Comparative Study of various Cloud Algorithms using Edge Cloud SIM

Ishita Arora[2], S. Beski Prabaharan[2]

[1]*Chitkara University, Punjab ,*
[2]*Galgotias University, Greater Noida*

Abstract

Cloud computing is the on-demand availability of computer resources, especially data storage and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet. It has various challenges, to solve the challenges, new technology is introduced by transferring the cloud into an edge server. For making massive changes such as reduced latency into the current system of cloud computing by introducing the latest automation. And this is time that we know which will be the most effective algorithm as there are quite a few of them are currently being studied. So as to find an algorithm that works the best for offloading different tasks. There are already many simulators that can simulate network activity at various levels comminute. Starting with current simulators, a significant programming effort is required to create a simulation tool that meets all requirements. Designing a new edge computing tool, on the other hand, will provide several technological challenges. A new simulator tool called EdgeCloudSim is particularly intended for edge computing frameworks to help overcome these hurdles. It satisfies the demand for edge computing, which is dependent on both computational and networking factors. There are numerous aspects to estimate. Edge computing using EdgeCloudSim. In this paper will be observing different algorithms already present to find the best approach for future use in the study of Edge Cloud Computing and for practical uses

1. Introduction

Edge computing covers a broad spectrum of concepts. The purpose of edge computing is getting assistance in offloading tasks from a neighboring edge server in close vicinity to the client for time-sensitive activities and mobile computing, edge computing offers a clear benefit. Accomplishing the whole task or some proportion of the task on the edge server will be remarkable precedence for the resource-restricted mobile devices.

ACI'22: Workshop on Advances in Computation Intelligence, its Concepts & Applications at ISIC 2022, May 17-19, Savannah, United States

EMAIL: ishitaaaroraaa@gmail.com (I.Arora);
b.prabharan@jainuniversity.ac.in (S.B.Prabaharan);
ORCID: 0000-0002-8011-9786 (S.B.Prabaharan);

Whereas, edge computing also provides little transmission delay as the clients do not have to enter WAN (Wide Area Network). New Schemes are being devised by the researches in the edge computing for the execution of the innovative approaches in the field of edge-cloud computing with technical characteristics that are important as a result, the researchers had to employ a realistic cloud environment to test their methods. However, owing to the constraints, using a genuine cloud environment would not be an efficient or cost-effective solution. Edge cloud can potentially be used in the field of edge computing to examine each and every diverse kind of issue. And this solution of the problems can be done in any timeframe. Changing the position where the task needs to be offloaded will make reduced time for the task which is it can narrow the time scale because the edge server does this work. Estimating the innovative design within a broad timeframe can be done using EdgeCloudSim.

IT (Information Technology) section has grown well in recent years. As the resources are extremely afar from the IoT (Internet of Things) devices. Data that is supposed to be exported to cloud should be in real time if not will further increase the latency. But so as to resolve the limitations of the cloud computing a new paradigm has come into the scene which is edge computing which further provides transportation of data in real-time with storage capabilities at the edge computing network which is on close proximity to the IoT devices. Due to decrease in the latency gaps, the offloading tasks can be completed in real-time and edge server also provides better streaming services such as Amazon Prime as they are bandwidth-intensive.

Fuzzy Logic (FL) is a method devised to reason the assigning of the offloading task to a particular server as it has human reasoning in it. Fuzzy logic further deals with numerous input and output variables. The basic idea behind the extraction of the problem to a certain level so that it can be recognized is what fuzzy logic does Fuzzy logic is modeled in such a way that it can indistinct all the details which are more relevant. Therefore, for a multi-objective optimization problem with multiple parameters, this is the most suitable method. It is often effortlessly accepting the conditions of the system providing flexibility to the system.

In this paper will we go through all the cloud computing algorithms which provide as an effective solution. We will be comparing the algorithm on different basis to extract the best algorithm for future use while choosing the best simulators for this survey.

2. Literature Survey

In the following subgroups, studies are run on task offloading in Edge-Cloud computing, Workload Orchestrator, the applications are served in edge or cloud simulations already in use where the way on how real time access of the services can be provided, the effectiveness of fuzzy logic are reviewed and discussed.

Due to the increasing admiration of this paradigm many simulators are being introduced [2]. Computational models are provided for the unrealistic cloud surroundings by the simulators. CloudSim [1], GreenCloud [3], and iCanCloud [4] are three prominent cloud simulators. CloudSim was created with Infrastructure-as-a-Service cloud computing environments in mind [1]. It allows you to simulate cloud components such as data centers, hosts, and virtual machines. Edge computing situations are distinct from traditional computing scenarios as these tasks do not need much time. Mobile devices offload tasks to the sting server, which are often handled at sub-second periods. Because the jobs are so little, generating a new VM for each request is inefficient. Green Cloud is an extension of NS2[3]. GreenCloud can implement the whole TCP/IP protocol reference model because it is an extension of NS2. Implementing the complete TCP/IP protocol reference model allows the energy modeling on network switches and connections. However, this adds cost to the system in terms of memory use and, as a result, simulation time, which is an impediment for GreenCloud.

The primary goals of iCanCloud are performance and scalability, in order to allow simultaneous simulation runs. It provides simulation of the computational elements of virtualized cloud systems, much as the other simulators. Edge computing solutions feature different user characteristics and hence topological properties in comparison with cloud systems. Cloud computer simulations address mobility, but users of such computing systems are mobile. In these simulations, the end-to-end transmission latency is generally regarded as a static number. But the connection between mobile users and therefore edge devices require wireless interfaces which require further network modeling. In addition, when considering IoT devices, apps used in edge computing also have different features.

Wang et al. [14] proposed in his work about the computational and communications are intended only for all the homogeneous resources [15], presented a method which aims to decrease the communication and computational delays which can be done as we migrate the VM to an unloaded server.

A priority-based facility that precedence according to the limit is constructed by Azizi [16] which is why nearest deadlines should be scheduled first. Their assessment does not justify the problem when the system is working on many IoT devices with the help of different resources. This work basically considers computational and communication demands. Sonmez et al. [12] this proposal includes Fuzzy logic, as it focuses more on the delay factor and on needs for computing and communication. In this approach, task offloading will potentially target the latency-sensitive applications whereas this does not include resource heterogeneity. Roy et al. [18] this method is aimed at lowering latency and load balancing across several edge nodes during execution. It proposed strategy resource heterogeneity is taken into account as it helps allocate tasks to an appropriate edge node according to the need of the tasks. In the last several years, there is much attention it was given to resource heterogeneity. Nan et al. [17] Lyapunov techniques have been proposed that assure the accessibility of the edge resources and thereby guarantee that the job is processed restricted. Whereas, this proposed technique does not include the impacts from the latency-sensitive applications. But it solves all the problems the algorithm aims to do as it reduces the cost for renting the cloud services by using edge resources.

Orchestration is a new concept in edge computing that is overly broad of a concept that has been compromised on several levels. An edge orchestrator will certainly also be used to serve a limited scope. Hegyi et al. proposed the method of solving the application deployment problem on the edge using application orchestration. [5]. Karagiannis et al. In this system the edge cloud orchestrator decide which edge server should be given which application [6]. This system takes into consideration some parameters such as network latency or remote server capabilities. And the workload orchestration is one that potentially decides where the task will take place [7].

Hosseini et al. [9] proposed a method in which they used the fuzzy logic approach as it helps get the average of the parameters. Moreover, the offloading ratio is calculated using the 2 parameters which are link delay and Signal-to –Noice Ratio (SNR). It operates on different layers as it also focuses on different decisions. Fuzzy logic is one of the most effective methods. Rathore et al. Used fuzzy sets to make an algorithm for security service [10]. Uses of Fuzzy logic gain the trust of the vehicle for the vehicular ad-hoc networks. [11]. in the last few years, fuzzy logic and workload orchestrator has been studied. Flores et al. approached a fuzzy-based approach used for code offloading which basically means that this approach uses fuzzy logic to decide whether offloading of the task should be done on a mobile device or the cloud server. [8].

3. Edge Cloud Sim

A modular architecture will be provided by EdgeCloudSim which will potentially provide support to Model mobility Wi-Fi, WAN, and equipment. EgdeCloudSim has five main accessible modules - Core, Network, Load Generator, Mobility and Edge Orchestration. The Individual module accommodates default implementation which can effortlessly be expanded that will essentially help at prototyping fast which may reduce a lot of effort.

1. Core Stimulation Module –in this module, the original file will load and perform the edge computing scenario.
2. The Edge Orchestrator Module - all the information collected by other modules are used in this module, so as to decide where and how can we handle client requests.
3. The Networking Module - The basic working of this module is more likely to be a single model server queue. The transmission delay in WAN and WLAN for both uploading and downloading data is considerably handled in this module.
4. Modular mobility - Edge device locations and customers are all managed by this mobility module. The focus of CloudSim is mostly using the concepts of traditional cloud framework never considers mobility.
5. Load Generator Module - Generation of different tasks with the available configuration is done in this module. According to Poisson distribution, the jobs are all created using the active/idle model defined by generating pattern.

The main function of a simulator is to compare each model's performance currently present takes into account the several facets of the models. Three configuration files are used by EdgeCloudSim to reduce the Programming work is reduced, and the model is more configurable. The first file employs key-value pairs as parameters such as simulation time and device count. The second file describes about the applications of XML descriptions in simulations. In the load generator model, the characteristics of the applications are used. The third file- in the XML format the location of the edge data centers and credentials of the edge devices are provided. EdgeCloudSim allows its users to use individual simulators, which simplifies the setup and execution of experiments.

3.1. Extensibility

Extensibility allows developers an environment that can be customized according to the demands of the users it also allows developers to change behavior without substituting the original code. When the extensibility is low, it will become acquainted with the specifics of the current architecture. The creators do not intend to utilize the currently accessible tool. EdgeCloudSim helps us to make new modules by integrating them for their personnel use by factory patterns which essentially helps to combine the components. As the figure 1, the concrete implementation is provided as the scenario factory class also handles the creation logic.

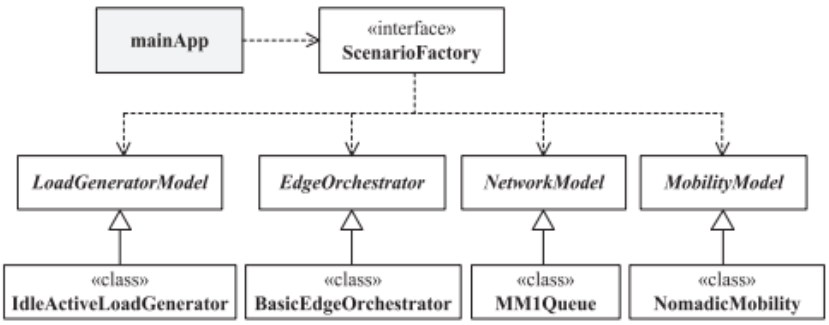


Figure 1: Factory pattern for simulation scenario [13].

Personal modules about the simulator can be used. This class will be help in modelling our custom modules.

In the single-tier architecture, the offloading of the devices is only limited to the closest edge datacenter. This further leads to congestion at the most attractive places (which means that a greater number of users are present). That leads to more task failure in the failure of the single-tier architecture in places with a greater number of users. Moreover, the service time keeps on increasing due to the congestion in that area. Because the various tasks may be offloaded to cloud servers, two-tier designs produce better outcomes than single-tier structures. In this approach, a probabilistic method is introduced by Sonmez et al., which is further used to decide offloading tasks which should be allocated to the cloud servers. The edge orchestrator helps the two-tier architecture to route offloading activities to any of the edge data centers in the network alike.

4. Fuzzy Logic Concept

4.1. Fuzzy Variables

The inputs are defined by the fuzzy system This concept's inputs include virtual machine usage, task length, the quantity of data to be transmitted for each job, and delay sensitivity.

1. WAN Bandwidth- The WAN Bandwidth is an essential indication when offloading work to the cloud server.
2. Task Length- The length of the task influences the time required to complete it.
3. Delay Sensitivity of Task- Taking longer time to execute a task is a reason for delay sensitivity.
4. VM Utilization- The information regarding the edge server's computational capacity at that point of time is determined by the VM utilization figure.If the threshold utilization if the number of edge servers exceeds the threshold level, the edge server is deemed crowded.

4.2. Fuzzification

At this stage, the all the required values by the fuzzifier will be taken as numerical input from incoming tasks. Then all the values will be assigned to the predefined linguistic variable function.

4.3. Fuzzy-Rule Base

A set of fuzzy rules is built like human reasoning is present.All the possible situations of all the applications and system congestion with a simple if-then rule. For defining the overall system performance these rules play a particularly significant role. All the outputs of the Fuzzy Rule-Base are further used in the fuzzification stage. The major goal of this is to provide low latency for applications by reducing data transfer from IoT devices to the cloud and eliminating nodes.

4.4. Defuzzification

The process of conversion of fuzzy output to crisp value from the output from the inference engine.

5. Comparison Between Different Approaches

Somme et al. [12] proposed the process of offloading, consideration the application tasks requirements and resource utilization. However, this approach uses homogeneous resources for determining where the offloading task will take place local edge or the cloud. They used a two-stage fuzzy logic to reduce the complexity of the operation.

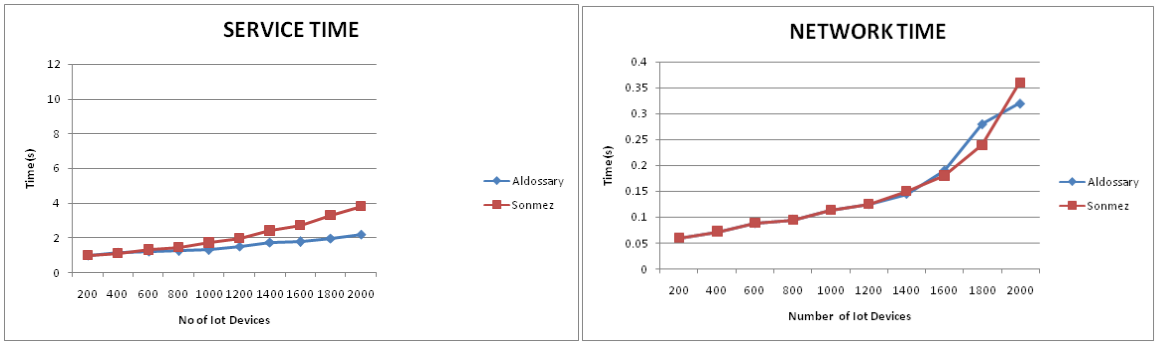
Aldossary et al. [13] proposed an approach that considers the heterogeneity of resources. Furthermore, the suggested technique assists the resource management inside the Edge-Cloud system in scheduling offloading activities in order to reduce overall service time and increase the efficiency of Edge-Cloud resources.

6. Analysis

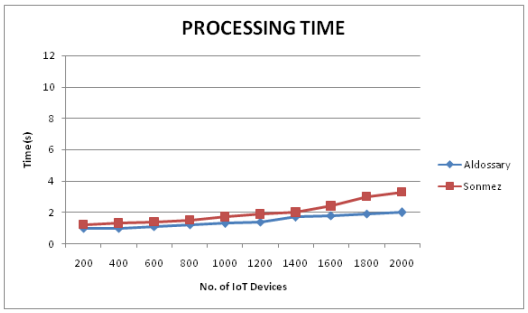
We will be considering three aspects, in which we are going to analyze and get the most efficient Cloud-Edge model for future proficiency. The three aspects are service time, average processing delay, and average network delay. The processing duration of each task will be determined by the processing, which might be one of the following: 1) the general service time at the local edge consists of WLAN time and processing time. 2) WLAN time and processing time are considered to be Collaborative Edge and general service time. 3) In the cloud, general service time includes WLAN/MAN/WAN time as well as processing time. We take the average for all jobs in each scenario, which is supported by the subsequent equation:

$$\text{Service Time} = \sum T_{\text{processing time}} + \sum T_{\text{network time/No. Of Tasks}} \quad (1)$$

Since Service time is an important part of IoT offloading Tasks. In the figure below we made a comparison of two different algorithms with no. of IoT devices. From the figure, we can evidently see that till the time system is unloaded all the algorithms behave the same way. Whereas, when we increase the no of IoT devices in the algorithm the Aldossary approach will be steady as compared to all the Sonmez approach.



(a) Service Time Graph (b) Network Time Graph



(c) Processing Time Graph

Figure 2: Graphs formulated for (a)Service Time (b) Network Time (c) Processing Time using EdgeCloudSim [13].

In Figure 2(a), it is observed that the results are differed with one another, when the system gets overloaded. Both the algorithms do have the same service time before the system gets overloaded.

From the Figure 2(b), we can see that whenever the total number of IoT devices is less than 1400. These 2 algorithms possess the same processing time. However, the Aldossary approach maintains its stability and surpasses the Sonmez approach.

7. Limitation And Future Work

Due to restricted amounts of time could not study more technologies coming in the edge computing paradigm due to time constraints. As more and more tools are been developed so as to reduce the limitations of the already developed models during offloading of a task to make it accessible for the clients and put less pressure on the server for better performance. For the future would like to dig deep in this ocean of knowledge and would like to take part in the development of new technologies.

8. Conclusion

As the trend of the new novel edge computing paradigm is increasing the need for a simulation tool that can estimate the proposed architecture The researchers tend to do cost-cutting by using simulators due to very high cost of using real cloud paradigm. EdgeCloudSim then addresses this demand as it offers a Mobility Model, a Network Link Model, and an Edge Server Model for evaluating the proposed approach by the researchers based on edge computing.

Edge computing ensures that more complicated offloading activities are not performed on mobile devices, which have limited storage space and battery life. The goal of Edge Cloud Computing is to further increase the responsiveness of mobile devices using the microdata centers nearby. An Edge Orchestrator approach is proposed by Sonmez to manage the edge resources and further increase the performance of the application offloading tasks.

From the survey in this paper, we can conclude that the approach proposed by Aldossary takes resource heterogeneity into account whose main reason is to reduce the latency in performing the task. Moreover, we compared the 2 approaches using the EdgeCloudSim, a simulation program, was used to compare the two techniques in an edge-cloud context. From this, we can clearly see that we can Further use Fuzzy Logic as it is can handle uncertainty in any system just by dealing with variables and which can further be represented by if-then rules.

References

[1] Calheiros RN , Ranjan R , Beloglazov A , De Rose CAF, Buyya R., “CloudSim: a toolkit for simulation of cloud computing environments and evaluation of resource provisioning algorithms”. Softw Pract Exp. 2011;41(1):23-50.

[2] James Byrne, Sergej Svorobej, Konstantinos M. Giannoutakis, Dimitrios Tzovaras , P. J. Byrne, Per-Olov Östberg, Anna Gourinovitch and Theo Lynn et al., “A review of cloud computing simulation platforms and related environments”, Paper presented at: 7th International Conference on Cloud Computing and Services Science; 2017; Porto, Portugal.

[3] Dzmitry Kliazovich · Pascal Bouvry · Samee Ullah Khan, et al. "GreenCloud: a packet-level simulator of energy-aware cloud computing data centers". J Supercomput DOI 10.1007/s11227-010-0504-1

[4] Alberto Núñez · Jose L. Vázquez-Poletti · Agustin C. Caminero · Gabriel G. Castañé ·Jesus Carretero · Ignacio M. Llorente, et al., "iCanCloud: a flexible and scalable cloud infrastructure simulator", J Grid Comput. 2012;10(1):185-209.

[5] Attila Hegyi, Hannu Flinck, Istvan Ketyko, Pekka Kuure, Csaba Nemes and Lajos Pinter,et al. "Application orchestration in mobile edge cloud: Placing of iot applications to the edge", in 2016 IEEE 1st International Workshops on Foundations and Applications of Self* Systems (FAS*W), Sept 2016, pp. 230–235.

[6] V. Karagiannis and A. Papageorgiou, "Network-integrated edge computing orchestrator for application placement," in 2017 13th International Conference on Network and Service Management (CNSM), Nov 2017, pp. 1–5.

[7] H. Flores, X. Su, V. Kostakos, A. Y. Ding, P. Nurmi, S. Tarkoma, P. Hui, and Y. Li, et al. "Large-scale offloading in the internet of things", March 2017, pp. 479–484.

[8] Huber Flores and Satish Sriram, et al., "Adaptive code offloading for mobile cloud applications: Exploiting fuzzy sets and evidence-based learning", in Proceeding of the Fourth ACM Workshop on Mobile Cloud Computing and Services, 2013.

[9] S. M. Hosseini, M. Kazeminia, M. Mehrjoo, and S. M. Barakati, et al. "Fuzzy logic based mobile data offloading", 2015, 23rd Iranian Conference on Electrical Engineering

[10] Shailendra Rathore, Pradip Kumar Sharma, Arun Kumar Sangaiah and James J. Park et al., "A hesitant fuzzy based security approach for fog and mobile-edge computing", Digital Object Identifier : 11.1109/ACCESS.2017.2774837

[11] Seyed Ahmad Soleymani, Abdul Hanan Abdullah, Mahdi Zareei, Mohammad Hossein Anisi, Cesar Vargas-Rosales, Muhammad Khurram Khan and Shidrokh Goudarzi, et al., "A secure trust model based on fuzzy logic in vehicular ad hoc networks with fog computing",2017, Digital Object Identifier 10.1109/ACCESS.2017.2733225

[12] Sonmez Cagatay, Ozgovde Atay, Ersoy Cem, et al., "Fuzzy workload orchestration for edge computing", IEEE Transactions on Network and Service Management (Volume:16, Issue: 2, June 2019), **DOI:** 10.1109/TNSM.2019.2901346

[13] Jaber Almutairi & Mohammad Aldossary, et al., "A novel approach for IoT tasks offloading in edge-cloud environments", J *Cloud Comp* **10,** 28 (2021). https://doi.org/10.1186/s13677-021-00243-9.

[14] Wang Shiqiang, Zafer Murtaza, Leung KK (2017), et al., "Online placement of multi-component applications in edge computing environments", IEEE Access 5:2514–2533.

[15] Tiago Gama Rodrigues, Katsuya Suto, Hiroki Nishiyama, Nei Kato, et al., "Hybrid method for minimizing service delay in edge cloud computing through VM migration and transmission power control", IEEE Trans Comput 66(5):810–819.2019

[16] Hiwa Omer Hassan, Sadoon Azizi1, Mohammad Shojafar, et al., " Priority, network and energy-aware placement of IoT-based application services in fog-cloud environments", IET Communications 14(13):2117–2129,2020.

[17] Yucen Nan, Wei Li, Wei Bao, Flavia C. Delicato, Paulo F. Pires, Albert Y. Zomaya, et al., "Cost-effective processing for delay-sensitive applications in cloud of things systems", In: 2016 IEEE

15th International Symposium on Network Computing and Applications (NCA), 162–169.. IEEE, Cambridge,2016.

[18] Deepsubhra Guha Roy, Debashis De, Anwesha Mukherjee, Rajkumar Buyya (2017), et al., "Application-aware cloudlet selection for computation offloading in multi-cloudlet environment", J Supercomput 73(4):1672–1690, DOI 10.1007/s11227-016-1872-y.

[19] Mandal, S., Khan, D. A., & Jain, S. (2021). Cloud-based zero trust access control policy:an approach to support work-from-home driven by COVID-19 pandemic. New Generation Computing, 39(3), 599-622.

[20] S. Beski Prabaharan, et. al., "Metaheuristic Technique based Dynamic and Energy Efficient Routing in MANET", International Journal of Innovative Technology and Exploring Engineering,(Nov 2019). ISSN:2278-3075, Volume-9 Issue-1, November 2019.