

A novel approach for new architecture for green data centre

Ahmed Abdulhassan Al-Fatlawi¹, Israa Al-Barazanchi^{2,3}

¹Department of Informatics System Management, Businesses Informatics College, University of Information Technology and Communication, Baghdad, Iraq

²Department of Computer Engineering Techniques, Baghdad College of Economic Sciences University, Baghdad, Iraq

³College of Engineering, University of Warith Al-Anbiyaa, Karbala, Iraq

Article Info

Article history:

Received Jul 16, 2022

Revised Aug 20, 2022

Accepted Sep 30, 2022

Keywords:

Algorithm

Green data center

Task scheduling

Temperature

Thermal management

ABSTRACT

The massive energy usage of data centers may be traced in part to the growing number of data centers and workstations because of economies of scale for cloud computing. It does, though, indicate wasteful power usage. Consequently, researching ways to improve the energy efficiency of datacenter equipment is now a crucial aspect in reducing datacenter power consumption. In this study, we describe methodologies and algorithms for flexible, energy-efficient, and effective load balancing in data centers, resulting in lower energy consumption by systems. Because of difficulties related with energy consumption, such as capital expenditure, operational costs, and environmental effect, renewable energy is becoming an increasing major consideration in data centers. With the rise in environmental consequences around the world, data centers must consider energy efficiency as one of the most critical factors. Cloud computing techniques have made a huge impact all over the world. Green DC is a concept that has been tested. We suggested an algorithm in this paper based on certain current algorithm limitations that will help to reduce environmental effect. We investigated the efficiency of our program further and used a load balancing method to improve its performance.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Ahmed Abdulhassan Al-Fatlawi

Department of Informatics System Management, Businesses Informatics College

University of Information Technology and Communication

Baghdad, Iraq

Email: Ahmed.fatlawi@uoitc.edu.iq

1. INTRODUCTION

Because virtual machines are used for every activity in cloud computing, virtual machines (VMs) make it simple to host computations and apps for many electronic users by creating the illusion of a unified system [1]. None of our present methods manage VM task scheduling with energy-saving techniques. The motivation stems from a research paper that a big quantity of data is kept in cloud data centers, resulting in a huge amount of current energy usage, however it is essential to compare the power consumption of these cloud data centers. According to a report, data centers use 0.5% of the total supply [2]. The overall energy usage of cloud data centers and their cooling units was 1.2% of total US energy usage in 2009 [3], and it continues to rise season after season. Because power consumed results in a considerable quantity of carbon dioxide emissions [4], a better cloud is required [5], resulting in energy efficient virtual machines load balancing. To achieve high performance computing, a variety of strategies can be used, [6] such as improving the application's algorithm. Hardware that is more environmentally friendly, voltage quality system characteristics, abstraction of computational resources, and so on [7]. The temperature of a computing device has a strong connection with its lifespan. As the need for cloud computing grows, so does the reliance on power [8]. The majority of relevant

cloud computing work on resources planning and problems follows a traditional approach [9], in which a schedule element determines which tasks are to be done at which sites based on function optimization [10]. Future electronic that improve system speed and utilization rather than boosting the value of application processing generally drive such objective function. Myint and Thein [11] created a novel methodology for integrating efficient green innovations into a scalable cloud computing architecture. Entire system performance in datacenters will be considerably enhanced using strength planning approaches, resource allocation, main exit, and a minimum VM architecture, according to the writer of this research [12] green cloud computing is envisioned to obtain no longer only efficient processing and usage of computing however additionally to reduce strength consumption. That is crucial for ensuring that the future boom of cloud computing is sustainable. Otherwise, cloud computing with an increasing number of pervasive patron gadgets interacting with records facilities will purpose a significant escalation of strength utilization. Cloud computing, which makes use of the parallel computing paradigm in statistics centers, has grown in reputation in latest years [13]. Cloud computing is a set of computer resources that offer laptop services. The global spread of facts facilities necessitates using strength, which ends up in a high working fee for cloud statistics centers [14]. For data garage, records centers use a whole lot of electricity. Cloud infrastructure's electricity production has been step by step increasing, and by way of 2020, it is predicted to attain 1,963 seventy four terawatt-hours (TWh) [15]. The boom rate of statistics middle's is kind of 9% consistent with 12 months, and as a result, strength consumption has double in the ultimate five years. The massive energy usage of data centers may be traced in part to the growing number of data centers and workstations because of economies of scale for cloud computing. It does, though, indicate wasteful power usage. Therefore, researching ways to improve the energy efficiency of datacenter equipment is now a crucial aspect in reducing datacenter power consumption. In this study, we describe methodologies and algorithms for flexible, energy-efficient, and effective load balancing in data centers, resulting in lower energy consumption by systems. The service level agreement (SLA) that cloud users and providers follow in the cloud system distinguishes from other systems' capacity load balancing issues. The goal of cloud providers is to meet the needs of its customers to maximize their advantages. Our suggested load balancing algorithm is dependent on the heat and energy usage of the system.

2. METHOD

The SLA that cloud providers and customers obey in the cloud system distinguishes it from other networks' resources load balancing issues. The goal of cloud providers is to meet the needs of its customers to maximize their advantages. Our suggested load balancing algorithm is dependent on the temperatures and energy usage of the equipment. There are two layers to the method. At the first layer, there is an operator who primary responsibility is to create users. There are various functions and platforms, each with its own set of standards, on which the work is done. After the project is created, a system is assigned to it that meets its requirements. Each task has its own set of requirements, such as: i) time, ii) system requirements (central processing unit (CPU) and memory usage), iii) the use of energy, and iv) thermometer.

In principle, the activities created by users are delivered to web applications located throughout the world, which then route them to data centres for execution. The new study sends the tasks to a data center selection framework (DCSF), which analyzes the energy consumed by several data centers and determines which one should be used to complete the jobs, Figure 1 shows the tasks submission process. A user base (UB) is a geographical area where many users submit activities to the provider.

The carrier issuer registers all facts middle in the statistics middle registration (DCR), as proven in Table 1. An information center id (DCID) is a sixteen-bit number, with the first four bits representing the carrier provider's identity and the subsequent 12 bits committed to the statistics middle's identity, which should be a random identifier generated by means of the carrier company. The service company need to preserve song of the variety of servers, routers, switches, and different components in a facts middle. The general power usage is decided, and the price is stored in DCR for later processing. The facts centre choice (DCSF), as shown in Figure 2, is used to pick out a statistics centre. The obligations which can be submitted to DCSF are initially put in a wait queue. While jobs are eliminated from the geared up queue for processing, they are assigned from the wait queue to the prepared queue. Primarily based at the visitors gathered by means of the DCSF, a threshold cost (Th) is taken into consideration.

If the variety of duties in the equipped queue > Th or the time > 60s, whichever comes first, the tasks are assigned to venture allocator (TA). TA then sends a request to electricity calculator module (EC), where the whole strength is calculated. The quantity of strength spent with the aid of facts centres is measured, and the records centre with the lowest electricity intake is assigned processor duties. DCR presents the records, inclusive of the records centre id and the range of servers. The power results module (SEM) calculates the overall amount of power used by information centre servers The IT strength intake (ITE) module calculates the power utilized by IT system. Determine 2 footwear the records middle choice framework.

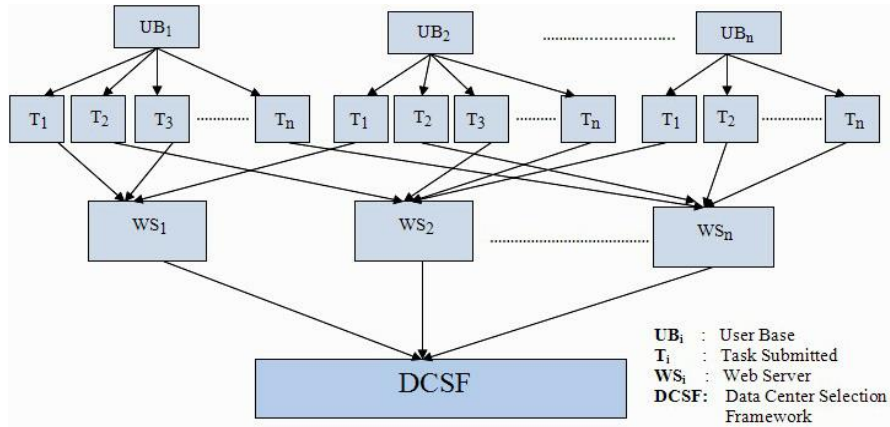


Figure 1. Tasks submission process

Table 1. Running the programmed three times with varied VM0 to VM9 variables

VM name	Temperature (1)	Temperature (2)	Temperature (3)
VM0	201	200	200
VM1	198	201	200
VM2	204	198	200
VM3	195	199	198
VM4	195	198	197
VM5	200	203	195
VM6	203	202	195
VM7	202	205	194
VM8	195	201	194
VM9	200	196	199

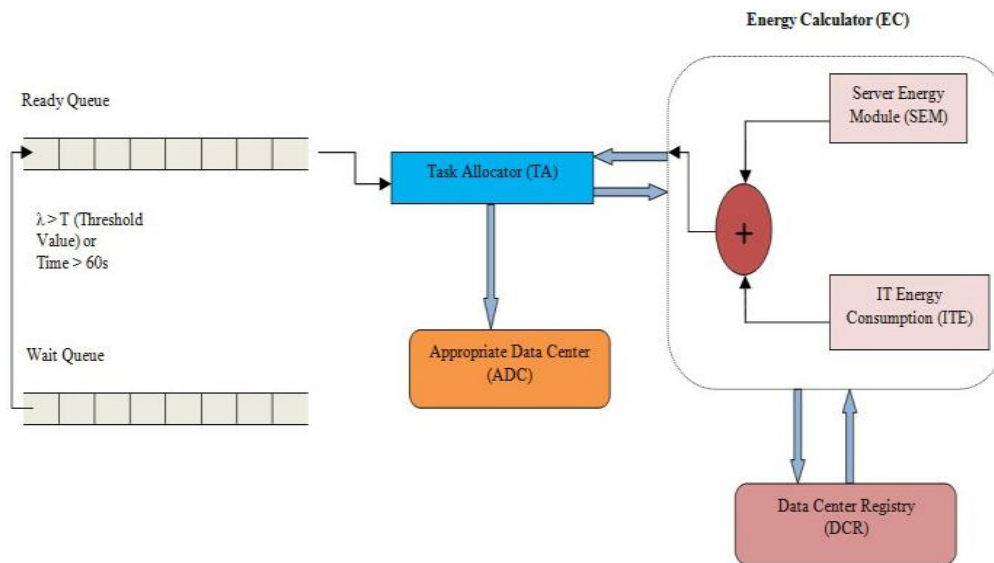


Figure 2. Data center selection framework

We propose the following algorithm for a load balancer's motive: in the scheduling queue, the scheduling will help create jobs. Jobs are queued until the administrator arranges them. The planner examines the program logic, such as how much an activity will raise the program's thermostat if it is scheduled. The scheduler's primary goal is to keep the humidity level below the maximum point. It will compare the latest temperature of the system. Typically, and how much the temperature has risen since the last execution on that platform. If the heat capacity is exceeded, the planner moves along to the next unit. However, if the platform's heat is below the crucial level, the scheduler will examine the platform's energy usage. The work will be completed on the current system if the device with the lowest energy usage is chosen. Each platform will have

its own range of features and characteristics, which are as continues to follow: i) the temperature of criticality, ii) lowest temperature, and iii) electricity consumption.

In the 2nd layer, a different cache is used to keep track of the qualifying machines, which will reschedule the VM throughout execution based on its energy consumption. Similarly, the energy of qualifying computers in a cache will be compared using the delpi method, which will order vms with slightly lower current-voltage characteristics. Voltage regulation promotes productivity while maintaining a low heat. Approaches alters the basic differences in energy environment in social workloads and schedules them to keep the semiconductor heat below a predetermined temperature range. A shorter real-time heat assessment is designed to test scheduling algorithms, allowing for more accurate execution time. Our proposed algorithm's flow chart is shown in Figure 3 shows the thermal and power aware workload scheduling.

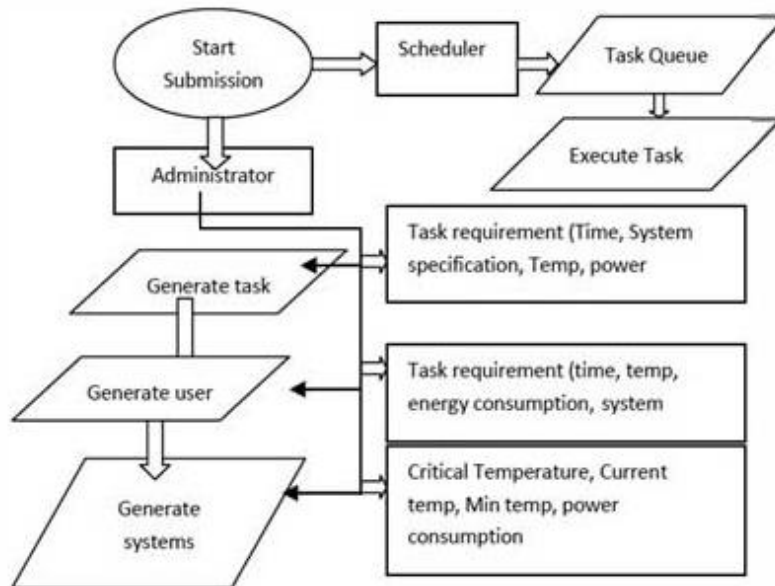


Figure 3. Thermal and power aware workload scheduling

The algorithm that was used was.

```

The system queue holds the entire system list.
Stemp queue contains systems with temperatures lower than the threshold temperature.
Tth: threshold temp.
Tsys: System temperature.
Sysm(n): System n
P(n): power of system n
S[i]: array that contain system with lowest power increment rate del(p). */
Algo START
while(event(task==true)) do Foreach system in system queue do
  If (Tsys < Tth)
  Add system to Stemp queue
  ENd if
End Foreach
Foreach system in Stemp queue
  Calculate Power (Sys(n) ,P(n))
  Pb: power consuming before allocation of task Pa: power consuming after initiating the task
  del(P): Pa-Pb End For each
Sort system acc. to the ascending order of del(P) in array S[] Allocate task to the system
with list del(P) from S[i] Check the temperature of the system (while the task is running)
Add system to system queue if (Tsys >= Tth)
From S[i+1], assign a job to the system.
If you add a system to the system queue, the process will come to an end.
  
```

For the experimental set-up of the algorithm, we used Java to install our method in green cloud workstation for theoretical calculations, and then we computed the execution time, or how long our algorithm will need to plan the eligible vms in the shortest time possible.

3. RESULTS AND DISCUSSION

We built our proposed algorithm in object oriented language and used the amount of available to make the application fluid. We run the programme three times to assess the system's execution time as well as the Scheduler's estimated number to manage the qualifying VM list, Table 1 shows running the programmed three times with varied VM0 to VM9 variables, Table 2 show average time to schedule and Table 3 shows the average power for each VM0-VM9. Table 3 shows the average power for each VM0-VM9. Finally Figure 4 shows the comparison of proposed algorithm with existing algorithm.

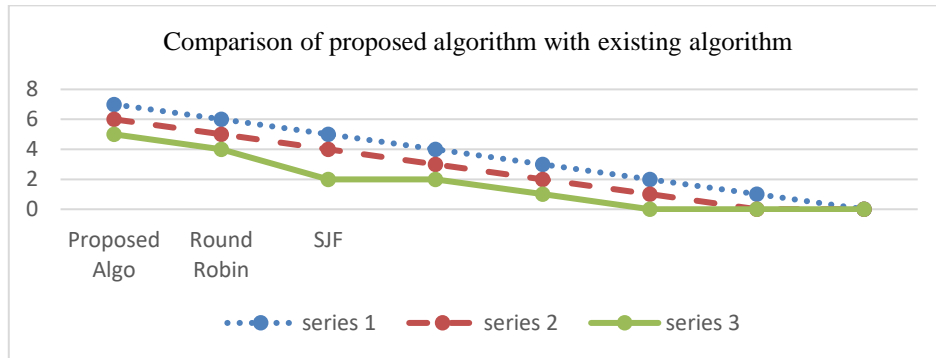


Figure 4. Comparison of proposed algorithm with existing algorithm

Table 2. Average time to schedule

Phase (temperature-n & power-n)	Average time to schedule (seconds)
1	8.2
2	8.4
3	7.08

Table 3. Average power for each VM0-VM9

VM Name	Power-1(Del P) Kw	Power-2 (Del P) Kw	Power-3 (Del P) Kw
VM0	50	45	54
VM1	50	44	50
VM2	55	47	47
VM3	44	48	48
VM4	54	50	50
VM5	56	51	44
VM6	52	46	48
VM7	51	44	52
VM8	50	49	48
VM9	51	50	54

In virtual cloud data centers, this work proposes ways to facilitate fuel, quality online tool provision. By lowering power consumption through VM size, extending servers computing resources, and equipment energy limiting, the introduces data, methodologies, and algorithms seek to increase energy–efficiency [16]. The thesis's initial section focuses on minimising energy consumption while keeping mechanical properties in mind. We look at how horizontal scaling, vertical CPU scalability, and CPU speed sizing affect quality and power consumption [17]. We access web performance and energy simulators that may be used to understand how a consumers react to changes in interest rates infrastructures [18]. There are a variety of reasons why the expenses of a datacentre’s energy usage may be unnecessarily high. The main cause is that semi of datacentres consume energy inefficiently, result in power loss or waste. Energy loss relates to power given by the user that is not immediately utilised by computation processes, [19]-[25] such as power delivery and conversion, cooling, illumination, and so on. The electricity consumption efficiency (PUE) metric is commonly used to assess energy loss. The PUE measure is the ratio of a building's power consumed to the energy usage of IT gear alone [26]-[32].

4. CONCLUSION

The results show of running the programme three times with varied VM0 to VM9 variables. There are 5 qualifying devices in the temperatures 1 column of the table whose heat is less than 200F. During in the run period, these qualifying machines will be checked again with the delpi operation with their contribute to the

overall success, which must be less than 50 Kw. As per in result tables, VM0, VM1, VM3, and VM8 are the virtual machines. As a result, these servers are now in charge of VM enough. The planning process took 8.2 secs. We proposed this job scheduling algorithm based on the simulation analysis in Green Cloud, and it could be a superior answer in terms of energy efficiency. In this work, a methodology for selecting data centers depending on their low power consumption for task processing is established. The amount of energy is estimated by adding the server's energy usage and the power usage of IT devices. The power consumption by virtualization for activity execution is combined to create the server's power. The findings clearly demonstrate that the designed approach surpasses current methods for data center allocation. In the future, we'll compare our current algorithm to several cloud computing scheduling methods to see if we can come up with a superior solution for power scheduling algorithms. To know which criteria are most appropriate to use for each specified task, more study is required to examine and evaluate the new family of data center suitable for statistical, which is based on a multidimensional approach and includes efficiency and safety. Simulating various situations and studying the association between different meter score and their performance characteristics and hazards can assist illustrate how a shift in variables affect hazard, and similarly, how a shift in risk variables influences meter outcomes. Because no tackle issues that incorporate all of the recommended parameters, new approach models and modelling techniques will be conducted to confirm and calibrated the measure. It could aid in the implementation of multiple data centre ways to improve measures, which would necessitate a concept. By keeping an eye on the includes considering, Users in data centers will gain a better understanding of data centre firms' performance from a broader perspective. To understand which parameters are most appropriate to use for each given purpose, more study is needed to assess and evaluate the new family of data centre metrics provided, which is based on a multidimensional approach and includes performance and risk.

ACKNOWLEDGEMENTS

The authors are grateful to the Iraqi Ministry of Higher Education and Scientific Research (MOHESR) for technically supporting the current research.




REFERENCES

- [1] R. Buyya, C. S. Yeo, S. Venugopal, J. Broberg and I. Brandic, "Cloud computing and emerging IT platforms: vision, hype, and reality for delivering computing as the fifth utility," *Future Generation Computer Systems*, vol. 25, no. 6, pp. 599-616, 2009, doi: 10.1016/j.future.2008.12.001.
- [2] H. R. Abdulshaheed and I. A. Barazanchi, "Smart solutions based-on cloud computing and wireless sensing," *International Journal of Advanced Science and Technology*, vol. 28, no. 8, pp. 526-542, 2019.
- [3] "Make IT green: cloud computing and its contribution to climate change," *Greenpeace International*. [Online], Available: <https://www.greenpeace.org/international/publication/7099/make-it-green-cloud-computing-and-its-contribution-to-climate-change>.
- [4] "IBM and cisco: together for a world class data center," 2013. [Online], Available: <https://www.redbooks.ibm.com/abstracts/www.redbooks.ibm.com/abstracts/sg248105.html>.
- [5] A. M. Manasrah, T. Smadi, and A. ALmomana, "A variable service broker routing policy for data center selection in cloud analyst," *Journal of King Saud University-Computer and Information Sciences*, vol. 29, no. 3, 2016, pp. 365-377, doi: 10.1016/j.jksuci.2015.12.006.
- [6] D. Kapgate, "Efficient service broker algorithm for data centre selection in cloud computing," *International Journal of Computer Science and Mobile Computing*, vol. 3, no. 1, pp. 355-365, 2014.
- [7] S. Yan, X. Wang, M. Razo, M. Tacca, and A. Fumagalli, "Data center selection: a probability based approach," *2014 16th International Conference on Transparent Optical Networks (ICTON)*, 2014, pp. 1-5, doi: 10.1109/ICTON.2014.6876288.
- [8] H. Xu and B. Li, "Cost efficient datacenter selection for cloud services," *2012 1st IEEE International Conference on Communications in China (ICCC)*, 2012, pp. 51-56, doi: 10.1109/ICCCChina.2012.6356938.
- [9] P. M. Rekha and M. Dakshayini, "Cost based data center selection policy for large scale networks," *2014 International Conference on Computation of Power, Energy, Information and Communication (ICCPDIC)*, 2014, pp. 18-23, doi: 10.1109/ICCPDIC.2014.6915333.
- [10] A. Jaikar, G. R. Kim and S. Y. Noh, "Matrix-based data center selection algorithm for a federated cloud," *International Journal of Multimedia and Ubiquitous Engineering*, vol. 9, no. 6, 2014, pp. 153-158, doi: 10.14257/ijmue.2014.9.6.15.
- [11] K. S. S. Myint and T. Thein, "Energy and cost efficient data centre selection for cloud services," in *proceedings of 3rd International Conference on Computational Techniques and Artificial Intelligence*, pp. 35-38, 2014.
- [12] A. A. H. A-Fatlawi and S. Kadry, "Green cloud computing: data center case study," *Handbook of Research on Cloud Infrastructures for Big Data Analytics*, 2014, doi: 10.4018/978-1-4666-5864-6.ch021.
- [13] V. Sharma, Dr. Rakesh and S. Bol, "Round-Robin data centre selection in single region for service proximity service broker in cloud analyst," *International Journal of Computers and Technology*, vol. 4, pp. 254-260, 2013.
- [14] D. Chudasama, N. Trivedi and R. Sinha, "Cost effective selection of data centre by proximity-based routing policy for service brokering in cloud environment," *International Journal of Computer Technology and Applications*, vol. 3, no. 6, 2012, pp. 2057-2059, doi: 10.1.1.587.7728.
- [15] K. Shyamala and R. T. Sunitha, "An analysis on efficient resource allocation mechanisms in cloud computing," *Indian Journal of Science and Technology*, vol. 8, no. 9, 2015, pp. 814-821, doi: 10.17485/ijst/2015/v8i9/50180.
- [16] I. Goiri et al., "Energy-efficient and multifaceted resource management for profit-driven virtualized data centres," *Future Generation Computer Systems*, vol. 8, no. 5, 2012, pp. 718-731, doi: 10.1016/j.future.2011.12.002.




- [17] Z. Xiao, W. Song and Q. Chen, "Dynamic resource allocation using virtual machines for cloud computing environment," in *IEEE Transactions on Parallel and Distributed Systems*, vol. 24, no. 6, pp. 1107-1117, June 2013, doi: 10.1109/TPDS.2012.283.
- [18] C. Papagianni, A. Leivadreas, S. Papavassiliou, V. Maglaris, C. C. -Pastor and Á. Monje, "On the optimal allocation of virtual resources in cloud computing networks," in *IEEE Transactions on Computers*, vol. 62, no. 6, pp. 1060-1071, June 2013, doi: 10.1109/TC.2013.31.
- [19] D. Jiankang, W. Hongbo, L. Yangyang and C. Shiduan, "Virtual machine scheduling for improving energy efficiency in IaaS cloud," in *China Communications*, vol. 11, no. 3, pp. 1-12, March 2014, doi: 10.1109/CC.2014.6825253.
- [20] "GoogleClusterDataV2," 2011. [Online] Available: http://code.google.com/p/googleclusterdata/Wiki/ClusterData2011_1.
- [21] I. A. Barazanchi *et al.*, "Blockchain technology-based solutions for IOT security," *Iraqi Journal for Computer Science and Mathematics*, vol. 3, no. 1, pp. 53-63, 2022, doi: 10.52866/ijcsm.2022.01.01.006.
- [22] Z. A. Jaaz, I. Y. Khudhair, H. S. Mehdy and I. Al Barazanchi, "Imparting full-duplex wireless cellular communication in 5G network using apache spark engine," *2021 8th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, 2021, pp. 123-129, doi: 10.23919/EECSI53397.2021.9624283.
- [23] S. Potluri and K. S. Rao, "Optimization model for QoS based task scheduling in cloud computing environment," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 18, no. 2, pp. 1081-1088, May 2020, doi: 10.11591/ijeecs.v18.i2.pp1081-1088.
- [24] S. Ouham and Y. Hadi, "Enhancement in resource allocation system for cloud environment using modified grey wolf technique," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 20, no. 3, pp. 1530-1537, Dec. 2020, doi: 10.11591/ijeecs.v20.i3.pp1530-1537.
- [25] A. Osman, A. Sagahyoon, R. Aburukba, and F. Aloul, "Optimization of energy consumption in cloud computing datacenters," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 11, no. 1, pp. 686-698, Feb. 2021, doi: 10.11591/ijece.v11i1.pp686-698.
- [26] F. T. Johora, I. Ahmed, M. A. I. Shajal and R. Chowdhory, "A load balancing strategy for reducing data loss risk on cloud using remodified throttled algorithm," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 12, no. 3, pp. 3217-3225, Jun. 2022, doi: 10.11591/ijece.v12i3.pp3217-3225.
- [27] R. Kumar, S. K. Khatri, and M. J. Diván, "Optimization of power consumption in data centers using machine learning based approaches: a review," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 12, no. 3, pp. 3192-3203, Jun. 2022, doi: 10.11591/ijece.v12i3.pp3192-3203.
- [28] R. M. A. -Hussein and A. H. Mohammed, "Optimized load balance scheduling algorithm," *TELKOMNIKA Telecommunication Computing Electronics and Control*, vol. 20, no. 1, p. 81-88, Feb. 2022, doi: 10.12928/telkomnika.v20i1.22464.
- [29] S. Kumaraswamy and M. K. Nair, "Bin packing algorithms for virtual machine placement in cloud computing: a review," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 9, no. 1, pp. 512-524, Feb. 2019, doi: 10.11591/ijece.v9i1.pp512-524.
- [30] S. A. Sahy, S. H. Mahdi, H. M. Ghenni, and I. Al-Barazanchi, "Detection of the patient with COVID-19 relying on ML technology and FAST algorithms to extract the features," *Bull. Electr. Eng. Informatics*, vol. 11, no. 5, pp. 2886-2894, 2022, doi: 10.11591/eei.v11i5.4355.
- [31] I. Al-Barazanchi *et al.*, "Remote Monitoring of COVID-19 Patients Using Multisensor Body Area Network Innovative System," *Comput. Intell. Neurosci.*, vol. 2022, pp. 1-14, Sep. 2022, doi: 10.1155/2022/9879259.
- [32] J. Li *et al.*, "Internet of things assisted condition-based support for smart manufacturing industry using learning technique," *Comput. Intell.*, vol. 36, no. 4, pp. 1737-1754, 2020, doi: 10.1111/coin.12319.

BIOGRAPHIES OF AUTHORS



Ahmed Abdulhassan Al-Fatlawi    received the B.S. degree in computer and communication engineering from RUC, Iraq, in 2009 and the M.S. degrees in computer science and communication from AUL, Lebanon in 2012, respectively. Currently, he is an Lecture at the Department of informatics system management, businesses informatics college, university of information technology and communication His research interests include artificial intelligence, distributed computing, database systems, image processing, cellular and mobile networks, data minig. He can be contacted at email: Ahmed.fatlawi@uoitc.edu.iq.



Israa Al-Barazanchi    received her Bachelor of Computer Science (BCS) from Department of Computer Science, Baghdad college of economic science university-Iraq-Baghdad in June 2002. In January 2010, she entered the master's program at the Faculty of Information & Communication Technology, Graduate School of Computer Science (Internetworking Technology), Universiti Teknikal Malaysia. She is currently a student Doctor of Philosophy in Information and Communication Technology. She is a lecturer in Computer Engineering Techniques Department. Editor-in-chief for international union of universities journal. Member of editor board in many scopus journals for computer science field. Head of researcher group. Member in many conferences panel and communications events. She is a reviewer of various high impact factor journals. Her research activities are: WBAN, WSN, WiMAX, WiFi on vehicular Ad-Hoc networks (VANETs), communications, networking, signal processing, IoT, IoMT, AI, smart healthcare systems, blockchain. She can be contacted at email: israa.albarazanchi@baghdadcollege.edu.iq and israa44444@gmail.com.