n}\sum_{k=1}^{n} N^{PRk}(z) \\ N^{PRn}(z)^{+} = \{A_{N1}, A_{N2}, \ldots\} \\ N^{PRn}(z)^{-} = \{B_{N1}, B_{N2}, \ldots\} \end{cases}$$

3.5.4 Impact

The numbers of page requests (NPR) are depend on the client's requirement to access the pages. Every page requests of application must be satisfy with the complete availability even if it needs to make the multiple instances of a single page. NPR also affects some diverse facets:

3.5.5 Stability

Cloud will be more stable if the NPR is high because the requested pages may contain the simply understandable data and the changes will not bother the client on that page and will not make the page hard to access.

3.5.6 Consistency

The page whose demand is very high is always remains in consistent state because even after handling many requests the page contains the valid data which increases the client's interest.

3.5.7 Reliability

A cloud which is more reliable, its NSR is higher because the information provided by this page is highly trustworthy and client can rely on this information.

3.5.8 Validity

The higher NPR the higher the validity because if a page is accessed more than other pages that page contains the information which is very popular and that page always provides important and recent data.

3.5.9 Sensitivity

The high NPR boosts the sensitivity because the page always serves the requests with more understanding and consideration.

3.5.10 Efficiency

Cloud with low NPR will not be efficient because the cloud applications page respond slowly for the page request and cause a limitation for its quality by acquiring several resources for a single request. So if the NPR will be high the efficiency will also be higher.

3.5.11 Case Study for NPR

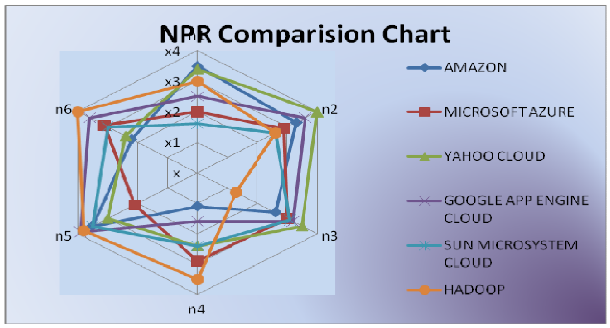

CHART 5: NPR Comparision

Every time when a client accesses the application, that application may another access to that page simultaneously with other users and that can affect the availability of the cloud. The comparison chart for NPR is shown in chart 5 for different instants of time.

4. THEOREM

The metrics in the previous section are defined for specific scenario which was based on a number of diverse facets. The theorem incorporates the all diverse facets collectively for a cloud. The theorem derived from all above defined metrics is used to evaluate the final performance of different clouds. The theorem will calculate the sets of **C_A (Z)** and **C_B (Z)** for all positive and negative effects on facets respectively, followed by the cloud which constitute to three cases best case, worst case and average case. Any cloud satisfying any of the three conditions will lies in that particular case for its performance. The theorem derived from the above purposed metrics is:

$$C_A(z) = T^{ARn}(z)^{+} \cup T^{CRn}(z)^{+} \cup N^{SRn}(z)^{+} \cup T^{VSn}(z)^{+} \cup N^{PRn}(z)^{+}$$

$$C_B(z) = T^{ARn}(z)^{-} \cup T^{CRn}(z)^{-} \cup N^{SRn}(z)^{-} \cup T^{VSn}(z)^{-} \cup N^{PRn}(z)^{-}$$

From the above metric three cases occurs:

CASE I: Best Case

$$if\ C_A(z) = I \quad \& \quad C_B(z) = \emptyset$$

If the above case occurs then the cloud's performance is the best because it satisfy all the diverse facets for availability.

CASE II: Average Case

Condition I

$$if\ C_A(z) = I \quad \& \quad C_B(z) \neq \emptyset$$

If the above condition occurs then the cloud's performance will be average because it does not satisfy all the diverse facets of availability.

Condition II:

$$if\ C_A(z) \neq I \quad \& \quad C_B(z) = \emptyset$$

If the above condition occurs then the cloud's performance will be average because it does not satisfy all the diverse facets of availability.

CASE III: Worst Case

$$if\ C_A(z) \neq I \quad \& \quad C_B(z) \neq \emptyset$$

If the above case occurs then the cloud's performance will be worst because the clouds do not satisfy any of the diverse facets of availability.

4.1 Analysis Chart

The different facets affecting the avaliability of clouds are studied and they are calculated to find their final performance after accessing the each cloud for the six times. Every time there is a slight difference between the results which was captured earlier. All these are shown in the charts above. A cloud may lie in any of the three cases and its performance can be best, worst or average.

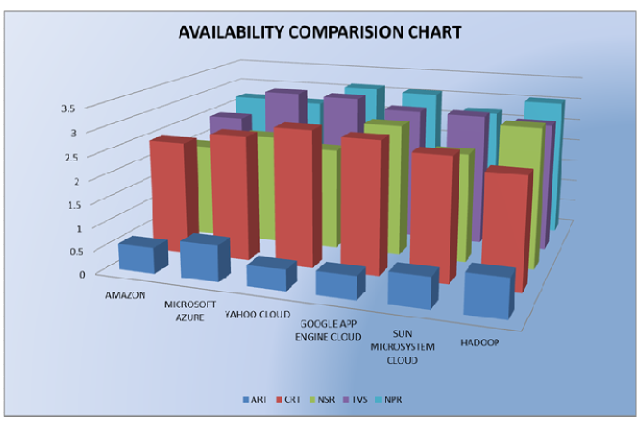

Chart 6: Analysis Chart

For every six cloud the availability comparision is shown in Chart 6. Results shows that all the six clouds are fall in the average case because some of the diverse facets are achieved by them and some are not so a few clouds fulfilied the condition I and others fulfilled the condition II of

CASE II. Clouds have to improve a lot to satisfy the best case condition because each has some shortcomings because of which availability of the applications are average but not the best. We have prepared a chart for clouds (Chart 6) which shows the final performance of clouds and their performane comparisions.

5. CONCLUSION

This paper gives the availability benchmarks for retrieving the quality of a cloud. Five cloud metrics are defined based on the availability of web applications provided by a cloud and their diverse facets. The metrics are applied to six different clouds and then compared for the quality cloud. Cloud's worst, average and best performance is also taken into consideration so that the clients can select the cloud according to what they really want. Each metric gives the indication on the quality of cloud and its behavior while delivering the web applications. The metrics are also applied to different cloud to calculate their performance for every facet and the final theorem has prepared and the three best, average and best case arise. Each case indicates some different behavior and whatever case is satisfied by the cloud that lies in that specific case means the case reflects the cloud's behavior.

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