Cloud Technology and Performance Improvement with Intserv Over Diffserv for Cloud Computing

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Abstract— Cloud computing, which is the today's and tomorrow's brightest venture, rising on the basis of the idea of the use of the online information, software and hardware. Cloud computing providing users three kinds of different service models; infrastructure services, platform services and software services; which in the run with all together as requested and meets the needs of users. With the transition to cloud computing we are able to have a chance to take advantage of many benefits of cloud computing. Increased security, monitored and maintained by the provider of a technical infrastructure, cost-saving, efficient use of resources, high flexibility, accessibility and device independent, you are able to benefit from the these opportunities as the possibility to give the desired performance every time. This paper describes the cloud computing technology with its features and continues with using advantages in business life. Traffic of a medium size company is examined in two different scenarios; LAN network and cloud computing network; and compared according to ftp, email, HTTP traffics using OPNET. In second part of the study, DiffServ and IntServ quality of service terms are studied over cloud computing model. A new approach is studied in order to improve the performance of cloud computing network in a medium sized company by combining IntServ and DiffServ in same network model. This model serves an improvement in business applications using cloud computing technology.

Keywords—Cloud Computing;Cloud Computing Service Models; OPNET; Cloud Computing QoS parameters; DiffServ; IntServ

I. Introduction

Especially lately information technology and social media internet sites often include articles about the benefits of cloud computing and their products. What is this technology, using without even realizing in our business and daily lives?

If we simply define the Cloud Computing, Cloud Computing: It is the only accessible architecture to the data, applications or services without any extra software, hardware or service infrastructure, which regardless of location [1].

According to the U.S. National Institute of Standards and Technology (NIST); “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” [2].

Cloud computing brings us a new platform to realize data sharing which is done previosly on web services such as social networking sites, file sharing portals by moving them to another dimension to be accessed anytime, anywhere. In this way, the world has shrunk even further, personal or corporate information has become much easier to achieve.

Cloud computing is not just about sharing the data at hand, but also the common use of infrastructure services or hardware sharing brought us the biggest advantage of cloud technology. In this way, by providing remote access to an infrastructure service, it is possible to have more efficient infrastructure resources available under our hands. Only limited activities are possible to do with a computer which is a low-cost and its hardware features are weak. But by connecting this computer to another strong computer, we have increased capabilities of the computer and we can do with these new features. In this way, users find the software they need already installed on the internet that are ready for use. Also by this way, they save thousands of dollars by depending on the amount they use and pay the appropriate amounts.

When it comes to services provided by in this new structure, it is estimated that three different service model: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). These three basic service models can be serving separately or both can be formed by bringing together depending on the structure.

Cloud computing is one of the most important technologies of future and adaption of this technology to our lives with maximum benefits is the main goal. Almost every major corporation in the IT industry now has some interest the area of cloud computing. For this reason, the aim of this study is to show the effective usage of cloud computing technology in business and daily usage rather than standard network infrastructure. The lack of research on active usage of cloud computing on business life is motivated us to work on this subject. The main idea behind our study is to show efficiency gained with using cloud computing in business area. In addition, more researches on this cloud computing will cause improvement in performance, security, scalability, development of applications compatible with cloud and usage area of cloud computing.

There were several whitepapers and general introductions to cloud computing, which provide an overview of the field but yet there is not an enough research on business or daily usage of cloud computing. We are well aware that a survey in such a fast moving field will soon be out of date, but such a survey like this would provide a good base for the Cloud Computing to set new work in context with, and that it can act as a resource for researchers new in this area. Another thing that is hoped to be accomplished with this paper is not only a clear picture of what the cloud does extremely well and a brief overview of them, but also a short survey on usage in real life, its performance and improvement of performance.

Today, emergence of the real-time applications demands more resources. The main challenge is to maximize the resource utilization by QoS mechanisms. The contribution of this work is to analyze QoS performance metrics such as end-to-end delay, delay variation, throughput, packet loss and queuing delay for real-time applications such as video and voice conferencing, e-mail traffic, ftp download in cloud computing networks. One of the main difficulties in cloud computing is the routing problem due to frequently change in topology causing more time in route setup and increasing the delay. The study explores how well the declared cloud protocols reply to various QoS performance metrics against different network scenarios.

In this paper we discuss the main parts of cloud computing, deployments and advantages for building clouds. Research in this field appeared to be split into two parts. One investigates the performance comparison between normal network and cloud network. Second one is to try to improve efficiency of cloud network by using performance metrics.

This paper is structured as follows: the service models of cloud computing are shown in the Section 2 outlines the work done in this area; Section 3,4 discusses deployment of cloud computing; Section 5 outlines the advantages that brings with cloud computing; Section 6 expresses the quality of service in cloud computing; Section 7 defines the problem, offers the solution and simulates the models; finally Section 8 concludes the review by summing up the research entire paper.

II. Related Work

To accomplish the objectives of our work, an evaluation of work done by other authors related to our objectives was studied. Several researches have concentrated on the Cloud computing network performance and also Quality of Service over the last decade. But there are few researches are realized in QoS effect on cloud computing area. Following papers in particular were considered.

The authors in [20] state the current state of the affair with respect to quality of services in the cloud computing environment. The paper also describes the key challenging areas that how resources are allocated to clients and what the roles of cloud providers are. Finally, it is observed that how the performance can be increased by improving various components in a scalable way with low cost, better performance and QoS.

The authors in [21], highlights DiffServ based QoS analysis in a wired IP network with more realistic enterprise modeling and presents simulation results of a few statistics. Four different applications are used in this work, i.e. FTP, Database, Voice over IP (VoIP) and Video Conferencing (VC). Two major queuing disciplines are examined i.e. 'Priority Queuing' and 'Weighted Fair Queuing' for packet identification under Differentiated Services Code Point (DSCP).

In [18], the authors were focussed on the enhancements of mapping between IntServ and DiffServ as a solution to provide a more scalable and efficient end-to-end QoS architecture in a radio access network. They observed that IntServ over DiffServ interoperation model has shown noticeable improvements in respect to the two mechanisms when used alone and provided satisfactory QoS guarantees even in an extreme congestion situation.

In [17], they evaluated the QoS that can be obtained by end applications when Integrated Services (IntServ) sub networks are connected together using Differentiated Services (DiffServ) network. Traffic from various IntServ classes with different priorities is mapped into appropriate DiffServ services such that QoS can be guaranteed to individual applications.

III. Cloud Computing Service Models

A. Infrastructure as a Service –IaaS

Inside cloud computing infrastructure, the bottom layer of the stack is used to refer these services. In this model, users configure the CPU, storage, network memory, and other essential information resources their selves which are needed and users able to install the operating system and applications which they desires. Although management and control of the infrastructure is not on customer, some operations on operating system level and some network components (Firewall, etc.) can managed by customer [4]. The users do not know where these computers are, how they are configured or how they are maintained. They only demand the services inside determined quality standards. Amazon's EC2 service can be shown as an example to this service model.

B. Platform as a Service –PaaS

Infrastructure is used to develop the application. Platform is offered as a service in this model. The users are able to install their self-developed applications or provided applications on cloud service. Except the user's own established application, there is no any control and management on the components on platform infrastructure by the user [4]. Google App. Engine service can be shown as an example to this service model.

C. Software as a Service –SaaS

In this model, the service provider's applications running on a cloud infrastructure, is made available to users. Applications can be accessed through any device with an internet connection by web browser, without any limitation as to time and location. Users do not have any control or management capabilities on components such as network, server, storage devices or operating systems. However, the application settings can be configured and specified by the user [4]. Email accounts can be shown as an example to this service model.

IV. Deployment of Cloud Models

There are different types of clouds available, each with benefits and drawbacks.

A. Public Cloud

The cloud service which is provided with servers on the Internet. Global cloud applications, storage, and other resources will be offered by a service provider to public users. These services are accessible for free or by the pay-per-use model, users will be charged. As an example, Microsoft and Google operate their own infrastructure and only provide access via the Internet [5].

B. Private Cloud

The cloud service is generated within the company servers. Private cloud is just a single run organization as a cloud infrastructure and managed by the built-in or third-party and hosted internally or externally [6]. The private cloud may at any other place as may be in institution's own building.

C. Community Cloud

A community cloud is a collaborative effort in which infrastructure is shared between several organizations from a specific community with common concerns (security, compliance etc.), whether managed internally or by a third-party and hosted internally or externally [1]. Community members have access to applications and data. As an example, by using a community cloud computing, State agencies can meet their needs on a joint cloud [6].

D. Hybrid Cloud

According to a company's data security and such reasons, hybrid cloud structure is the result of using both private and public cloud. Hybrid cloud is a combination of two or more cloud, these are different, separate clouds but they are interconnected to each other so that they offer multiple docking model possibilities [6]. On the private part of the hybrid cloud, critical applications can be found. Public part of the hybrid cloud owes the applications where security concerns are less [3]. Hybrid cloud architecture needs both in-house resources, as well as the remote server-based cloud infrastructure. Inside Hybrid clouds, in-house applications shall be flexible, secure [7]. Businesses use their private cloud in their normal company activities; in case of a sudden increase of capacity, they meet their high peak load requirements from public cloud [3].

V. Advantages of Cloud Computing

Cloud computing provides so many features to us. In addition to the advantages for individual users, it brings many advantages for corporate implementations. With the transition to cloud computing, institutions can provide a more secure infrastructure that can be monitored by specialists, cost-efficient systems, efficient use of sources, high degree of flexibility and high performance any time needed [2].

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Moreover, it also brings features like remote teleconference and meeting services for companies with multiple offices, ability to manage contact lists, projects, and personal documents and reach up-to-date documents regardless of where you are [8].

A. Scalability

If the need for purchasing computers differs frequently or there is a progressive upgrade in computers, cloud technology will help you to manage about this situation. Instead of buying new devices, installing and configuring them, you can buy a third party CPU cycles or an external storage device [9]. Since cost depends upon the consumption, purchase of new equipment is more costly. If you think you fulfill your needs or you have stuff more than you need, then you can easily request your service provider to revise your needs and lower down unnecessary things [9]. Hardware development in this technology also prevents you from extra update costs.

B. Simplicity

Costs for buying new equipments and the IT costs for configuration and management of these equipments results as lack of technical knowledge in companies [9]. In the general distribution model of cloud computing, capital costs has become operational costs. Cloud eliminates all IT infrastructure costs which cannot be afforded by especially small and medium-sized companies.

C. Security

Security is enhanced by data centralization. With the help of improved security focused resources, active and passive cryptography, strong ID authentication, cryptography and secure algorithms, effective security services are provided [10]. Security is much more superior to traditional systems because service providers are able to allocate resources for security problems instead of customers [11]. In addition if multiple redundant areas are to be used, security will be improved. Our data in different data center locations of the world will be accessible in case of any emergency status by their backup [12].

D. Performance

Service proving companies are trying to meet the needs of business life with the help of latest technological hardware and higher bandwidths. In order to prevent the system from connection failure or overload, extra routes and load balancing techniques are being used for nonstop service [13]. When needed, performance increase in user activities is also provided. Effective use of resources, distribution and instant performance monitoring are useful for multiple user systems and especially for companies [1].

E. Flexibility

It is not essential to connect to any platform so as to access cloud services. Location of service providers are not considered in cloud technology. Service can be provided at any time and in anywhere as long as there is an internet connection. It is able to be used in any device or operating system like Windows, Mac, iPhone, iPad, Blackberry, Windows Mobile or Android [12].

VI. Quality of Service in Cloud Computing

QoS for clouds is already a necessary and hot topic in research community. Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance. QoS criteria are numerous and are highly dependent of the application, such as throughput, delay, jitter, loss rate [13]. In our research we implement two main services; IntServ and DiffServ into our network model.

In our work, we propose a new model leads to a proposal to combine the DiffServ and IntServ, using the IntServ control mechanism at the edge of the network and DiffServ within the core network.

A. Differentiated Service (DiffServ)

DiffServ is a computer networking architecture that specifies a simple, scalable and coarse-grained mechanism for classifying and managing network traffic and providing quality of service (QoS) on modern IP networks [14]. With Differentiated Services, the network tries to deliver a particular kind of service based on the QoS specified by each packet. Differentiated Services is used for several mission-critical applications and for providing end-to-end QoS. By using DiffServ, traffic is classified based on priority. Then the traffic is forwarded using one of three IETF-defined per-hop behavior (PHB) mechanisms. This approach allows traffic with similar service characteristics to be passed with similar traffic guarantees across multiple networks [15]. The DiffServ architecture is composed of a small set of per-hop forwarding behaviors, packet classification functions, and traffic conditioning functions this architecture provides Expedited Forwarding (EF) service and Assured Forwarding (AF) service in addition to best-effort (BE) service as described below.

1) Expedited Forwarding (EF)

The Expedited Forwarding (EF) model is used to provide resources to latency (delay) sensitive real-time, interactive traffic.The EF service provides a low loss, low latency, low jitter, assured bandwidth, end-to-end service [16].

2) Assured Forwarding (AF)

The assured forwarding (AF) model is used to provide priority values to different data applications. This service provides reliable services for customers even during network congestion. Classification and policing are first done at the edge routers of the DiffServ network. In-profile packets should be forwarded with high probability.However, out-of-profile packets are delivered with lower priority than the in-profile packets [17].

3) Best-Effort (BE)

This is the default service of DiffServ, and it is also name default Per-Hob-Behaviour (PBH). It does not guarantee any bandwidth to customers, but can only get the available bandwidth. Packets are queued when buffers are available, and dropped when resources are over committed [17].

B. Integrated Service (IntServ)

The idea of IntServ is that every router in the system implements IntServ, and every application that requires some kind of guarantees has to make an individual reservation. IntServ provides services on a per flow basis where a flow is a packet stream with common source address, destination address and port number. Because of routing delays and congestion losses, real-time applications do not work very well on the current best-effort Internet. Video conferencing, video broadcasting, and audio conferencing software need guaranteed bandwidth to provide video and audio of acceptable quality. To support these service requirements it has been necessary to modify the Internet infrastructure to provide control over end-to-end packet delay and bandwidth administration [18]. Resource Reservation Protocol (RSVP), Guaranteed Service and Controlled-Load Service are the widely used protocols inside integrated services. We will examine RSVP in our proposed model.

1) RSVP

The Resource Reservation Protocol (RSVP) is a Transport Layer protocol designed to reserve resources across a network for an integrated services Internet. RSVP can be used by either hosts or routers to request

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or deliver specific levels of quality of service (QoS) for application data streams or flows. RSVP defines how applications place reservations and how they can relinquish the reserved resources once the need for them has ended. RSVP requests resources for simplex flows: a traffic stream in only one direction from sender to one or more receivers [19].

VII. Problem Definition and Solution

Based on the above described advantages of cloud technology,a remote multiple office company will be created and simulated on both LAN network and cloud network in order to compare the performance of the network in this section. In the second part, by adjusting the QoS parameters, performance improvement will be simulated.

General impression has been reached with the performance measurment criterias considering the different usage scenarios for groups of 8-hour daily office work in accordance with the traffic density of the simulation results.

A. Scenario Design

1) Standard Network Infrastructure (LAN Model)

Scenario creation is implemented in OPNET Modeler 14.5. Figure 1 shows us the normal network infrastructure for multiple office company. This company includes 1 head office (Istanbul) and 2 remote offices (Ankara, Budapest). In this topology, PPP_DS3 links are used between offices and 10BaseT LAN connections are used inside offices.

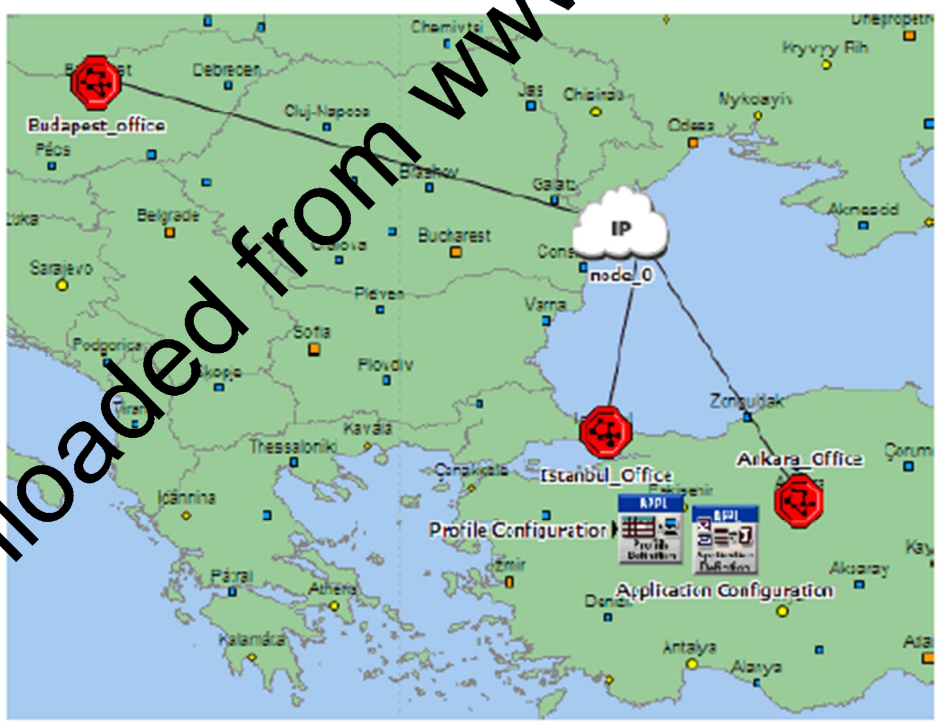

Figure 1 – Standard Network Infrastructure (LAN Model)

Figure 2 expresses us the design of head office. Head office consists of 3 servers (Ftp, Email, and Web) and has 3 floors with offices. Remote offices include manager and researcher groups same as head office and 3 floors as head office.

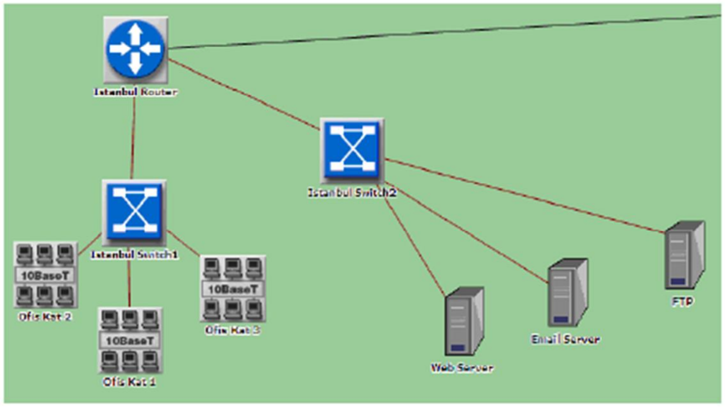

Figure 2 – Head Office

2) Cloud Network Infrastructure

Figure 3 shows us the network infrastructure of same company designed with cloud computing technology. In this topology, PPP_DS3 links are used between offices and 10BaseT LAN connections are used inside offices.

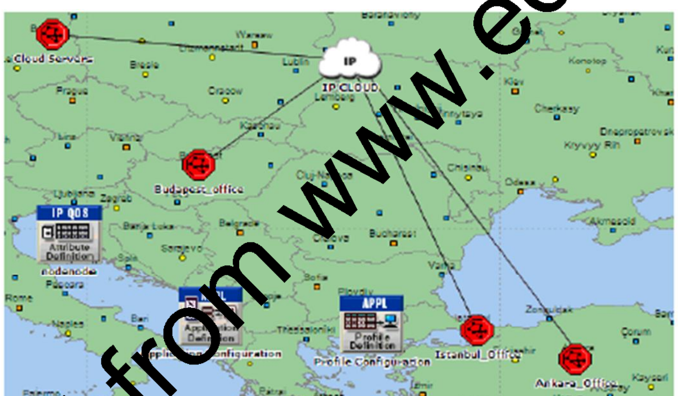

Figure 3 – Cloud Model

As opposed to other scenario, servers are located inside remote cloud service provider's server farms instead of inside company in this cloud model scenario. Figure 4 shows the design of the headquarters for us in this scenario. Remote offices design stay same as previous model.

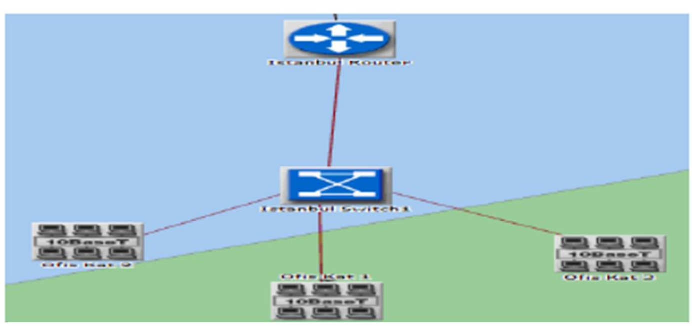

Figure 4 – Head Office

3) Proposed IntServ over DiffServ on Cloud Network

Figure 5 shows us the IntServ over DiffServ model implemented on cloud network subnet. As it seen in the figure 5, IP cloud subnet is designed again. There is a DiffServ zone contains DiffServ routers and outside of that zone the conversion to IntServ is done on border routers. Black lines pass through the routers represent the border routers. The cloud server router, Istanbul router, Ankara Router and Budapest Router is configured with IntServ features.

Router Name	QoS Profile	Queuing Profile
Istanbul Rtr	RSVP / IntServ	PQ
Budapest Rtr	RSVP / IntServ	FIFO
Ankara Rtr	RSVP / IntServ	PQ
Cloud Server Rtr	RSVP / IntServ	WFQ
BorderRtr1/Cloud	EF / DiffServ	WFQ
Border Rtr2/Ist	AF / DiffServ	PQ
Border Rtr3/Bdpt	BestEffort/DiffServ	FIFO
Border Rtr4/Ank	AF / DiffServ	PQ

Table 1 – Router Profiles

Every IntServ router connects the Ip Cloud Network (DiffServ Zone) via Border Routers. Table 1 shows us the configuration profile of the routers.

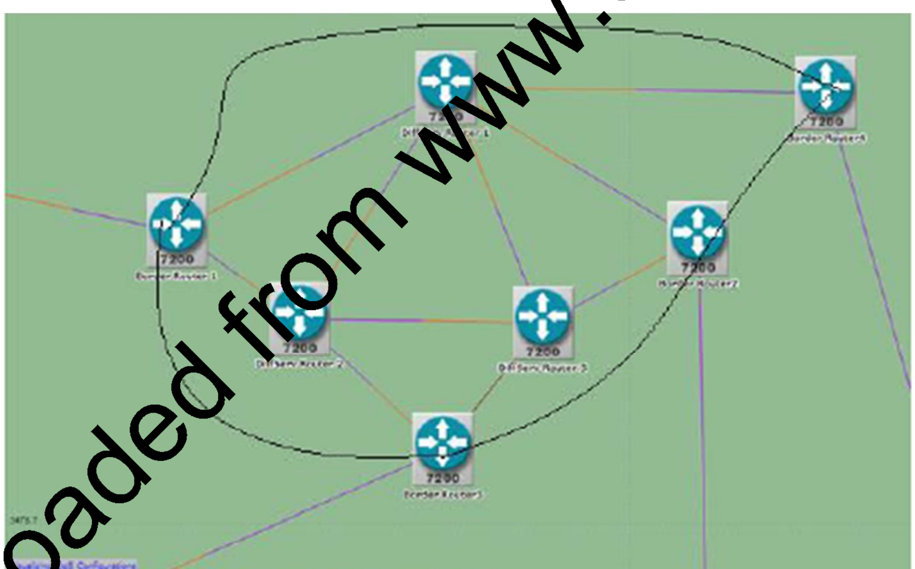

Figure 5 – IP Cloud Subnet with DiffServ Zone

B. Simulation Parameters

Before starting the simulation, we focus on simulation parameters. The users inside the offices are divided into two groups. Managers and Researchers. Inside one office, there are 10 manager profiles and 50 researcher profiles.

Application	Manager	Researcher
Email	Heavy	Low
VOIP	GSM	None

Web Browsing	Low	Heavy
File Transfer	Low	Heavy
Video Conf.	Heavy	None

Table 2 – User Profiles

C. Simulation

1) Comparision of Standard Model and Cloud Model

These two scenarios were simulated based on real working hours (8 hours- 1 day) in order to observe the daily traffic and compare these models using OPNET modeler. E-mail traffic, web page response times, ftp download response time, Ethernet delay were used in order to carry out performance analysis.

In figure 6, we are able to see the ftp download response times of both models. Compared to the responses time, cloud model is much better than LAN model. Time dependent increase in download traffic causes slowdown in LAN model. On the other hand, cloud model show stable and better performance during the simulation period through its strong infrastructure.

Another comparison criteria in our simulation is HTTP page response time. Figure 7 tells us the page response time is faster than LAN model.

Figure 8 shows us the email download response time of two models. It is easily seen that cloud model has much better performance than a LAN model. Increasing email traffic causes slowdown in LAN model by the time. Cloud model performance does not effect from any increasing traffic in this period.

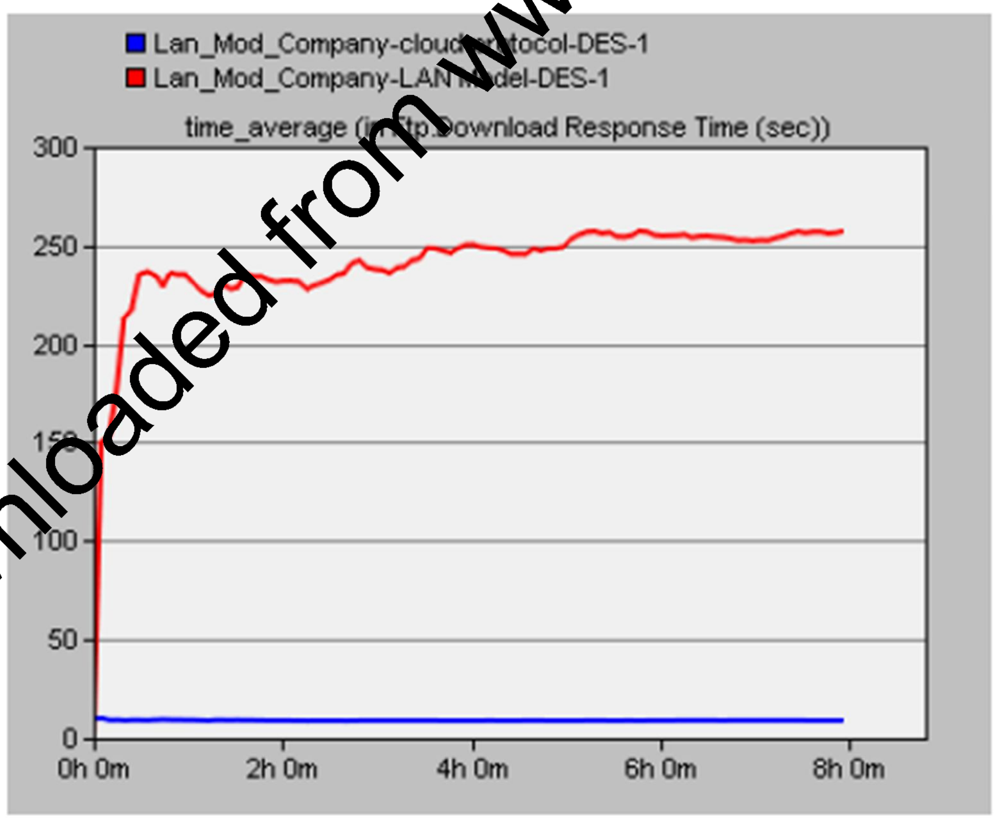

Figure 6 – FTP Download Response Time

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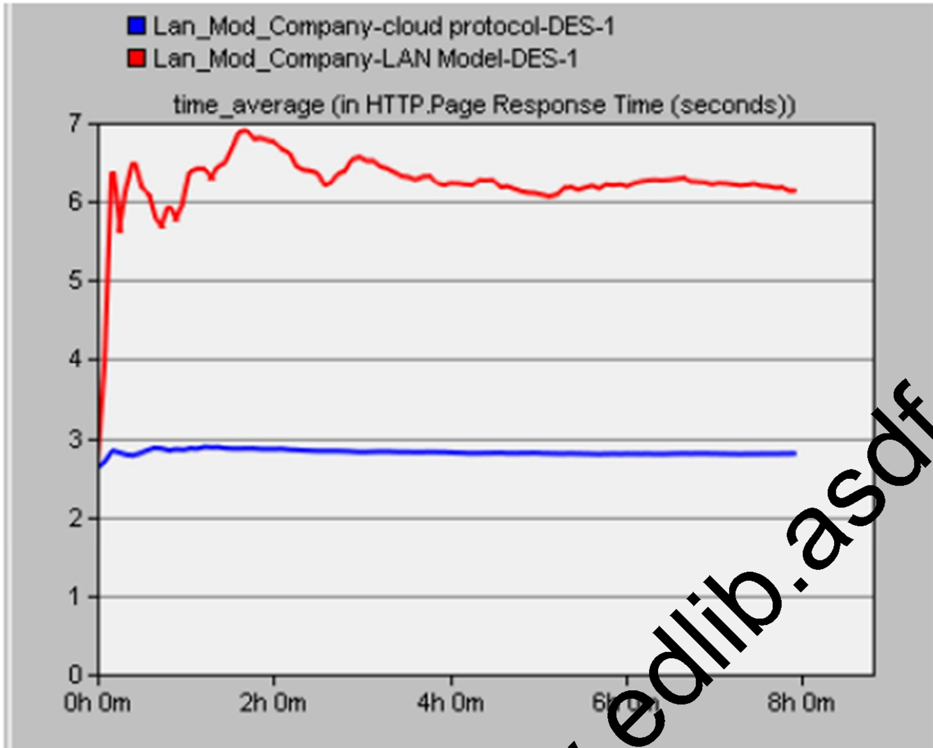

Figure 7 – HTTP Page Response Time

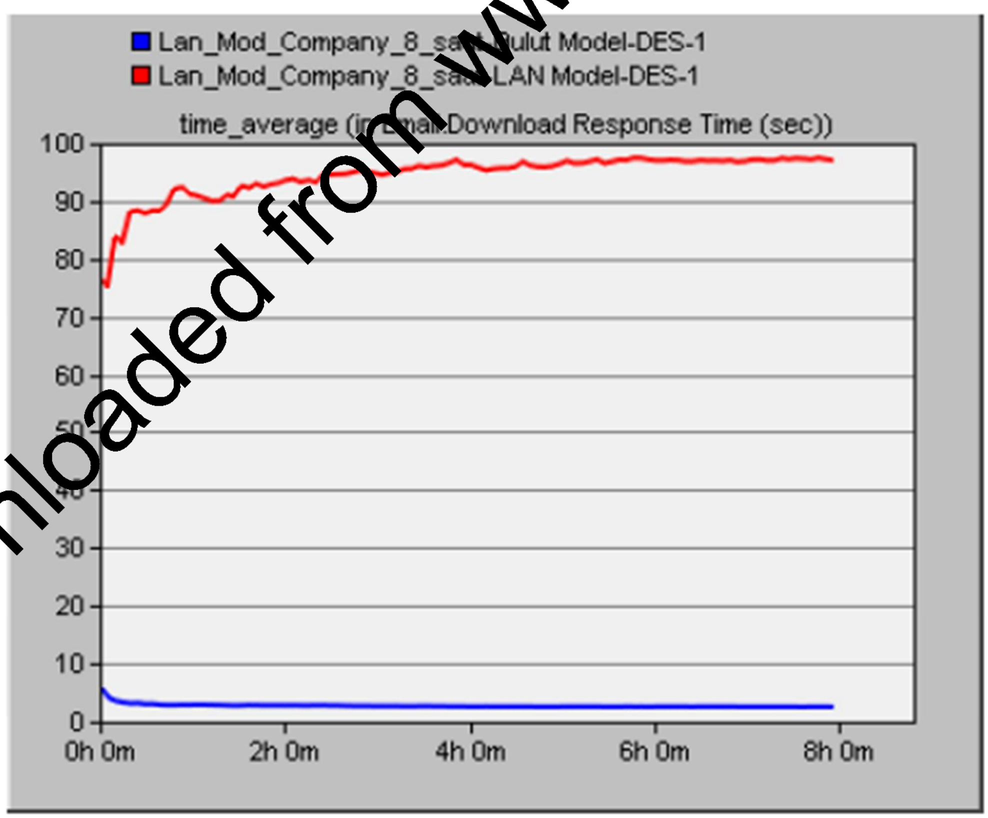

Figure 8 – E-mail Download Response Time

2) Performance Improvement of Cloud Model Using QoS

As mentioned in the quality of service of cloud computing section in order to improve the performance of cloud model,IP Cloud network is designed again with a DiffServ zone and existing routers are configured according to IntServ profile. In our simulation we used Priority Queuing (PQ), Weighted Fair Queuing (WFQ), and First-In-First-Out (FIFO) to examine the effect of different queuing disciplines on packet delivery. Each router has some queuing discipline that governs how packets are buffered while waiting to be transmitted as expressed in table 2.

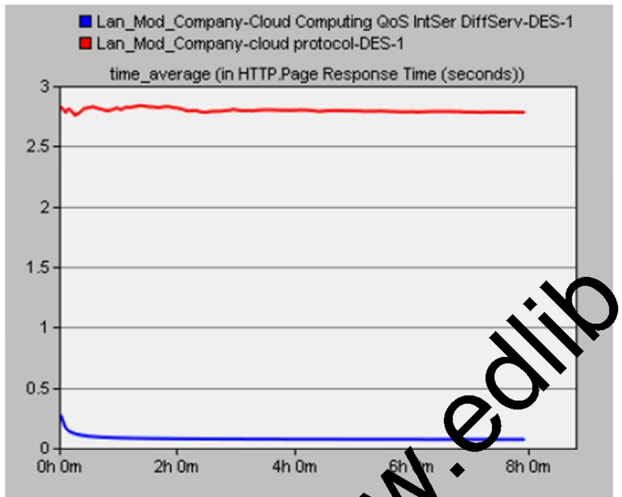

Figure 10 – HTTP Page Response Time with Qos Profiles

It is observed that with newly designed cloud topology in accordance with QoS profiles, we gathered improved performance from the cloud model. As it is easily seen from figure 10, HTTP page response time highly decreases with the new configuration as well as email download response time.

QoS profiles have a big positive impact on email download response time in figure 11. Finally, Ftp download response time become much smaller with this new QoS profiles which is observed from figure 12.

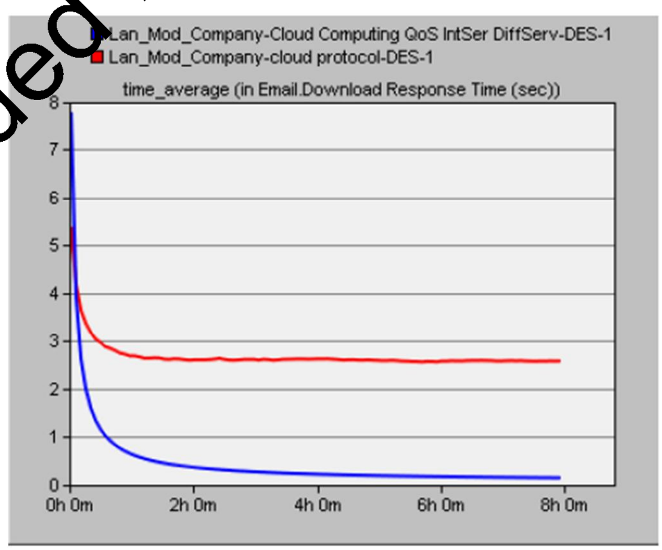

Figure 11 – Email Download Response Time with Qos Profiles

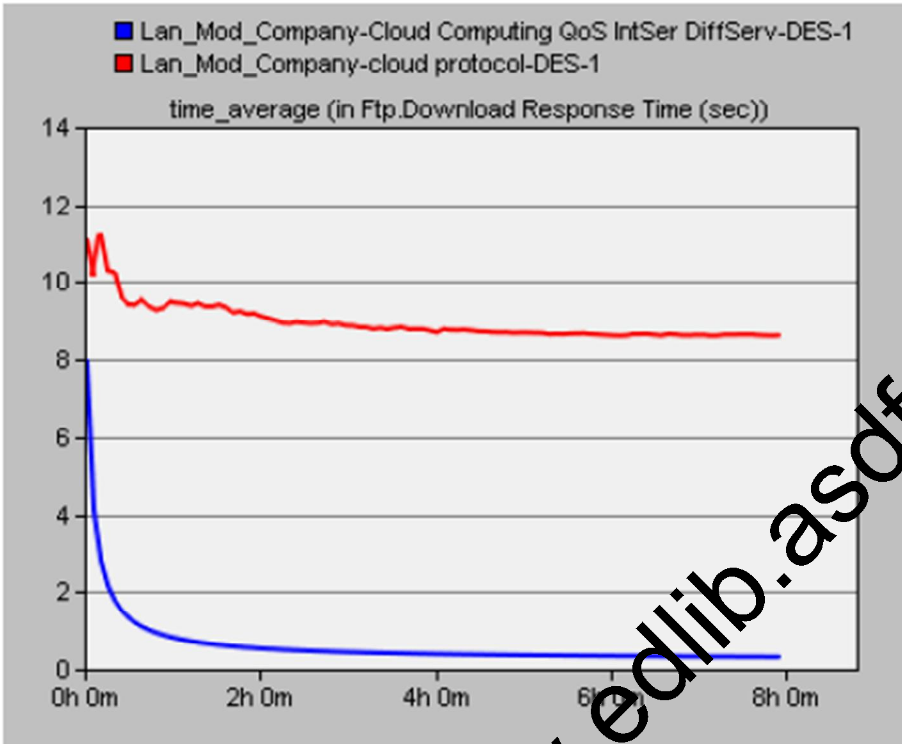

Figure 12 – FTP Download Response Time with Qos Profiles

The applied queuing disciplines are able to be used to control which packets get transmitted and which packets get dropped . The queuing discipline also affects the latency experienced by a packet, by determining how long a packet waits to be transmitted. We are able to see the reflection of these feautres from the graphs above. Positive improvement is achieved with the newly applied design into cloud topology.

VIII. Conclusion

Cloud computing allows all kind of user profiles to use same software, same database, same infrastructure at any time from any location that has internet connection. At the same time, complaints or satisfactions of clients are immediately detected and be answered as soon as possible. Thus, the quality and flexibility of the services to be provided and the cost advantages can be obtained. With this application, it is possible to avoid waste of unnecessary performance, electricity use and labor. Savings can be reached on global scale.

In first part of the study, two network infrastructures are designed (Cloud and LAN model) and their performances are compared in HTTP, E-mail and Ftp traffic. As a result, cloud model indicated better performance in all three traffic type under specified conditions. In second part, we evaluated the QoS that can be obtained when Integrated Services (IntServ) sub networks are connected together using Differentiated Services (DiffServ) network. Results of different queuing for QoS management of IntServ/DiffServ networks, is reported. With this work, assigning QoS profiles to the cloud model, performance improvement is gathered in cloud model in all three traffic conditions.

As a future work, it is possible to study on data routing algorithms and load balancing algorithms in order to improve performance of the cloud network and the studies can be implemented on big scale networks. Likewise, using other QoS profiles, different combinations and methods better performances can be reachable. The advantages of the using cloud computing technology widely in business and daily life shall encourage researchers to spend time on cloud technology.

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