Energy Aware Scheduling Algorithm for Cloud Computing Environments under Uncertainty Tasks

Dr.R.Parimala[1] and Dr.R.Karthikeyan[2]
[1]Principal, Ambari College of Arts and Science for Women, Arakkonam, Tamil Nadu, India.
)[2]Asst. Prof. in Department of Computer Science, Sri Sankara Arts and Science College, Kanchipuram, Tamil Nadu, India.

Abstract— In the last few years, the huge expectation in cloud computing environments has attracted many industries like automobile, IT , medicine and etc., The reason behind this attraction is resource sharing with low cost. But the problem is with the service providers. They have to guarantee 100% uptime and security. Offering a low-cost cloud environment to customers will cost the service providers a huge power consumption which in turn affects the environment using carbon emission. Many researchers have contributed their ideas to maintain 99.99% uptime with different scheduling techniques. Very few techniques consider power consumption along with the scheduling process, but they fail to concentrate on uncertainty issues. One such uncertainty issue is overload and underload. We propose a Dual Active - Energy Aware Scheduling algorithm to address the above-mentioned problems. At the end of the simulation, we found that our DA-EAS has good performance and consumes much less power than the conventional systems.

Index Terms—Cloud Computing, Scheduling, Power Consumption, Resource Sharing

I. INTRODUCTION

It is the current era where all the data storage has gone cloud. In the past, Computers would need large rooms with costly components to perform home and office stuff. Not only cost, they consume more power. Now, such devices are replaced by high-speed processors and cloud data centers [1]. Cloud computing services can be mentioned as a new approach to the dynamic provisioning of computer services supported by state of art data centers that use virtual machine technologies. Big social giants like Google, Facebook, and IBM have deployed enormous data centers around the world for their uninterrupted services. The power consumption of these data centers is noted about 3% of the Global Electricity demand. Consequently, resource sharing by multiple hosts has been an attractive demand by the users for better power-optimized solutions. In cloud data centers, primary fractions of computing applications are in real-time. Cloud Computing services are often treated as Dynamic and uncertain tasks [2, 3, 4]. When the Dynamic and uncertain tasks are left uncontrolled, the power consumption of the data centers goes wild and has a huge impact on the environment.

Most of the research works have contributed only to the uncertainty issues in the cloud. More researchers are interested in these types of data centers because power consumption not only has an impact on the Return on Investment (ROI) but also causes environmental hazards [3,4,5]. Of all types, heterogeneous clouds require more energy due to the heterogeneity of hardware and software. For systems where the CPU consumes more power in the system, Leverage Dynamic Voltage and Frequency Scaling (DVFS) are proposed to reduce the CPU's energy consumption [6, 7]. On the other hand, it should be noted that power consumption is not the only major factor to be noticed in Virtual Machines / Cloud Systems. Other parameters like memory subsystem monitoring & access, and resource allocation are being addressed by many other researchers [8,9]. However, these solutions will always have performance degradation and violation of the service-level agreement (SLA).

In the cloud environment virtual machines, VMs offer plenty of power reduction and load-optimizing solutions. When the network load goes high, additional VMs can be added to the network at ease. In the other case during underloaded scenarios, VMs can be merged concerning the demand, and the idle hosts can be shut down. It is noted that the idle hosts consume 50% of the power when it is fully operative [10]. The demands for cloud systems arise only during the need for limited resources. In this view resource sharing is the first and foremost objective to be solved. However, solutions targeting resource allocation fail to concentrate on the power utilization of the system. To get balanced and effective performance resource allocation strategies should be developed along with the power efficient model. The problems arise due to the uncertainties between the VMs and the host device [11]. For the above-said problems, we worked to parameterize the uncertainties, controlling the negative effects of resource allocations and the steps to reduce power consumption by proposing the Dual-Active Energy-Aware Scheduling (DA-EAS) method. Our proposed system combines Proactive scheduling and Reactive scheduling to complete real-time tasks under uncertain situations. The major concept of our proposed DA-EAS method is to rank the nodes according to their energy demand. Once they are ranked, our strategic cloud manager will schedule VMs and put them in operative mode as per the demand for energy from the hosts. The steps involved in the scheduling process are explained in the later sections. Energy Demand is calculated as a ratio between the load of the application and the energy consumed by the application. Further, this article is organized as follows: Section 2 discusses the literature done for this work, proposed DA-EAS method is presented in Section 3. Section 4 explains the performance evaluation of the system. And finally, Section 5 concludes the research work with the future scope.

II. RELATED WORK

Energy-aware scheduling algorithms have seen tremendous interest among researchers. Those works are classified into two models. First, Virtual machine-based models, and the second is based on Dynamic Voltage and Frequency Scaling (DVFS).

A. *Dynamic Voltage and Frequency Scaling Model*

There will be a trade-off between the parameters involved in the system design. When there is a trade-off between power consumption and performance, DVFS concentrates on power reduction in cloud data centers. An environment-conscious scheduling approach for cloud data centers was proposed by Garg et al., where a near optimal energy-efficient scheduling algorithm is used to limit the CPU frequency [12]. An extended work is done by Li et al., called Relaxation-based Iterative Rounding Algorithm (RIRA) for multiprocessor platforms to minimize the overall energy consumption [13]. In [14], a new algorithm MVFS-DVFS is proposed to utilize the slack time at maximum and control the energy consumption in the processors. This results in a poor experience to the users who opted for cloud resource sharing for cost cut down factor. In the earliest of energy efficient elastic scheduling method is proposed, which chooses to concentrate on energy consumption and the workload in demand [15]. These energy consumption techniques at a trade-off of user experience are not much appreciated by the research community and the trend has been set on Virtual Machines and further literature is carried out on virtualization techniques.

B. *Virtual Machines*

Many proposed works on VMs concentrate on reducing and increasing the physical hosts based on the demand. Most of the research work proposes to turn off the host when they are idle. They will help in reducing the power consumption at the same time the workload of the system is kept in control. In [16], a deep study has been done in accounting for the cost of the migration of VMs with a unique resource manager. However, a much more improved scheduling method under green cloud computing parameters was developed by Youngee et al., [16]. For all these works a pioneer strategic solution [17] which considers energy consumption, resource utilization, and performance of overall workload was proposed to meet the programming constraints. However, such a system fails to produce the desired solutions under uncertainty conditions. A recent work by Hsu et al. was able to merge the tasks to increase resource utilization with no trade-off between energy consumption and performance [18]. This system can optimize energy usage in cloud systems.

III. DUAL ACTIVE ENERGY-AWARE SCHEDULING APPROACH

Considering all these drawbacks we developed our DA-EAS method where during the preprocessing stage a node that requests a VM will be set under test scenarios to rank it based on the Energy Demand (ED). Then the system builds proactive-based schedules; the user also requests VMs and the needful uncertain factor. These steps are explained in detail in the following sections. A graphical cloud system is shown in Figure 1.

A. *Preprocessing Stage*

In the pre-processing stage, we perform calculations for estimating the Energy Demand for a node with various applications and hardware. Their resource allocations like CPU-intensive, memory-intensive, and I/O-intensive workloads are also ranked based on their demands. With all this information a node is ranked and labelled before its association in the cloud.

Energy Demand = Application load / Energy consumed by the application.

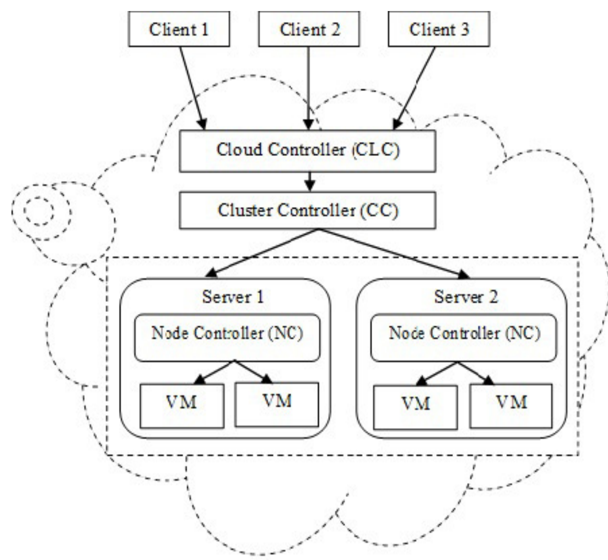

Fig. 1 Cloud Set-up of simulation

B. *Execution of DA-EAS*

When a node starts to use a VM for its resources, conventional scripts installed in the cloud system start to collect the power consumption (this can also be done with an external power meter). To optimize the system, the first step is repeated with different types of VMs, and the result is stored along the label. To estimate the Energy Demand (ED), the cloud controller does a simple math, where the average power is multiplied by the time taken to complete the application request which gives the energy consumption by the application.

Then the ED is estimated by the Eqn (1). Once the pre-processing is completed DA-EAS algorithm is executed. To optimize the energy consumption in the cloud systems DA-EAS maintains three individual Strategic tables, (i) Fitting case points (Fcp), (ii) Residual case points (Rcp), and (iii)

Operating case points (Ocp). Case points are a group of information like VM Size, max host potential (HPmax), ED, and application type. When a demand rises, the user will send a Sync request with the application type and the required VM size. Based on the DA-EAS, all the workload will be assigned to the respective nodes with maximum ED.

IV. PERFORMANCE EVALUATION OF DA-EAS

It is much more important to validate the work by comparing the performance results of the DA-EAS with the other conventional techniques. For the comparison, the following parameters are calculated and plotted against task count. Among all the plotted evaluations, the proposed DA-EAS finds promising results. Total Energy Consumption: For performing a set of tasks (T), energy is consumed by the hosts in the cloud data center.

A. Guarantee Ratio

Contribution by the proposed system to complete the set of tasks before the deadline.

B. Resource Utilization

The average host utilization during the process execution time.

C. Stability

A factor of absolute deviation between the forecasted starting time of tasks and the realized starting time during actual scheduled execution. For simulation purposes, we use CloudSim for the steps involved as discussed in the previous sections. The test cases are executed for a varying number of tasks from 10000 to 80000. In Figure 2(a), we see that the guarantee ratio for other scheduling algorithms finds it difficult to attain their maximum offering range. On the other hand, DA-EAS has a higher stability rate in terms of all the other parameters Vs the number of scheduled tasks. To examine more, we deploy our proposed method against other parameters like task deadlines and uncertainty of the tasks. Their graphical performances are plotted in Figures 2, 3, and 4.

```
sync_req(VM Size, App)
start
node.optimum = { }, EDmax = 0
∀ node in the list do
if node.Rcp holds (VM Size && App ) then
if node.Ocp ==ϕthen
EDmax = EDcurrent
node.optimum = node
end if
end if
else
EDmin = eval.ED(VM Size, App)
∀App in Orc do
EDcurrent = eval.ED(VM Size, App)
if (EDcurrent < EDmin)
EDmin = EDcurrent
end if
end ∀
if (EDmin < EDmax)
EDmax = EDcurrent
node.optimum = node
end if
end if
end ∀
if node.optimum is in SLEEP then
set WAKEUP
end if
grant access to node.optimum
end
```

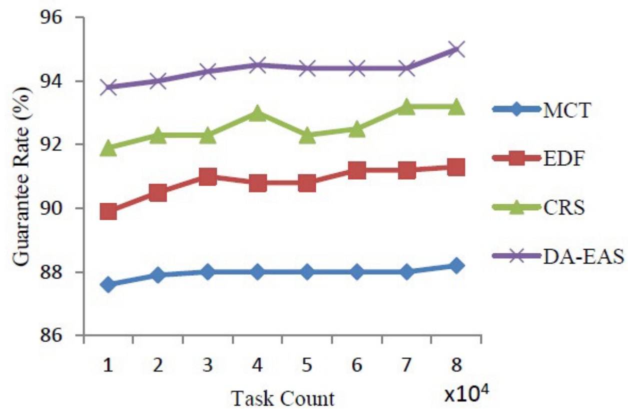

Fig. 2a. Performance based on Number of task

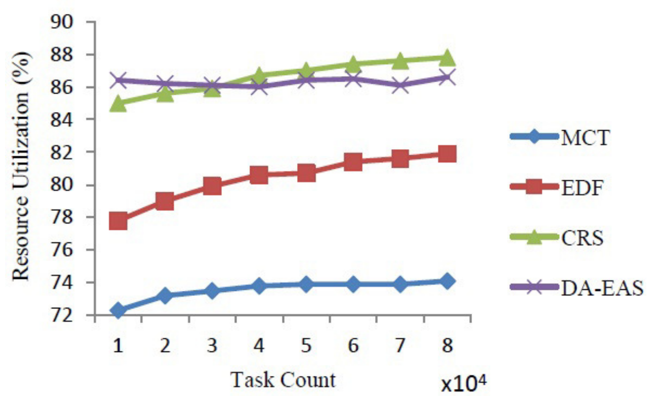

Fig. 2b. Performance of Task based on Resource Utilization

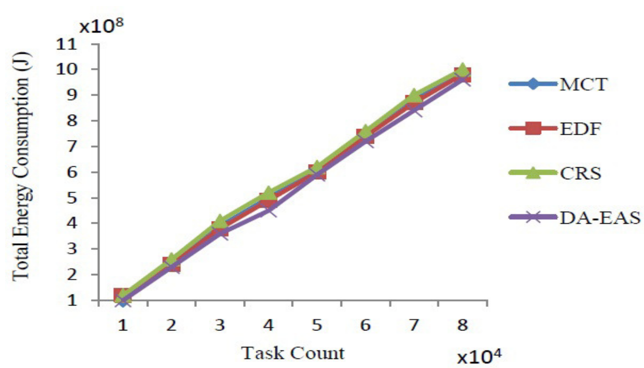

Fig. 2c. Performance of Task based on Energy Consumption

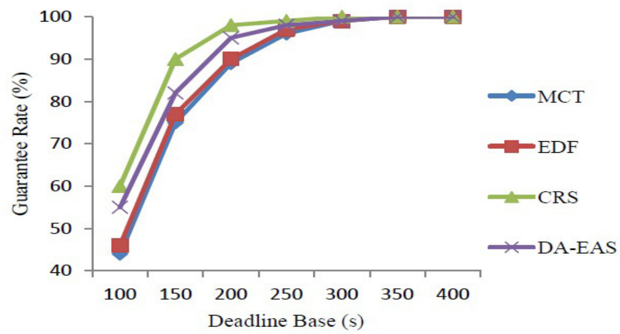

Fig. 3a. Performance based on Task Deadline

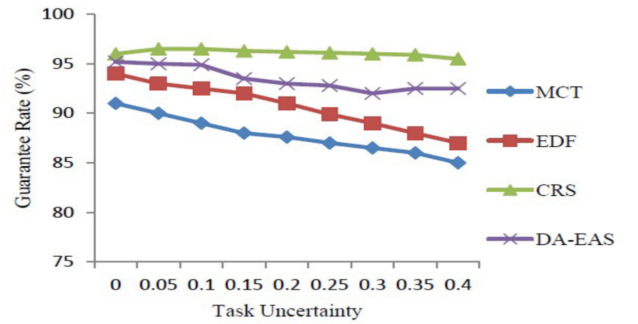

Fig. 4b. Performance based on data rate of Uncertainty Task

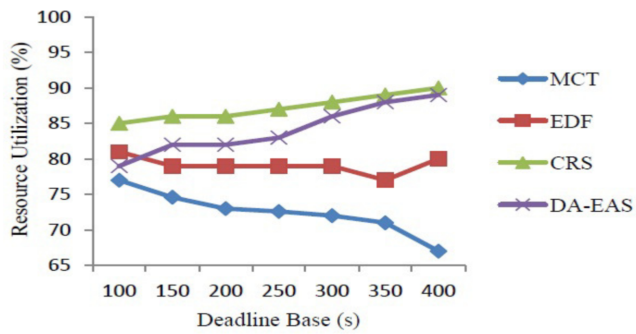

Fig. 3b. Performance of Deadline base Resource Utilization

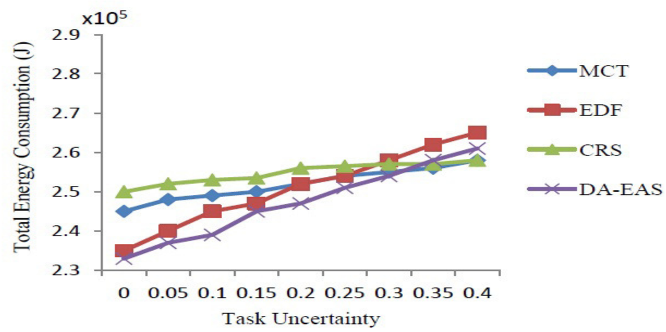

Fig. 4c. Performance of task Uncertainty based Energy Consumption

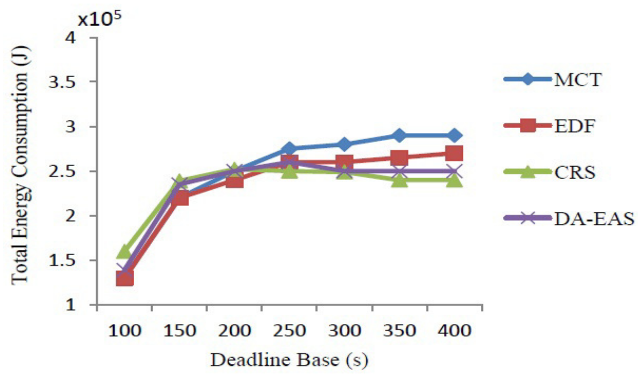

Fig. 3c. Performance of Deadline base Energy Consumption

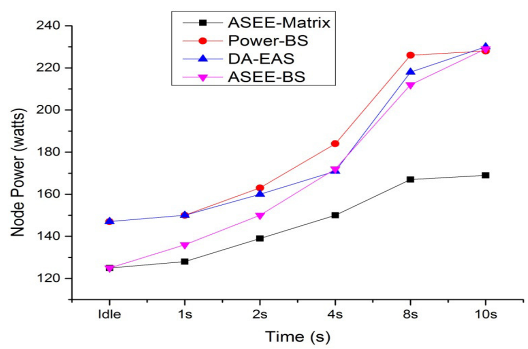

Fig. 5. Energy Consumption of nodes at varying time interval

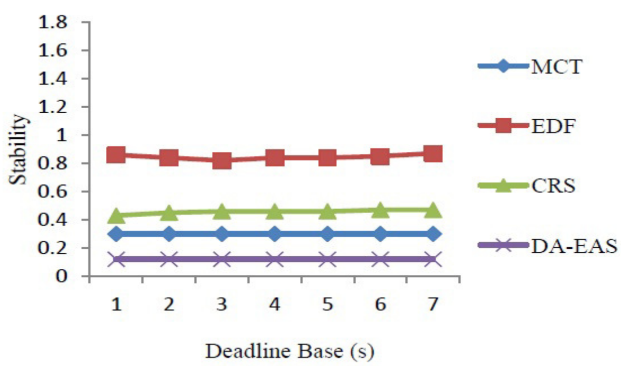

Fig. 4a. Performance based on Uncertainty in Task

It clearly shows that DA-EAS outperforms all the other conventional scheduling techniques in the cloud environment. For the power scenarios, tests were performed promptly and the power consumed by a node in Watts has been plotted in Figure 5. With all these test results, the proposed energy-aware scheduling technique will be suitable for cloud systems where higher efficiency can be achieved at an optimized power level.

V. CONCLUSION AND FUTURE SCOPE

The hype and huge demand for cloud computing systems have given us a chance to develop an energy-aware scheduling technique. Under this scenario, we proposed the Dual Active–Energy Aware Scheduling technique which is capable of achieving higher efficiency and also finds its hot place in terms of optimized power consumption. In the practical application, the proposed DA-EAS is suitable for enterprises that are small, medium, and huge sized. With all this astonishing performance cloud computing systems will never settle for advancement, they will be hungry for more and more optimized solutions. We foresee that the security issues in cloud computing systems need more attention and it should not be done at a cost of power consumption. Hence the future work of this scheduling technique can be combined with any security-based approaches to maintaining optimized power consumption.

VI. REFERENCES

[1] E. Aguiar, Y. Zhang, M. Blanton, M. *"An Overview of Issues and Recent Developments in Cloud Computing and Storage Security"* pp. 1–31. Springer, Berlin, 2013.

[2] S.P. Ahuja, D. Komathukattil, "*A survey of the state of cloud security"* Network Communication Technology. Vol. 1, Issue 2, pp 66–75, 2012.

[3] M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. H. Katz, A. Konwinski, G. Lee, D. A. Patterson, A. Rabkin, M. Zaharia, Technical Reports on Clouds: "*A Berkeley View of Cloud Computing"*. Electrical Engineering and Computer Sciences University of California, 2009.

[4] A. Aviram, S. Hu, B. Ford, R. Gummadi, "Determinating timing channels in compute clouds", In Conference Proceedings of the ACM Workshop on Cloud computing and Security, pp. 103–108, 2010.

[5] G. Back, W. C. Hsieh, *"The KaffeOS Java runtime system"* ACM Transaction Program Language System. Vol. 27, Issue. 4, pp 583–630, 2005.

[6] S. Herbert, D. Marculescu, *"Analysis of dynamic voltage/frequency scaling in chip multiprocessors"*, in Conference Proceeding: of ISLPED'07, 2007.

[7] D. Snowdon, S. Ruocco, G. Heiser, *"Power management and dynamic voltage 590 scaling: Myths and facts"*, in Conference Proceeding of Power Aware Real-time Computing, 2005.

[8] Q. Deng, D. Meisner, A. Bhattacharjee, T. F. Wenish, R. Bianchini, *"Multiscale: Memory system dvfs with multiple memory controllers"*, in conference Proceeding of ISLPED'12, 2012.

[9] Y. Song, et al., *"Multi-tiered on-demand resource scheduling for vm-based data center"*, in Conference Proceedings of International Symposium on Cluster Computing and the Grid (CCGrid'09), pp. 148–155, 2009.

[10] Y. Ma, B. Gong, R. Sugihara, R. Gupta, *"Energy-efficient deadline scheduling for heterogeneous systems"*, Journal of Parallel and Distributed Computing Vol. 72 Issue. 12, pp 1725–1740, 2009.

[11] D. Bruneo, *"A stochastic model to investigate data center performance and QOS in IAAS cloud computing systems",* Parallel and Distributed Systems, IEEE Transactions on Vol. 25 Issue. 3, pp 560–569, 2014.

[12] S. K. Garg, C. S. Yeo, A. Anandasivam, R. Buyya, *"Environment conscious scheduling of hpc applications on distributed cloud-oriented data centers",* Journal of Parallel and Distributed Computing Vol. 71. Issue. 6, pp 732–749, 2011.

[13] D. Li, J. Wu, *"Energy-aware scheduling for frame-based tasks on heterogeneous multiprocessor platforms",* In: Parallel Processing (ICPP), IEEE 41st International Conference on IEEE, pp. 430–439, 2012.

[14] N. B. Rizvandi, J. Taheri, A. Y. Zomaya, *"Some observations on optimal frequency selection in dvfs-based energy consumption minimization"*, Journal of Parallel and Distributed Computing, Vol. 71 (8), pp 1154–1164, 2011.

[15] X. Zhu, R. Ge, J. Sun, C. He, *"3e: Energy-efficient elastic scheduling for independent tasks in heterogeneous computing systems"*, Journal of Systems and Software, Vol. 86. Issue. 2, pp 302–314, 2013.

[16] A. J. Younge, G. Von Laszewski, L. Wang, S. Lopez-Alarcon, W. Carithers, *"Efficient resource management for cloud computing environments"*, In the Conference Proceeding of Green Computing, IEEE International Conference, pp. 357– 364, 2010.

[17] S. Srikantaiah, A. Kansal, F. Zhao, *"Energy aware consolidation for cloud computing"*, In the Proceedings of Conference on Power Aware Computing and Systems. Vol. 10. USENIX Association, 2008.

[18] C. H. Hsu, K. D. Slagter, S. C. Chen, Y. C. Chung, *"Optimizing energy consumption with task consolidation in clouds"*, Information Sciences Vol. 258, pp 452– 462, 2014.

[19] S Balamurugan, S Saraswathi, "*Design of Energy Aware Scheduling Algorithm for Executing Scientific Workflows in Cloud",* International Journal of Engineering and Advanced Technology (IJEAT), Vol. 9, Issue. 2, ISSN: 2249-8958, December – 2019.

[20] S B Alla, H B Alla, A Touhafi and A Ezzati, "*An Effcient Energy-Aware Tasks Scheduling with Deadline-Constrained in Cloud Computing*", MDPI – Journal/Computers 2019, Vol. 8, Issue. 46, doi:10.3390/computers8020046.

[21] Z Peng, B Barzegar, M Yarahmadi, H Motameni, "*Energy-Aware Scheduling of Workflow Using a Heuristic Method on Green Cloud*", Hindawi – Scientific Programming, Vol. 2020, Article ID-8898059, September 2020.

AUTHORS DETAILS

Dr.R.Parimala received a Master of Computer Applications from the University of Madras, Chennai, Tamil Nadu, India in the year 2003. Doctor of Philosophy received from Bharathiar University Coimbatore, Tamil Nadu, India in the year 2019. She is currently Serving as Principal of Ambari College of Arts and Science for Women, Arakkonam, Ranipet District, Tamil Nadu, India. She has published more than 10 research papers in reputed international journals. Her main research work focuses on Cloud Computing and Security, Cryptography Algorithms, Network Security, and Data Mining. She has more than 16 years of teaching, 10 years of Administration, and 7 years of Research Experience.

Dr. R. Karthikeyan received a Master of Science from the University of Madras, Chennai, Tamil Nadu, India in the year 2009, and Ph.D from SCSVMV University, Kanchipuram in the year 2018. He is currently working as an Assistant Professor in the Department of Computer Science, Sri Sankara Arts & Science College (Autonomous), Kanchipuram, Tamil Nadu, India. He has published more than 10 research papers in reputed international journals. He has presented at three international conferences and attended various international workshops. His main research work focuses on Data and Wireless Communication, Data Mining, Network Security, and Cloud Computing. He has 15 years of teaching experience.