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A ZONE TIME BASED VEHICULAR AD-HOC CLOUD NETWORK SERVICES MANAGEMENT SYSTEM

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ABSTRACT

Vehicular Ad-hoc Networks (VANET) is a network infrastructure that provides the communications among vehicles and have many Characteristics including reducing congestion, minimizing accidents, reducing fuel consumptions etc. The concept of cloud computing basically relies on using of the idle vehicles resources and provision it for other vehicles either for free, or a user only pay for services used (e.g. memory, processing time and bandwidth etc.). Exploiting the added benefits of Cloud Computing and merging it with VANET is an advance step that requires a special designs and solutions to accommodate VANETs characteristics with the cloud concept requirements. The main problem for vehicular cloud networks is high mobility and difficult predictability in urban area, making it difficult to implement in connection and data processing, because continuous interruptions in communication lead to loss data. Therefore, in this paper, we proposed a system to manage some vehicular cloud network services to ensure all these services completed without dropped or disconnected during execution time. We adopt the concept of dynamic vehicles, which will satisfy the needs of the users. Dynamic vehicle is evaluated with respect to spending time within the zone, this time is calculated in several ways and in most cases the best vehicles participating in the service are selected depending on zone time. The proposed system is compared with the normal system. For accurate comparison, two important metrics are selected, i.e. throughput and packet delivery ratio to evaluate the two systems. The results proved that our system is more reliable and efficient than the normal system in different scenarios.

Keywords: *NS2, VANET, VCC, VCC services, Zone time.*

1. INTRODUCTION

A VANET is a set of vehicles are connected wirelessly in specific area that use the information communication between vehicles to provide best services for traffic management. These types of connections allow vehicles to share many types of information, such as safety information for preventing accidents, investigation after the accident or traffic jams. VANETs have received great attention recently by vehicles manufacturers because of the prospect of providing many solutions such as road safety, vehicle safety, traffic efficiency[1].

Different types of communication technologies associated with the automobiles have been developed so far. The latest of these technologies that have been adopted by the vehicles is the use of mobile Internet. which the vehicle is increasingly embedded in the general situation of contemporary networked digital technologies. In future, vehicles will be equipped with communications facilities, computing, sensors and the Internet service based on this step will be ubiquitous[2].

Vehicular Cloud Computing (VCC) is a new technology, which takes advantage of traditional cloud computing to create model for the drivers of VANETs. Thus, the purpose of VCC is to provide many benefits for customers in VANET, such as reducing the trip cost, decreasing traffic congestion by leading drivers for best path to destination. VCC also used to reducing accidents, minimize travel time and environmental pollution, and to ensure loss energy usage of low energy[3].

The idea of the Vehicular Cloud is to share vehicle resources to provide a specific service to the customer in cloud computing networks. These resources consist of CPU, RAM and storage unit. These components are the basis of each vehicle entering the vehicle network where the vehicles will share their spare resources for other vehicles.

In this paper, we propose a system to manage the services in the cloud computing networks that can be operated in the VANET. Our system works to manage these services between the service requester (customer) and the service provider in the vehicular cloud networks. Hence, the continuous movement in the vehicular networks, especially in the urban environment makes the implementation of cloud computing services without intermitting is more difficult. The proposed system is simulated and compared to the normal system using the NS-2 network simulator. We analyze our results by using the throughput and Packet Delivery Ratio (PDR) metrics.

2. RELATED WORKS

In [4] Mershad at. el. proposed a novel scheme calling it (CROWN) that exploits the presence of Road Side Unit (RSU) to act as cloud directories that store information about mobile cloud servers, giving a mobile cloud server the name of transportation server, or STAR. An RSU will store for each STAR the type of resources it offers, the attributes of each resource and the required price per resource unit. Hence, the RSU will form a distributed dynamic index of the locations and resources of the STAR. Furthermore, RSU will share with its neighbor RSU the information it has about STAR so that the operation area of each STAR will be maximized up to a certain limit. The proposed system includes provisions for allowing vehicles to send requests about the resources they require for the RSU. Hence, the RSU searches for the best possible STAR that can satisfy users' requests, according to the criteria specified by users (delay or cost).

In addition, CROWN includes an option for users to manually select the STARs they prefer according to their criteria.

The weakness of this scheme is the dependable on the RSU infrastructure which is not always exist and build in various environments. The system should be robust and operate in worse case situation without RUS backbone.

Sibaï, at. el. [5] introduced a service provision approach for software as a service. A VCC is formed on-demand when a customer's vehicle requests software as a service. The system models a software as a service as a VANET application that requires infrastructural resources (IaaS) to be run correctly in the network. This may be the case of road safety applications that require collecting traffic information from the network. In road safety software as a service, the required services may be sensor data. The mechanism objectives to select convenient service provider vehicles take into account the mobility of the vehicles. The mechanism is evaluated by a series of experimentations on OMNeT++ network simulator.

This paper supports a specific case study where the ambulance vehicle required knowing the situation of the accident severity. Many challenges facing this scenario as an example the redundancy of data sent by various vehicles inside the zone of accident make the scheme an inaccurate and not consistent.

In [6], Meneguette at el., proposed a cooperative and adaptive resource scheduling scheme called CARESS for the vehicular cloud. CARESS depends on SMART[7]which creates a structure to provide service and resource in the vehicular cloud. They are considered in the proposing system the vehicles have one or two available resources that can be used in the cloud. These resources are selected at random method, hence diversifying the types of available opportunities for the group of vehicles to connect. However, one of these resources will compose a service that has a high priority in the system. The other one is allocated to as normal service. The services of the allotted time are from 60 seconds for each service. CARESS also has a cache mechanism which will make them easy to search for resources in the vehicular cloud. In spite of the paper is tackling the quality of service but the intermitting time is not considering.

In all the above previous work the intermittent of the communication among vehicles in dynamic environment is not specified. Through this research we are trying to cover this gap by a scenario which the dropping the connection is mean lose services and benefits of VCC.

The rest of the paper is organized as follows: In section 3 the background of the vehicular cloud is described, in section 4, the proposed system is explained in detail. Section 5 describes the zone time calculation. In section 6, results analysis is presented in detail; finally, in section 7 represent the conclusion of this paper.

3. BACKGROUND

3.1 Vehicular Cloud Computing

VCC is a kind of mobile Cloud computing [8],defined as "A group of largely autonomous vehicles whose corporate computing, sensing, communication and physical resources can be coordinated and dynamically allocated to authorized users"[9][10].

The huge number of vehicles in parks and streets will be treated as under-utilized and plentiful computational resources, which can be used for providing public services for other users. VCC exploits the unused computing power and resources. In VCC some vehicles owners may agree to rent unused onboard resources, when these vehicles spend long hours in a parking. For example, travelers put their cars in the airport parking spaces while traveling. The airport management authority will provide computing resources from these vehicles and use it to process information center upon request.

Traffic congestion is another example of huge vehicles compute resource. The drivers in the traffic jam will agree to offer their unused vehicles resources and traffic information, which will help traffic management to execute complex simulations designed to solve traffic congestion problem by rescheduling all the city traffic lights according to best flow traffic[3].

Also vehicular cloud computing is to offer on-demand solutions for unpredictable events in a proactive fashion such as natural disaster and emergency evacuation, that is mean we don't need Pre-construction infrastructure to manage traffic [9].

3.2 Vehicular Cloud Computing Architecture

The VCC architecture consists of the following three main layers[3]:

- Inside-vehicle layer
- Communication layer
- Cloud layer

Inside-vehicle layer: In this layer, the information is collected from inside the vehicle and sent to the cloud. The inside-vehicle layer, evident from its name, this layer is located inside the vehicle and is responsible for monitoring all sensors inside the vehicle and collecting information such as driver manners' recognition, driver's health, Smartphone sensors, and inertial navigation sensors (INS)[11].

Communication layer: This layer is responsible for communication in VCC. There are two types of connections in this layer vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). In V2V connection information is exchanged between vehicles directly such as alert message in emergency situations known as Emergency Warning Messages (EWMs) created if a driver indicates the abnormal state on the street. All an unexpected action for example mechanical failure occurred in the vehicle, a warning message is sent to nearby vehicles are considers as a V2V. The second type of the Communication layer is an intermediate layer between the vehicles and the cloud include a connection V2I.This layer is responsible for exchange of data and information between vehicles, infrastructures and the cloud by using wireless networks. The V2I connection is used to increase the driver's safety level on highways by decreasing the accident, delays, and congestion by improving flow traffic, and provide

Wireless Roadside Inspection (WRI) for track vehicles automatically[12].

The cloud layer: This layer includes three sub-layers inside it: application layer, cloud infrastructure layer, and cloud platform layer. In the first sub-layer, various applications and services. The cloud infrastructure also includes two sub-layers which are cloud storage and cloud computation. Cloud storage is used to store the information that is collected by the inside-vehicle layer and storage inside it depends on the type of applications. The computation part is used to calculate and process the computational tasks which provide faster performance. Cloud platform is located between an application layer and infrastructure layer; cloud platform is responsible for the operating systems of applications in the application layer.

3.3 Vehicular Cloud Computing Services

There are many services available under VCC infrastructure such as:

Network as a Service (NaaS): -This service allows driver and passenger to share Internet access with other vehicles within the range. For example, the vehicle that has access to the Internet and does not consumed completely can offer or rent this facility for other vehicles [13].

Storage as a Service (SaaS): In this service, storage devices are shared when nearby vehicles have free storage space and other vehicles may require extra storage to execute their applications. Because of the small size and the expensive price of storage, while other vehicles have huge Gigabytes of storages[14]. Hence, vehicles with extra capacity will provide SaaS, they are able to use the storage for backup purposes [9].

Cooperation as a Service (CaaS): In this service can be used in case of poor infrastructure or use this service by V2V connection and does not need a V2I. CaaS works as a clustered, and each cluster has specific services to offer such as road conditions, safety information and nearby fuel stations[14].

Computing as a Service (COMaaS): There is many vehicles available on roads and parking lots, which contain unused computing resources. In this service, the sources of computing are presented to process and analyze the huge data and return the results to the user.

Information as a service (INaaS): There are many events that may change the way of the journey such as traffic congestion, road conditions, emergency situations, and accidents, so drivers need this information that can be requested from other vehicles All of these factors can influence their driving and those services together can be recognized as Information as a Service.

4. PROPOSED VEHICALAR CLOUD SYSTEM

The major challenge in vehicular cloud networks is high mobility and difficult to predict vehicles movements in urban area, which makes it difficult to implement in continuous connection, so to avoid interruptions in communication which is leads to loss of data, we propose a new Vehicular Cloud System to reduce the interruptions and provide reliable services.

4.1 System Architecture

The system architecture of our proposed solution consists of three major layers: Cloud Layer, Communication Layer, and Inside-Vehicle Layer.

Each layer is responsible for a particular function, and they work in conjunction with the each other i.e. each layer provides a function for the other layer. Each layer has dedicated duty that provides a function for other layers so there is a relation among them. Layer 3 provides a service to layer 2 and layer 2 provides a service to layer 1 and so on.

Figure (1) shows the layered involved in system located in various places. In the next sub-sections, we discuss each layer and its functions and services in detail.

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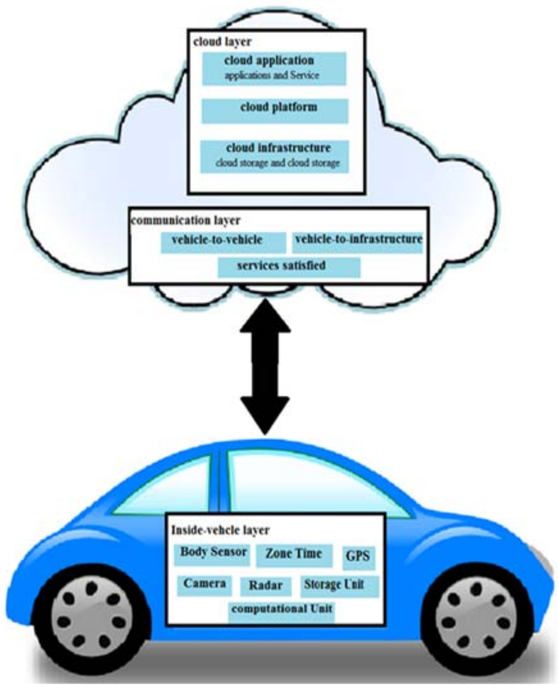

Figure 1: Proposed system Architecture

4.1.1 Cloud Layer

The cloud layer is the highest layer in the system. It is one of the most important layers in cloud computing for vehicles. The major advantages of this layer are data aggregation, in addition, in this layer the complex computation is executed in short time.

The cloud layer further consists of three internal sub-layers: cloud infrastructure, cloud platform, and cloud application. The cloud infrastructure layer again encompasses two sub-layers: cloud computation which is used to calculate the computational tasks to provide faster performance, the second layer is cloud storage the data gathered by other layers will be stored in this layer, such as pictures that captured from the cameras and geographic information system etc.

4.1.2 Communication layer

The second most important layer of the proposed system is the Communication Layer, which is responsible for the communication among Vehicles in the Cloud Network. The Communication Layer operates between Cloud Layer and the Inside-Vehicle Layer. It offers two types of connection; V2V and the V2I. Both connections are used for the exchange of operational data among vehicles, infrastructures, and the cloud over Wireless network.

By Focusing on this layer, we have modified this layer by adding the Service Satisfied Layer as a new component. The new Service Satisfied Layer applies several conditions before the connection is established with the cloud network. For instance, if a customer request for a specific service, then it will search the nearby vehicles with the specified area in which the customer is located. Furthermore, it will only establish the connection if the vehicle nearby and satisfy the customer service requirements.

4.1.3 Inside-Vehicle layer

The third layer in vehicular cloud computing is the inside-vehicle layer. This layer is responsible for monitoring, recording and collecting data and information from inside the vehicle, while the vehicle is mostly in motion. Inside-Vehicle Layer share valuable information such as Vehicle's Location and its speed, free storage space and idle computational unit to other vehicles to use.

In our proposed system, we add a new factor to this layer. The factor will calculate the zone time, which is the time spent by a vehicle in the certain zone.

To calculate zone time by this method two main parameters are required: speed, current location within the zone. From the above two parameters the spent time of the vehicle within the zone and the direction of the same vehicle are calculated for all moving vehicles. The best vehicle is chosen to participate in the service providing depending on the time it takes within the zone and its direction towards zone center. Of course, it is difficult to determine the exact time because of the nature of the urban vicinity which may have many intersections. Furthermore, the nature of road network, acceleration and declaration of vehicle are all influence the determination the spend time.

However, in highways time calculation is easier and precise due to the constant speed of a vehicle in contrast with urban environment. In addition, highways have a few intersections.

Zone time will be calculated after each interval time or before execution of services. The result keeps and stored it in the cloud storage to sharing it with other VCC layers.

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5. ZONE TIME CALCULATION

In our proposed system the focusing on the zone time which represents the vehicle time spent in a specific zone. There are many services depended on this time to ensure all services are completed without interruptions. The time calculation is one of the major challenges in VANET and VCC.

5.1 Dynamic Vehicles

Vehicles are mostly mobile running across streets and roads from one zone to another. Such movable vehicles are difficult to provide services to the customer because of the mobility. Another main reason is that their direction is unpredictable. To solve this problem, in our proposed system we use the multiple time query strategies by asking about several factors for each vehicle.

Zone time depends on multiple factors; speed, position, and distance. These three factors are changed continuously and by involved them in computation zone time to find vehicle wait time in a zone. Our system supports computation these three factors as depicted below:

To calculate the vehicle's distance, there are two ways:

- The first method calculated after service request in the satisfied layer. The distance between requester service vehicle and dynamic vehicles.
- The second calculate the distance between movement vehicle and zone center. This method works every interval time and may be calculated before service requester in the inside-vehicle layer.

There is another factor which may affect zone time calculation. This factor is vehicle direction in the zone after computing the distance between vehicle and zone center we can identify the direction from this distance.

There are two types of vehicles with respect to directions in our proposed system, the vehicle is keeping away from zone center or the vehicle is approaching to zone center. The method to determine the direction of vehicle by computes distance in current time and in subsequent time.

Our system compares between the current distance and pervious distance. The vehicle direction is from outside to inside zone (nearest the zone center) if the current distance is less than previous distance from zone center and vice versa. All those steps are summarized in Algorithm 1.

Algorithm (1): Calculate zone time of Dynamic vehicles
Input: vehicles speed and vehicles position within zone for each vehicle
Output: Compute zone time for each vehicle
1. **Begin** 2. **Get vehicle's position** 3. **Get vehicle's speed** 4. **Get** time simulation 5. **For each** vehicle within zone 6. **IF** vehicle's speed >zero 7. Calculate zone time 8. **Else** 9. Ignore the vehicle 10. **End IF** 11. **End For** 12. **End**

5.2 Services Satisfied

As we mentioned before, the second layer in VCC is communication layer. It's responsible for communications in cloud computing network among all neighbor vehicles. The communication layer is located between the cloud layer and the inside-vehicle layer. Its included two connections types: The V2V and V2I communication type.

After the time inquiry phase, the service management process begins to manage the customer's requirements. When the system receives request packet from a user, the system determines user position and the zone to which it belongs. It searches in its zone for one or more vehicles that could satisfy the user requirements.

Suppose the current time is 11:20 a.m. and the time inquiry in its registration data to 2:00 p.m. and the user has indicated in the request packet that the access duration is 2.5 hours. The system will accordingly add 2.5 hours to the current time and gets a time (1:50 p.m.) that is less than 2:00 p.m., which is the time at which the vehicles expect to leave the VANET. Hence, in this case, the vehicles satisfy the access duration condition. And this is shown in Algorithm 2.

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Algorithm (2): Check weather vehicle can satisfy the service or not

Input: All vehicles have zone time inside zone

Output: Add vehicle to service satisfying

```
Begin
Get vehicle's zone time
For each vehicle within zone
  IF vehicle's zone time<service time
     Add vehicle to service
  Else
     Ignore the vehicle
  End IF
End For
End
```

5.2.1 Vehicular Cloud Services Management

There are many types of computing services that can be provided by vehicular clouds:

- **NaaS:** Some vehicles will have a spare bandwidth from the Internet that can be shared with other vehicles. These vehicles can be a gateway to access the Internet for other vehicles. When the user requests this service, he should specify the time and bandwidth that he wants. The system will search for vehicles according to the following equation.

$$NaaS = \text{Zone number}_{user} = \text{Zone number}_{vehicle} \text{ AND } BW_{user} \leq BW_{vehicle} \text{ AND } T_{user} + T_{current} < T_{zone\ time} + T \quad ..(1)$$

SaaS (virtual network hard-disk): When a user needs storage to save his files, the system search for vehicles that offer SaaS, have a storage capacity greater than that required by the user. In this service, the system will estimate the time required to transfer files depending on the data rate of the network, So when the user requests this service, the system will search for vehicles that have enough space to share according to the following equation.

$$SaaS = \text{Zone number}_{user} = \text{Zone number}_{vehicle} \text{ AND } C_{user} \leq C_{vehicle} \text{ AND } T_{estimate} + T_{current} < T_{zone\ time} + T \quad ..(2)$$

- Data as a service or DaaS (virtual data provider): when a user in a vehicle may require specific data: for example, state traffic, a video file, a city map, latest news, road conditions, etc. These data do not need access to the Internet which can be provided locally, rather than uploading them to the World Wide Web, This reduces cost and quick access to data, When the user requests this service, he must specify the type of data, the system will search for vehicles according to the following equation.

$$DaaS = \text{Zone number}_{user} = \text{Zone number}_{vehicle} \text{ AND } data_{request} \subseteq data_{vehicle} \text{ AND } T_{user} + T_{current} < T_{zone\ time} + T \quad ..(3)$$

5.3 Simulation Parameters and Evaluation

One of the important factors in network simulation is the initial parameters. They specify the performance and the behavior of the vehicular cloud computing network in NS-2, Simulation parameters of proposed system have been determined as terminal command line (TCL)parameters in NS-2, which are summarized in table 1.

Table 1: parameter of proposed system

Parameter	**Value**
Channel type	Wireless channel
Antenna model	Omni antenna
Network interface type	Wireless Phy
Interface queue type	Drop tail
MAC type	Mac/802.11
Radio propagation model	Two ray grounds
Number of nodes	120
Simulation area	40km *14km
Simulation time	1000 sec
Packet size	1500 KByte
Speed	10-100 km
Number of zones	15
Zone size	2km *2km
max packet interface queue	50
Transmission range	250 m

6. RESULT ANALYSIS

In our study we compare our system with the traditional system. We mean by traditional system all the nodes participate in providing a service randomly without any conditions.

The performance analysis of two systems has been measured based on two types of metrics. The first of these metrics depends on the time of simulation and send/receive packet. The second type of metrics depends on the change of the number of vehicles verses packet delivery ratio to show how two systems are behaving.

6.1 Evaluation of proposed System

In this scenario, the vehicle that offers its resources is moving in specific zone. Selecting this vehicle which will satisfy the requested service is vital. Hence, the high movement of the responder vehicle in vehicular cloud network makes hard to satisfy all the requested services. The cooperation as a service is selected as requested service because it does not need a long time to complete. The two systems will be evaluated after a service request is received in a zone and identify the requirements to satisfy this service. If the required service needs 40 seconds to complete and five vehicles can share their sources.

Table 2 Specifications of the service required

Specifications of the service required	
Number vehicles needed for service	5 vehicles
Time required for service	40 secs
Number of vehicles in the zone	20 vehicles
service type	CaaS

Simulation results of the influences number of moving nodes verses throughput are illustrated in figure 2. From this figure we can see the two systems start with close values and continue with the same closer effects for all simulation time. It's clear that the proposed system proves 19.4% better throughput than the normal system, and the reason surly is the selected vehicle can provide the service than the other vehicle which does not matching the conditions that required in our system.

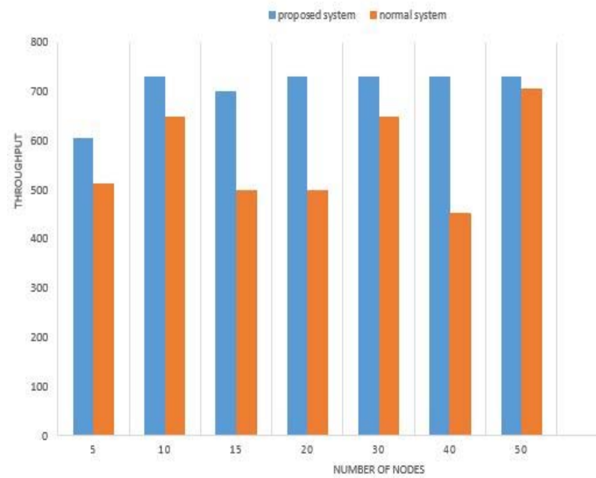

Figure 2: Throughput Versus Nodes Number

From figure 3 obviously the performance of the proposed system with regarding Packet Delivery Ratio(PDR) is better than the normal system. The proposed system keeps 18% its efficiency as increase the size of the network in reverse with the normal system. While, the normal system is fluctuating its performance as the size of the network is increased. The reason behind that is the selecting the vehicle which has the direction towards the center of the zone and spend a long time in the zone in comparison with other vehicles. The good performance of the proposed system refers to checking the type of vehicles which is avoiding the interruption happened.

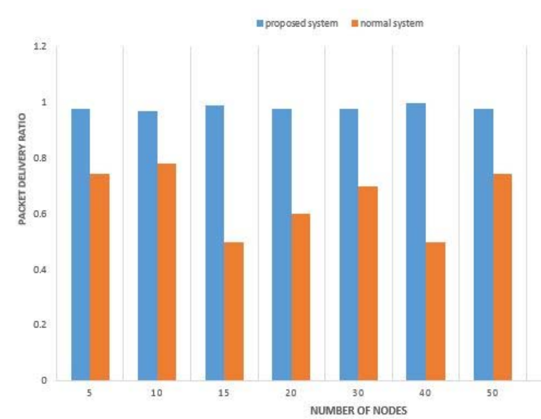

Figure 3: PDR versus number of nodes for two systems

7. CONCLUSIONS

The aim of the paper is to propose a system to manage the services in the cloud computing networks that can be operated in the vehicular ad hoc networks. The system works to manage these services between the service requester and the service provider in the vehicular cloud networks. Due to the continuous movement in the vehicular networks, especially in the urban environment makes the satisfaction and implementation cloud computing services so hard and difficult.

The system was simulated and compared to the normal system, which does not contain characteristics and conditions in order to know how much improvement has been achieved while using our proposed system. PDR and Throughput are two metrics were selected to measure the behavior of two systems. The improvement for our system is obviously achieved 19.4% ratio and 18% ratio for throughput and PDR respectively. For future work we plan to take other services in various environments and check our system responses.

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