Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

An Efficient Approach for Minimization of Energy and Makespan in Cloud Computing

Manoj Challa[1], Danthuluri Sudha[2]

[1]Department of CSE, CMR Institute of Technology, Bengaluru India.
[2]Department of CSE, CMR Institute of Technology, Bengaluru India.

ABSTRACT

Cloud computing is a rapidly growing technology that offers different services to end consumers in a limited amount of time through a pay-as-you-go model. Furthermore, the rise of cloud computing has an additional benefit for implementation in a massive scientific workflow. The scientific workflow describes a calculation sequence that allows the analysis of distributed and hierarchical data; since this workflow involves a large number of tasks, energy consumption is a major concern. Therefore, we propose a solution that not only reduces energy consumption but also reduces processing time. Furthermore, we have developed an efficient approach by considering energy as a parameter and varying the size in montage scientific workflow model to reduce energy and the time of processing.

Keywords: Cloud Computing, Scientific workflow, energy consumption, Processing time, Virtual machines.

1. Introduction

Cloud computing has gained popularity because of its outstanding features. Cloud is a distributed system which contains a collection of inter-connected devices. This model uses empty resources that increase economic efficiency by increasing the level of consumption and reduced energy use. The main purpose of using the Cloud is data sharing, resources and resources between users. Cloud offers many applications that benefit users. The focus is on improving the use of computers processing time and reduce energy consumption. Cloud is used as a mode to pay per usage. The payment is made only for the services used. Services provided by cloud computing in particular is divided into three categories namely Software as Service (SaaS), Infrastructure as a service (Iaas) and Platform as a service (Paas) [1]. In 2016, 289 data centres in Europe alone consumed 3,735,735 MWh of total power [2]. As a result, it is unavoidable that the data centre would erupt in terms of power and numbers in order to satisfy the heavy demands of consumers. This raises environmental concerns, as coal, gas, and oil power 66.8 percent of the world's energy in 2017 [3], and allows the population to adopt renewable cloud computing technologies. A workflow consists of a series of computing steps that must be executed using third-party software, posing VM management challenges. Workflows in

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

the cloud are executed on VM instances (VMIs), which are generated from real VMs. From a single VM, we can create several independent VMIs. Processing and scheduling these workflow task large amount of time due to its complex nature. Task management and resource allocation are also major issues in both Grid and cloud computing and plays major role for improvising various parameters like energy, load and makespan. The cost advantage of these computing paradigms is affected by the scheduling of cloud services to customers by service providers. Traditional scheduling techniques are impossible to implement in a cloud setting due to its complex, distributed, and sharable properties. The primary goal of resource distribution is to enable cohesive resources to meet their efficiency goals. Although many jobs are working at the same time, they each need different services. In this paper, we propose the Energy minimization algorithm (EMA) for scientific workflow in the field of cloud computing, the purpose of which is to reduce energy utilization and processing time while performing complex tasks of this scientific flow. The test results, on the basis of applications of real-world science applications, demonstrate the functionality and performance of our proposed algorithm.

2. Related Study

In this section, we have discussed various energy minimization and task scheduling techniques. Proposed a framework called CARE Resource Broker (CRB). CRB rules are followed in create, manage and assign virtual resources to the cloud environment. The maximum planning rating for CRB is 80% [4]. Suggested a way to plan a major problem in the cloud. divided into dependent activity. The sequence of activities is linked to the DAG tree. Editing this activity, the algorithm focuses only on reducing makespan [5]. Proposed profit planning for cloud services. Profit means service quality [6]. The proposed algorithm for scheduling similar tasks in the cloud system to improve performance. Similar processing is installed on the cloud computing. It looks for paid jobs [7]. Introduced Berger's model for cloud computing. It exercises a double standard of justice. The first barrier is to differentiate the user's work based on QoS and the second barrier is to fail to use resources [8]. Proposed adaptive resource allocation technique for pre-emptible jobs [9]. Proposed genetic based cloud scheduling approach [10]. A market-oriented scheduling polices are proposed and, in this model, scheduling policy considers user budget level and task dead line [11]. Proposed live virtual machine migration-based algorithm for decreasing power consumption. Along with this technique, they have adopted the practice of server consolidation for better computing proficiency and lesser power and cooling expenses [12]. For a given data produced rate and transmission delay, an average transmission energy strategy for minimising unit data is proposed [13]. Proposed Meta-heuristic algorithms have been implemented to solve NP-hard problems like task scheduling whether it is for computation process, industry, and employee scheduling good performance to solve makespan, energy consumption, and load balancing [14]. Proposed Chaotic symbiotic organisms search approach which minimize makespan and cost [15]. Two different approaches such as Genetic

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

Algorithm and Max-min algorithm have been discussed and a green optimized energy-aware scheduling using genetic algorithm have been provided which consume less energy to the Virtual machines [16].

Finally, from the related works we conclude that different approaches were used to schedule resources and minimize energy. Also, we need to provide an efficient resource handler that provides minimum energy utilization and processing time.

3. Proposed Model

In this section we will discuss about the proposed system model and minimizing the energy and the processing rate. Figure 1 depicts the proposed system model, in which the task computations will be done in parallel. Our proposed model acquires appropriate usage of resources with respect to infrastructure like storage, local area network (LAN) and virtual machine controller (VMC) as shown in the figure1. When a new job is allocated, we need to consider its time of arrival a_t and the total size which is denoted by s_t in bits. Depending on the complexity of the job, tasks is divided into n number of sub tasks and each sub task will be computed parallelly by the VMs. The Maximum number of VMs used to complete the execution of the task is assigned by the VMC and can be represented as $M_j >> 1$. To improve the efficiency and performance of the model we consider the size of the job remains constant over the given time period.

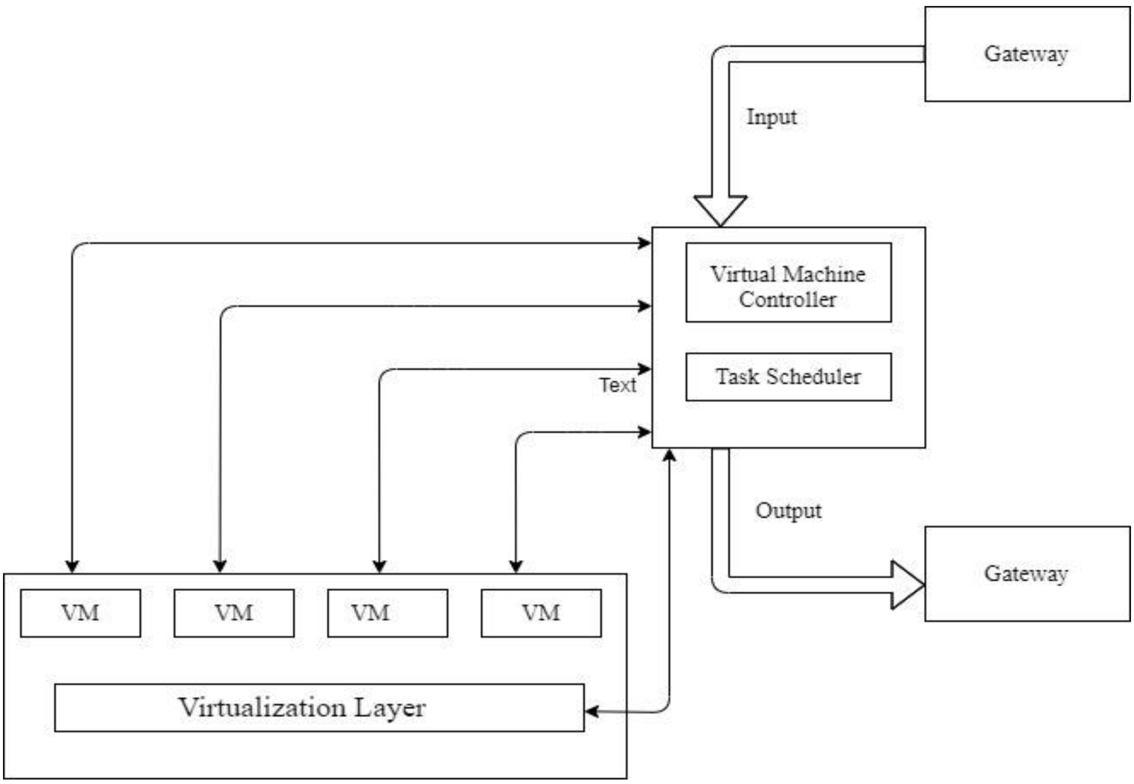

Figure 1. Proposed system model

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

Let us consider the task size and communication rate as shown in the below equation

$$C_{j,}\ j=1, \ldots\ldots\ldots N$$
$$S_{j,}\ j=1, \ldots\ldots\ldots. N \quad (1)$$

Each job is divided into d parallel task

$$\sum_{j=1}^{n} Cj = Ck \quad (2)$$

The execution time per each job is given in the below equation

$$\{2ET(j)\} + € \leq V_c \quad (3)$$

The energy consumption is given as

$$\sum_{j=1}^{n} y_i \left(C_j \cdot (c_j)^{-1}\right) \Omega(j) E_j + q_k \left(c_j - c_j^n\right)^2 + 2p(S_j)\left\{C_{-i}(S_j)^{-1}\right\} \quad (4)$$

The first two terms in the above equation represents the energy utilized via reconfiguring and communicating while processing the tasks and the last term denotes the point-to-point link that helps for transmitting the bits. By considering the parallel processing and transmission rate the energy minimization can be formulated as shown below.

$$\min\{S_j\} \sum_{j=1}^{n} 2Q_j^t(S_j)(S_j)^{-1} C_j \quad (5)$$

Let us consider virtual machine instances for the given task to process and the virtual machine configuration mappings to get the starting time (STx,y) and finish time ($FT_{x,y}$) to calculate the total execution time (CTx,y) of the task. Let the complete execution time is calculated as shown in the below equation

$$CTx,y = STx,y + ET_{x,y} \quad (6)$$

In the above equation first term represents starting time and the second term represents execution time for the task size on a particular virtual machine instance. Further, we calculate the makespan as shown in the below equation

$$MS(w, \mathbb{R}) = \max_{v_w \in v(\omega), v_k} \{CT_x, y\} \quad (7)$$

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

In the above equation v_w indicates, $v(\omega)$ indicates task set of workflow $and\ v_k$ virtual machine instance set.

The minimization of makespan, energy consumption is evaluated by considering montage workflow which is discussed in the next section.

4. Results & Discussion

In this section, we evaluate designed model on montage dataset using our proposed model with the existing model. Montage workflow is an application which is made by NASA where multiple inputs images are taken for generating the custom mosaics. Montage workflow comprises four distinctive da file with its various variant; moreover, these variants are related in terms of make span, energy intake and average power.

4.1 Comparative study

Table1 compares the existing model while the VM is set at 60. The Montage 25 model uses 48.68, while the ECWSD model uses 58.72. When the Montage 50 model is used the existing takes 97.72 and the proposed takes 82.03. When the Montage 100 is used the existing model takes 125.93 and the proposed model takes 100.94. Similarly, when the montage 1000 is used the existing model uses 1081.89 and the proposed uses 945.53. The graphical comparison is as shown in figure 2.

Table 1. Comparison of Makespan with the existing model

Workflow variant	Montage_25	Montage_50	Montage_100	Montage_1000
EMA	48.68	82.03	100.94	945.53
CWSD	58.72	97.84	125.93	1081.89

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

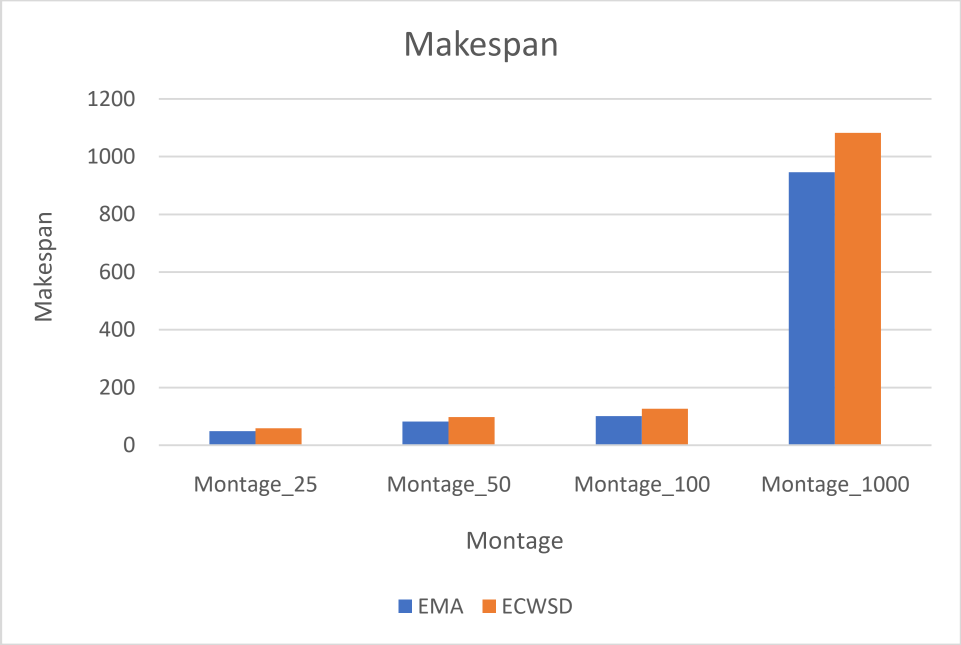

Figure 2. Graphical Comparison of makespan with the existing model

Table 2 depicts the comparison of existing model with the proposed model for the energy consumption by setting the VMs at 60. For the Montage 25 model the energy consumption by the proposed model is 34.536j and whereas the existing model consumes 45.242j. For the Montage 50 model the energy consumption by the proposed model is 35.445j and whereas the existing model consumes 72.215j. For the Montage 100 model the energy consumption by the proposed model is 63.582j and whereas the existing model consumes 86.367j. Similarly, for the Montage 1000 model the energy consumption by the proposed model is 819.978j and whereas the existing model consumes 994.703j. The figure 3 shows the graphical representation of the model.

Table 2. Comparison of Energy consumption with the existing model

Workflow variant	Montage_25	Montage_50	Montage_100	Montage_1000
EMA	34.536	35.445	63.582	819.978
ECWSD	45.242	72.215	86.367	994.703

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

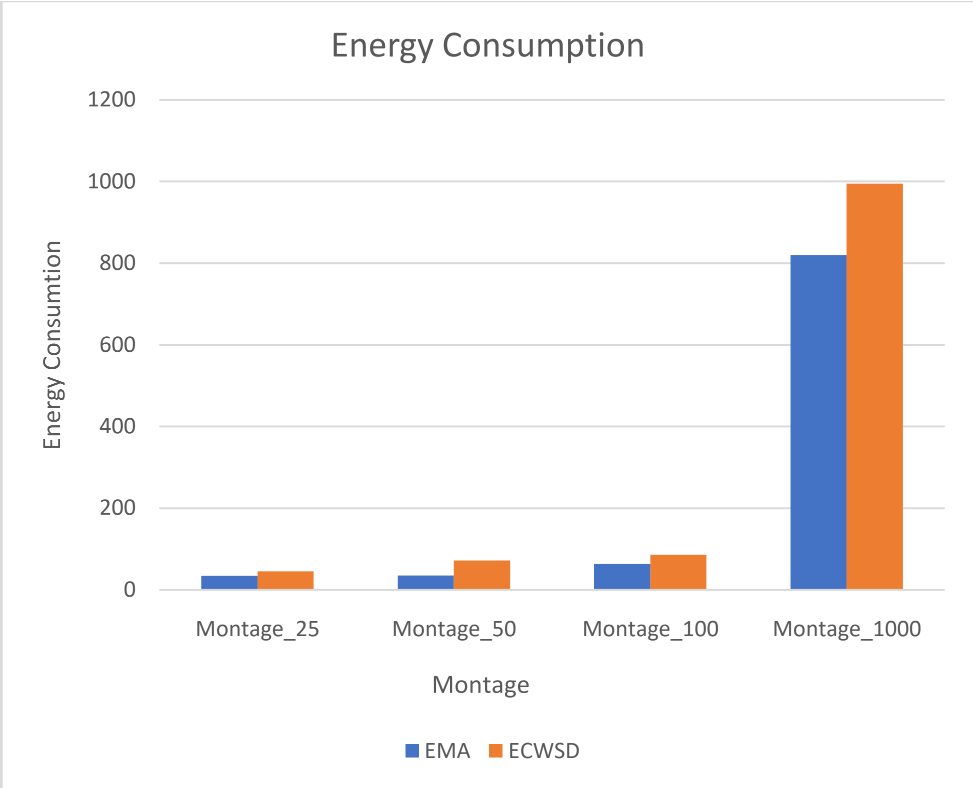

Figure 3. Graphical Comparison of Energy consumption with the existing model

Table 3 depicts the comparison of existing model with the proposed model for the average energy consumption by setting the VMs at 60. For the different Montage model like 25,50,100 and 100 the average energy consumption by the proposed model is 15.9j and whereas the existing model consumes 19.437j. The figure 4 shows the graphical representation of the comparison done.

Table 3. Comparison of Average Energy consumption with the existing model

Workflow variant		**Montage_25**	**Montage_50**	**Montage_100**	**Montage_1000**
EMA	PS	15.9	15.9	15.9	15.9
ECWSD	ES	19.437	19.437	19.437	19.437

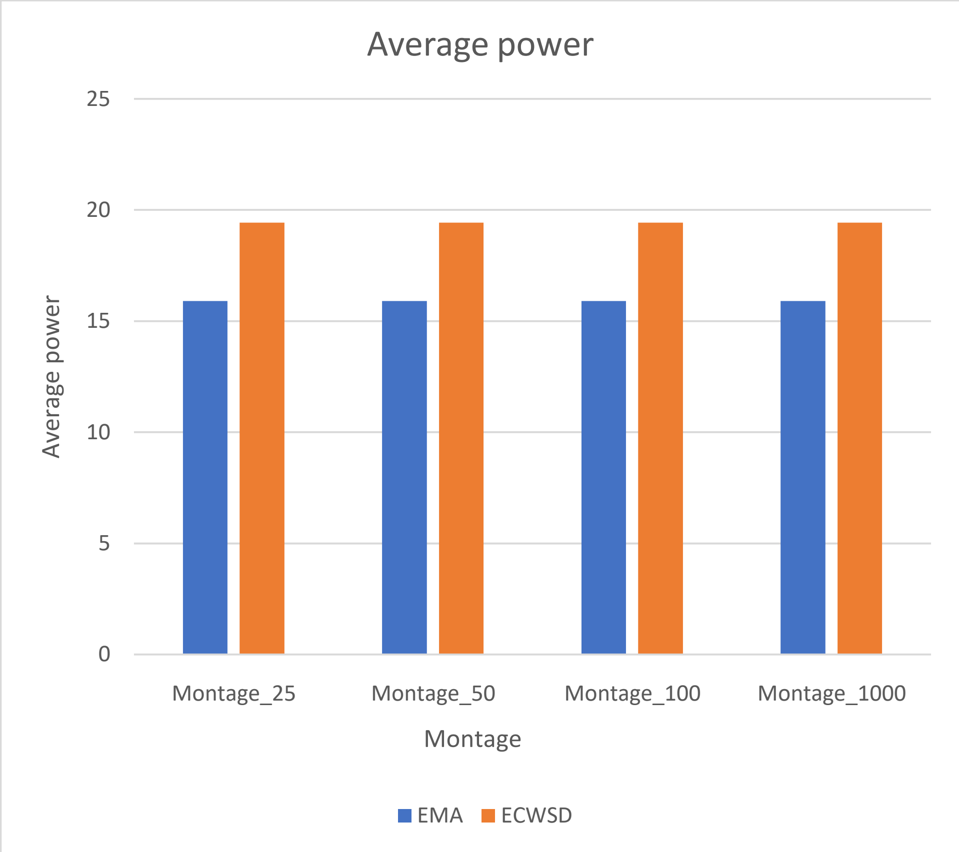

Figure 4. Graphical Comparison of Average Energy consumption with the existing model

5. Conclusion

Cloud computing technology offers significant benefits to IT industries several cloud benefits such as high availability, resource allocation and load balancing. The main purpose of research work is to reduce energy and makespan. In this paper we have proposed an energy reduction algorithm. We have scheduled the tasks based on the nature, size and the complex nature of the workflow jobs to achieve minimum processing rate based on the temporary reduction. Makespan usage and power consumption are reduced using our proposed algorithm and out performs well when compared with the existing models. In the future algorithm it can used for varying job sizes and fault tolerant activities.

References

[1] V.A. Lepakshi, Dr. Prashanth C S R, "A Study on Task Scheduling Algorithms in Cloud Computing", International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 11,2013.
[2] M. Avgerinou, P. Bertoldi, and L. Castellazzi, "Trends in Data Centre Energy Consumption under the Energy Efficiency," Energies, vol. 10, no. 1470, pp. 1–18, 2017.
[3] IAE, "Electricity Statistics," 2017. https://www.iea.org/statistics/electricity/.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 7422 - 7430
Received 25 April 2021; Accepted 08 May 2021.

[4] Thamarai Selvi Somasundaram, Balachandar R. Amarnath, R. Kumar, P. Balakrishnan, K. Rajendar, R. Rajiv, G. Kannan, G. Rajesh Britto, E. Mahendran, B. Madusudhanan, “CARE Resource Broker: A framework for scheduling and supporting virtual resource management”, Future Generation Computer Systems, Vol. 26, , pp. 337-347, 2011.

[5] Sen Su, Jian Li, Qingjia Huang, Xiao Huang, Kai Shuang, Jie Wang, “Cost-efficient task scheduling for executing large programs in the cloud”, Parallel Computing, Vol. 39, pp.177–188, 2013.

[6] Young Choon Lee, Chen Wang, Albert Y. Zomayaa, Bing Bing Zhoua, “Profit-driven scheduling for cloud services with data access awareness”, Journal on Parallel Distributed Computing, Vol.72, p p.591– 602,2012.

[7] Jiayin Li, Meikang Qiu, Zhong Ming, Gang Quanc, Xiao Qin, Zonghua Gu, “Online optimization for scheduling preemptable tasks on IaaS cloud systems”, Journal on Parallel Distributed Computing, Vol.72, pp. 666–677, 2012.

[8] Baomin Xu, Chunyan Zhao, Enzhao Hu, Bin Hu, “Job scheduling algorithm based on Berger model in cloud environment”, Advances in Engineering Software, Vol. 42, pp. 419–425, 20111077, 2011.

[9] Jiayin Li, Meikang Qiu, “Adaptive Resource Allocation for Preemptable Jobs in Cloud Systems”, IEEE Computer Society, pp.31-37, 2010.

[10] Zhongni Zheng, Rui Wang, Hai Zhong, Xuejie Zhang, “An Approach for Cloud Resource Scheduling Based on Parallel Genetic Algorithm”, IEEE 2011, pp.444-447, 2011.

[11] Mohsen Amini Salehi and Rajkumar Buyya, “Adapting Market-Oriented Scheduling Policies for Cloud Computing”, Springer LNCS 6081, pp. 351–362, 2010

[12] Jeba, Jenia & Roy, Shanto & Rashid, Mahbub & Atik, Syeda & Whaiduzzaman, Md. (2019). “Towards Green Cloud Computing an Algorithmic Approach for Energy Minimization in Cloud Data Centers”. International Journal of Cloud Applications and Computing. 9. 59-81. 10.4018/IJCAC.2019010105.

[13] F. Wang and G. Wang, "Study on Energy Minimization Data Transmission Strategy in Mobile Cloud Computing," 2018 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computing, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld/SCALCOM/UIC/ATC/CBDCom/IOP/SCI), 2018, pp. 1211-1218, doi: 10.1109/SmartWorld.2018.00211.

[14] Fajar Kusumaningayu, Antoni Wibowo, “An Optimization of Makespan, Energy Consumption, and Load Balancing on the Task Scheduling in Cloud Computing using Particle Swarm Optimization (PSO)”. International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-4, November 2019.

[15] M. Abdullahi, M. A. Ngadi, S. I. Dishing, S. M. Abdulhamid, and B. I. Ahmad, “An efficient symbiotic organisms search algorithm with chaotic optimization strategy for multi-objective task scheduling problems in cloud computing environment,” J. Netw. Comput. Appl., vol. 133, no. 1 May 2019, pp. 60–74, 2019.

[16] Kar, I., Parida, R. N. R., & Das, H. (2016). Energy aware scheduling using genetic algorithm in cloud data centers. 2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT). doi:10.1109/iceeot.2016.7755364.