# Measuring the Impact of Geographic Location on Cloud Computing Performance & Efficiency using OPNET Tool

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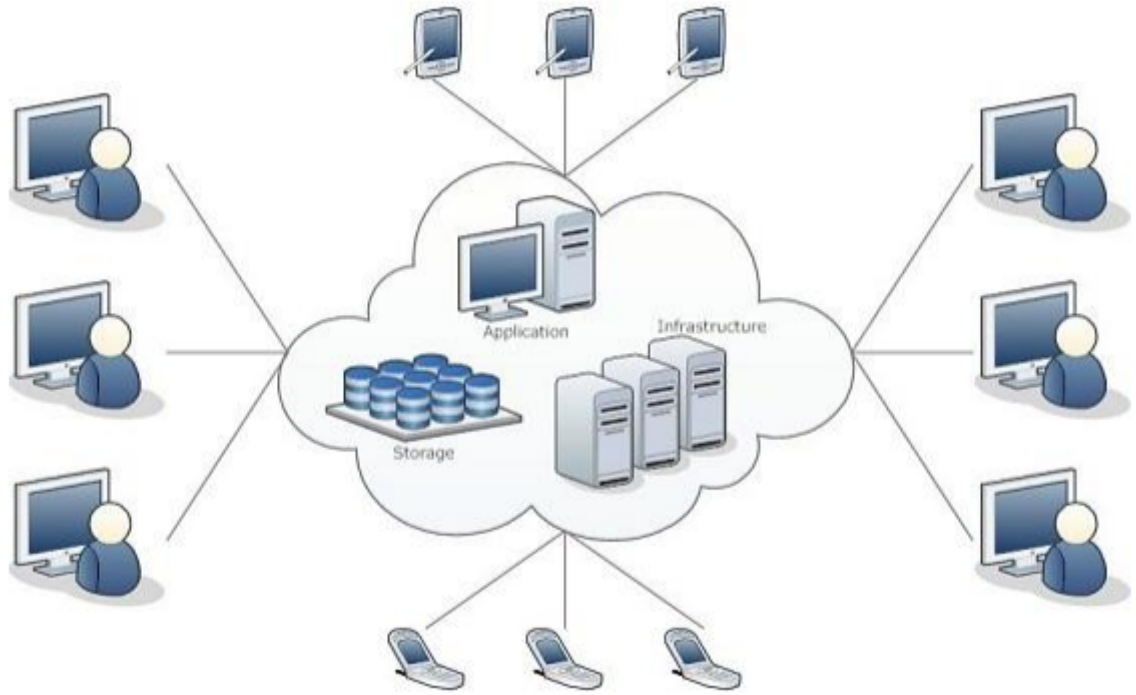
**Abstract**

Cloud computing is the delivery of computing services — including servers, storage, databases, networking, software, analytics, and intelligence — over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale. Cloud-computing services cover a vast range of options now, from the basics of storage, networking and processing power, through natural language processing and artificial intelligence as well as standard office applications. In this research paper, authors have created three different networks. In which, first of all, we implemented Cloud network of Physical location in India Region. Secondly, we created the same network in Cloud Australia region location. Third and finally, we created a cloud network in America Region to find the different overall performance metrics such as Video, Voice, E-mail and Database.

## 1. Introduction

Cloud Computing refers to manipulating, configuring, and accessing the applications online. It offers online data storage, infrastructure and application. The term Cloud refers to a Network or Internet. In other words, we can say that Cloud is something, which is present at remote location. Cloud can provide services over network, i.e., on public networks or on private networks, i.e., WAN, LAN or VPN. Applications such as e-mail, web conferencing, customer relationship management (CRM), all run in cloud. In IP networks, the main task of a routing protocol is to carry packets forwarded from one node to another. In a network, routing can be defined as transmitting information from a source to a destination by hopping one-hop or multi hop. Routing protocols should provide at least two facilities: selecting routes for different pairs of source/destination nodes and, successfully transmitting data to a given destination.

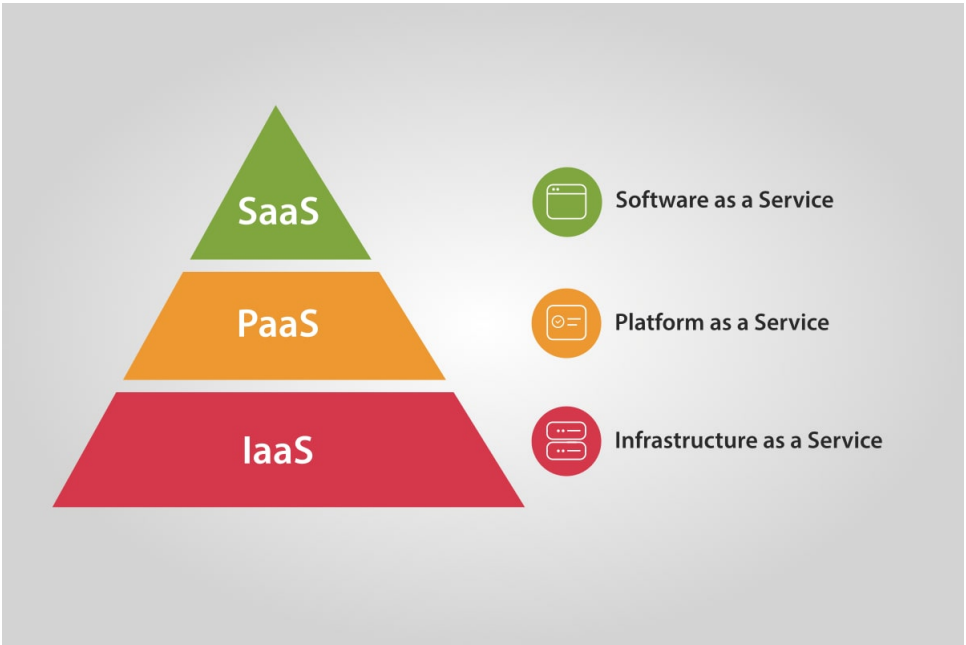
Figure 1.1: Example of Cloud Computing




## 2. Service Models in Cloud Computing: Exploring IAAS, PAAS, and SAAS

Cloud computing has transformed the way businesses and individuals access and manage their computing resources. It offers a range of service models that provide varying levels of control, management, and customization. These service models are known as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Each of these models offers distinct advantages and use cases, enabling organizations to tailor their cloud strategy to their specific needs.

Figure 2.1: IaaS, PaaS and SaaS Model



### 2.1. Infrastructure as a Service (IaaS)

IaaS is the foundation of cloud computing, providing virtualized computing resources over the internet. With IaaS, organizations can rent and manage fundamental IT infrastructure components, including servers, storage, networking, and virtualization. This model offers the highest level of control and flexibility, as it allows users to build, deploy, and manage their own software and applications on the cloud infrastructure.

### 2.2. Platform as a Service (PaaS)

PaaS offers a higher level of abstraction compared to IaaS, providing a platform and environment for developers to build, deploy, and manage applications without having to worry about underlying infrastructure complexities. PaaS providers offer a set of tools, libraries, and services that facilitate application development, reducing the time and effort required for deployment.

### 2.3. Software as a Service (SaaS)

SaaS is the most user-centric cloud computing model, delivering software applications over the internet on a subscription basis. In the SaaS model, users can access and use software applications without the need to install or manage them locally. SaaS applications are typically hosted and maintained by the service provider.

## 3. Cloud Computing

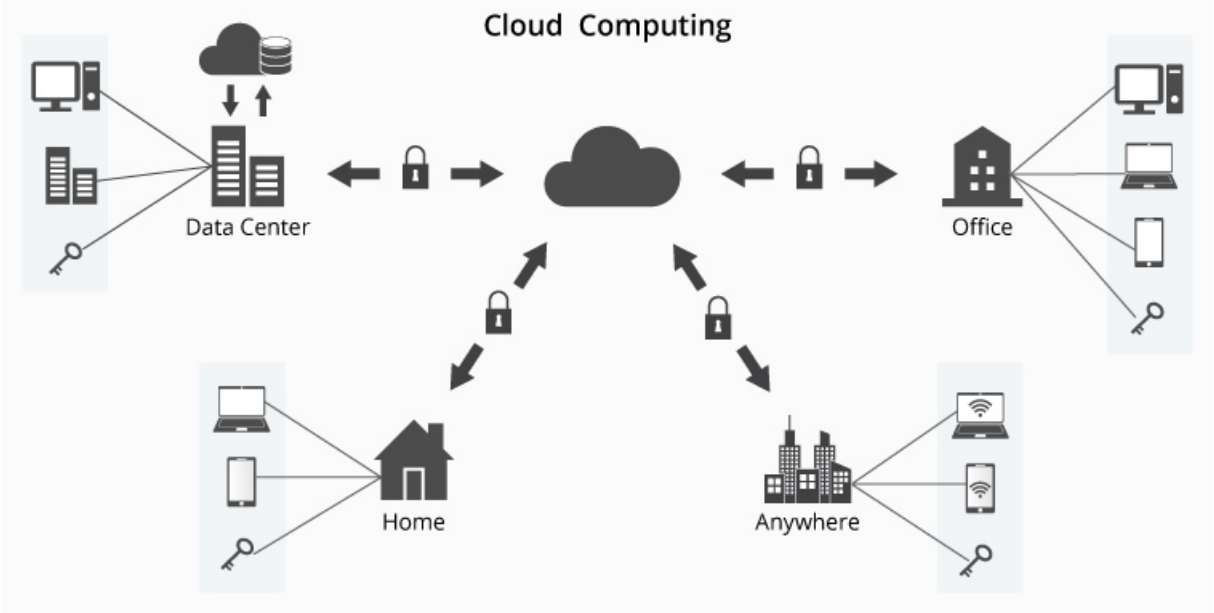
### 3.1. Cloud Infrastructure

Cloud infrastructure refers to the underlying physical and virtual components that make up a cloud computing environment. It encompasses various resources such as data canters, server farms, networking components, storage systems, and virtualization technologies that work together to provide cloud services and resources to users. Let's explore two key components of cloud infrastructure: data canters and server farms.

### 3.2. Data Center

A data center is a centralized facility equipped with specialized hardware and software to manage, store, and distribute data and applications. Data centers are the backbone of cloud computing, providing the physical space and resources required for cloud services to operate efficiently. They house a large number of servers, networking equipment, storage devices, cooling systems, and power distribution units.

Figure 3.1: Cloud Computing




### 3.3. Server Farms

A server farm, also known as a server cluster or server pool, refers to a collection of interconnected servers that work together to provide computing resources and services. In a cloud context, server farms are a fundamental part of the cloud infrastructure, forming the core computational backbone of cloud services.

## 4. Literature Survey

[1] Abhishek Gautam (2022) provided introduction to cloud computing, about its development and, purpose of the development. In this paper, he has concluded that there are mainly three services provided: (1) SaaS (Software-as-a-Service), (2) PaaS (Platform-as-a-Service), (3) IaaS (Infrastructure-as-a-Service). Author has discussed how all these services working and what are their benefits. Author has proposed the types of cloud computing, its importance and benefits.

[2] S.B. Syed (2021) analysed the performance of cloud computing for distributed data center using Cloud-Sim software with the objective of reducing total cost, identification of response time and data center hourly loading. Author recommended the future researchers to continue this research and make use of many more data center to get the optimum best result performance with the reduction in total cost.

[3] S. Ashwini Sheth et al. (2021) analysed that cloud computing marks the commencement of a new stage in the arena of data and communication technology as it carries with a development paradigm which has the possible to change the way in which computing was done. Users are still getting aware through this expertise and a change from conformist subtracting to cloud computing will ensue but progressively. Owed to this technology, developers with novel ideas about internet services will no longer need to spend large amounts of currency in structure their programs and tools substructure abilities.

[4] Raghav Mittal, Areebakazim (2020) described that Denial of Service (DoS) is a computer crime where machines and other resources are made unavailable to its legitimate users by flooding the resources with unwanted requests when connected to the internet. Since most of the functions of the organization are automated and stored in servers, security must be taken care of at the highest level. Distributed Denial

of Service (DDoS) is a major threat to the network. Since the network is the basic requirement in cloud computing or other latest technologies and DoS being distributive in nature should be addressed properly. This paper gives the comparison of a healthy network with that of DDoS network in order to define the declination of the performance of a cloud network under this attack. The DDoS network shows how the performance deteriorates in this particular scenario. OPNET Modeler 14.5 is used as a simulation tool. In details, effect of DDoS becomes more severe when the sources of the attack increases, also the attackers are hard to detect. It can also be concluded that business organization should deploy proper mechanisms against DDoS attacks.

[5] P. Kanchanadevi et al. (2020) analyzed that cloud computing is the flexible platform to outsource the data from local server to commercial cloud. However cloud provides tremendous benefits to user, data privacy and data leakage reduce the attention of cloud. For protecting data privacy and reduce data leakage, various techniques has to be implemented in cloud. There are various types of cloud environment, but we concentrate on Hybrid cloud. Hybrid cloud is a combination of more than two or more cloud. Where critical operations are performed in private cloud and non-critical operations are performed in public cloud. So, it has numerous advantages.

In this paper, they focused on data security through encryption scheme over Hybrid Cloud. There are various encryption schemes but they also have data security issues. To overcome these issues, Attribute Based Encryption Scheme with Dynamic Attributes Support (ABE-DAS) has proposed. Attribute based Encryption Scheme with Dynamic Attributes Support technique enhance the security of data in hybrid cloud.

[6] J. Divya, S. Shivagami (2020) analyzed Cloud HSM, which is a cloud-based hardware security module (HSM) that licenses to successfully incorporate secure key amassing and better crypto exercises than Cloud applications. Cloud HSM has no blunt costs and enables to start and stop HSMs on-demand, allowing us as far as possible when and where it is required quickly and cost-enough. Cloud HSM is a directed organization that robotizes repetitive administrative tasks, for instance, hardware provisioning, programming fixing, high openness, and fortifications. Cloud HSM is one of a couple of Cloud organizations, including Cloud Key Management Service (KMS), which offer a raised degree of security for your cryptographic keys. KMS gives a straightforward, monetarily clever way to deal with manage encryption keys on Cloud that meets the security prerequisites for the greater part of customer data. Cloud HSM offers customers the decision of single-inhabitant access and authority over their HSMs.

[7] Mohammed Aleisa et al. (2020) presented two cloud-based IoT implementations using a real-life platform that is used in industry. One of the implementations has a fog layer between the IoT devices (i.e., sensors) and the cloud, whereas in the other implementation, IoT devices were directly connected to the cloud. The purpose of these experiments was to better understand the impact of the additional fog layer on the performance of cloud-based IoT environments. We examined the performance of the two implementations and showed that adding a fog layer between the IoT devices and the cloud positively impacted the connect, message publish, ping, and subscribe metrics for the first 15 minutes. At the 1-hour time point, the implementation that did not have a fog layer performed better. We also noticed that both implementations gave consistent results (i.e., increasing, decreasing) using the AWS metrics, which indicates credible results. In the future, they have plan to use the same metrics to evaluate the performance of IoT Fog-Cloud environments that utilize encryption-based access control to determine

how the encryption and decryption operations affect the performance of cloud-based IoT environments, with the aim of providing practical solutions.

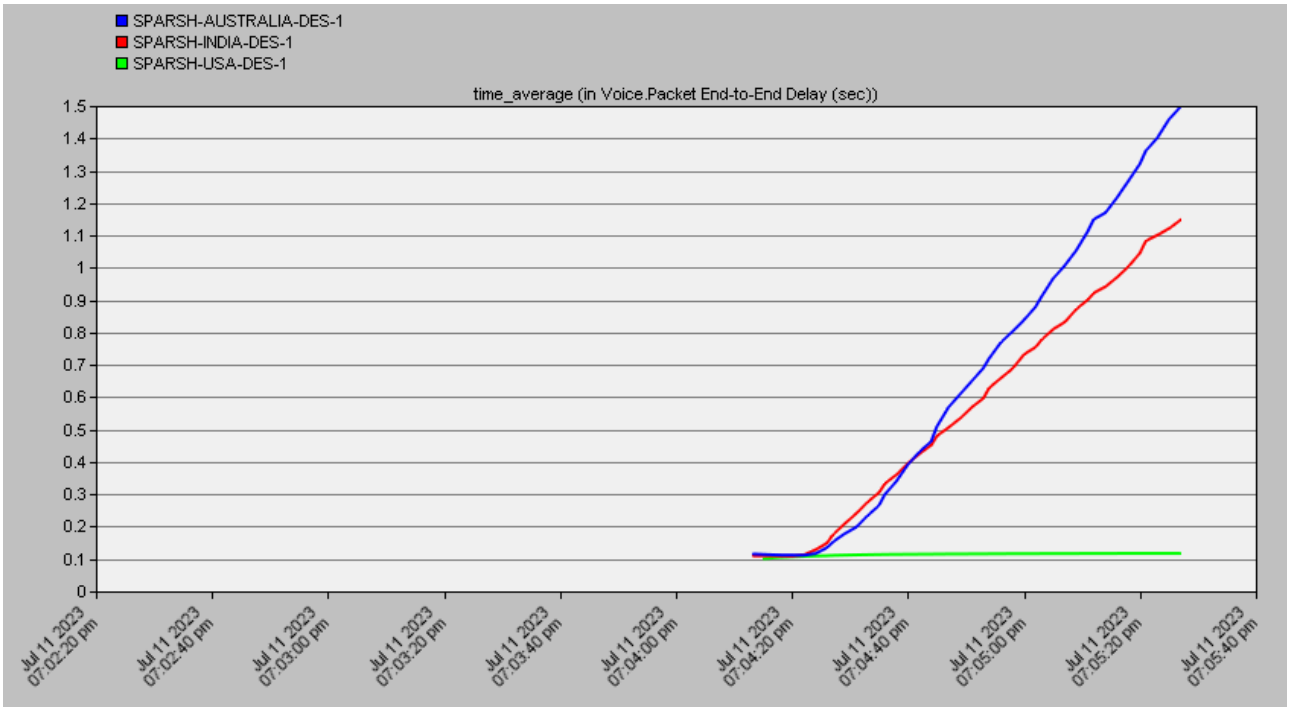
## 5. Results and Discussion

As per this section within the final step, needed results were obtained. If the results aren't keeping with our selection, then user will once more modification the planning section then runs to find the output OPNET Simulator has been used. Three different scenarios' have been created with different geographically locations - USA, India and Australia. Their results have been described in brief.

### 5.1. Voice End-to-End Delay

It is the time taken for a packet to be transmitted across a network from source to destination. End-to-End delay or one-way delay (OWD) refers to the time taken for a packet to be transmitted across a network from source to destination. It is a common term in IP network monitoring, and differs from round-trip time (RTT) in that only path in the one direction from source to destination is measured.

Figure 5.1: Voice End-to-End Delays

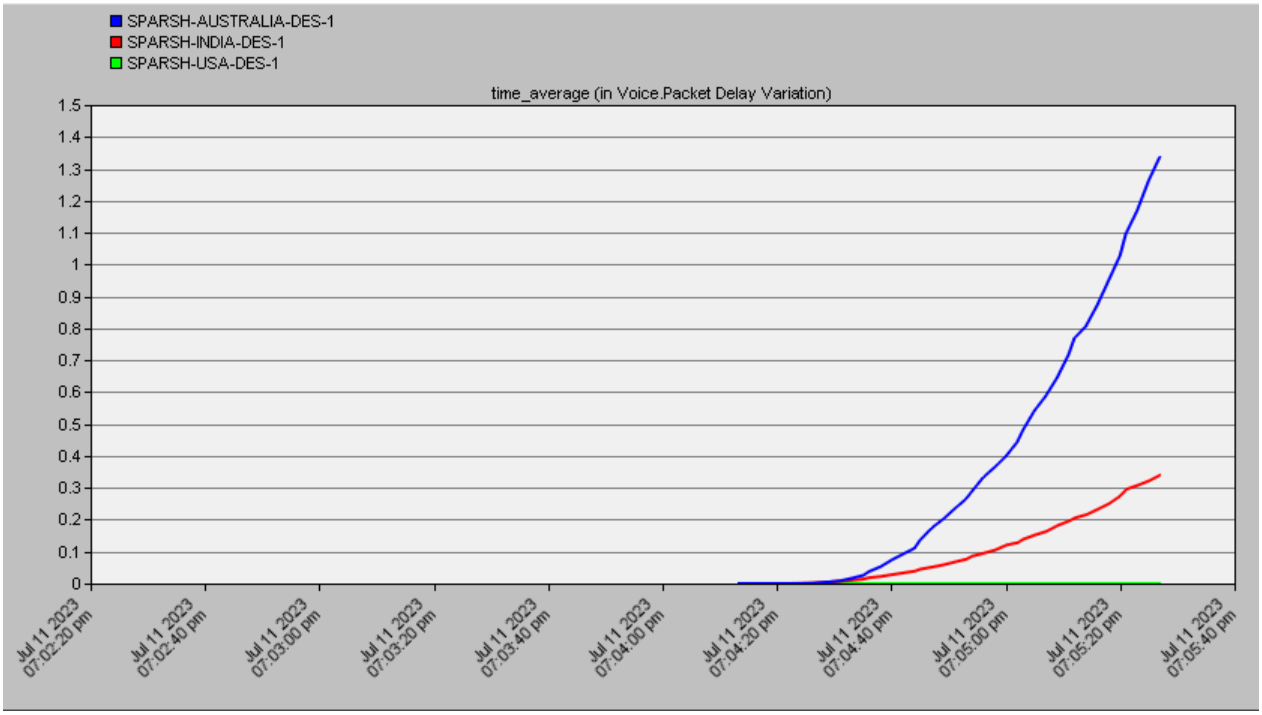



Above figure, in which Voice Delay from One End to other End is descried, is showing that Network Cloud USA is so far better that Australia as well as India.

### 5.2. Voice Delay

Overall delay in Voice Performance Metric Delay is an audio signal processing technique that records an input signal to a storage medium and then plays it back after a period of time. When the delayed playback is mixed with the live audio, it creates an echo-like effect, whereby the original audio is heard followed by the delayed audio.

Figure 5.2: Voice Delay

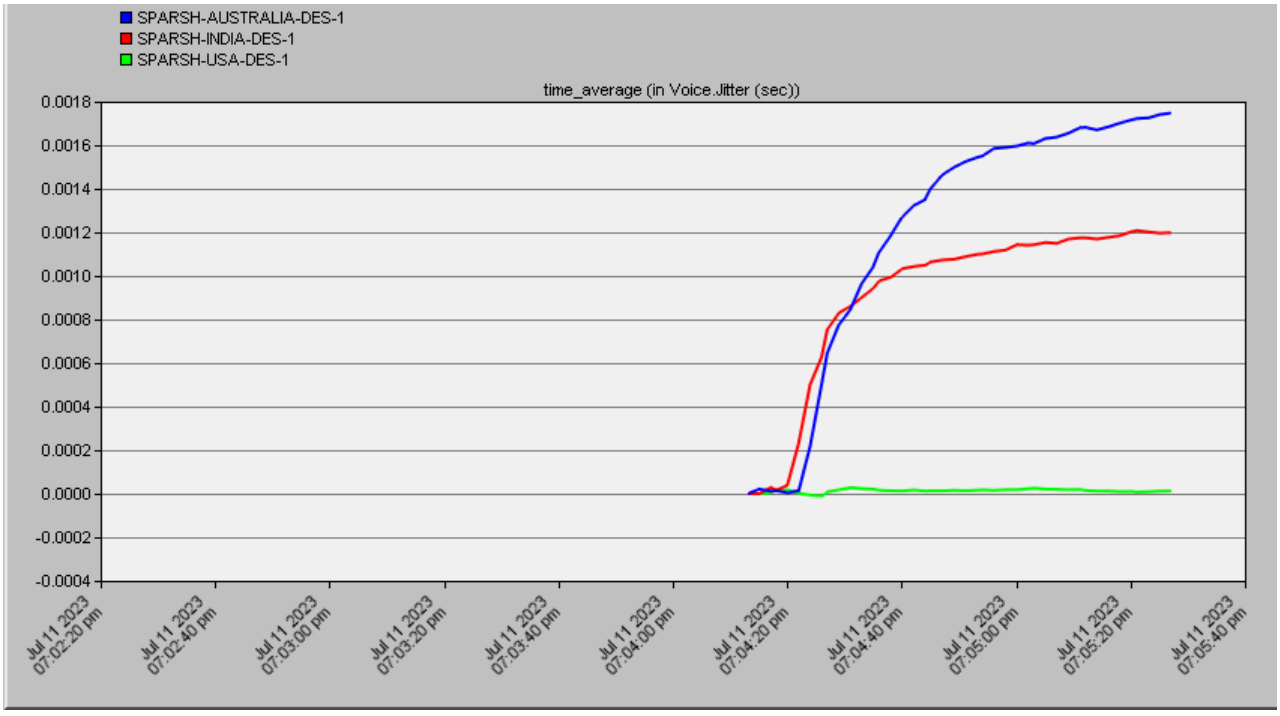



Network Cloud USA is providing best performance in Voice Delay also. It shows that Network Cloud USA is so far better than Australia as well as India.

### 5.3. Voice Jitter

In Voice over Internet Protocol (VoIP) technologies, jitter refers to a delay in receiving a voice data packet.

Figure 5.3: Voice Jitter

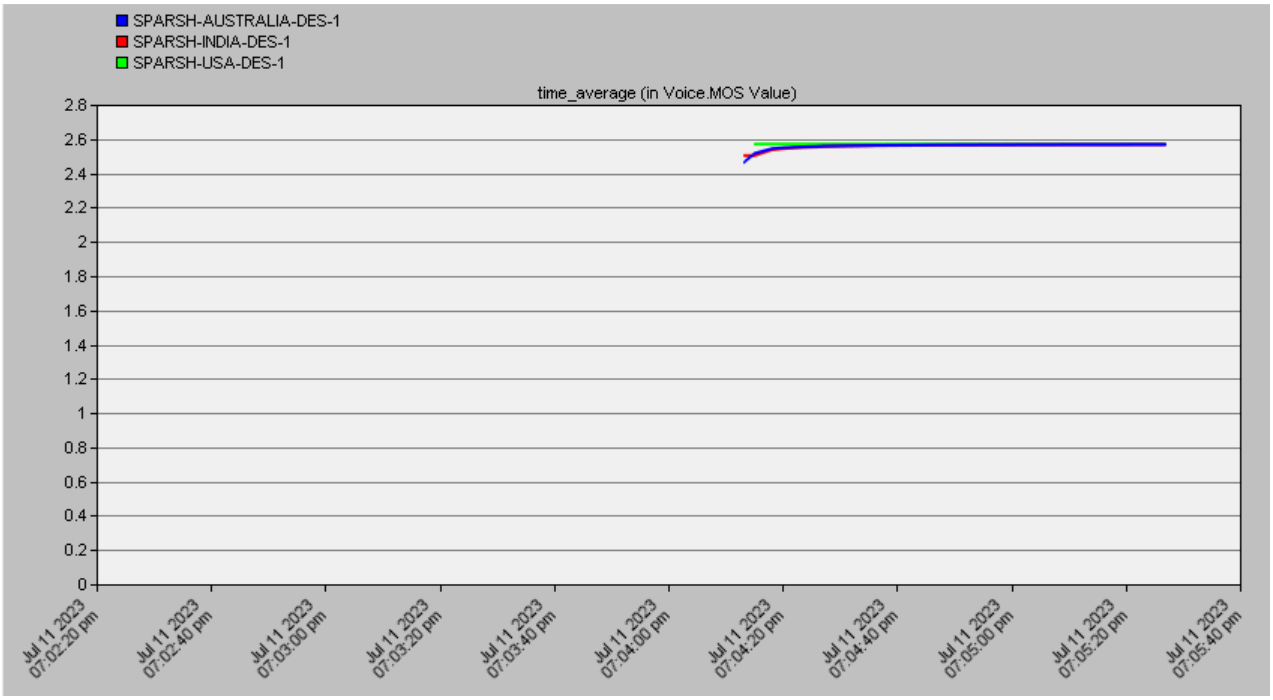


In Voice Delay Network Performance, Australia network delay time is worst. Cloud India is providing better than Australia. Network Cloud USA is providing minimum delay among them.

### 5.4. Voice MOS Value

The Mean Opinion Score (MOS) has been a commonly used metric to measure the overall voice call quality for decades.

Figure 5.4: Voice MOS

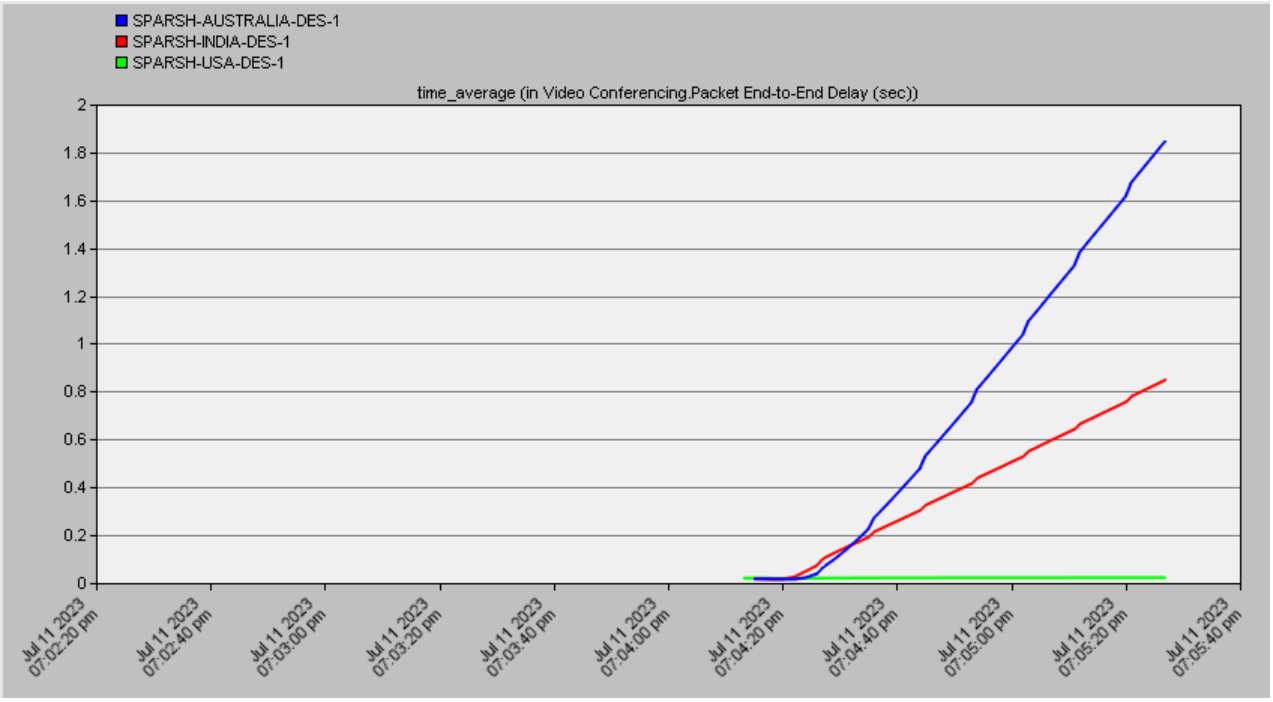



As in others Voice results, Network Cloud USA is providing much better performance. In MOS also, USA is best among all the networks. Australia and India providing equal MOS value.

### 5.5. Video End-to-End Delay

It is the time taken for a packet to be transmitted across a network from source to destination. As per the below figure, in which Video Delay from one end to another end is described, is showing that Network Cloud USA is so far better than Australia as well as India.

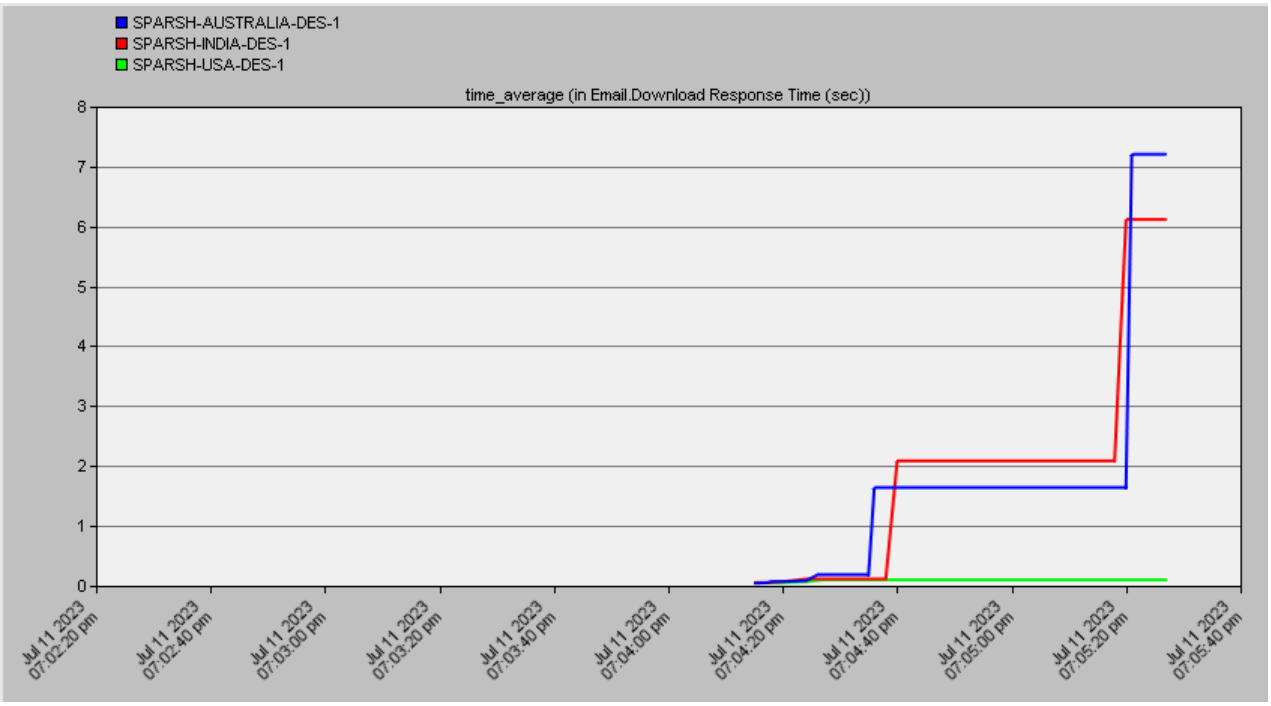
Figure 5.5: Video End-to-End Delay




## 5.6. E-mail Download Response Time

The time taken to download a particular e-mail data is known as E-mail Download Response Time.

Figure 5.6: E-mail Download Response Time

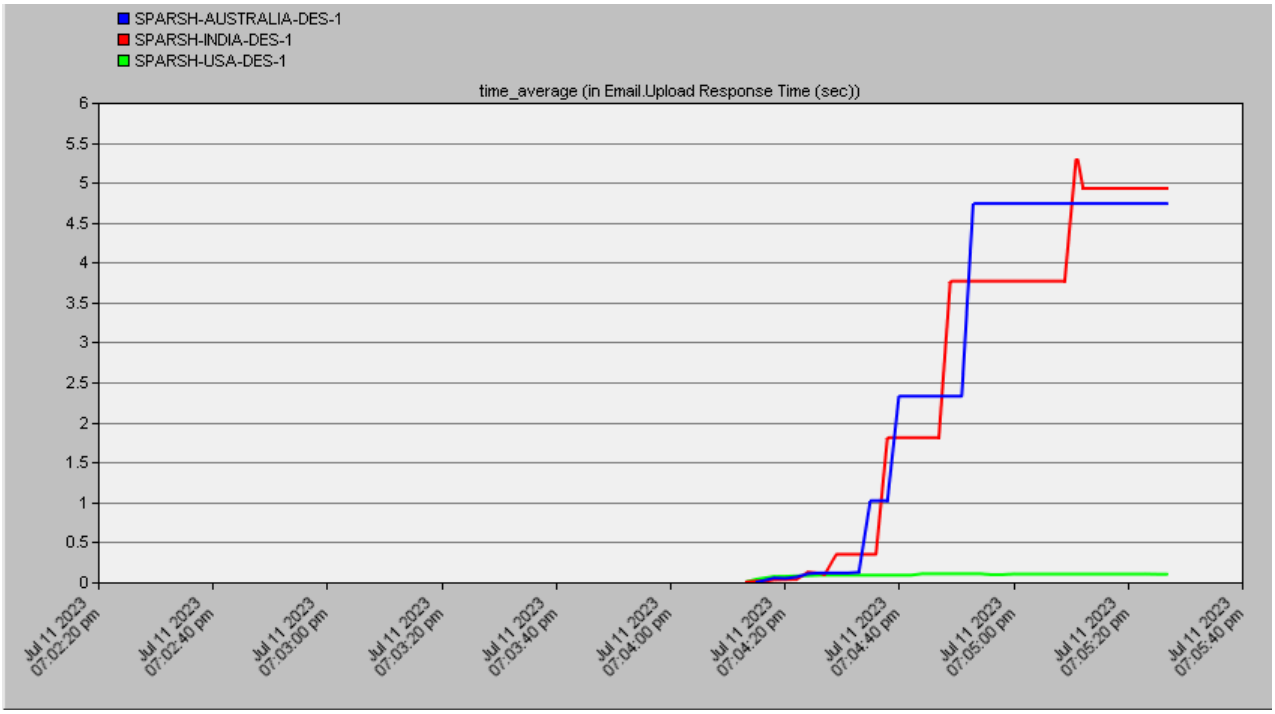



Results in the above figure is showing the network performance with OPNET simulator, in which, it is showing that worst download response time is above 7.20 seconds, which is provided by Cloud Australia Network. Cloud India is little bit better than Australia. Network Cloud USA is the best with just 0.10 seconds.

### 5.7. E-mail Upload Response Time

Time taken to upload a particular e-mail data is known as E-mail Upload Response Time.

Figure 5.7: E-mail Upload Response Time

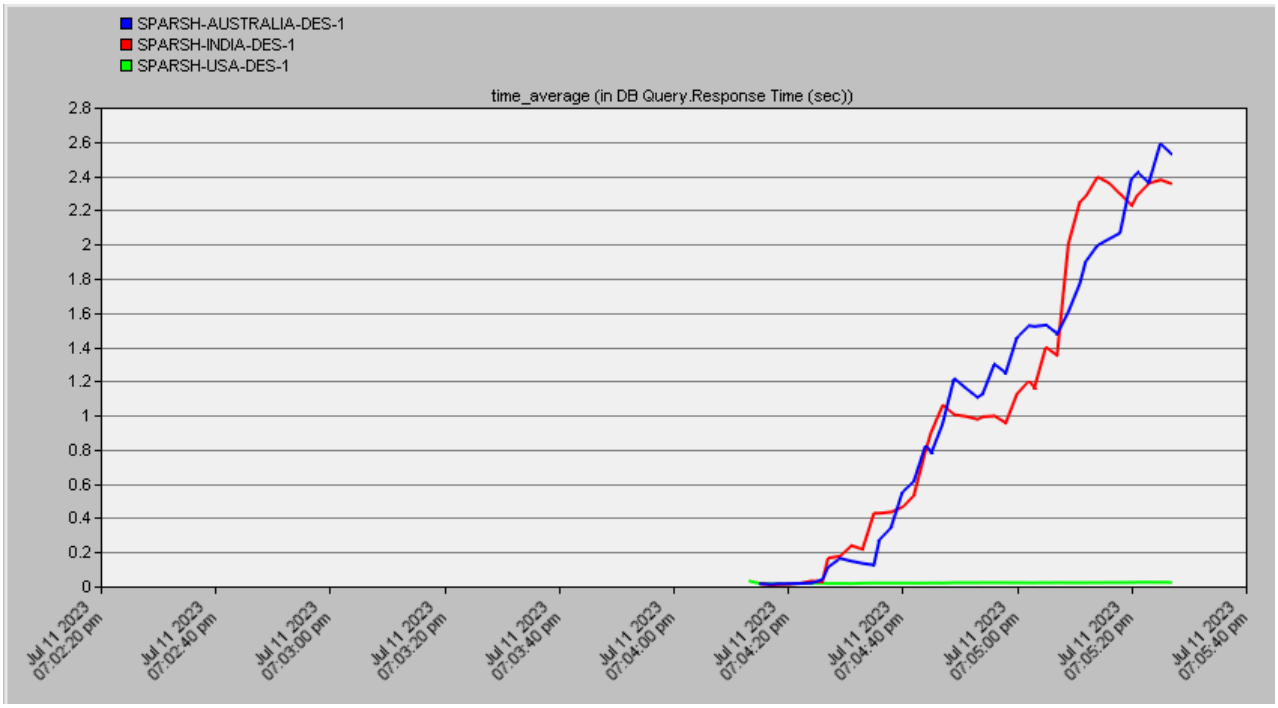



Results in the above figure is showing that network performance with OPNET simulator, in which, it is showing that worst download response time is little bit above 4.9 seconds, which is provided by Cloud India Network. Cloud Australia is little bit better than India Network. Cloud USA is the best with just 0.10 seconds.

### 5.8. Database Query Response Time

The time elapsed between an application sends a request to a database server and it receives a response is called Database Query Response Time.

Figure 5.8: Database Query Response Time




Above figure is showing the results of Network Performance with OPNET simulator, in which, it is showing that worst Database Query Response time is 2.52 seconds which is provided by Cloud Australia Network. Cloud India is little bit better than Australia Network Cloud. Cloud USA is the best with just 0.02 seconds.

## 6. Conclusion and Future Work

The server location does have an impact on the speed from the end-visitor's location. The time taken for data to be transferred between two points on a network and the amount of data transmitted in a specific period is essential for assessing client speed. When cloud services are close to the local users, it reduces network latency caused by long connections. It can be concluded from the results that Network Cloud USA is providing the best results in every performance metrics such as Voice End-to-End Delay, Jitter, Voice Delay, Video End-to-End Delay, E-mail Upload as well as Download Response Time, Database Query Response Time. Network Cloud Australia gave worst performance. In the future, network performance can be analysed with security term also.

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