A Real-Time Cloud Based Model for Mass Email Delivery

Nyirabahizi Assouma, Mauricio Gomez, Seung-Bae Yang, and Eui-Nam Huh

Department of Computer Engineering
Kyung Hee University
Suwon, South Korea
{assouma,mgomez,johnhuh}@khu.ac.kr,
tdory@bizisolution.co.kr

Abstract. Cloud computing is a new computing technology that recently becomes an attractive area. Email was one of the first tools to embrace the Web and make the transition to "cloud-based". However ubiquity of email make its performance an important issue, overloaded email server causes the delay of email delivery especially mass email delivery which results to latency of email process. Using cloud based ressource will benefit email performance process and meet the deadline provided in SLA.In this paper, we propose the cloud model for reducing the delivery time of mass email by using the cloud based services within efficient use of resources.

Key words: Cloud computing; Mass email; Resource allocation; Scalability; SLA

1 Introduction

Cloud computing consists in offering scalable and often virtualized resources as services over the internet in pay as you go manner [1] based on SLA (Service Level Agreements) established through negotiation between the service providers and consumers [2][3], that includes software, platform, and infrastructure as services. The most important ideas behind cloud computing is scalability and the key technology that make that possible is virtualization [1].One of the most popular applications on the Internet is E-mail. It is delivered instantly, anywhere across the globe. However, sending mass email is still a challenging problem in case there is a concentration of a lot of emails to a mail server which may lead to very high network bandwidth utilization and overloading email server [4], and this affect latency, performance along with other services that result to a low email deliverability. Expectedly as a particular mail list grows larger, it becomes progressively more resource intensive and time consuming to manage and process [5]. This paper studies the scenarios of legal mass email messaging delivery. To further taking the advantage of cloud huge computation servicies, executing different intensive applications with parallel processing to achieve performance may benefit the email system,especially in case of mass email delivery. Beside,

as a tool of communication it has to maximize the deliverability and complete before or meet the deadline which is the character of real time system. The three major contributions of this paper are: a)Investigate on email system and the use of cloud based resources to balance the workload of mass email requests and reduce the delivery time in order to meet the deadline time of SLA. b)Design the cloud model to dynamically allocate the resources in the cloud to overcome the overloading server's issue caused by huge amount of processed emails and the network load in efficiently utilization of the resources. c)Present the resource allocation mechanism that enables the knowledge of the number of VM required for balancing the workload of a big number of requests that have deadlines. The rest of this paper is organized as follow: Section 2 survey the related works, the third section present the proposed approach, the fourth present the performance evaluation and in the last section we present the conclusion.

2 Related work

Researches have been done in the area of email system in general, and also recently the cloud computing is taking high level in the research topics. In [6] authors proposed and integrated to SMTP client different components to serve for an enhanced and reliable methodology of message delivery,in [7] is proposed a new procedure for the client/server procedure to improve and enhance the SMTP protocol, and reduce the delay time ,In [8] they presented that a significant share of the latency both for sending and receiving e-mails is due to serial processing of commands However, all these works considered only latencies in view of protocols issues, and improve the delivery time by inserting or removing some command. In our approach we are considering the use of cloud based resources to improve the delivery of the email especially mass email and meet the deadline.On this matter of improving the email system performance by using cloud based resources services, [9] propose the use of cloud based resource to allow the scalability and dynamic load balancing between brokers for its cloud based message brokering service. Gmail, Yahoo, and Hotmail have some services of cloud based emails but on the investigation done on this matter, there isn't any specific document which describes their functions. Our work differ from the above researches in the way that is going to combine some cloud computing resource allocation technique investigated with the email system to balance the workload of mass email by allocating scalable cloud based resources in order to improve the delivery of mass emails and meet the deadline provided in SLA.

3 Proposed approach

3.1 Overview of the email system sending part

SMTP is the delivery protocol of electronic email [10], SMTP client process a delivery request and it flows through different states. Switching between the different states is triggered by the commands and responses within the request

cycle [6]. We show how we have used its whole workflow process to dispatch its workload in various modules: evaluating function, addressing function and sending function, each of them is responsible of accomplishing specific functions. Fig. 1. By receiving the email delivery request and after the TCP(Transport Communication Protocol) connection between the servers, there is the evaluation of email accounts, where email addresses accounts are validated and grouped to host, the next is communication with DNS(Domain Name Server)to get the IP address of the email account that have to be considered for the delivering; once the IP address have been accorded, it comes a part of various command of communication between email servers in order to deliver email to their destinations. In all the process the errors that could appear are handled by error handler Fig. 1.

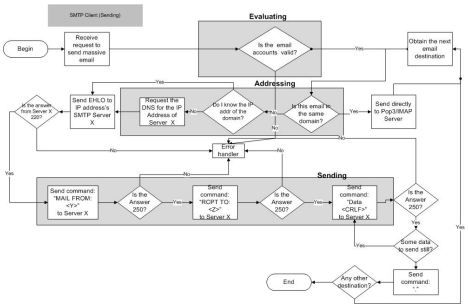

Fig. 1. Workflow of SMTP, sending part of email

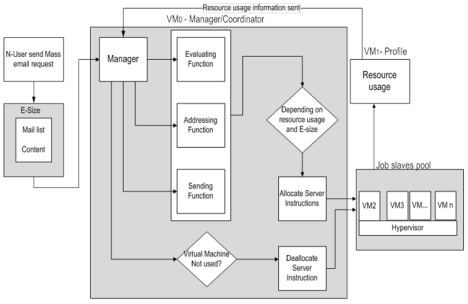

Fig. 2. System Architecture

3.2 System Architecture

The proposed approach named A Real-Time Cloud Based Model for Mass Email Delivery is a contribution to email system performance in case of mass email deliverability, also to cloud computing by using resources allocation efficiently. We present the proposed model which consists of different modules that work together to balance the workload of mass email delivery requests. it improves the performance of the email delivery by using the scalable cloud based resources that will result in minimizing the delivery time of the mass email in order to meet the SLA deadline. Fig. 2 The model is composed by the manager which is the management module in cloud computing environment.It monitors all the functions related to managing the SLA provided between the provider and the users, handling the VM allocation, load balancing and scheduling the VM allocation. It allocates the virtual server machines according to the coming workload and requires the profile or resource usage module of virtual machines. In other part, there are three different functions we stated above: evaluating function, addressing function and sending function defined in this model; each function has

task to work on, in purpose of balancing the workload of request and, depending on the resource usage and the size of the email the allocation instruction are going to be given, so that a number of VMs can be released, then, they will be the deallocation of virtual machines when there is no more use of them.

3.3 Mathematic analysis

Let i, be the number of request $i = 1, 2, 3n$ to process mass email delivery through the cloud based resource, and let sz_i be the size of email ,this size of email consists of the content and mail list which include N_i number of recipients. According to the user request SLA constraint of time, let D_i be the deadline time of sending mass email for request i, the workload of each mass email is dispatched into small possible modules: E_{ij} evaluator function, A_{ij} addressing function and S_{ij} is the sender function where i is the request number and j the domain number, the evaluating function will validate and group the emails that are going to the same domain, n is the set of available Virtual machines$VM_1, VM_2, ...VM_n$, each $VM \ni n$ will be allocated considering the workload in email lists and to the resource available. The resources have different characteristics like amount of MHz of CPU, various bytes of memory and network bandwidth resources. We assume that the request i will meet the deadline D_i if enough number of VMs n which have the available resources are allocated. However, we need to know how many VMs have to be allocated in order to meet the deadline D_i. The objective of our paper is to minimize the time delivery by using the cloud based resources, here we are considering the number of VMs with enough resource like CPU, Memory, network bandwidth, that can be used to balance the workload. Total time to send email for request i with worst case time t_i to N_i number of recipients should be inferior or equal to deadline $D_i : Tw_i \geq D_i$

$$nt_i + \frac{N_i}{n} t_i \leq D_i \tag{1}$$

Where n is the number of VMs to be allocated in order to meet the D_i, and Tw_i is the total time to send email in worst case and t_i is the worst case time unit to send email to its recipient.After evaluating(1) the deadline condition that every request must fulfill in order to finish on time provided in SLA is shown in the equation (2)

$$D_i \geq 2t_i \sqrt{N_i} \tag{2}$$

From the above equations, the challenge is to find the number of VMs that can contribute to balance the workload of massive email requests and minimize the delivery time in order to meet the deadline in SLA. From (1) we have:

$$Tw_i = nt_i + \frac{N_i}{n} t_i \leq D_i \tag{3}$$

This formula means that the worst time to send the email should not be the superior to the one of the deadline, from this equation we need to get the number of VMs n.

$$f(n) = n^2 - \frac{Di}{ti} n + Ni \leq 0 \tag{4}$$

Equation (5) Drive us to find the number of virtual machines n that can contribute and minimize the delivery time in order to meet the deadline

$$n = \frac{1}{2}\left[\frac{D_i}{t_i} \pm \sqrt{\left(\frac{D_i}{t_i}\right)^2 - 4N_i}\right] \tag{5}$$

From the above equation, the final VM number can be obtained by two solutions and we need the minimum number of VM n between those solutions that can be allocated; therefore, the final solution is the minimum n. In this case n found, is the number of VM that can be used in order to balance the load and minimize the time Tw_i to meet the deadline D_i. Real time tasks have to finish before D_i. Using the equation in the above formula, will help to be able to know n that the manager module can use to allocate and send mass email in timeliness manner, which will contribute in maximizing the delivery of mass email.

4 Performance evaluation

In this section we simulate a number of different mass email delivery requests to find the minimum number of VM that can contribute for delivery and meet the deadline time. We consider ten different requests i to send mass email to a different number of recipients N_i for a number ranging from (N_i=2000 to 20000). Different scenarios have been evaluated and our approach shows significant improvements. In order to demonstrate the performance, we compare the time taken by our approach versus the deadline time provided in different request i; in the result, all the deadlines are met considering that the mass email delivering task finish even before the deadline, Fig3. Our approach can not only meet the deadline but also accomplish the task within an average of 45% of the time determined in the SLA. In addition, in second comparison our approach shows good performance where it reduce at 97% the time that taken by the

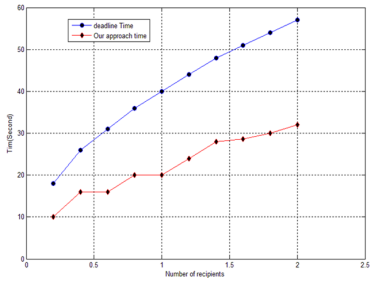

Fig. 3. the performance of delivering mass email to meet the deadline time

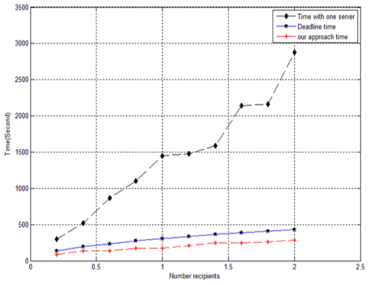

Fig. 4. the performance of delivering mass email to meet the deadline time

delivering time with one mail server. Fig4. The experiment shows that our approach performs well to maximize the deliverability by reducing the time that could be taken by using only one mail server.

5 Conclusion

In this work we proposed the Real-Time Cloud Based Model for Mass Email Delivery that contribute in maximizing the deliverability of mass email by using the scalable cloud based resource and meet the deadline requirement provided in the SLA.

Acknowledgments. This work was supported a grant from the NIPA(National IT Industry Promotion Agency) in 2012 Global IT Talents Program and the MKE(The Ministry of Knowledge Economy), Korea, under the ITRC(Information Technology Research Center) support program supervised by the NIPA(National IT Industry Promotion Agency) (NIPA-2012-(H0301-12-1004)

References

1. Furht, B., Escalante, A.: Handbook of cloud computing. Springer-Verlag New York Inc (2010)
2. Buyya, R., Yeo, C., Venugopal, S.: Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities. In: High Performance Computing and Communications, 2008. HPCC'08. 10th IEEE International Conference on, Ieee (2008) 5–13
3. Chieu, T., Mohindra, A., Karve, A., Segal, A.: Dynamic scaling of web applications in a virtualized cloud computing environment. In: e-Business Engineering, 2009. ICEBE'09. IEEE International Conference on, Ieee (2009) 281–286
4. Bertolotti, L., Calzarossa, M.: Models of mail server workloads. Performance Evaluation **46**(2) (2001) 65–76
5. Kucherawy, M.: E-mail system with methodology for accelerating mass mailings (June 6 2006) US Patent 7,058,687.
6. Haggag, M.: Enhanced delivery through a smart smtp client. International Journal on Intelligent Cooperative Information **4**(1) (2004)
7. Al Bazar, H., et al.: A new approach to enhance e-mail performance through smtp protocol. (2008)
8. Charzinski, J.: Observations in e-mail performance. In: ITC Specialist Seminar, Würzburg, Germany. (2002) 133–142
9. Oh, F., Kim, S., Eom, H., Yeom, H., Park, J., Lee, Y.: A scalable and adaptive cloud-based message brokering service. In: Advanced Communication Technology (ICACT), 2011 13th International Conference on, IEEE (2011) 498–501
10. Postel, J.: Simple mail transfer protocol. Information Sciences (1982)