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An Improved Resource Utilization System for Fog Computing Environment

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***Abstract*-**Fog computing has expanded the horizons of cloud computing services near to the users. Firstly the IoT devices were used exclusively VMs but this results in high energy consumption. At the cloud layer the problem of resource utilization has been practised. But at the Fog layer the problem of Overutilization and Underutilization of resources occur. So, to overcome this problem we are designing a model for resource utilization that achieves best result for both service provider and end users. The current system incorporates an adaptive way for the utilization of resources at the cloud layer. But at the Fog layer the adaptive way of cloud layer are not being practised. The Fog layer allows pre-processing of requests but have limited resources. In order to overcome this problem, this paper, proposes a mechanism for improving the resource utilization at fog computing layer. Our proposed model is not only beneficial for the fog service providers in terms of good resource utilization but also equally beneficial for the fog service users in terms of good response time.

Keywords*-Fog Computing, Internet of things (IoT), Virtual Machine (VM), Quality of Service (QoS), Data Centers (DC)*

I. INTRODUCTION

Fog computing is an expansion of cloud computing services near to the vicinity of users. The purpose of fog layer is to minimize latency and overcrowding of network. It is a focus of the current research. Although the resources and services offered by cloud and fog are same, but the latter is categorized by low latency and geographically circulated nodes for supporting movement and interaction at real-time.

The extension of cloud computing has become possible due to Fog computing. Cloud computing offers data, computation, storage, and application services for the end-user.

RESOURCE UTILIZATION MECHANISM IN FOG COMPUTING ENVIRONMENT

Lot of the researches have implemented resource utilization mechanisms for Cloud Computing and Grid Computing environments. The resource utilization in fog computing is to manage the resources to increase the efficiency. [6]Thus there is need of fog or edge computing. But there is a problem of limited resources in fog computing and we have to manage the resources efficiently. In this paper we are representing that how we are managing the resource utilization in fog computing environment.

The organization of the paper is as follows, Section I describes the introduction of the fog computing, Section II contain the information about the background or related work on the resource utilization in fog computing, Section III provide the details about the system model used in this paper, Section IV contain the simulation setup in which the tool used and the configuration of the model is defined, Section V shows the results, Section VI shows the conclusion respectively.

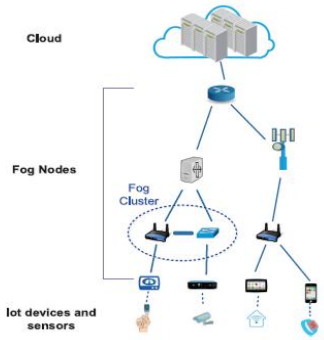

Fig.1 Organization of Fog [6]

II. RELATED WORK

The resource utilization has been considered one vital factor to amplify the working efficiency of the fog layer. The distribution of the workload has increased the resource utilization ratio. This ratio leads to increment of overall performance to achieve the maximum user's satisfaction. Hence the maximum utilization of resource can be achieved.

Numerous researches are there in the field of resource utilization in Fog Computing Environment in which some have been discussed below:
Xiaolong Xu et al. [1] has proposed a method for load balancing in fog environment. The name of the method is DRAM and its main aim is to achieve high load balancing in the fog and the cloud computing.

Weiwei Lin et al. [2] introduced the resource allocation at the appliance level, rather than finding out the way to match the physical resources to virtual resources to get good resource utilization in cloud computing environment. The proposed scheme is implemented on Cloud Sim, and the results shows that the implemented model improve resource utilization and reduce the user usage cost.

Usha et al. [3] proposed that this study focuses on the recent research works undertaken within the resource management space of Fog computing conjointly also compares various edge computing paradigms. At the end, other issues that are left as future challenges are highlighted.

In Fog computing environment the resource management is an important factor for better utilization of available resources for IoT applications.

Hu et al. [4] designed a architecture to compare it with the normal cloud computing, and a appliance case within the fog computing atmosphere was suggest.

Yousefpour et al. [5] proposed a mechanism which minimizes the delay for devices. They develop associate degree to guage the policy and show however the projected framework helps to cut back IoT service delay.

Mahmud et al. [6] proposed a policy to maintain the Quality of Service (QoS) to satisfy service delivery time and to maximize the usage of the resources.

Maiti et al. [7] presented a model in fog computing which reduces service latency and energy consumption. The future work also involves the designing of the architecture based on efficient resource utilization.

Khakimov et al. [8] emulated the operations on the network nodes below the fog computing conditions. Fog computing is also the key solution to avoid the ultra-low latency
Kapsalis et al. [9] presents a fog computing architecture that diverges from the basic level to centralized fog model which also contains a cooperative model.

Salman et al. [10] proposed a model for the combination of the mobile devices and software defined networks.

Aazam et al. [11] provide a model for resource management in the fog computing. They mainly focus on the resources by predicting the algorithm model.

C. Prazeres et al. [12] introduced the term Fog of Things (FoT) which means that IoT services are provided near to the edge of a network which also reduces the delay.
Hong [13] proposed a fog computing architecture that implements a real testbed and test it among the diverse usage scenarios. They study the usage scenarios and optimizes the problem.

Chen et al. [14] developed a model for the cloud-fog layer. In which they mainly focus to manage the resources so that the quality of service can be maintained easily.

Akintoye et al. [15] formulate the task allocation in a single cloud/fog computing environment through a Genetic Algorithm. At last, the experiments ardole out the results which improves the Quality-of-Service in the cloud/fog computing.

Cheol-Ho Hong et al. [16] proposed that technical challenges to managing the limited resources in fog/edge computing have been addressed to a high degree. However, a few challenges still remain to be made to improve resource management in terms of the capabilities and performance of fog/edge computing.

III. SYSTEM MODEL

The proposed model consist of the following entities:-

- IOT Devices
- Broker
- Fog Layer
- Cloud Layer

★ **IOT Devices:-**
IoT devices are the devices which connect wirelessly through a network and which can easily transmit the data. The IoT devices can be monitored and controlled remotely. The examples of the devices are wireless sensors, softwares etc.

★ **Broker:-**
Service broker is a computing service device that works as a third party between the end users and service provider and it performs the task of the scheduler. It also manage the allocation of users' request to right DC(s) [17]. The broker act as a scheduler between the IoT devices and the Fog layer. The main task of a broker is to check the VM free for an IoT device. If all the VMs are busy than the request is added in the waiting queue otherwise if a VM is free than a VM is allocated to an IoT device. If an IoT device gets a VM than the

request is passed to the Fog layer for processing and if a VM is not free than an IoT device waits for some time until a VM gets free.

★ **Fog Layer:-**

Fog computing is a distribution of computing that connects the cloud layer data centers and the IoT devices. The fog computing environment infers infrastructure as well as provide platform to run the software services. [18]. Fog computing is an expansion of cloud computing services near to the vicinity of users. The purpose of fog layer is to minimize latency and overcrowding of network.

★ **Cloud Layer:-**

In this work, we assume that all the requests need to be satisfied at Fog layer .So, this work is limited to the IoT devices and the Fog layer.

The Fog layer consist of two sub- entities that are:-

- **Work Load Analyzer**
- **Virtual Machine**

1. **Work Load Analyzer:-**

It checks the request arrival rate and service rate per interval. Whereas, the estimation of the interval of two is an important parameter.

2. Virtual Machine:-

A virtual machine (VM) is an emulation of a computing system. Virtual machines square measure supported laptop architectures and supply practicality of a physical laptop. Their implementations might involve specialized hardware, software, or a mixture.

This section describes the proposed algorithm that is designed for resource utilization system for fog computing environment.

The algorithm is stated as:-

RESOURCE(s, λ, μ)

1. temp = s
2. ρ = λ/(temp* μ)
3. U = ρ *100
4. if(U > max)
5. temp = temp+1.
6. ρ = λ/(temp* μ)
7. U = ρ *100
8. end if
9. else
10. if(U < min)
11. temp = temp-1
12. ρ = λ/(temp* μ)
13. U = ρ *100
14. end if
15. end else
16. return temp
17. end resource algorithm

Where, s denotes number of running virtual machines, U denotes the utilization, λ represents the require arrival rate, μ denotes the require service rate, max value denotes the maximum value of threshold utilization which is set default as 80 and min value represents the minimum value of threshold utilization which is set default as 40.

The below flowchart shows the working of the proposed model. The flowchart shows that how an IoT device requests the broker to get a VM. The broker checks for the free VM if all VMs are busy than the request is added in the waiting queue. If an IoT device gets a VM free than its request is send to the Fog layer for processing. The Fog layer has some entities that are workload analyzer and Virtual machines.

The figure is shown as:-

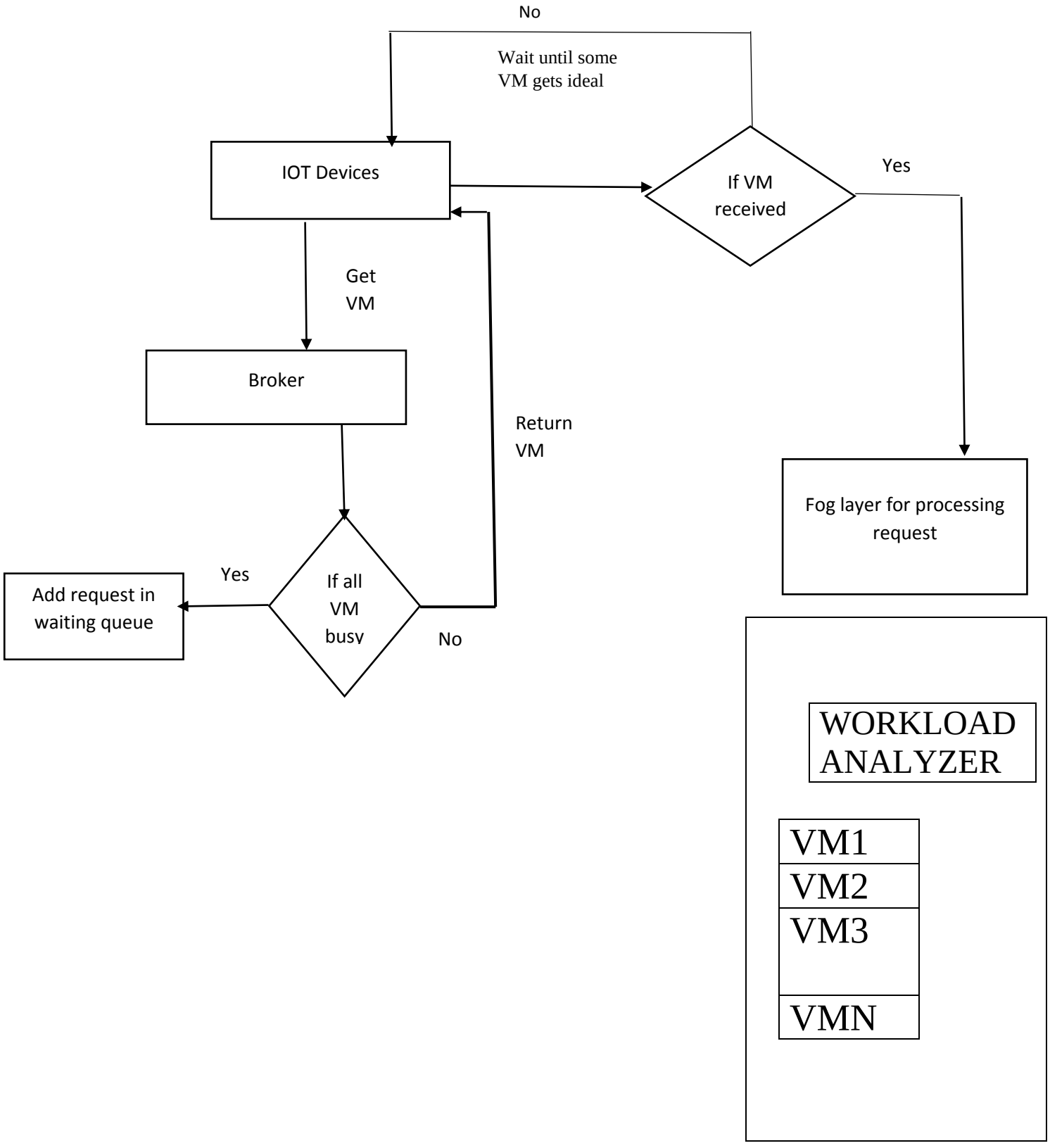

Fig. 2 working of the proposed model

IV. SIMULATION SCENARIO

- **Tool Used:-CLOUDSIM**

CloudSim is a tool that is used to model and simulate the cloud computing infrastructures and services. This software is open source and is widely used in cloud simulators in the research and academia. It is written in Java language.

- **Configuration:-**

The proposed simulated model is consists of one data center with 50 hosts and octa core CPU which is equipped with 16 GB of RAM whereas the configuration of the Virtual machines is 2.5 GHz with single core CPU equipped with 2GB of RAM. They follow space shared policy which means that in this the resources are not shared among the processes. A process owns the virtual machine until it finishes its execution. It minimizes the free RAM according to the number of processing elements.

We simulated the scenario for ten hours where request arrival rate is normally distributed.
During the peak hours, the minimum requests arrival rate is 2 per minute and maximum request arrival rate is 10 per minute. However, during the low request hour's minimum request arrival rate is 2 per minute and maximum request arrival rate is 5 per minute. The total number of requests during the complete 10 hours of simulation is 2409. We kept each request size as 30,000 MIs (Million instructions). The input and output data of request is kept as 1000 Kbs.

We compared the proposed model with fixed VMs provisional schemes.

V. RESULTS AND ANALYSIS

This section shows the detailed comparative analysis of the proposed system. We compared the proposed system with the fixed virtual machine provisioning systems.

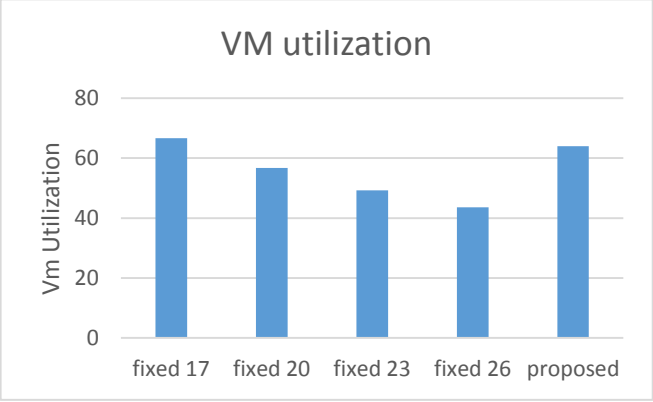

Fig 3. A graph for virtual machine utilization

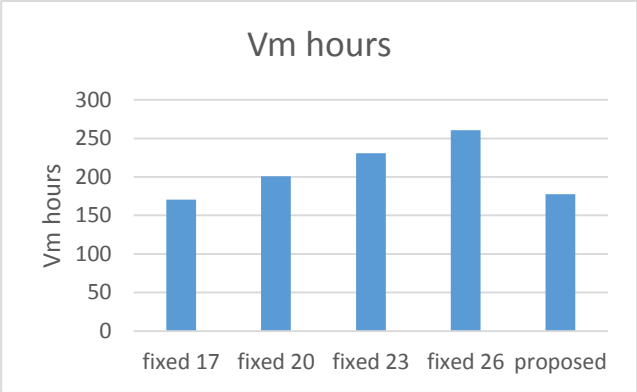

Fig 4. A graph for virtual machine Hours

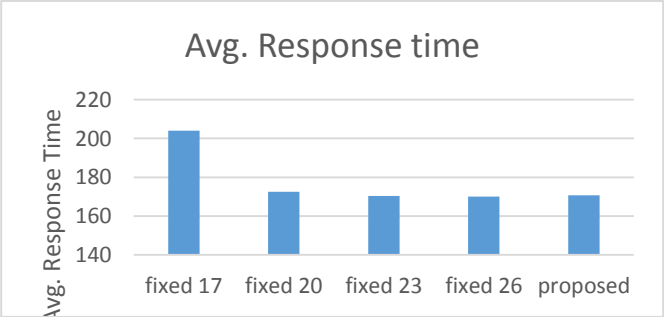

Fig 5. A graph for Average Response Time

The system with fixed 17 result in best utilization rate with highest response time. At the other extreme the system with fixed 26 results in least utilization rate with best response time. The proposed model achieves utilization rate nearly to fixed 17 and the average response time near to fixed 26.The proposed model is best for both service provider and service user. We also estimated VM hours in our work for all of the system. Fig 4. Depicts the proposed system spans VM hours near to the fixed 17 system. Such system are beneficial for data centers as this system reduces energy consumption. In addition such systems can be used by SaaS provider for maintain the VM releasing cost.

VI. CONCLUSION

In our paper, we proposed a model that manage the resource utilization mechanism. Depending upon the number of service users it maximizes or minimizes the virtual machines. According to which the best utilization rate and response time is achieved. To achieve this goal the broker is placed between the user and the edge devices. The main aim of the broker is to manage the resources efficiently and the broker is working as a scheduler in our proposed mechanism.

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