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A strategic performance of virtual task scheduling in multi cloud environment

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Abstract An emerging technology of cloud computing has major issue as scheduling the task and resource allocating. To avoid this issue, there are suggestions on different scheduling algorithm and that has its own merits and demerits. The proposed virtual task scheduling in multi cloud environment using three different scheduling algorithms such as equal load balancing (ELB) algorithm, high priority scheduling algorithm and rate based scheduling (RBS) algorithm. These different scheduling algorithms are used based on the number of tasks and number of virtual machine in multi cloud environment architecture. If the number of task is equal to number of virtual machine, ELB scheduling algorithm is used. If the number of tasks is greater than the number of virtual machine, high prioritization scheduling algorithm is used. If the number of tasks are lesser than the number of virtual machines, RBS algorithm is used. By using these three different scheduling algorithms we can improve the makespan, average efficiency of the multi cloud computing. Simulation results have analyzed the overall performance by comparing these three different scheduling algorithms. From these simulation results, proposed virtual task scheduling which increases the makespan and reduces the delay and energy consumption.

Keywords Virtual machine · Task scheduling · Resource sharing · Equal load balancing · Makespan

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1 Introduction

Computing is divided in to three categories such as P2P computing, grid computing and cloud computing. P2P computing transmits the data between two different networks and it will be formed using overlay architecture. Grid computing is used to allocate the resource from the pooled resources and this helps to avoid the scheduling process. Cloud computing has the resources for cost and this resource can be obtained by using pay per use scheme. This cloud computing technique uses virtual machine for the reduction of cost and energy consumption. Cloud computing involves three service models offering three services and four deployment models. Those services are software, platform and infrastructure. Generally cloud computing involves hardware, operating system and application layer. The virtual machine will be introduced on either of this layer based on the application. In case of cloud computing, software is used as a service and hardware layer as virtual machine. In the case of platform as service, it uses the operating system for virtual machine. If it requires infrastructure as service, this will use the application layer for virtual machine transformation. With the help of virtual machine, it can reduce the energy consumption and cost. Virtual machine concentrate on the reduction of energy consumption and this will act as virtually and that will avoid the unwanted transmissions. Cloud computing consist of service providers and internet providers. Service provider is used to generate the service like software, platform and infrastructure. Based on the requirements, service will be provided. Internet providers are the customers or users who are also named as cloud clients. There are four different types of clouds based on their deployment model such as public cloud, private cloud, hybrid cloud and multi cloud. Public cloud has its own service provider and internet provider. In private cloud, service provider has its own internet provider

with authentication. In hybrid cloud, combining two different cloud services in a single form was important task. In multi cloud, service provider has connected different internet provider with a separate link. Each internet provider will be managed by their respective service providers. It denotes that the service provider has more number of internet services with more number of users. Due to this reason, it requires scheduling for better efficiency.

1.1 Scheduling approaches

Sontakke et al. [1] suggests the green cloud computing algorithm for better resource allocation with the help of virtual machine. After getting the request from user, this proposed algorithm allocates the channel and virtual machine for data transmission. That helps to reduce the power consumption and overload issues. Pradhan et al. [2] presents great discussion on cloud computing, which is used to store the data. So this cloud computing requires more space and resource allocating. These two requirements had been solved using the modified Round Robin Resource Allocation Algorithm. Chandran et al. [3] explains about the fuzzy logic and neural network model to improve security resource allocation scheme for cloud computing technologies. This technique has scheduling manager, security manager and trust manager for each purpose. Based on this management, it can increase the safety transmission and safety resource scheduling for users. Wang et al. [13] discusses the scheduling framework for cloud robotics which is used to solve the resource sharing problem. This co-localization technique is used to decrease the optimization problem and increase the resource allocation scheme.

2 Related work

Feng et al. [4] discusses the time service factor which is used to avoid the resource allocation problem and queuing problem. Experimental results analyze the performance and have shown that the proposed scheme gives optimal solution for the resource allocation problem. Verma et al. [5] proposed the heuristic approach in cloud computing for better performance in resource allocation by using the virtual machine. This will avoid the crucial issues in the cloud computing and allocate the virtual machine for each host that helps to reduce the power consumption. Zhang et al. [6] proposed the two step online scheduler which has done proper scheduling. The first step will be scheduling for eligible host and then second step will be to allocate the pre scheduling for waiting host. Zeng et al. [7] suggest the cloud of cloud techniques for maximizing the multi cloud service users and reduce the optimization cost with the help of neighboring resource algorithm and global resourcing algorithm. Thaman et al. [8] presents parallel distributed and grid cloud computing for cloud service providers to give the best resource sharing scheme. This technique analyze all the optimization techniques from that it selects the genetic algorithm for resource allocation on cloud service providers and cloud users in cloud computing. Tiwari et al. [9] suggests the load balancing management scheme for achieving good performance in computing. By using virtual machine, the performance can increase; virtual machine has its own memory and CPU. If any of the link fails, it can make an efficient transmission using virtual machine by allocating the resources in the cloud computing environment. Passacantando et al. [10] discusses about the hourly based service for cloud service providers in the cloud computing. This technique is mainly focusing on reducing the cost even in multiple cloud system with the help of virtual machine. Here it takes software as a service for resource sharing and also for better performance in cloud computing. Pan et al. [11] proposed the cross entropy based optimization approach and this will help to reduce the revenue maximization problem. Here cloud providers will help to serve the virtual machine on the entire host in the cloud computing technology. Fouz et al. [12] suggests new scheduling algorithm to reduce the cost and time that increases the resource and quality for cloud computing. This technique is used to increase the quality of the performance in the cloud computing. Zhang et al. [16], Chauhan et al. [14] suggests the prioritized task scheduling in cloud computing for better performance. Xu et al. [15], Wang et al. [17,18] discusses on the workflow scheduling algorithm for increasing the service reliability, cloud service and fault tolerance in cloud computing. Finally, all over existing approaches concentrated on performance improvements and also has its own merits and demerits.

2.1 Cloud-DLS (C-DLS)

Dynamic trusted scheduling for cloud environment involves trusted model for an efficient communication between the providers and users. It involves network, cloud computing services, trustworthy model and client. Network is used to access the medium, then it passes to the cloud services and then to trust worthy model. The process of trustworthy model involves:

- Initially get the task from task queue and will be forwarded to the schedule manager.
- Schedule manager forward the task to trust model to analyze and verify whether is it trustworthy.
- Trustworthy process involves the local transaction and cloud services. If it is trustworthy, that will forward it to the task scheduler through the schedule manager.
- Task scheduler allocates the resource scheduling task to their respective client in cloud computing.

Due to this process, there will be unnecessary transactions between the schedule manager and task scheduler. After receiving the task, it can directly communicate to the trust model. By avoiding the scheduling manager, it can decrease the delay and increase the performance. This is one of the existing model that is used for trust scheduling in cloud computing.

2.2 Adaptive EE scheduling (AEES)

Another existing model is adaptive energy efficient real time data scheduling. With the help of voltage controller, it can schedule the data in cloud computing. Initially data will be arrived in the queue. From that first data it will be taken and then will be assigned with a voltage level and that particular voltage level will be reduced by the local cluster member by reducing the energy consumption. The process of adaptive energy efficient scheduling (AEES) mechanism is as follows:

- Data are stored in the queue, from which data will be taken and is verified whether this is real time or not.
- If it is real time data, allocate voltage level and that voltage level can be reduced using local voltage adjusting algorithm using the cluster members. This helps to reduce the energy consumption.
- If it is not real time data, that leads to drop and will be transformed to the rejected queue.

Due to this process, it cannot transmit the non-real time data. This technique is only applicable for real time data transmission. This technique generates more drop rate due to the avoidance of non-real time data.

The existing techniques have more delay and drop rate. To avoid this issue, proposed a new technique as virtual task scheduling for multi-cloud environment (VTSM).

3 Proposed-virtual task scheduling for multi-cloud environment (VTSM)

In cloud computing, task assigning and resource scheduling is the most complicated and important task. These two steps in a single process proposed a new technique which is VTSM. This will use the virtual machine to avoid the energy consumption, task assigning process and resource scheduling that will be done in the multi-cloud environment. The process of the proposed VTSM is as follows:

- Generate multi-cloud architecture with single service provider and multiple internet providers.
- Assigning the task from users or customers will be provided to the service providers.
- Generate the virtual machine that will hide the physical layer.
- By using virtual machine, it creates more number of resources between the users and service providers.
- Assigned task will be scheduled to the resources which were created by virtual machine.
- The communication process will be done between the clients and cloud service providers through the virtual resource.

By using this proposed algorithm, it can reduce the delay, energy consumption and also increase the service rate, available rate and arrival rates.

3.1 Multi cloud environment

Multi cloud computing environment involves application layer, cloud provider, cloud management and virtual physical layer. Figure 1 shows that the multi cloud architecture which consist of different layers in the cloud computing.

Figure 1 shows that the multi cloud architecture consists of layers of multi cloud computing. Physical virtual layer is used to generate virtual resource for the users. Cloud management is used to know the status of the cloud and also to make the decision for which cloud it will be in active state. This will support all the services and will be cataloged. All the database will be stored in the storage. Cloud services provide the infrastructure as service for the multi cloud architecture. An application layer is used for the process of data flow.

Single cloud computing will be produced high overload due to the single internet providers. But in multi cloud computing, it will distribute the work load evenly to their internet providers.

Figure 2 shows that the process of proposed algorithm. This algorithm generates virtual router for each user to access the resource. By using that particular resource, users will research the on the service providers and internet providers based on their task.

3.2 Virtual machine

Virtual machine process generates virtual router between the cloud service providers and users. This will help in reducing the delay and energy consumption. By using this virtual machine, it can generate even workload to all the available resource. Virtual machine (v) consists of three steps such as application, allocation and virtual machine. Users (u) will access the application and then allocate the virtual machine to each users. Based on the application, virtual machine will generate $u \times v$ matrix. Here, u/v should be greater than 1 that indicates the number of users should be greater than the number of virtual machines. At that time, work load will be

Fig. 1 Multi cloud architecture

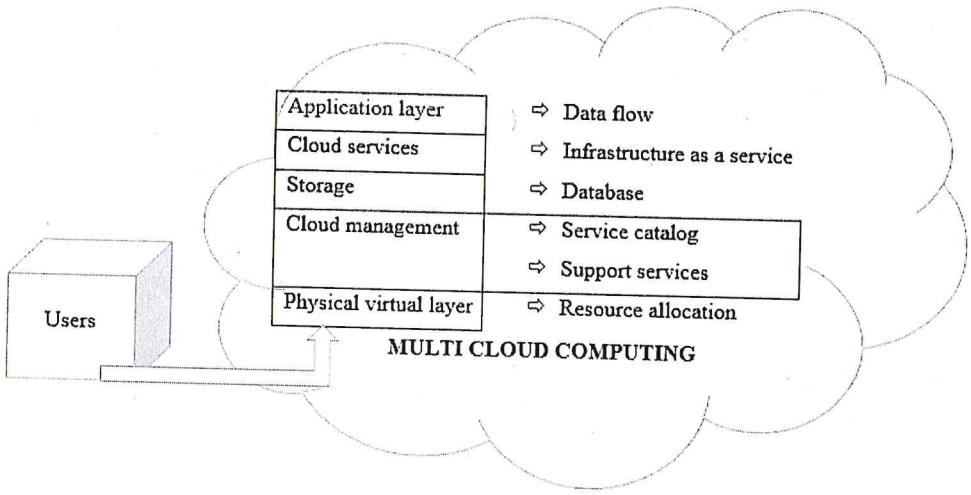
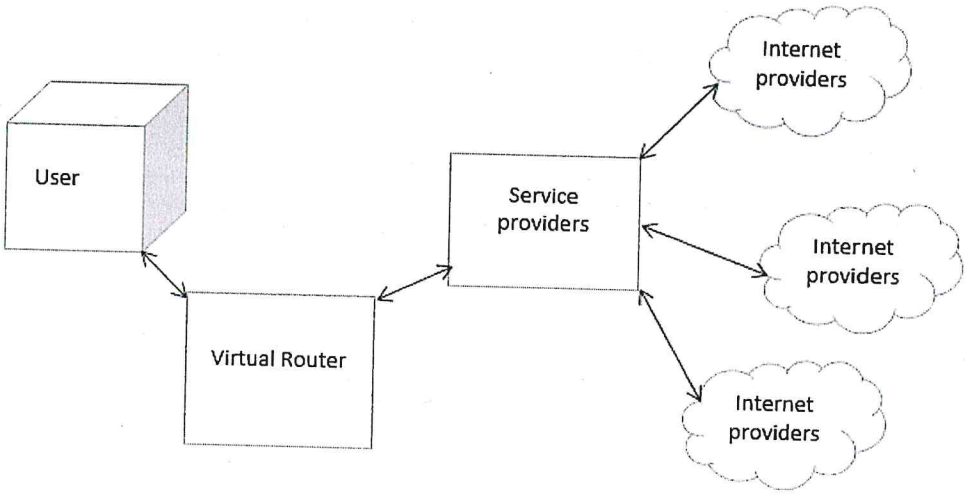


Fig. 2 Process of virtual task scheduling for multi-cloud environment (VTSM)



evenly distributed. This process will reduce the makespan. Makespan is stated in Eq. 1.

$$Ms = \max_{x \in u; y \in v} Ct[x, y]. \tag{1}$$

Makespan is defined as the maximum task time on completion of task with respect to $Tc(x)$ and $Vm(y)$. $Tc(x)$ is xth task completion time and $x = 1, 2, \ldots, u$; and $Vm(y)$ is yth virtual machine and $y = 1, 2, \ldots, v$; the running time of virtual machine calculation is necessary for scheduling. To find the running time of virtual machine, it requires processing time. The process time of virtual machine $Vm(y)$ is $Pt(y)$. The process time for the task $pt(x)$ is stated in Eq. 2.

$$Pt(x, y) = Cc(x)/Pt(y), \tag{2}$$

where Cc is the computational complexity for the ith task and $pt(y)$ is the processing time of yth virtual machine and $Pt(x, y)$ denotes the processing time of task $pt(x)$ by virtual machine $Vm(y)$.

To compute all the task from $1, 2, \ldots, u$ the virtual machine can estimate the running time of each virtual machine by using the Eq. 3.

$$R(y) \underset{y \in 1 to v}{\longrightarrow} = \sum_{x=1}^{u} Pt(x, y). \tag{3}$$

Here, running time of each virtual machine should be lesser than or equal to task completion time.

$$\sum_{x=1}^{u} Pt(x, y) \leq \max_{x \in u; y \in v} Ct[x, y]. \tag{4}$$

Compare Eqs. 1 and 4.
Rewritten the Eq. 4 as

$$\sum_{x=1}^{u} Pt(x, y) \leq Ms. \tag{5}$$

Table 1 Specific notations

Notations	Abbreviations
U	Number of users
V	Number of virtual machine
Ms	Makespan
Tc[x]	xth task completion time
Vm[y]	yth virtual machine
Ct	Completion of task
Pt(x)	xth task processing time
Pt(y)	yth virtual machine processing time
R(y)	Running time for yth virtual machine
Pt(x, y)	Processing time of xth task to yth virtual machine
Cc	Computational complexity
Cm	Cloud manager
v(y)	yth virtual machine
u(x)	xth users or task
Unn	Number of users based on the prioritization
U1	Task for 1st priority
Un	Task for nth priority
y(v)n	nth priority assigned to vth virtual machine
Hr(u)	uth high rated task
Lr(u)	uth low rated task
y(1)	1st virtual machine
y(v)	vth virtual machine

If the condition of fourth equation satisfies, this proposed algorithm will help to reduce the makespan and also to increase the resource utilization scheme. That will be shown in Eq. 5.

3.2.1 Notations

Table 1 shows the notations and their respective explanations used in the proposed virtual task scheduling algorithm.

3.3 Task scheduling

The next process is task scheduling, users will generate the task and that will be assigned to the virtual machine. Virtual machine will generate the resources for the scheduled task to make an efficient performance. There are three different types of scheduling algorithm which was used in the proposed algorithm based on the number of task and number of virtual machine. The first one is equal load balancing (ELB) algorithm, second is high prioritization (HPR) algorithm and third one is rate based scheduling (RBS) algorithm. By using this three algorithms, can estimate the performance of the proposed algorithm.

3.3.1 ELB algorithm

ELB algorithm will distribute the task (u) evenly to all the available virtual resources (v). The steps of the ELB algorithm are as follows:

- Get u and v values; u is number of tasks or users and v is number of virtual machines.
- If u is equal to v, do this procedure.
- Divide the task based on the number of virtual machine.
- Allocate the virtual resources to each task.
- This will be maintained by the cloud management.

Algorithm-ELB

Input: $x=1, 2...u;\ y=1, 2...v;$
Output: allocate u in v equally
Check stack FULL
Get *u and v*
If $u = v$
Cm decides ELB \\ Cm-cloud manager
Allocate $v(x)=u(y);$ \\ Equally distributed
Else
Cm allocate other scheduling algorithm
Vary *u and v*
End
Else
Wait until
Stack FULL
end

For example; $u = 3;\ v = 3.$

$$v(1) = u(1),$$
$$v(2) = u(2),$$
$$v(3) = u(3).$$

Algorithm 1 explains that the task will be distributed equally to the virtual machines. By using this algorithm we can avoid the delay, overload and energy consumption.

3.3.2 High prioritization algorithm (HPR)

If the number of users is greater than the number of virtual machine, it will use this HPR algorithm. All the tasks are formed in the stack after that it verify the task levels and number of virtual machines. If $u > v$, it divides the task based on the prioritization level. After that, high task prioritization will be allotted the virtual resources, next will be given to medium level prioritization and finally low level prioritization. The step involves:

- Check the stack, get the u values.
- If $u > v$, divide the task based on the prioritization.

- First priority ($u1$) given to HPR task.
- Second priority ($u2$) given to medium prioritization task.
- Third priority ($u3$) given to low priority task.
- Allocate v to $u1$ next $u2$ and $u3$.
- This will be monitored and decide by cloud management.

Algorithm 2: HPR

Input: get $x=1,2...u;\ y=1,2...v;$
Output: Scheduling based on prioritization
Check stack
If stack FULL
Get u
If $u > v$
Decides *Cm* \\ Cm-Cloud manager
Use HPR
*Divide Unn=x(u)/*Pr \\ based on
Pr-prioritization; divide
prioritization level up to n
U1→ FP \\ FP is first priority
.
.
.
Un→LP \\ LP is last priority
Allocate v(y)n=Un \\ Allocate
virtual machine v varies from 1
to v to the prioritization task Un;
n varies from 1 to n.
Else
Cm allocate other algorithm
Vary u and n
End
Else
Wait
Until stack FULL
End

Algorithm 2 explains the HPR Algorithm, here virtual resources allocated based on the priority level. Prioritization is allocated and the rearranged stack allocates the virtual resources from high priority task to low priority task. This algorithm will also help to reduce the delay and drop rate and overloaded.

3.3.3 Rate based scheduling algorithm (RBS)

The third algorithm is RBS algorithm and this cloud computing uses the pay by use concept. If any of the tasks has high rate, virtual machine will be allocated for that task. If the stack has completely filled the task, cloud manager will verify the number of tasks and number of virtual machines. If $u < v$, there is no issue to schedule here because large number of virtual resources are available for lesser number of tasks. Due to this, scheduling the task based on the high rate users. The steps of the RBS algorithm have following steps:

- Check the stack level.
- Get the u and v values.
- If u < v; available more virtual resources.
- So that will be used for the rate.
- This will allocate the high rate task to the virtual resources.

Algorithm-RBS:

Input: Get $x=1,2...u;\ v=1,2,....v;$
Output: Scheduling done based on the high rate
If Stack FULL
Get u and v
If $u < v$
Cm decides RBS
Allocate $y(1)=Hr(u)$ \\ high rated task 1st priority
$y(v)=Lr(u)$ \\ low rated task
Else
Cm allocates other scheduling algorithms
Vary *u and v*
End
Else
Wait Until stack FULL
End

Algorithm 3 explains that the RBS algorithm uses the pay per user concept, if the task has high rate, it will be ready to transmit using the virtual resources. And this algorithm helps to increase the efficiency of the cloud computing and will also avoid the performance degrade.

4 Experimental results

Results have been analyzed using the Netbeans IDE simulator in the windows PC. Here, we analyzed the performance of the proposed technique of three different scheduling algorithms with the existing methodology such as C-DLS and AEES. Compared to the existing approach, proposed VTSM with the three different algorithms such as ELB scheduling algorithm, high priority scheduling algorithm and RBS algorithm. The parameters are used to analyze and know the performance of the cloud computing. That parameters include delay, jitter, energy consumption, efficiency, makespan and overload ratio. The overall simulation time is assigned as 200 s. For these three different algorithms, different input levels are given. For ELB algorithm, number of users as 100 and number of virtual machine as 100. Next, HPR algorithm has assigned the number of users as 100 and number of virtual machine as 50. Finally, for RBS algorithm, number of users are assigned as 50 and the number of virtual machines as 100.

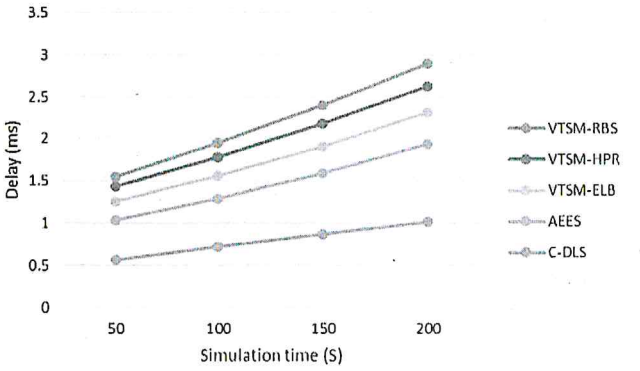


Fig. 3 Delay analysis

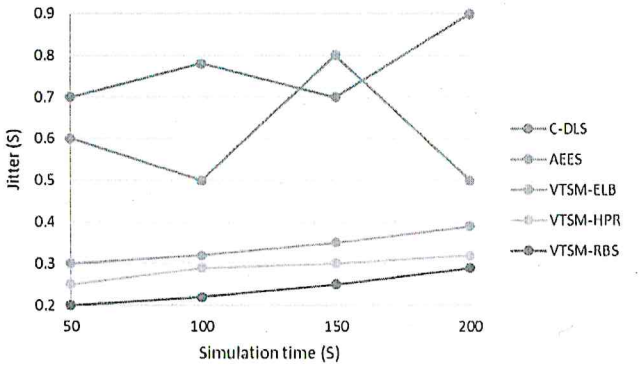


Fig. 4 Jitter analysis

Figure 3 show that the delay analysis and that the proposed scheme has reduced the delay with the three different scheduling algorithms compared to the existing approaches. ELB completely reduce the delay by equally distributing the number of tasks to the virtual machines. HPR scheduling algorithm reduces the delay by allocating the available virtual resources to the high priority for an efficient communication. RBS algorithm will reduce the delay with the availability of more number of virtual channels for the lesser number of assigned tasks.

Figure 4 shows the jitter analysis which shows reduction by using proposed VTSM with three different algorithms. Latency is high in existing approaches such as C-DLS and AEES. But the proposed technique reduces the delay even in three different scheduling algorithms.

Figure 5 shows the efficiency analysis and this will be estimated using the overall performance, where the reduction in the delay leads to the increase in network efficiency. The proposed VTSM with ELB algorithm achieves 92% of average efficiency. VTSM with high priority based scheduling algorithm achieves 85% of average efficiency. VTSM with RBS algorithm has 83% of average efficiency. Compared to the existing C-DLS and AEES algorithm, proposed VTSM has increased the average efficiency.

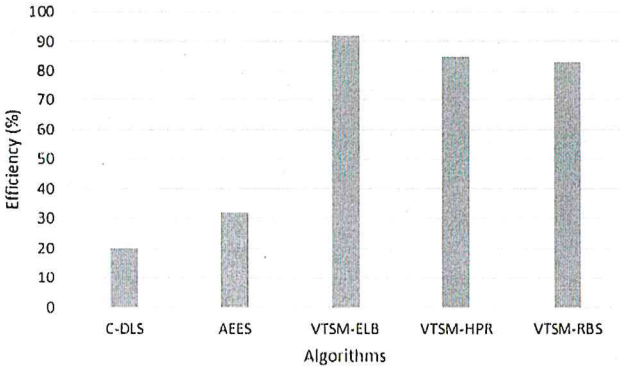


Fig. 5 Average efficiency

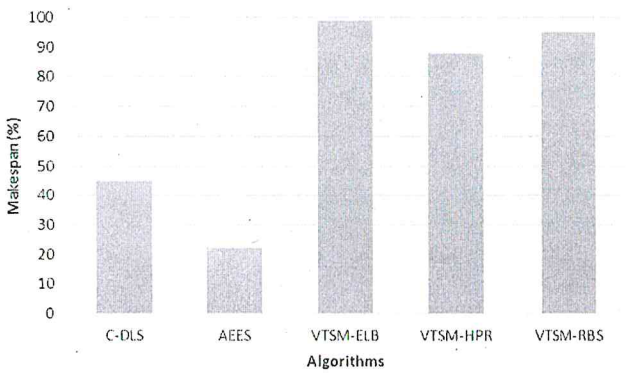


Fig. 6 Makespan in percentage

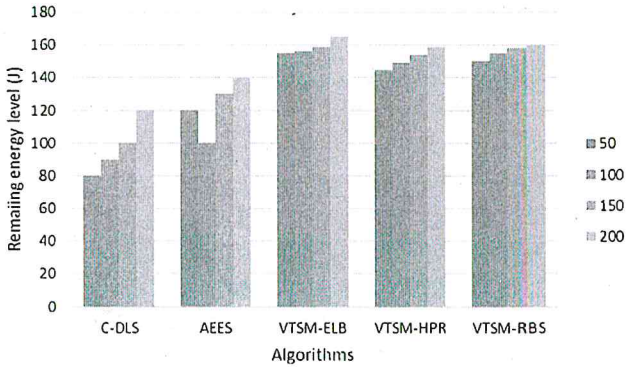


Fig. 7 Energy level

Figure 6 shows the makespan analysis and it is used to increase the lifetime of the multi cloud environment. The proposed VTSM with ELB algorithm has higher makespan due to the distributed equal number of tasks to their equal number of virtual machines. By using the HPR algorithm has 88% of makespan and RBS algorithm has 95% of makespan due to more number of available virtual resources for the lesser number of tasks. Compared to the existing C-DLS and AEES, proposed virtual task scheduling algorithm increases the makespan.

Table 2 Comparison of parameters

Algorithm/parameters	C-DLS	AEES	VTSM-ELB	VTSM-HPR	VTSM-RBS
Makespan (%)	45	22	99	88	95
Average efficiency (%)	120	140	165	159	160
Average response rate (%)	40	60	92	83	89
Utilization (%)	34	46	95	82	90

Figure 7 shows the energy consumption, initially energy limit for all the cloud members is 200 J. When the simulation ends the remaining energy in every cloud member is found which is used to calculate the energy consumed. Compared to the existing approach C-DLS and AEES, proposed VTSM has reduced the energy consumption.

Table 2 shows the comparison of parameters to compute the performance of the existing and proposed approaches. Here, when compared to the existing C-DLS and AEES technique, proposed VTSM has increased the makespan, average efficiency, average response rate and resource utilization by using three different scheduling algorithms.

5 Conclusion

The proposed VTSM with three different scheduling algorithm increases the makespan and average efficiency reduces the delay, energy consumption and jitter. Compared to the existing approaches such as C-DLS and AEES, proposed VTSM has achieved high performance of multi cloud computing. By using these three different algorithms it can reduce the delay and increase the makespan. ELB algorithm will distribute the loads equally, high priority scheduling algorithm is used to give the priority to the HPR task and the RBS algorithm allocate more number of virtual resource to lesser number of tasks based on the high rated task. Simulation results have shown that the proposed virtual task scheduling algorithm increases the makespan and reduces the delay and energy consumption.

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