International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Green Cloud Computing: An Implementation in Block Chain

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ABSTRACT

Cloud computing has evolved into an outstanding solution for addressing the issues of high-volume data storage and processing, with low-cost, high-speed, on-demand, and pay-per-use features. Block chain technology is a relatively new and influential financial technology that has fundamentally transformed corporate interactions. A decentralised network supports and employs a wide range of cryptographic schemes. This safe and resilient transaction is being combined with another prominent computing paradigm, cloud computing. Despite significant growth in the field of cloud computing and related services, achieving the implementation of green clouds This detailed green cloud implementation report aids in understanding future research issues in the green cloud. This work also focuses on the use of blockchain technology for green cloud computing in order to overcome hurdles and risks. This study suggests utilising Python to evaluate and apply the algorand blockchain and enhance the blockchain trilemma.

Keywords: Green Cloud, Blockchain.

Introduction

For the past decade, cloud computing has been the most popular computation platform for commercial organizations, allowing entrepreneurs to focus on their core company activities rather than investing time and money in infrastructure maintenance. According to NIST, cloud computing provides numerous services such as IaaS, PaaS, and SaaS to entice business app owners to embrace and migrate cloud services to their business app modules, as shown in Figure 1. Cloud-based data centres, platforms, servers, and other infrastructure services are sufficiently elastic to meet customers' unexpected need for large amounts of resources. According to Heininger, the cloud's dispersed deployment patterns, pay-per-use billing policy, on-demand connection, high-speed networks, and low-cost resources are assisting in the adoption of new cloud-based companies, from multinational to small-scale. Most electronics, such as smart phones, tablets, smart watches, health care equipment, and sensors, are now connected to clouds for private data storage. Most software applications, including e-mail, messengers, workplace apps, social web networks, e-cart apps, audio and video streaming apps, broadcasting, and entertainment services, use cloud services to store, process, share, and safeguard data. To provide high-quality services to its global clients, Google housed all of its services, including Gmail, Google Earth, Google Drive, Google Play, and YouTube, on its own cloud platform (GCF). Forbes reported cloud figures in September 2018, revealing that the global public cloud revenue value is currently 175.8 billion dollars. With a 17.3 percent growth rate, public cloud revenue is expected to reach 206.2 billion dollars in 2019, representing the world's fastest growth rate of cloud use. Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform, and IBM Cloud are some of the most prominent cloud service providers in today's industry.

While the elastic nature of the cloud meets the expectations of cloud service users, service providers are suffering from tolerating the massive power consumption by data centres, which leads to high operational costs, increased carbon emissions, and lower earnings.

Clouds address the majority of the problems faced by today's businesses, but they have a few notable limitations, including high power consumption, longer CPU idle times, the need to deploy resources at the upper bound, the emission of carbon gases, and the generation of massive electronic waste (e-waste).

There is an urgent need to build today's cloud environment as eco-friendly as possible, such as "Green Cloud Computing."

Figure 1 Cloud Computing Service Layers Architecture [4]

Figure 2 Cloud Computing Service Layers Architecture [4]

The phrase ordinary cloud computing focuses on effectively storing and processing data, but green cloud computing is a revolutionary reform in cloud computing that is developed with the main purpose of changing the cloud environment into an eco-friendly one. Green clouds are distinguished by their energy efficiency, virtualization, multi-tenancy (high-end usability), consolidation, automation, robustness, recyclability, and sustainability of cloud resources. The world's green environment must not be harmed by naive developments such as cloud computing; thus, specialists strongly advise that "cloud computing must regard the ecological gaining along with the economic."

Green cloud computing tries to build the cloud environment to be eco-friendly, which means that the cloud should not exploit nature's greenness in any manner. For example, a cloud environment carefully adheres to energy efficient power management rules and procedures in order to conserve electricity, yet it relies on coal-based thermal stations for power supply, resulting in indirect environmental damage. As a result, green cloud policies and standards must be created with the direct and indirect detrimental consequences of clouds on ecological in mind. Aside from regulations and standards, the green cloud architecture requires a set of monitoring tools and technologies. The core tools and technologies needed to create the green cloud computing architecture are depicted in Figure 2.

GREEN CLOUD COMPUTING

The use of a computer system and information technology services has made living easier and more comfortable. It also boosts processing speed and electricity consumption. This enormous level of electricity usage causes greenhouse gas emissions as well as pollution. Energy usage is also rising as a result of systems being left on even when not in use. A considerable amount of energy is also squandered in IT since data centres require a lot of electricity and corresponding cooling capacity, which is not always available, causing environmental pollution. Green computing is concerned with the notion of decreasing energy usage, recycling, and eliminating harmful materials, but it is also concerned with lowering business travel, sharing resources (cloud computing), and optimising. Inadequate power and cooling capacity might also result in energy loss. All of this contributes to the dirty environment. It was also discovered that the majority of data centres were using outdated technologies and lacked enough cooling capacity. All of this points to a dirty environment. Environmental contamination might be caused by flaws in manufacturing procedures, packaging, and computer and component disposal. Toxic chemicals are employed in the manufacture of computers and components, and they can infiltrate the food chain and water. According to one source, "Information Technology energy consumption is expanding twelve times faster than overall energy demand," and data centres produce 150 metric tonnes of CO_2 each year, with the volume constantly increasing[xc]. Various organizations have been founded in order to develop standards and rules. These are some of the organizations:

1. The Green Grid is a global network of IT firms and people working to increase energy efficiency in data centres all around the world. Green Grid board members include AMD, EMC, Intel, APC, HP, Microsoft, Dell, IBM, and Oracle.
2. The United States Environmental Agency is a federal agency that was established to preserve human health and the natural environment. These organisations were founded to minimise greenhouse gas emissions and other pollutants caused by wasteful energy consumption; and to make it simple for customers to from the perspective of a user in an organisation. There are several essential measures that may be made to dramatically reduce electricity usage and environmental effect.

According to the Environmental Protection Agency, around 30% to 40% of computers are left on over weekends and after business hours, with approximately 90% of these PCs remaining inactive. Any application developed in a green computing environment will employ the most efficient physical resources.

Because many industrialised countries have superior technological capabilities, a massive volume of computer systems and associated items are thrown every day. These items are distributed to other underdeveloped nations. Recycling of electrical goods is accomplished in this manner. Furthermore, recycling elements used in the production of computer hardware such as tin, silicon, iron, aluminium, and so on, as well as electronic products such as audio visual components, mobile phones, and other portable electronic devices, contribute significantly to energy efficiency. Recycling computer equipment, such as lead and mercury, allows for the replacement of equipment that would otherwise be built. The reuse of such equipment allows for energy savings and a reduction in the environmental effect caused by electronic trash.

Virtualization

A system administrator can use virtualization to merge numerous physical systems into virtual ones on a single server, allowing it to run different operating systems and become more powerful. Energy efficiency may be achieved by plugging in fewer physical equipment, which decreases power and consumes less electricity. Several commercial firms and open-source groups are currently providing software packages to help with the move to virtual computing. It is the reality that virtualization does not optimise energy and resource efficiency on its own. Thus, when paired with the appropriate skills and operational and architectural standards, automation reduces the requirement for physical infrastructure, maximising the energy and resource efficiency of server virtualization.

Cloud as a Green Computing

Businesses are quickly migrating from conventional systems to cloud-based systems due to its faster scale-up/scale-down capacity, pay-per-use, and access to cloud-based services without the need to purchase and manage on-premises equipment. The pay-per-use feature of cloud infrastructure delivers energy and resource efficiency at the same time, encouraging customers to utilise just the resources they demand. By shifting the load from traditional servers to cloud servers, an IT firm may meet energy efficiency and sustainability goals. Unfortunately, the IT industry obtains 70% of its power from greenhouse gas-emitting fossil fuels such as coal, leaving a huge carbon footprint. If cloud companies wish to offer environmentally friendly services, they must invest in renewable energy sources. This may be accomplished by generating energy from renewable sources such as wind and solar. When the screen is turned off, it consumes just 59W. According to this notion, if everyone moved from Google to Blackle, the planet would save 750MW every year. This was an excellent example of Green Computing.

BLOCKCHAIN TECHNOLOGY

This section explains the general model and the operation of the Blockchain model. Blockchain architecture is being developed as a reference architecture for cloud computing, edge computing, and fog computing. It will also be used with a different large-scale distributed model. It is now integrated with a cloud system to offer a more secure system.

Origins of Block chain

Block chain technology is a type of distributed architecture that employs cryptographically signed transactions. It works in a block-by-block fashion. Cryptographic mechanisms are linked to each block. The transactions' authenticity should be validated and verified at every single point of failure. It makes use of numerous aspects of the Peer to Peer (P2P) concept. The broker costs for authorizing transactions are not incurred in this arrangement. Because this Blockchain approach provides strong and scalable security to its end systems, Blockchain technology is expected to flourish. Hackers are also having difficulty exploiting flaws in transaction systems. As a result, transactions are simpler and more accessible. Figure.3 depicts the fundamental components of Blockchain P2P architecture.

Hashes

It is one of the key components of the Blockchain model, which supports a variety of use cases. Its primary function is to encrypt the data delivered in the block. It can calculate data of any size. The adjustments made in the input can be used to display the output with those changes. The SHA-256 algorithm is frequently utilized in a variety of real-time applications.

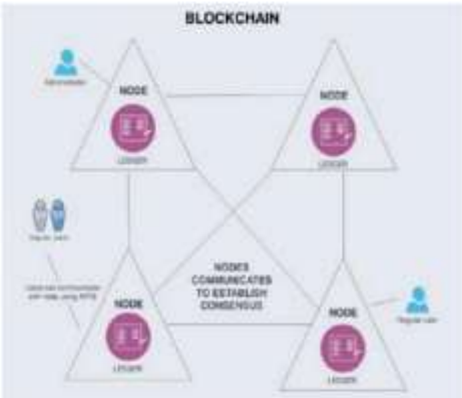

Figure 1 Blockchain technology in P2P architecture

Ledgers

It is made up of a series of transactions. Each node has a copy of the ledger of transactions. Pen and paper are extensively employed in the traditional technique for keeping ledgers. Adoption of new computing technology has followed the same logic. As a result, a centralised ledger is employed with certain drawbacks, such as single point of failure, i.e. sudden data loss, and centralised committed transaction verification with third party agent.

Blocks

End users provide a transaction id to each node in a block. The subsequent activities are carried out using this transaction index till the procedure is completed. Mid-operations will not save time in the transactional process. All committed transactions are kept in a transaction pool, which acts as a queue. Mining nodes are in charge of updating the transaction process at each stage. As a result, a block is made up of the whole collection of transactions. The Blockchain system rejects incorrect transactions. This approach proves the rigidity of data since the resulting hash would vary drastically if a single bit of the block was changed. In addition, a copy of each block's hash is shared across all nodes to strengthen security. Because every node can check if the hash matches, this technique precludes any alteration.

BENEFITS OF BLOCKCHAIN IN CLOUD COMPUTING

Decentralization

Dependence on a centralised server for data management and decision making puts the entire system at risk if it fails, and big crucial data loss stored on the central server might occur. A hacker assault also poses a risk to the central server. The Blockchain in CoT can help by providing a decentralized system in which several clones of the same data are kept on various computer nodes. The problem of data loss cannot emerge since several copies of the data are already available on many nodes.

Improved Data Security

Point-to-point encryption ensures data security during transit and storage. IoT data is frequently concerned with personal information, and the disclosure of this data might jeopardise personal security. These circumstances that arise in cloud infrastructure represent a risk. The solution to this challenge is to deploy Blockchain in cloud computing, which has the ability to provide increased security to the entire architecture while also keeping data transactions sequential. Data files are kept on multiple nodes after being divided into encrypted fragments.

Permanent Audit Trial

One of the primary advantages of Blockchain in cloud computing is its long-term audit trails. Blockchain keeps a permanent Proof of History (PoH) of all previous transactions and modifications, allowing for a verifiable delay function. It not only allows PoH but also assists in arranging the transaction information in the right sequence and preserving a period.

Fast Disaster Recovery

When employing Blockchain technology, the record of transactions is broadly distributed. Because the Blockchain is made public to many authorised users, any failure in one Blockchain node has no effect on the other Blockchain copies. Even if a single node fails, the system continues to operate and the Blockchain is upgraded. Any failing node of the network may obtain the current condition of the Blockchain database as soon as it comes back online, based on the record of the transactions and changes history of the Blockchain experiments.

Fault Tolerance

Blockchain data may be duplicated over a strongly networked network of computer servers with the use of collaborative Clouds. Because of the interruption of any cloud node, the danger of a single failure is reduced and uninterrupted services are enabled.

Scalability

Because the number of Blockchain transactions on large scale Blockchain applications may be enormous, having robust data processing services for high transaction execution is critical for allowing scalable Blockchain services. Because of the cloud's scalability in this industry, Blockchain activities may be supplied with on-demand computer resources. As a result, the combination of cloud computing with Blockchain might foresee a highly scalable integrated system.

LITERATURE REVIEW

As part of our research on "Green Cloud Computing," we extensively evaluated various publications, conferences, white papers, and web sources to obtain the most accurate information about green cloud computing and its features. In this part, we give a review of the literature on green cloud computing using previous research articles. Each noteworthy research activity in the field of green cloud computing is discussed briefly, along with author information. This material assists inexperienced research academics in understanding the assessment of green cloud computing and the advancements it has made since its inception.

Anton Beloglazov and Rajkumar Buyya, 2012, The fast increase in demand for processing power caused by modern service applications, along with the change to the Cloud computing paradigm, has resulted in the construction of large-scale virtualized data centres. These data centres require massive quantities of electrical energy, resulting in significant running expenses and CO2 emissions. Cloud providers may improve resource use and minimise energy consumption by dynamically consolidating virtual machines (VMs) utilising live migration and converting idle nodes to sleep mode. However, the need to provide high-quality service to clients necessitates addressing the energy-performance trade-off, since extreme consolidation may result in performance deterioration.

Anton Beloglazov and Rajkumar Buyya, 2010, offer an innovative approach for dynamic consolidation of VMs based on adaptive usage thresholds, which ensures that Service Degree Agreements are met to a high level (SLA). Using workload traces from over a thousand Planet Lab computers, we confirm the proposed technique's excellent efficiency across various types of workloads.

Archana Patil and Rekha Patil 2019, The cloud computing has become a remarkable option to meet the issues of high-volume data storage and processing, with low-cost, high-speed, on-demand, and pay-per-use qualities. Despite significant growth in the field of cloud computing and related services, achieving the implementation of green clouds is still in the works due to a lack of research and various impediments in its implementation.

D. Brooks, M. Martonosi et al. 2001, created a "Dynamic Thermal Management" system based on CPU level clock gating techniques This aids in running the main processor at maximum-low power, however testing on this strategy shown that it has a minor influence on CPU performance.

D. Kliazovich et al. 2010, created an NS-2-based simulator to track power usage in green cloud data centres He used the simulator to record the power consumption numbers of the cloud using an Intel Xeon 4-core CPU, 8MB DDR3 RAM, and a cache value of 3.33GHz. To calculate the power usage at each entity level, they simulated and monitored the servers, routers, connections, switches, and workloads.

J. Chase et al. 2001, suggested the "energy aware provisioning" approach for distributing the burden of incoming requests to idle servers in order to save energy and use resources more equally. This approach distributes the burden of a request evenly among all feasible instances in order to execute the operations as quickly as possible (as committed in SLA). In this situation, the resources are sharing the real process among themselves in order to solve the problem of underutilization of resources.

J.G. Koomey 2007, conducted a study on USA data centers consuming power values along with the other computational devices consuming power values. With this data he estimated that, by 2005 the power consumption value of data centers is 0.65% of total US generating power.

John Judge et al. 2008, discussed how to minimise data centre power usage while maintaining server performance and availability Finally, he suggested that using low voltage resistant processors, power management tools (to monitor and manage power), virtualization techniques (to increase processing power with the same resources), blade server design, and efficient cooling mechanisms are the best practises for designing energy efficient clouds.

L. Benni et al. 2000, A survey on system level design strategies to increase the performance of the cloud dynamic power management (DPM) procedure was given. They carefully revised previous research on different system level dynamic power management approaches as part of their survey. They thoroughly detailed System Component level power management, System level power management, Network level power management, and other significant dynamic power management strategies.

Manjinder Kaur 2018, explained Green cloud computing is a catch-all term for initiatives to promote sustainability both within and outside of the IT sector. The green IT movement aims to minimise the IT industry's consumption of energy, trash, and harmful chemicals. In many other businesses, network-connected mobile and computer devices provide sustainability through automation, virtualization, and decreased travel. Green cloud computing is the study of designing, manufacturing, and using digital technologies in a way that minimises their environmental effect. These methods not only conserve energy but also save operational costs. Green cloud computing is planning, manufacturing, and utilising digital environments in a way that minimises their environmental effect.

Mirsaeid Hosseini et al. 2018, described In compared to traditional information technology techniques, cloud computing is a potential paradigm in which organisations and corporations embrace elastic cloud services on a pay-per-use model to cut expenses. Virtualization is a widely used technology in modern datacenters (DCs) to increase resource usage, minimise greenhouse gas emissions, and cut total costs. To satisfy the demands of the virtualized cloud environment, virtual machine (VM) migration is frequently used inside and across DCs. For example, server consolidation necessitates VM movement in order to control power. Additionally, live VM migration is required for load balancing, fault tolerance, system maintenance, and lowering the service-level agreement (SLA) violation rate.

Nachiket Vaidya, Ernst and Young 2020, explained Cloud computing is no longer a novel concept in the computing world, and it has altered the IT sector by making services more easily deployable. Personnel may construct or reset the whole infrastructure for a computing resource in fifteen minutes by clicking a button, which is available in three distinct cloud computer service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (IaaS). These approaches provide three distinct and distinct issues for cloud forensic investigations. This study discusses the problems and potential connected with Forensics in the Cloud Computing Environment.

Oscar Castillo, Patricia Melin 2021, outlined a detailed analysis of the current state of the art in the intersections of green computing and computational intelligence fields, as well as their applicability to real-world situations Green computing is the appropriate use of computers and their associated resources to achieve environmental and ecological goals. Computational intelligence, on the other hand, is a field that includes methods and concepts for developing intelligent systems, such as neural network models, fuzzy logic systems, and evolutionary algorithms. The interplay of the two fields might result in intelligent systems capable of producing ecologically responsible and eco-friendly applications, so assisting in the achievement of the primary aims of green computing.

Pat Boher et al. 2020, Based on efficient power management approaches, while running web servers at low usage levels with little influence on performance They used system logs as the primary input sources to calculate the energy usage of a web server at varying degrees of use. They implemented an efficient power simulation technique to monitor the CPU and other resources' utilised energy values, which aids in projecting future energy needs.

Pinheiro Eduardo et al. 2001, Investigate the use of load balancing and unbalancing techniques in cluster-based systems to minimise power consumption and enhance processing performance. They created a cluster-based system with a "on & off mechanism" to automate electricity on and off operations based on demand. This method was deployed at the server and operating system levels, with positive results in resource optimization.

Prof. Riyaz A. Sheikh 2010, Discuss a policy that emphasises our duties as computer users and encourages us to adopt behaviours that maximise the use of these incredible tools while limiting the negative repercussions that may arise during their usage. ICT has now evolved into a critical department for the success of every organisation. Most organisations rely on the numerous advantages that computers give by utilising computing resources to execute a wide range of tasks such as employment, research, teaching, and learning.

Saurabh Kumar Garg 2020, describes the function of cloud users Cloud computing is a cost-effective and highly scalable platform for running HPC, corporate, and Web applications. However, the rising demand for Cloud infrastructure has significantly increased data centre energy usage, which has become a crucial concern. High energy usage not only translates to significant operational costs, reducing Cloud providers' profit margins, but also to high carbon emissions, which is not ecologically beneficial. As a result, energy-efficient solutions are necessary to reduce the environmental effect of Cloud computing. To create such solutions, a thorough examination of the Cloud's power efficiency is necessary.

Yamini, R. 2012, Energy usage in cloud computing is examined using both public and private clouds. Cloud computing with green algorithms can allow for more energy-efficient processing power utilisation. Today's most serious environmental concern is global warming, which is driven by carbon emissions. Green computing is brought about by the energy crisis, and green computing necessitates the rethinking of algorithms and systems for energy efficiency. Green IT is the study and practise of using computer resources in an efficient, productive, and cost-effective manner.

Result

Implementation with CloudSim

The Cloud Simulation Comparison project, which depends on the CloudSim Plus Automation tool, was used to create the results. The studies were carried out using a machine equipped with a dual-core 2.8 GHz Hyper-Threading Intel i7-4558U CPU and 8GB of RAM. Each result was created from a simulation scenario described in a YML file, as shown in Table 1(Figure 4).

Table 1 Comparison of simulation time with framework

Framework (Cloudsim 4.0.0)	**Simulation Time**	**Vm Allocation Policy**	**DCs**	**Hosts**	**VMs**	**Cloudlets**
Round Robin Scheduler	21.7 min	Simple (Worst Fit)	1	20000	40000	50000
Green Scheduler	14.8 min	First Fit*	1	20000	40000	50000
DENS Scheduler	15.2	Simple (Worst Fit)	1	20000	40000	50000
Algorand Blockchain	13.3 min	Best Fit*	1	20000	40000	50000

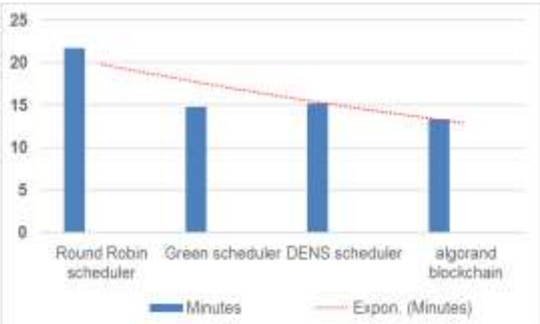

Figure 4 Bar chart of simulation time with framework

Implementation with Blockchain

Table 2 (Figure 5) compares the impact of various scheduling algorithms on data centre energy consumption. The data is derived assuming an average data centre load of 30%. A round-robin scheduler uses the greatest energy. It prevents any servers or network switches from being shut off for the duration of the data center's operation. The Green scheduler is the most efficient. It frees up over two-thirds of servers and network switches, resulting in huge energy savings. When compared to a round-robin scheduler, the Green scheduler cuts data centre energy consumption by half.

Table 2 Data center energy consumption [8]

Parameter	**Power consumption (kWh)**			
	Round Robin scheduler	Green scheduler	DENS scheduler	Algorand Blockchain
Data center	417.5 K	203.3 K	212.1 K	180.2 K
Servers	353.7 K	161.8 K	168.2 K	152.3K
Network switches	63.8 K	41.5 K	43.9 K	38.4 K

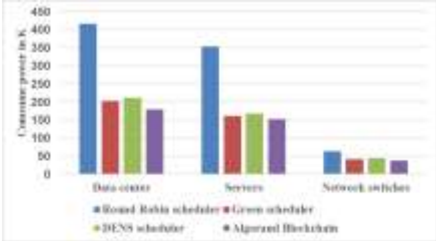

Figure 5 Bar chart of Data center energy consumption

In comparison to the Green scheduler, the DENS approach adds about (a) 4% to total data centre utilisation, (b) 3% to server energy consumption, and (c) 1% to switch energy consumption. This slight increase in energy consumption is justified by the need for more computing and communicational resources, as identified by the DENS approach and required to maintain an acceptable level of job execution quality. The DENS method, unlike the Green scheduler, identifies congestion hotspots in the data centre network and modifies its job consolidation process accordingly. It is especially important for data-intensive applications, which are constrained more by communication resource availability than by processing power. The Algorand implementation lowered data centre power consumption to 180.2 K, server power consumption to 152.3 K, and network switches to 38.4 K, all of which were lower than the prior approach.

CONCLUSION

Round Robin, Green, DENS, and Algorand Blockchain are highlighted in the simulation results for a three-tier data centre design. The Algorand Blockchain's operational information, as well as its ability to maintain an adequate level of QoS for the end user despite a little increase in energy consumption. As a result, lowering energy usage in cloud data centres while ensuring optimal management of its resources such as VMs and servers has become a must-achieve goal. This criterion is connected to the green cloud concept, which may be utilised to aid with environmental protection. This article investigates a variety of approaches for optimising green cloud resource allocation, the majority of which focus on virtualization, migration, and consolidation. As a result, the suggested technique optimises resource management by taking into consideration all important energy indicators and significant predicted limits of VM allocation in PMs, as well as energy usage in the cloud computing data centre. Implement Blockchain in green cloud computing as well.

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