Providing a resource scheduling algorithm based on recommender system in order for development of cloud computing

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Abstract
Cloud computing has caused a new revolution in computer science. This computing includes key technologies such as services, virtualization, and data centers. Data centers include locations where computer and computing facilities are located. These centers are responsible for providing energy, maintenance, and air conditioning for computing devices. Data centers face new challenges, including dynamic distribution of virtual management and resource sharing. The infrastructure resources of cloud computing can be widely distributed in different phases according to the needs of different users. Efficient planning strategy and algorithms should be used tailored to the needs of different businesses and in order to meet business goals. The key goal in cloud data centers is to improve system performance and service quality. Consequently, with the increasing expansion of data centers, the scale of energy consumption has seriously become a major problem. Also, energy consumption greatly affects cost and surrounding environment. Therefore, in order to develop scheduling of cloud resources, recommender system can be used in order to improve cloud computing. Using the recommender system, the considered service can be recommended to the user according to his needs; so this system can provide the customer with the right resource. In this paper, firstly the types of scheduling and resource scheduling algorithms are examined. Then, recommender system is considered in this paper as a key solution. Finally, the recommended resource scheduling algorithm based on recommender system has been provided. The results show that the impact of the recommender system on resource scheduling has improved economic scheduling parameters and flexibility and has caused cost reduction and profit increasing.

Key words:
Cloud computing, resource scheduling, resource scheduling algorithm, recommender system

1. Introduction

Cloud computing is a model for presenting and using IT services in which a set of technologies are used. In addition, the model itself has led to emergence of newer technologies. It should be noted that cloud computing can be considered as a technology, tool and solution according to the subject of discussion. For this reason, cloud computing is said to be a model that describes computing industry, but it alone lacks technology, tools or methods of doing work, and these details are outlined in later architecture and subsequent implementations. But after implementation, it is called cloud computing (Marinescu, 2013; Rittinghouse and Ransome, 2009).

The scheduling system controls various tasks in order for increasing work completion rate, increasing resource efficiency and increasing computing power in cloud computing environment. In fact, the goal is to identify a processing source from the collection of resources that a task requires it for processing in such a way that more tasks can be processed in less time. Scheduling is considered as a key process for user requests in cloud computing. From one point of view, scheduling in cloud computing can be done from the perspective of user (economic model) and system (innovative model). The scheduling goal is to reduce the response time and to improve utilization of source. To achieve this goal, there are various scheduling algorithms that some examples of scheduling algorithms such as economic, virtualization, client-server, and resource scheduling can be named (Magoulès et al, 2012).

Scheduling strategy in cloud infrastructure tools is divided, according to their type of workload, into static and dynamic groups. In order to design static and dynamic scheduling strategy, sometimes there is need to a workload model or several models of workload. The challenge of most algorithms in their workload efficiency is resource allocation and assignment of tasks (Arya and Verma, 2014).

In order to compare and improve efficiency of algorithms, principles should be specified to determine the purpose of using scheduling algorithms. Therefore, various parameters are considered for this comparison and improvement. These parameters include cost reduction, profit increase, runtime constraint, quality control, economic optimization, reliability, energy improvement, load balance, improved computing and resource efficiency. In the domain of virtualization in cloud infrastructure layer, different resource scheduling algorithms have been developed to improve parameters of profit increase and cost reduction

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(Fakhfakh et al, 2014; Liu et al, 2014). In this paper, the scheduling of cloud computing resources will be examined and evaluated from a variety of perspectives such as challenges, algorithms and strategies.
With the help of recommendations provided by authorities or other people, in case of lack or shortage of knowledge, also you can select. Most people use recommender systems for decision making. Nevertheless, there are problems with the recommender systems which are related to issues such as the motivation to recommend (the provided recommendations may be in favor of a particular company), privacy, and high maintenance costs of these systems. Most people are forced to choose in situations where there is not enough personal experience about a specific subject. Individuals in their daily lives use other people's recommendations through spoken language, recommended letters, published reviews of books or films in newspapers, and general reviews such as Zagat Restaurant Guide (Resnick and Varian, 1997).
In the next section of the paper, the second chapter focuses on cloud computing and its layered architecture. The third chapter examines cloud scheduling and various scheduling algorithms and resources. The fourth chapter examines recommender system as the main topic of the paper. The fifth chapter deals with examining the recommended model and comparing it to other works. Finally, the results and future works of the paper are reviewed.

2. Cloud computing

Cloud computing is one of the most vital cogitable components in the process of creating and delivering services. Users find their services through knowing the place of location and the method of their delivery. Computational systems are provided in order to provide services in a variety of types. Some of these computational systems are: cluster computing, network computing, and recently mass computing which is also known as cloud computing. Cloud computing popularity, after the emergence of its primary concepts in 2007, is growing much ahead of other computational approaches. Development of software that rather than being run on single computers are available to millions of users as a service is increasingly being developed in the world of computing. Hence, mass computing (cloud computing) is structurally similar to a cloud mass that allows access to applications from anywhere in the world. With these concepts, there is no definite definition of cloud computing; clouds or clusters of distributed computers can create resources and services on demand in a network (Fakhfakh et al, 2014; Liu et al, 2014; Velte et al, 2009).

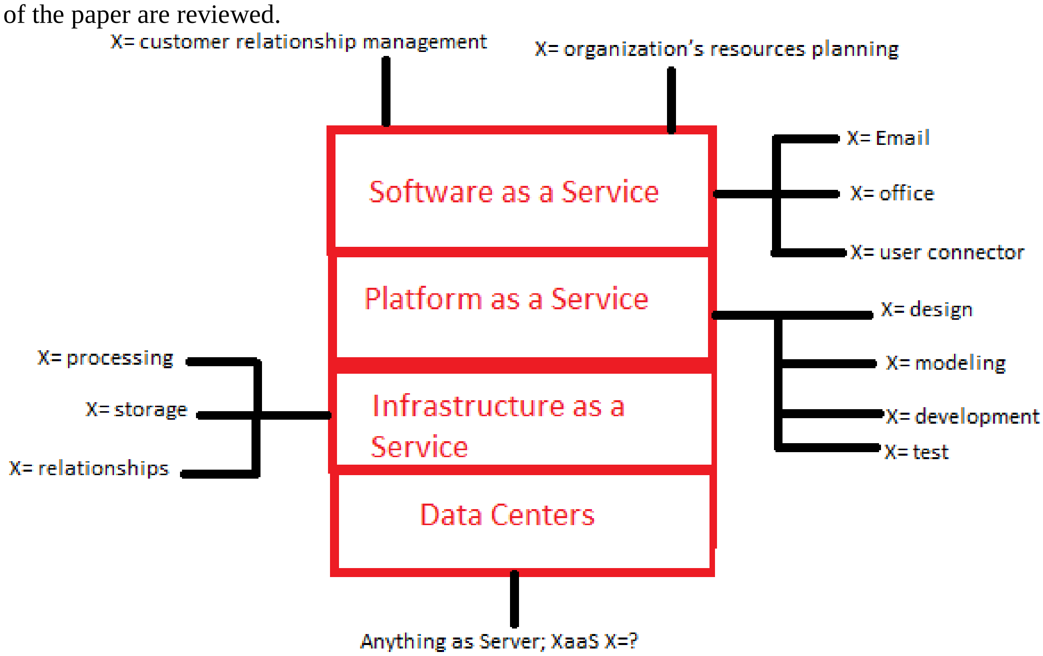

Figure 1: cloud computing layers' architecture (Marinescu, 2013)

In the definition of cloud computing, five factors play a crucial role. These factors include providing services based on customer demand, widespread access to the network, resource sharing, elasticity, measurability and service quality assurance (Rittinghouse and Ransome, 2009). Cloud computing has different service layers. Each layer is a basis for its upper layer. These layers are divided into three categories of Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The services of cloud applications or software as a service are

put on the Internet, and the user does not need to install software. Platform as a service allows the user to have settings with control and monitoring on the environment on which the program is based. In infrastructure layer as a service, the user can use basic computing resources, such as processing power, storage space, network components, and middleware. However, with regard to customer requests, cloud hierarchical layers can have changes in the infrastructure and achieve the concept of "Anything as a Service" (XaaS) (Dillon et al, 2009; Marinescu, 2013).
Implementation in cloud computing is possible in public, private and hybrid clouds. IT organizations place their applications according to their application on public, private or hybrid clouds. The information does not depend on location. Generally, public clouds are on the Internet and private clouds are in a certain area. Private clouds can also be placed in shared spaces. Companies pay attention to a lot of points in choosing their cloud computing model. For example, for a given problem they use different models. In order to be put it in public cloud, a temporary application is needed, because the need to purchase additional equipment is resolved by a temporary need; therefore, an application that requires service quality or requires data location geographically, is better to be in a private or hybrid cloud (Dillon et al, 2009; Marinescu, 2013).

3. Scheduling algorithm

Scheduling is considered as a key process for user requests in cloud computing. In cloud computing, it's sometimes necessary to process user requests with a collection of virtual machines from existing resources. Scheduling algorithms play a very important role in cloud computing because the purpose of scheduling is to reduce response time and to improve utilization of source. Figure 2 shows different types of scheduling algorithms (Magoulès et al, 2012).

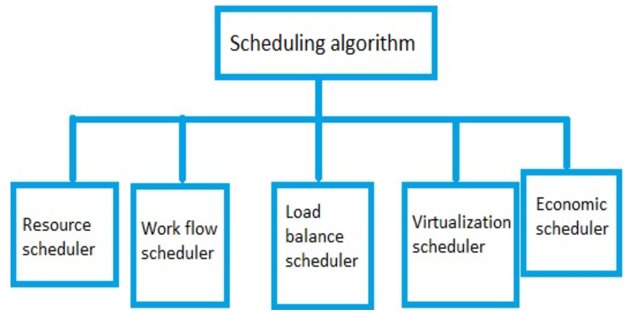

Figure 2: types of scheduling algorithms

3.1. Scheduling algorithms parameters

In this section, various types of examined parameters that are used to improve scheduling algorithms are reviewed. Each of these parameters has a unique property and evaluation of these parameters is important for cloud planning and organizational issue. The parameters of scheduling algorithm are divided from several perspectives, which include: cost reduction, profit increase, runtime limited, quality control, economic optimization, reliability, energy improvement, load balancing, improved computing, resource efficiency, Scalability and increase of speed and efficiency (Fakhfakh et al, 2014; Liu et al, 2014).

Types of scheduling algorithms

Economic schedulers: Economic schedulers are used to resolve management resources in various computational models such as cluster, distributed data, grid networks, parallel devices, peer-to-peer networks, and cloud computing. The existing applied economic scheduling middleware is not limited to the cloud platforms that were introduced. For this issue, we can in practice test the applicability and appropriateness of these economic schedules for allocation of supportive cloud resources. Table 1 examines economic scheduling (Magoulès et al, 2012).

Table 1: examining calculation model and economic model in economic scheduling

Calculation model	Economic model	Scheduling
Cluster	Tendering	Cluster-on-demand
Cluster	Commodity	Mosix
Peer-to-peer	Auction/bartering	Staford Peers
Mobile-agent	Relative shared auction	D'Agent
Grid	Tendering	Faucets
Grid	Auction/Commodity	Nimrod-G
Distributed information	Previous price	MarketNet
Cloud	Commodity/tendering/auction	Cloudbus
Cloud	Commodity exchange/Double auction	OpenPEX
Cloud	Previous price/tendering/Commodity exchange	EERM

Scheduling from the perspective of virtualization:

In cloud computing, it is sometimes necessary to process user's request with a set of virtual machine from the existing resources; in the same way, virtual machine-dependent scheduling algorithms can be at the top of the agenda. Samuel has provided an algorithm based on virtualization for sequence of work with resource constraints to achieve the minimum total elapsed time. Richard has proposed a classic three-machine scheduler model with an optimal paramount of n items, taking into account the total elapsed time as the goal of the target function. Edward introduced flow shop scheduler using split and refresh technique for n actions and three machines. Duudak has described an algorithm for optimal sequences for n actions on m machines without permission of passage (Bala and Chana, 2011; Shaw and Singh, 2014).
Load balance: Load balancing in cloud computing devices is a challenge. Load leveling is usually mechanized for continuity of a service when one or more components of the set fail. The components are monitored regularly, and when one of the components does not respond, the load balancer rises and does not send traffic on that component. With suitable load leveling in the place of resource consumption, the problems can often be minimized which not only reduces costs and creates green computing, but also keeps the pressure on the unique circuits low that potentially prolongs their life (Begum and CSR , 2013). Figure 3 shows balancing process.

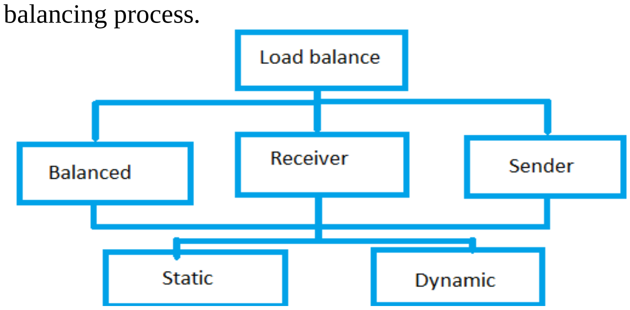

Figure 3: load balancing work process

Workflow scheduling: cloud computing provides a change model and a computational model based on urban services. The process that draws works in workflow is called workflow scheduling. Workflow scheduling optimizes some algorithms, user cost and time. Workflow algorithms in order for development of access, trust, productivity, and load balancing consider a cloud for resources (Edwin and Madheswari, 2013).
Resource scheduling: the issue of resource scheduling in the cloud computing environment is a very important issue. In a cloud computing environment, each user may encounter hundreds of virtual resources when running any task. In this situation, assignment of tasks to virtual resources by the user itself is impossible. The goal of using cloud computing systems is to minimize the cost of using resources by service providers and also to maximize the revenue resulted from providing service to consumers' applications. The scheduling system controls various tasks in cloud system in order to increase the completion rate of work and increase resource efficiency and thus increase computational power (Luo et al, 2012).

3.2 Resource scheduling

Cloud computing depends on virtualization to some extent. Clouds can be said to be virtual branches. Therefore, it's a critical task to schedule tasks across different non-uniform physical machines. Resource scheduling has several key processes that include strategic planning, target optimization, algorithm, scheduling system architecture, determining required resources and data center analysis (Singh and Chana, 2016; Yan et al, 2016; Zhan et al, 2015).

3. Resource scheduling strategy

The Amazon cloud computing scheduling strategy is a combination of strategies of cost and satisfaction of the needs of different users, including load balance and high reliability. Differential of costs, acceleration of response speed, business classification, general standard authority and load balance play an important role in Amazon scheduling strategy (Madni et al, 2016).
The IBM belonging to big internal business companies is cloud computing infrastructure. IBM resource scheduling management performs important actions regarding resources strategy. It configures virtual machines sooner or provides them based on optional models. It allows users to choose hardware infrastructures, processor, memory and online operating systems. Online operating systems do any information as the start time and end time of works and booking of urgent sent requests. Finally, users who receive resources can request an increased use time of resources (Madni et al, 2016).
HP Company is another important company in cloud resources scheduling strategy. An HP data center document systematically defines an image of HP data center cost model. HP is an important and useful reference for cost model that describes each of the data center elements in terms of cost according to the equation (total cost = space cost + power cost + cooling cost + operating cost). An example is the environment and the space around the power source and its maintenance and repair. HP model is a very comprehensive model and provides an example in terms of cost for data centers (Madni et al, 2016).
The cloud resources strategy in VMWARE Company is done based on three principles of improvement of resource utilization, improvement of reliability and load balance. VMWARE has currently focused on virtualization and

recovery and dynamic immigration. The main focus of VMware Data Center Company is to improve resource utilization and dynamic migration and recovery through virtualization. Virtual machine management (enhancement, deletion, and update) is mainly done manually, and scheduling principally uses timelines (Madni et al, 2016).

3.4. Resource scheduling algorithms

Client/server scheduling: this scheduling has been done based on value, scheduling of cloud algorithm, which is based on economic issues. Based on two phases, a pattern is provided for cloud resources scheduling: 1. Availability of resources in cloud clusters changes: according to application, distribution of cloud resources, location of resources, and unpredictability; 2. Saving resources before implementing a virtual machine instead of them requires cloud resources. The scheduling pattern in scheduling processes should be atomic. Therefore, scheduling of cloud resources can be provided like the customer (consumer) and the vendor (supplier), which is called store theory (Yang et al, 2011).

Resource scheduling of data centers: this scheduling model can be considered a type based on virtualization. In this method, an algorithm has been recommended for planning virtual machines based on frameworks, margins and processors in a data center in order to minimize communication cost. There are three successive stages in planning a variety of prioritized jobs. No network layout has been used. Rather, only the data cost transferred for network requests has been considered. The description considers in its proposed model the challenges that any provider faces when designing and deploying data centers. The main objective of this work is to analyze and examine the existing resource management sets and it provides a set that maximizes using source of data center in massive computing environment (Abu Sharkh et al., 2013).

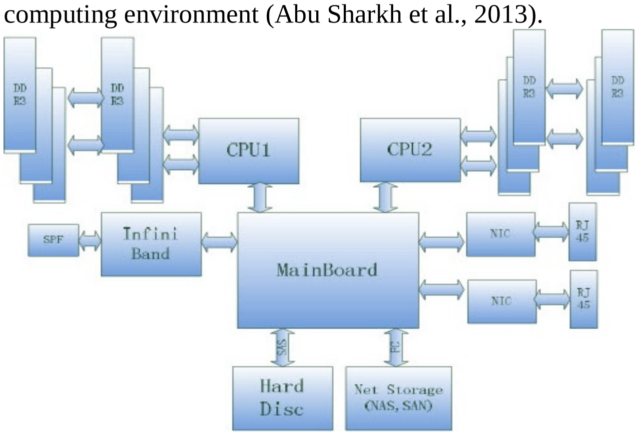

Figure 4: energy consumption scheduling structure (Luo et al, 2012)

Scheduling based on energy source: in order to effectively control energy consumption of cloud computing, firstly, the method of very much consumption of cloud computations should be measured. Therefore, basing cloud computing energy consumption model is a priority. In cloud computing environment, the node structure is the same as traditional servers, although this structure leads to the issue that the main service resources can be provided that provide service, as a direct service to the user of its parallel processing, connected networks and storage execution which is generally better. Figure 4 shows the scheduler structure of energy consumption (Luo et al, 2012).

Cloud download optimization algorithm: in this model the cost of user time in cd is determined by the length of time the user is notified and the length of time that he has corrected the file, which are called response time and correction (recovery) time, respectively. The combination of this time can be used to measure quality of service. The greater the cost of user time is effective in reducing user satisfaction. This time cost will make users go to somewhere else. Regarding the service creator, it controls user's satisfaction through timetable when it is willing to process and when it is informed to the user. Both of these collectively affect rent of cloud storage resources to store it in cloud storage. As a business creator in cloud, the creator of cloud download considers user satisfaction with more reduction of the cost of storage resources (XU et al, 2014).

Multistage planning algorithm: generalized scheduling algorithm searches for the optimal scheduling sequence for n imagined requests, on m types of virtual machines. This algorithm, considering the total elapsed time as the target function, finds the optimal scheduling sequence among the possible available scheduling sequences. If the number of virtual machine types (m) is even, then s is equal to ((m / 2) +1), and otherwise, s is the rounded m / 2 (Motavaselalhagh et al, 2015).

Optimal resource scheduling algorithm: in order to achieve an optimization in cloud scheduling, this optimal algorithm was recommended. In this algorithm, Improved Genetic Algorithm (IGA) has been used for automated scheduling and its use is in order to increase speed and advance the process of using resources (Luo et al, 2012).

Improved algorithm based on price, for scheduling tasks: this algorithm was presented for better mapping of tasks to resources in cloud. This algorithm measures scheduling of cost of resources and efficiency of computing, and increases percentage of computing and communications (Garala and Dobariya, 2015).

Resource Aware Scheduling Algorithm: this new task algorithm is called RASA. This algorithm includes two traditional scheduling algorithms of Max-Min and Min-Max. RASA uses the benefits of Max-Min and Min-Max algorithms and covers its weaknesses. The results of the experiments show that RASA acts better than scheduling algorithms existing in large-scale distribution systems (Alahmadi et al, 2015).

Virtual machine resource supply workflow algorithm: using cloud resources requires easier access for requesting because most clients have certain cost and time limits that need to be completed; so, there is need to specific program hierarchy to optimize the position of tasks of the client regarding specific virtual machines. Programs can be carefully designed in two categories: independent package of affairs and workflows. In order to help improve this issue, a mathematical model is designed for cost, which is used in single and multiple types. This model determines methods for the last two methods; the complexity of workflow programs is called for more experimental method to determine general relationship. For this purpose, traditional workflows are considered to cover a wide range of possible cases (Frincu et al, 2014).

Energy efficiency migration stabilization algorithm: this algorithm is based on an efficient energy of Virtual Machine Migration (VM) and dynamic algorithm stabilization based on multiple sources of energy efficient model. This algorithm can minimize energy consumption with a quality of guaranteeing services. This algorithm seeks migration in virtual machines in order to design a threshold method for two people using multiple sources. Particle swarm optimization method is efficient, but it is not suitable to improve energy consumption of virtual machines, that this algorithm, using resource sharing, helps to improve the efficiency of virtual machine. Compared to traditional methods, this algorithm, using some active physical nodes, reduces virtual machine migration and as a result, increases efficiency. This algorithm shows improvement given the energy efficiency in cloud computing data centers (Li et al, 2015).

4. Recommender system

Recommender systems help much to the strengthening natural social processes. In a typical recommender system, people express their interests as inputs, and then the system collects the interests and sends them to the appropriate receiver; in some cases, an initial conversion may also be performed at the time of collection. In other recommender systems, the value of system depends on correct matching capability, between what is provided by the recommender and what the user likes (Resnick and Varian, 1997).

Some systems can only use the interests that users have explicitly stated. But there are systems that can also obtain the implicitly expressed interests. User interests may be named or not, which, if nameless, they are labeled by source identifier or by an alias. The content of an evaluation can be either a single bit (recommended or not recommended) or non-structured text interpretations; and different methods are used to evaluate the products. The products can be ranked according to scores earned by ratings, and products that have been negatively scored in ratings can be eliminated. Is recommending a good product or recommending a bad product very costly? How are these costs compared to the benefits of accessing a good product? Examining these costs is necessary for proper interaction with the user, as the cost of inappropriate decisions and choices is high, such as the cost of making wrong medical treatment decisions (Resnick and Varian, 1997).

Considering the set of recommendations, the recommender people and the consumer people is necessary. Who offer recommendations? Do recommenders usually tend to evaluate many products to manage the big collection of recommendations? How many consumers are there? The answers to these questions are factors that affect selection techniques. The automatic matching of people in a large collection and with the help of the tastes they have, in the conditions that they may not know each other, is very valuable. Providing recommendations to each individual with respect to their different interests and with a small number of experts is valuable (Resnick and Varian, 1997)

As mentioned above, in recommender systems, the interests of individuals can be gained in two ways. In the first method, interests can be gained by the profile that the person has created. In the second method, interests can be implicitly gained by monitoring the user's behavior over existing resources. Future systems, in order to provide recommendations, will probably need to consider pre-requisites for recommendation receivers, such as monetary compensation. Recommender systems increase concerns about personal privacy because if a user in the system is able to know about the recommendations offered to other users, or in other words, one can evaluate the recommendations offered to other people, a violation of privacy occurs because individuals may not be willing that their habits and opinions to be exposed to the public. Some recommender systems allow people to be present in the system anonymously or with a pseudonym, but this is not a complete solution, because some people may tend to a combination of an average privatization and receiving credit, according to the actions they take in the system (Resnick and Varian, 1997).

It is costly to maintain recommender system. It is necessary to think that using which business model can help generation of enough revenue to cover costs. One model is that the receivers of the recommendation will subscribe to the system or pay for each use. The second model is making money through advertisers. Recommender systems are very useful to advertisers because these systems generate marketing information details about consumers. If a user expresses his opinion on a book, publishers can make sure that the user has viewed ads for that book. The third model is to determine a rate for business owners who intend to evaluate their products. Filmmaker marketers for example,

pay a fee for receiving the vote of their films (Resnick and Varian, 1997).
The last two business models are threatened for deviation. Mass marketing computer magazines that have reviews and advertisements are often accused of having their reviews in favor of companies that have advertised heavily in these magazines. In this case, perception of discrimination by consumers is very inappropriate. Recommender systems that advertise products or recommend products for evaluation, in order to maintain credibility of the system, must be ensured that the content of recommendations and advertisements is such that users can understand that this content is not biased (Resnick and Varian, 1997).
In recommender systems that have many users, for each user there is a user like him present in the system. Therefore, individuals prefer to use larger systems. When several recommender systems start competing in a market, there will be a very intensive competition, because it's likely that the competition will have few survivors. This suggests that in each market there may be one or two major recommender systems that these systems deal contracts with sellers of products in order to offer recommendations, and act as a service provider that adds value to a product (Resnick and Varian, 1997). Various techniques are used to implement recommender systems; a brief description of four techniques of the recommender system is presented in the following. A) Collaborative filtering (CF): this is a well-known recommender algorithm that uses the ratings or behaviors of other users in the system in order to offer prediction and recommendations to a user. The basic assumption in this approach is that from the opinions of other users, a reasonable prediction for priorities of a user can be provided (Ekstrand et al, 2011). B) Content-based (CB) filtering system: it recommends products based on the relationship between product content and user preferences; in fact the content of each product is compared with the content of the products liked by the user in the past (Van Meteren and Van Someren, 2000). C) Computational intelligence (CI): this is a branch of Artificial Intelligence (AI). Artificial Neural Networks (ANN) and Swarm Intelligence (SI) are among the techniques of computational intelligence and have so far had a significant impact on strengthening recommender systems (Abbas et al., 2015). D) Filtration systems can be combined in a variety of ways. A Hybrid Recommender System combines various techniques in order to eliminate the constraints of each of them (Shih and Liu, 2005).

5. Recommended plan

Scheduling algorithm performs various tasks in cloud computing, in order to increase speed and increase resource efficiency and thus increase power consumption. Scheduling of user requests in cloud computing for resource provision is a major process in the cloud computing algorithm. In the domain of algorithm, it is sometimes necessary to process a user's request with a set of cloud infrastructures from the existing resources. In the main plan section, the goals that are being improved and influenced by the proposed plan are described. This category of goals explain improvement and increase of speed between organizations in the level of cloud environment service and also improve infrastructure of cloud resources with respect to important parameters of scheduling algorithm such as access level, economic optimization and optimization of computing resources, and ultimately improve the correct use of cloud resources in cloud computing with being influenced by scheduling algorithms. In addition, the recommended plan by using recommender system has improved resource scheduling algorithm in cloud computing. The issue of scheduling in cloud computing environment is a very important issue. Scheduling system controls various tasks in cloud system in order to increase work completion rate and resource efficiency, and thus increase computational power.
Different analyzes of scheduling algorithm and various parameters in other various categories have been examined. Nevertheless, many research and surveys are still needed to develop and improve the parameters of service development, optimization of execution time, resource allocation, optimization, flexibility, computational resources and interactivity. Scheduling algorithm can play a key role in developing and improving this issue. In scheduling algorithm, tasks and resources must be properly identified. In fact, the goal is to specify a source of processing from the set of resources that a task requires for processing, in such a way that more tasks can be processed in less time. Scheduling algorithms play a very important role in cloud computing, because the scheduling goal is to reduce response time and improve utilization of source. Hence, in this paper we have used recommender system in order for development of cloud resources.
The problem of dissatisfaction of users and cloud providers can be achieved by approaching algorithm in cloud computing in order to increase it and in customer satisfaction in order to improve it. Resource management of data centers servers, while being planning and delivering tens of thousands of client requests based on virtual machines existing in data centers servers, often have problems such as resource allocation, that using resource scheduling algorithms can improve cloud resources given the task assignment parameter. Given that there have been concepts and approaches about cloud computing before, so cloud computing is not a new topic. However, due to ongoing changes in the methods of building, development, installation, scalability, updating, maintenance and payment for user applications and the infrastructure running on cloud computing, everything is getting new in that. Scheduling is considered as a key process for user requests in cloud

computing in order to provide resources. In cloud computing, it's sometimes necessary to process user's request with a set of virtual machines from existing resources. An effective way and a scheduling algorithm based on cloud computing can have a great performance in achieving high efficiency.

5.1. Recommended algorithm

This algorithm acts to develop improvement of cloud resources scheduling algorithms in order to develop recommender system in cloud environment. Before expressing the algorithm, we examine the number of cloud software (such as Cloudlet[1]). By default, the number of cloud software is between 1 and 500 cloud software.

In the predefined cloud datacenter, a function has been defined to improve resource allocation that here virtual machines have helped to better expression of algorithm. This function has been specified given the needs of the user that the system recognizes how many cloud software to use; that n is ultimately the number of virtual machines for allocating cloud applications in virtual machines. Figure 5 shows the function algorithm of n_function.

Given the mentioned function, the main code segment of scheduling algorithm is examined. Firstly, the user sends a request to the seller according to his needs. The seller system receives the needs and information sent by the user (customer). The system provides predefined resources (resources include cloud programs and virtual machine). Before the resources reach the customer, resource scheduling algorithm based on recommender system enters to the action and performs the action of resource allocation. For example, the system has provided 10 cloud programs in the form of 10 virtual machines. Here VM is Virtual Machine, Value_VM is the Number of Virtual Machines, Cloudlet is Cloud Application, Value_C is the number of cloud applications and n is also the function that has been described above that specifies how to allocate cloud resources in virtual machines. Given the n function, in this example that we have 10 cloud programs in the form of 10 virtual machines, the value of n is n = 2. The algorithm equalizes the number of virtual machines to zero, and according to formula 1, according to cloud programs, specifies the number of virtual machines and improves resource allocation for a recommender system.

Formula

1) $$Value\_VM = Value\_C \ (Value\_C / n)$$

[1] In Chladsim simulator environment, this is referred to a unique set of cloud or the number of applications of cloud.

```
float n_function (float i) {

 float n;

      for ( i = 1 ; I <=50 ; i ++ ) {
           return n = 2 ;
 }

      for ( i = 51 ; I <=100 ; i ++ ) {
           return n = 3 ;
 }

      for ( i = 101 ; I <=250 ; i ++ ) {
           return n = 4 ;
 }

      for ( i = 251 ; I <=500 ; i ++ ) {
           return n = 5 ;
  }
}
```

Figure 5: function algorithm of n_function

Then, after applying scheduling algorithm in order to improve resource allocation, the resources are updated and sent to the client. The customer, given his needs, achieves his desired resource at the lowest cost. Hence, recommender system can be an appropriate solution for improving cloud resource scheduling algorithm. Figure 6 shows the code segment of scheduling algorithm.

```
Start:
Client: Request_User (Sending Data);
Server: Information_User (Receive Data);

// Sending Data to Cloud.

Server: Information_User (Providing Resource);

// Processing information.

Server: Scheduling_Algorithm (Allocation Resource)
{

// The effect of the allocation resources in the Scheduling Algorithm

VM = Value_VM;
Cloudlet = Value_C;

If ( Value_VM == Value_C || Value_VM >= Value_C ) {

    While ( Value_VM =! N (n) ) {
          Value_VM = 0;

          Value_VM = Value_C / ( Value_C / n (n) );
      }
   }
}

Client: Request_User (Receive Data);

End;
```

Figure 6: code segment of the recommended algorithm of resource scheduling

The recommended resource scheduling algorithm that acts by using recommender system eventually has led to reduction of cost (from the user's point of view), and increase of profit (from the perspective of the system).
Resource allocation based on recommender system will improve flexibility parameter. Flexibility itself includes parameters that improve virtual machine sharing, resource allocation, and reliability and efficiency. In this algorithm, sharing of virtual machine and allocation of resources has been improved. In future, by development of resource scheduling algorithm based on recommender system, it is possible to improve the parameters of reliability and efficiency in order for flexibility.
Increasing profits and reducing costs from economic perspective will lead to economic improvement and optimization. This is partly done in this algorithm. However, in future, by development and improvement of the recommended algorithm in terms of economic optimization, resource scheduling algorithm and recommender systems can be improved.

5.2. Recommended plan

In Figure 7, a flowchart of the recommended plan determines how scheduling algorithm performs its work. First, a specific organization or user sends its request to the system. Before receiving of information by the system, authentication is first performed and then the user's request is sent to the system. Firstly, user's request is reviewed and its needs are identified and go to the next step. In this step, after reviewing, cloud resources are recommended. Before sending the recommended resources, the user enters another step. This step is the recommended scheduling algorithm according to the recommender system. The scheduling algorithm, receiving the recommended resources, improves it and then the resources are sent to the user. The hypothetical user or organization receives its requested resources.

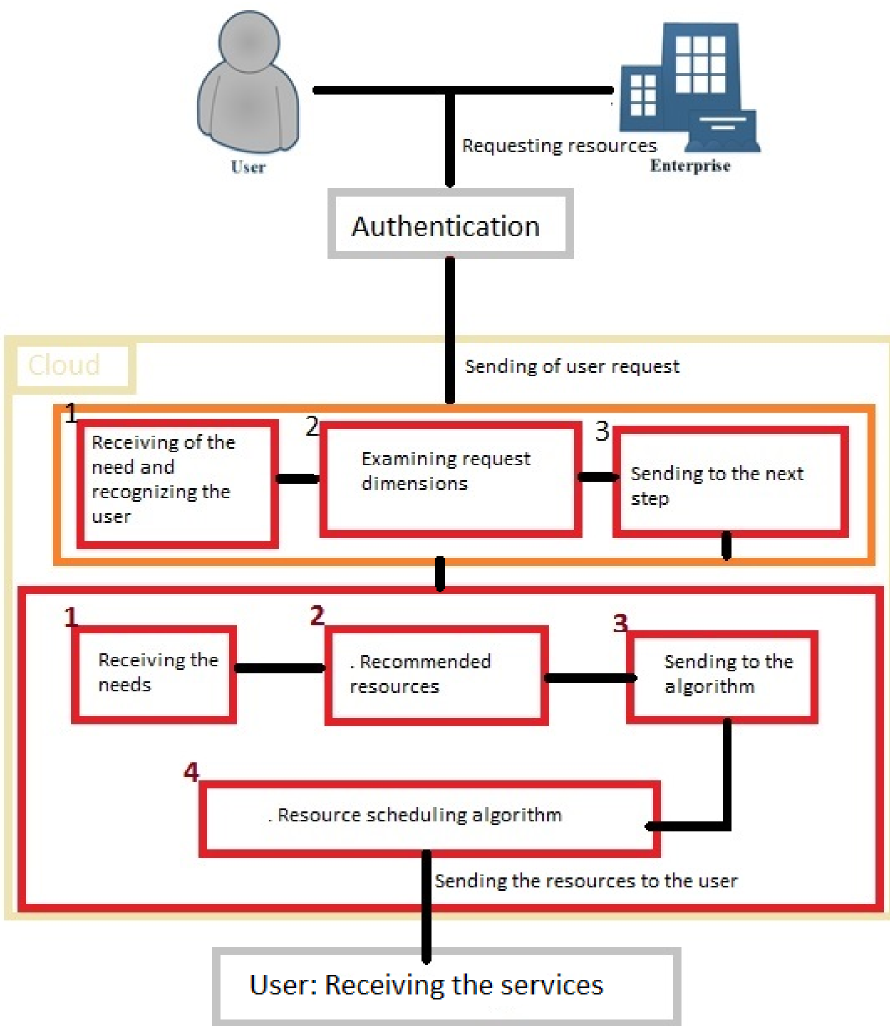

Figure 7: Flowchart of the recommended plan

5.3. Testing and simulation

In order for simulation of the recommended algorithm, Chladsim tool has been used. In Chladsim the three sections of creation of data center, virtual machine and cloud are of particular importance. They are examined in the code segments below. In order to show the results of the proposed work, you must first consider some resources. This can be done in two ways. In this paper, since the goal is to improve allocation of resources, the first method has been used. The components of the first method include the number of clouds, the number of virtual machines, and valuing of the number of resources. Also, the components forming the second method include hard amount, processor amount, bandwidth, host amount, the number of processor core, and data center number.

The recommended plan has been compared with two other algorithms. The proposed algorithm has been tested once without the impact of the recommender system. On the other hand, it has also been compared with task scheduling algorithm. Figure 8 shows the runtime and Figure 9 shows the average runtime compared between the recommended plan and other works. The recommended plan has significantly improved run-time.

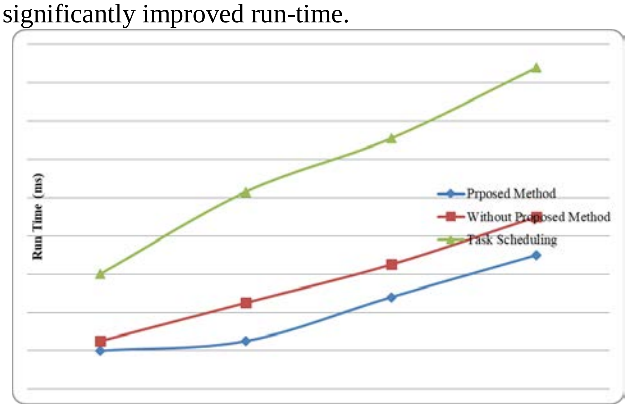

Figure 8: Review and testing of the recommended plan based on runtime

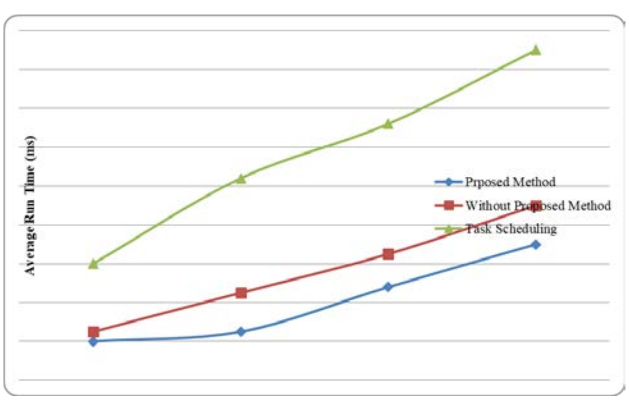

Figure 9: Review and testing the recommended plan based on average run-time

6. Conclusion

Cloud computing needs to be combined with various algorithms and theories in order to be developed and improved. Hence, recommender system in line with scheduling algorithms can help much to development of cloud computing environments. This paper, by proposing a resource scheduling algorithm based on recommender system, has attempted to improve and develop cloud computing. The proposed scheduling algorithm has improved parameters such as optimizing cloud resources, sharing and increasing profits in developing cloud computing with the impact of the recommender system. The scheduling algorithm based on recommender system, by its impact on allocation of cloud resources and quality control, has resulted in satisfaction of most of the users, because the proposed resource has been recommended according to their needs. The purpose of this paper is better improvement of two basic parameters of resource sharing and profit increase in the stated areas. Allocation of cloud resources based on recommender system has been expressed in terms of the issue of scheduling algorithm. Hence, the providers can improve cloud environments in order to get better resources and attract cloud users. Approximate and computational algorithms based on the facilities between quality control and runtime can be investigated for the future of the recommended plan. Of course, it's worth noting that hardware constraints can also play an important role in the future work of this plan. However, everything is being refreshed due to continuous changes in the method of building, development, installation, scalability, updating, and infrastructures that are run on cloud computing.

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