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Analyzing the deployment and performance of Multi-CDNs in Pakistan

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Abstract- **The Content Delivery Network (CDN) is a distributed network of surrogate servers that are used by the content providers to disperse the most recent content. It distributes the content to diverse categories of their clients at a low latency across the globe. However, these networks can have different types of strengths and weaknesses to serve millions of clients in different regions. Therefore, deploying the software updates is a challenging task for content providers to their different clients (e.g., PC users and mobile users). The previously conducted researches on multi Content Delivery Network analysis and deployment are limited. In order to comprehend a detailed analysis is presented in our article for the mechanism of delivering software updates, the working structure of the two established operating systems such as Windows and iOS. RIPE Atlas lab datasets are being used on a large scale to measure the data, which is collected from 9,000 RIPE Network Coordination Centre to investigate the regional trends in the deployment of Multi-CDN software updates. Our contribution is that we take the datasets from the RIPE Atlas Network Coordination Center and perform analysis through python. Especially, with the use of methodology and datasets, understand the latency performance of the different Content Delivery Network providers in different regions. We calculated the Mean Round Trip Time (RTT) of seven months in the Pakistan Region and notice the variation in results. A comparison between two competing operating systems, Microsoft and Apple is presented in our research for delivering software updates. The clients of Microsoft download updates from the local Internet Service Provider (ISP) while approximately 80 percent of Apple clients download updates from their own service providers. So, the results show that the proposed work is more efficient than the previously conducted researches on Multi CDN.**

Index Terms-- **Internet Service Provider (ISP), Multi Content Delivery Network, Operating System (OS).**

I. INTRODUCTION

Nowadays, high-level video streaming such as Netflix and YouTube have been ruling the Internet traffic recently. Internet traffic will continuously expand with the invention of high-resolution video formats. With the high utilization of Internet video traffic, the service providers are needed the best solution for providing rapid content [3,4]. The Internet is drastically changing each part of human life by using a wide scope of applications for business purposes. However, the Internet infrastructure did not support the reliability, portability, and performance of today's advanced business applications request and create hurdles. These hurdles are becoming more critical with the evolution of present and future Internet applications. However, the pioneered concept of Content Delivery Network (CDN) is to minimize all types of hurdles [1]. In addition, the Content Delivery Network is a distributed network of surrogate servers that are used by the content providers to distribute the latest content. These Content Delivery Networks can have different kinds of strengths and shortcomings to serve a large number of customers in various areas [13].

These days, numerous organizations use multiple Content Delivery Networks to distribute content and improve reliability rather than a single Content Delivery Network. The use of multi-CDN is known for almost 10 years, the already conducted researches on multi Content Delivery Network deployment are limited. The people on the Internet are not know about the Multi-CDN deployment and performance. Further that, The Content Providers are interested to analyze the deployment and performance of well-known operating systems such as Microsoft, Apple [14]. In this study, the RIPE Atlas lab datasets are used to analyze the performance and implementation of multifold Content Delivery Networks in different regions**.** Our goal is to propose an approach where we broaden the earlier examination and the collection of datasets. Further, we create the procedures to distinguish CDN cache servers and relegate them to a suitable strategy to CDN suppliers. We use this method to perform a large-scale analysis, check the performance, and deployments of many Content Delivery Networks [2].

The major contributions of this paper are as per the following:

- Our focus on Multi-CDN deployment and performance utilized by two prominent software manufacturer organizations (Microsoft and Apple) for conveying operating system (OS) updates to their clients.
- This will analyze the problem of delivering software changes to diverse categories of clients across the globe.

We take the datasets from the RIPE Atlas Network Coordination Center and perform analysis through python.

- We calculated the latency of Microsoft IPv4, IPv6 and Apple IPv4 in different continents from January to July 2020.
- In addition, we observed and calculated the latency of Microsoft IPv4, IPv6 and Apple IPv4 in Pakistan region from January to July 2020.

In this perception, we inspect the accompanying focuses: what is the major difference in delivering content between two operating systems Microsoft and Apple in diverse regions by means of latency. Second, how we can characterize the deployment and performance of Mulit-CDN in terms of latency. Furthermore, what can be the most significant deployment and performance measurement which makes a difference between two competing operating systems such as Microsoft and Apple?

Latency Impact in Different Months. Clients which are lived in different regions of Pakistan experience different latency impacts in different months. In addition, we observe the variance of Mean RTT in different months of 2020.

Regional wise Performance. There are consequential localities wise varieties in the client side latency over mainland. While clients in well-established locales such as North America, Europe notice an average delay of 30 ms, the clients in underdeveloped areas such as Africa, Asia and South America notice the average latency as 190 ms.

II. LITERATURE REVIEW

These days, major online video streaming, for example, Netflix and YouTube have been administering Internet traffic lately. Web traffic will persistently grow with the creation of high-goal video formats[3,4]. Al-Abbasi et al.[3] Suggested the model for video web-based frameworks which is consist of Edge-caches, CDN sites, and the origin servers.

Aloui et al. [5] proposed new design for Cloud base CDN, Client's most famous videos are put away in Edge caches to satisfy the dynamic demand of customers and furthermore give the nature of administration. Kong et al.[6] proposed an efficient architecture for edge computing, Date processing at the level of network side. Edge computing concerns different challenges such as delay, protection, privacy, and bandwidth costs. So, the researcher recommended the energy fanless efficient edge computing architecture. Diab et al.[7] exhibited architecture for Telco-CDNs content distribution networks which are managed by connection provider. This proposed conspire is better in various manners, for example, execution, income is more prominent than other proposed arrangements.

Canali et al.[8] recommended numerical models used to plan private CDN (P-CDN). Nowadays, multimedia traffic control is a challenging task for organizations. In some cases, there are many organization are putting investment in dedicated network infrastructure and make their own private CDN. CDN schemes are different from traditional CDN. Due to 5G, The industry is quickly moving toward the advancement of the Ultra High Definition (UHD) media to distribute the services. In addition, there are different types of devices that give services to the end users, providing security and quality of service. Hence, Carrozzo et al. [9] depict the requirements and situations shown in the 5G-MEDIA project. In which planned arrangements related to point of access point and dataware house in the network.. In this project, content is provided through central production centers. So, our vCDN framework is the connection point for mobile broadband services to the users which are connected to 5G. The proposed solution is efficient for caching and media content management.

Author in [10] proposed a model to deliver content in optimized manner in the Content Delivery Network. Further, Content Delivery Network is one most effective solution for distributing content across the world which uses content cache and routing principles for content delivery. In this model, the high priority is providing quality of service to the end-users and effective use of the content cache. Tode et al. [11] proposed a modern Content distribution framework which is enable a manageable Information Centric Network capacity on an IP organization, presenting a breadcrumbs based network. Furthermore, it presents a gainful characteristic by collaboration as follows: each well-known content is automated store on the proxy servers without replication. However, Sosa-Sosa et al.[12] Introduced a technique to boost the tradeoff among execution and limit of utilization.

Yuqi et al.[21] proposed a video forecasting base technique which is called SCVP. Furthermore, Yuqi et al gave this method to handle the problem of video forecasting. In addition, the proposed technique estimates the various factors such as the active limit of users, the similitude of videos, the same interest of users with similar video content and top ranking videos. Zhao et al.[18] proposed a hereditary base program in cloud storage to improve content conveyance Network innovation. It recommended the model which provides the network physical infrastructure to the distribution of the latest content in cloud base storage. Furthermore, the proposed solution is to minimize the cost of content delivery. Ali et al.[19] recommended an optimal caching policy solution that Provides the network cache based on user preferences and group mobility. It gives the cost-optimal caching policy. Doan et al.[20] performs a large scale analysis to evaluate Netflix data distribution for residential networks. In this estimation, the key perception is latency and throughput. So, the throughput has increased three times when streaming content is delivered through ISP caches.

III. METHODOLOGY

In this section we proposed a detailed methodology. Initially, a detailed description is provided on how we collect datasets and perform analysis. In this way, we differentiate the different types of Edge caches and study the multi-CDN deployment. We perform our analysis using two well-known operating systems (OS) updates such as Microsoft and iOS [2].

We discuss the process steps of our methodology and experiments. These steps include different types of process activities. Figure 1 represents a framework of RIPE Atlas process steps.

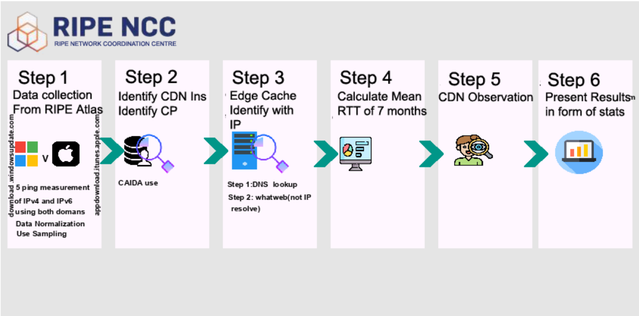

Figure 1: Methodology framework

A. PROCESS OF GATHERING INFORMATION

A detailed description is provided on how we collect datasets and perform analysis. In data collection, we take seven-month data measurements by using RIPE Atlas Network Coordination Center nodes. These nodes are located in approximately three thousand Autonomous Systems (ASes). So, we analyze the performance and deployment of multi-CDN by use of two well-known Operating System (OS) such as Microsoft and iOS [15]. Furthermore, in this measurement, data collection is done through ping measurement in the RIPE Atlas lab. In these measurements, two types of domains are used which are download.windowsupdate.com, appdownload.itunes.apple.com. In addition, in this network measurement used 5 pings for IP address resolution and each probe revolves the domain name. There are different types of parameters recorded during 5 pings measurement i.e., average, minimum and maximum round-trip time. In Microsoft operating system, pings are played out all day long in both IPv4 and IPv6. In Apple update URL, IPV4 performs every 15 minutes ping [2]. Our data set summarizes are shown in the table 1.

Table 1: Summary of our datasets

	Begin Month	End Month	Total data
MSFT IPv4	January 1, 2020	Jully 31, 2020	54,445,265
MSFT IPv6	January 1, 2020	Jully 31, 2020	24,473,862
Apple IPv4	January 1, 2020	Jully 31, 2020	216,944,665

Furthermore, measure the number of client's prefixes of RIPE Atlas toward Microsoft's IPV4 for each day. Our measurement results show that a larger part of probes exist in European region. However, our network measurement shows the different client and server prefixes in different regions. In each day network measurements the number of client's prefixes are increased [2].

Data normalization: After all, the probes measurement distribution is unbalanced toward different types of regions i.e., Europe. So, we normalized each ping measurement from the Autonomous system in a given time. There are many ways of doing normalization. In these types of measurements, we use two types of normalization techniques. We apply the random sampling method on Round Trip Time (RTT) estimations from all the networks. Second, we recognize all clients in various areas. After it, we use APNIC Lab for taking information about Autonomous Systems (ASes) (Visible ASNs: Customer Populations) However, we apply the sampling techniques on the measurements and give the results of normalized data in a time frame [2].

B. IDENTIFYING CDN INSTANCES

By using probe options of RIPE Atlas measurements, the software update URL is resolved. In this section, we express the way through which we can identify the organizations (Content Providers or CDN).

Identifying Content Providers: Content provider to deliver the latest content to their clients. There are different types of organizations that provide low latency content to their customers such as Level 3 CDN, Cloud Front. Particularly, these types of ASes are considered the families of Content Provider ASes. Therefore, we use CAIDA's Autonomous System to find the families of Autonomous Systems. In addition, we use AS2Org for identifying the content provider's families. Through this method, we determine the 40 Autonomous Systems which belong to the Microsoft family and 11 autonomous systems that belong to Apple family (CAIDA, 2017).

C. IDENTIFYING CDN EDGE SERVERS

Cache servers which play an important role to carry content nearer to end-clients with effectiveness. When a client requests an edge cache, we watch some IP address are unrelated to CDN. We perform the following steps to determine the Content Delivery Network which response to the edge cache IP address [2].

- Most importantly, we utilize the DNS query on the IP address then we develop methods to recognize the CDNs dependent on hostnames.
- Secondly, we use the WhatWeb tool for scanning IP addresses and domain names. In such a case, when not all server IP resolves to a hostname or this settled hostname doesn't have a place with a given CDN. In that case, we use methods to identify the IP addresses [WHATWEB].

With the use AS2Org, we identify the several Microsoft server address who belong to CDN families. Furthermore, regular expression techniques are also used to identify the Microsoft IP address. Finally, we utilize various sorts of techniques for recognizing the Edge Cache CDN instances, for example, WhatWeb, AS2Org, and DNS lookup [2].

D. LIMITATIONS OF RESEARCH

We talk about the problems which we face during the research measurements and as well discuss the mitigation techniques for them.

Skewed distribution of RIPE Atlas probes. During this study, we analyze all probes in the measurement in which the majority of probes are located from European clients. Due to this, the overall performance will be one-sided towards European clients.

So, we evaluate the performance base on continents and finish the geographically difference.

DNS resolutions failure and others problems. In this network estimation, we face various kinds of difficulties like (**1%** Microsoft IPv4, **15%** Microsoft IPv6, and **7%** Apple IPv4) PING and DNS resolution failure which give no outcome. Because of this, we pull back all these data points from our measurements.

IV. RESULTS AND DISCUSSIONS

In this segment, we discuss the detail results. Furthermore, through this longitudinal measurement, analyze the different features of a single Content Delivery Network. It has been observed from the previous literature review that some organizations use the multi Content Delivery Network instead of a single Content Delivery Network in case of failure. But, the already existed literature has not described the detailed mechanism of multi Content Delivery Network. To overcome this gap, a deep study of content distribution and performance of Content Delivery Network is performed on two noticeable operating systems, Microsoft, and iOS. To understand the deployment of multi Content Delivery Network the researcher used an alternate approach to check Round Trip Time and investigate the latency. This methodology, the researcher takes the measurements and performs analysis of multi-CDNs. Especially, in this measurement, the researcher understands all mechanisms of multi-CDNs and several points (1) to check the performance of different Content Delivery Network providers in different regions (approximated latency) (2) to check the Content Delivery Network providers switching impact on clients [2].

A. MICROSOFT IPV4 RESULTS

In this segment, we calculate the Mean Round Trip Time (RTT) of a prominent operating system such as Microsoft IPv4 and show statistical results in the form of bar chart and line graph. Figure 2 represents a Microsoft IPv4 Round Trip Time (RTT). Figure 2 shows the 7-month calculations of Mean Round Trip Time (RTT) of 5 regions. It shows the circulation of middle RTT esteems for Microsoft IPv4 customers individually. These Round Trip Time (RTT) values vary in different months for each region.

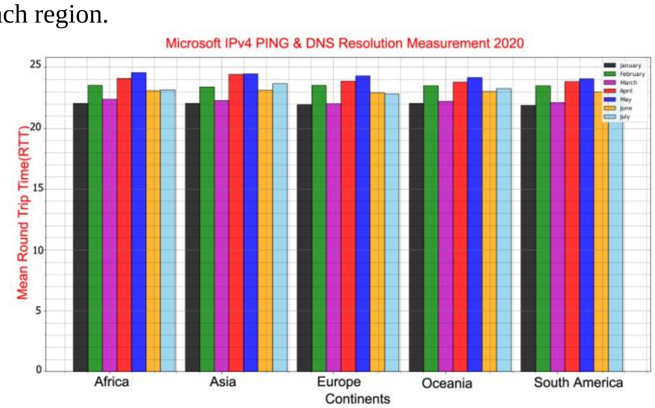

Figure 2: Microsoft IPv4 RTT.

Figure 3 represents a Microsoft IPv4 Maximum, Minimum and average RTT in line graph. The Figure 3 refers to the comparison summary of Maximum, Minimum and Average median RTT in different regions. There is a significant difference in results found in different regions. Figure 3 shows that the greatest RTT is seen in the period of May and the least RTT is seen in the long stretch of January.

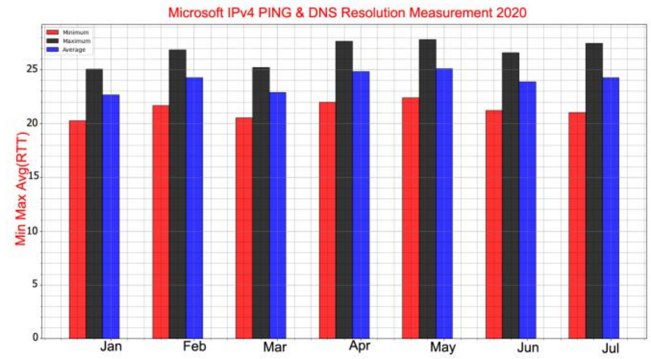

Figure 3: Microsoft IPv4 Max, Min and Avg RTT.

B. MICROSOFT IPV6 RESULTS

We calculate the Mean Round Trip Time (RTT) of a prominent operating system such as Microsoft IPv6 and show statistical results in the form of bar chart and line graph. Figure 4 represents a Microsoft IPv6 Round Trip Time (RTT). Figure 4 shows the different median RTT values for IPv6. These Round Trip Time values vary in different months for each region.

In Fig. 5, we notice the Maximum Mean RTT is recorded in the period of June and least in the long stretch of January. Figure 5 represents a Microsoft IPv6 Maximum, Minimum and Average RTT in line graph. There is a significant difference in results found in different regions. Figure 5 shows that Maximum Round Trip Time is observed in the month of June and minimum RTT is observed in the month of January.

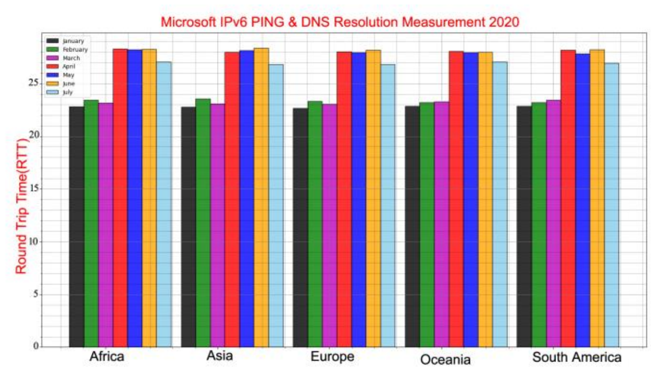

Figure 4: Microsoft IPv6 RTT.

C. APPLE IPV4 RESULTS

In this segment, we calculate the Mean Round Trip Time (RTT) of a prominent operating system such as Apple IPv4 and show statistical results in the form of bar chart and line graph. Figure 6 represents an Apple IPv4 Round Trip Time (RTT). Figure 6 shows that the Maximum RTT are seen in the Asian region in the month of January and Minimum RTT are seen in European region in the period of May.

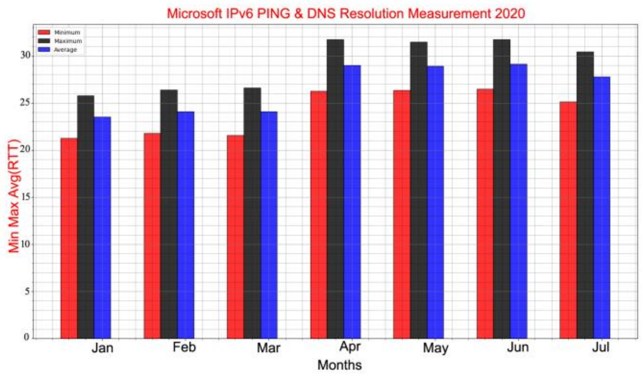

Figure 5: Microsoft IPv6 Max, Min and Avg RTT.

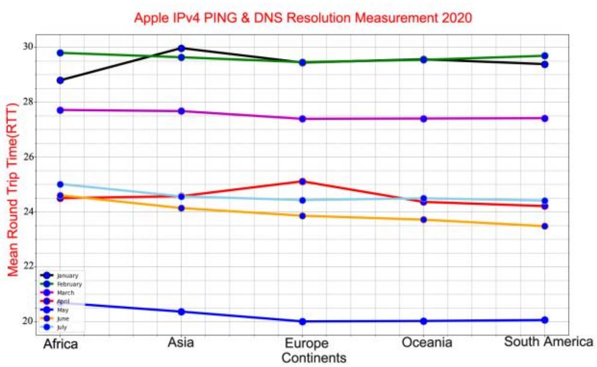

Figure 6: Apple IPv4 RTT

Figure 7 shows that the maximum median RTT of Apple IPv4 clients are observed in the month of January and minimum RTT is observed in the month of May. The findings show that the Edge Cache gives minimal latency to their clients with Midian RTT esteems that are somewhere in the range of 28 and 32 milliseconds.

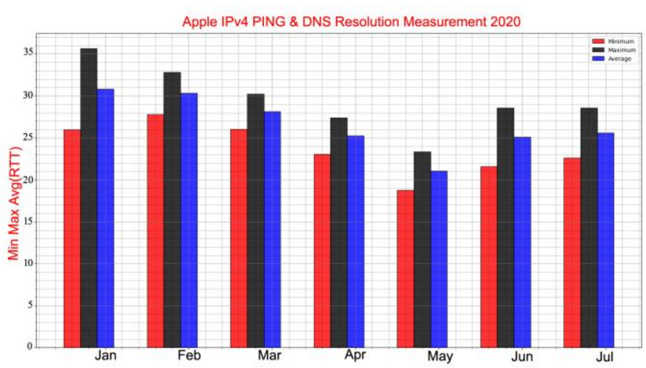

Figure 7: Apple IPv4 Max, Min and Avg RTT.

D. MICROSOFT IPV4 RESULTS IN PAKISTAN

In this section, we calculate the Mean Round Trip Time (RTT) of a prominent operating system such as Microsoft IPv4 in Pakistan Region and shows the statistical results of seven months. Figure 8 represents a Microsoft IPv4 Round Trip Time (RTT). The middle RTT faced by IPv4 customers is roughly 103 ms in three months such as January, February, and July. Furthermore, Figure 8 shows that the peak value estimation of the middle RTT saw by IPv4 customers in Pakistan is roughly 132 ms.

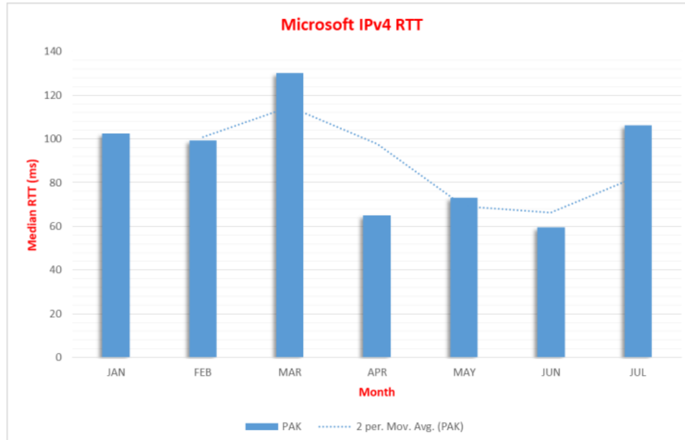

Figure 8: Microsoft Ipv4 RTT in Pakistan

We calculate the Mean Round Trip Time (RTT) of a prominent operating system in figure 9. It show the highest values of RTT are in the month of March.

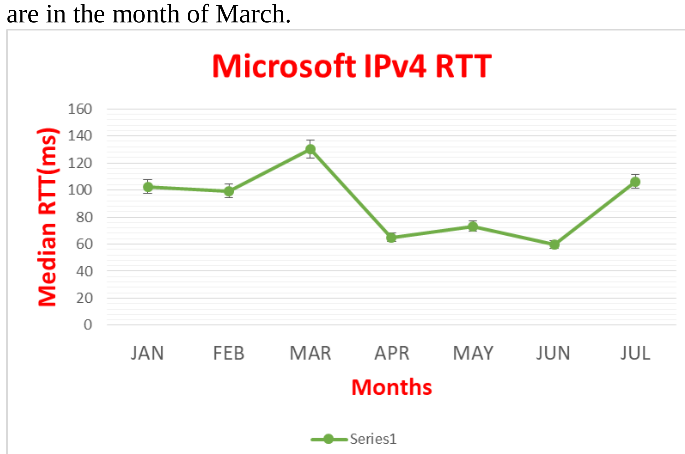

Figure 9: Microsoft Ipv4 RTT in Pakistan

By the above shown experiments, the accuracy is calculated to be also 92% given in Tbl-II.

Table II: Comparison of efficiency with State-of-Art methods

Method	Precison
Singh *et al* [2]	90%
Emile Aben [3]	85%
Our Methodology	92%

V. CONCLUSION

It has been keenly observed from the literature review that some organizations use multi-CDN instead of single Content Delivery

Network in case of failure. In addition, it is also observed that two different strategies are used by Microsoft and apple for pushing updates to their clients. Microsoft utilizes edge caches to convey data nearer to its clients while Apple's customers use the organization of their own Internet service provider. Furthermore, the performance of Microsoft clients in the developing regions is noticed to be following the downward trend so there is need for betterment. The detailed study of this research reveals that the customers who are shifted to the cache servers for receiving the content have noticed a considerable improvement in the performance. However the flip side of it, we observe clients face high latency when they receive content from Level 3. Furthermore, we observed variance in result values of Mean Round Trip Time (RTT) during the different months in Pakistan region. Finally, the results accuracy is 90% and it is more suitable than existing methods.

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