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Energy Management in Cloud Through Green Cloud Technologies

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Abstract

To address the issue of storage and processing of large-scale data, Cloud Computing has gained swift progression in the field of technology. Though offering solutions to many problems, cloud computing is still in the early stage of research and implementation. It suffers from many challenges namely security, standardization and energy consumption. In this paper, we focus on the issue of energy consumption through cloud computing and the technology known as Green Cloud Computing to tackle the said issue. Green Cloud Computing plans to lessen the immense energy utilization, the requirement of physical equipment, destructive fossil fuel byproducts and so on. To shield our current circumstances from cloud technology's adverse consequences, the cloud framework should be updated toward green registering. Green cloud computing broadly centers around the planning of effective clouds with green qualities like efficient energy management, virtualization, load balancing, green servers, reusability, grid computing and recyclability.

Keywords

Cloud Computing, Green Cloud Technologies, Virtualization

1. Introduction

Cloud Computing can be defined as a framework for empowering helpful, on-request network admittance to a common reserve of computing assets, such as servers, storage, networks and other services, which could be quickly provisioned and delivered with negligible management toil [1]. Thus, it is the utilization of a web of internet hosted remote servers instead of local servers for storing and processing data. Examples of clouds include services such as Amazon web service, iCloud of Apple, Google cloud, Microsoft Azure, etc.

The technical traits of cloud computing are as follows:

i. Shared resource reserve (virtualized and physical supplies)
ii. Dynamic resource scheduling
iii. Huge computing resources
iv. Excessive scalability & elastic

The architecture of a cloud can be partitioned into the primary stack and the administration. The primary stack consists of three layers [2]:

i. Resource – It is the framework layer. This layer is made out of virtual and physical processing, stockpiling and systems administration assets.
ii. Platform – Due to its complexity, this layer is partitioned into many sublayers. The processing sublayer deals with managing dispatching. A capacity sub-layer gives limitless capacity and storing capacity.
iii. Application – This layer ensures on-request ability and adaptable administration.

The architecture of a cloud can also be partitioned into frontend and backend connected to each other through a network i.e., the internet.

2. Classification of Cloud

Cloud Computing is classified into two categories- Deployment and Service Models [3].

2.1. Deployment Models

i. Private Cloud - The cloud foundation is worked exclusively inside a single association and oversaw by the association or a third party in any case whether it is remote or not [4].
ii. Community Cloud - A few associations mutually build and offer similar cloud frameworks as well as strategies, prerequisites and values.
iii. Public Cloud - The public cloud is utilized by the overall population and the cloud specialist organization has the full responsibility for public cloud with its own approach, worth, and benefit and charging scheme. Numerous famous cloud administrations are public such as Amazon's S3 EC2 and Google Cloud.
iv. Hybrid Cloud - The cloud foundation is a blend of more than one cloud of the above kinds, that stay distinguished however are bound together by normalized or exclusive innovation which empowers information and application transfer.

Amazon has also introduced a new type of cloud known as Virtual Private cloud (VPC). It is a cross between Public (Amazon Cloud) and Private cloud (IT infrastructures).

2.2. Service Models

Cloud Computing is classified into two categories- Deployment and Service Models [3].

i. SaaS - Software as a Service lets cloud customers host their applications that can be accessed by numerous clients via networks, for instance a web browser [5]. Cloud customers cannot manipulate the cloud framework that regularly utilizes a multi-tenancy system infrastructure, that is, various applications of cloud customers are arranged in one logical surrounding in Saas to gain optimization in security, speed, data management and wide scale economies. Example- Google Docs and Mail.
ii. PaaS - Platform as a Service lets cloud customers develop cloud applications and services, such as SaaS, on the PaaS cloud. It is a development tool supporting the complete software life. This calls for PaaS to have hosting environ-

ment and owning development architecture comprising programming support, tools, data computing and more. Example- Google AppEngine.

iii. Iaas - Infrastructure as a Service allows cloud clients to immediately use IT configuration furnished within the IaaS cloud. Virtualization is substantially utilized in IaaS cloud to be able to integrate or decompose materialistic reserves in an impromptu way to satisfy development or shrinkage in aid calls from cloud clients.

iv. DaaS – Data Storage as a Service is formed when the transfer of virtualized storehouse on call becomes a disparate Cloud service. DaaS might be visible as a unique kind IaaS.
Example- Apache HBase, Google BigTable and Amazon S3.

3. Green Cloud Computing

Cloud computing requires enormous servers to be firmly combined with the framework, the rising utilization of which amounts to weighty utilization of energy and gigantic emanation of CO2. As energy consumption has been a detrimental worry of late, the aforementioned issue produced the significance of green cloud computing that gives procedures and calculations to decrease energy wastage by integrating its reuse.[6]

Green Cloud Computing in cloud engineering plans to decrease the gigantic power utilization, water utilization, need for hardware equipment, foundation and hurtful fossil fuel by-products and so on. To safeguard our current circumstance from cloud adverse consequences, the specialist co-ops should embrace and refresh their cloud framework towards green models. Green cloud computing broadly centres around planning of productive cloud models with green qualities like recyclability and so on.

Thus, Green Cloud Computing is making server farms and electronic gadgets harmless to the ecosystem and eco-accommodating, all in all, it is portrayed as the examination of designing, planning, producing, arranging and utilizing of registering peripherals in a manner that reduces their natural brunt [7].

The significant attributes of green cloud are energy productivity, virtualization, multi-tenancy, solidification, reusing and eco-friendliness.

4. Green Cloud Architecture

Green Cloud Computing is a mutually beneficial model between the cloud provider and the climate. Green cloud not just advantageous to the climate, it additionally expands the benefits of services providers by using the assets proficiently by demanding a few administration strategies and qualities in the existed.

Green cloud computing engineering is planned with the cloud data centres, Green Cloud Provider (GCP) and Cloud consumers. Cloud server centres provide like IaaS, PaaS or SaaS. The Green Cloud Provider (GCP) is planned as a cloud administration specialist module, permitted to screen the cloud foundation and tasks to guarantee the related clouds as green.

The GCP screens the power and resources management at every level by introducing the module level energy utilization meters. In the wake of getting the power utilization data from screens, GCP examines the utilization subtleties and recommends the energy productive solutions. A virtual instance of cloud is made by the process scheduler at runtime to handle the approaching call quickly and accurately. The virtual instances are utilized to upgrade the capacity of physical components by using them at max conceivable level.

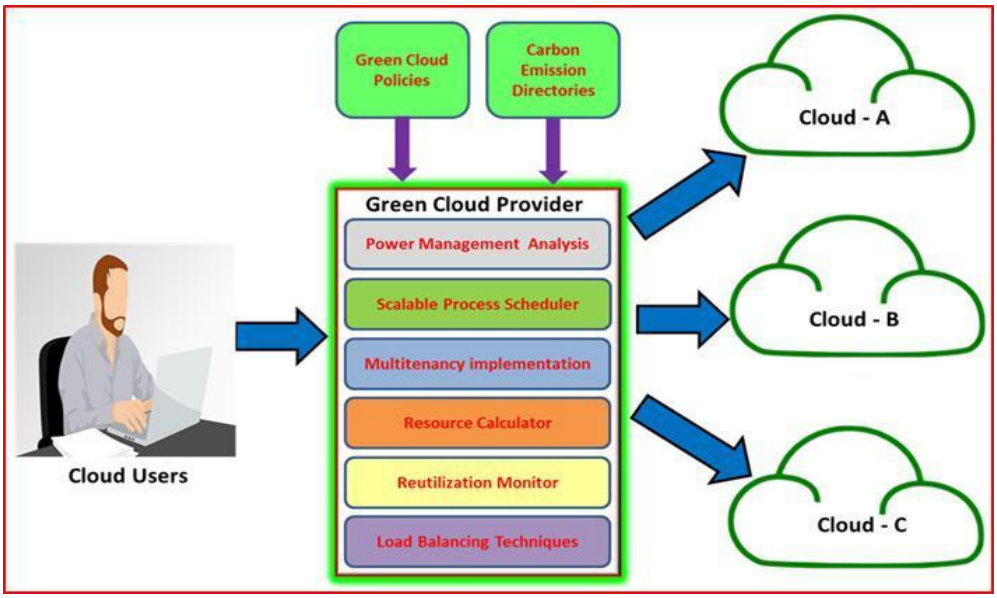

Figure 1. Architecture of a Green Cloud [8]

Green cloud policies and fossil fuel by-product registries are the third-party policies. Their planned approaches and principles help to develop the green clouds from existing cloud models. At last, the end consumer is an IT director of any association, who can interact with GCP to felicitate their association applications on green cloud [8].

5. Energy Consumption in Cloud Models

A critical figure in the computation of energy utilization servers in cloud models is the energy used for cooling. The power usage effectiveness (PUE) is the fraction of the complete power utilization of a centre (information or exchanging focus) over the all-out power utilization of IT gear (servers, capacity, switches, and so on.) [9]. Energy in cloud models is consumed in the following parts [10].

i. Data Centres – A data centre has three fundamental parts- data storage, servers, and a LAN [11]. The data centre interfaces with the remainder of the network through a gateway switch. The power utilization information for every server is acquired by working out the most extreme power utilizing the power horsepower calculator, then following the protocol that typical power use for advanced servers is 66% of the greatest power [12].

Table 1. Energy consumption in data centres of a cloud [10]

	Equipment	Capacity	Power Consumption
Storage	HP 8100 EVA	604.8 Tb	4.9 kW
Content Server	HP DL380 G5	800 Mb/s	225 W
Computation Server	HP DL380 G5	-	355 W
LAN	Cisco 6509	320 Gb/s	3.8 kW
Gateway Router	Juniper MX-960	660 Gb/s	5.1 kW

ii. **Network** – A corporate cloud network contains many ethernet switches connected in a tree-like design. A little Ethernet switch at down level could equalize total traffic on one structure floor, and a few higher level switches

equalize total traffic from various structures or grounds. The energy EC expected to ship a single bit from the server to a client through a corporate network is

$$E_c = 3 \times 3 \times \left(\frac{P_{les}}{C_{les}} + \frac{3P_{es}}{C_{es}} + \frac{P_g}{C_g}\right) \quad (1)$$

where P_{es}, P_{les}, and P_g are the power used by the Ethernet switches, small switches, and server gateway switches. C_{es}, C_{les} and C_g are the limits of hardware in bits each second. The normal use of Ethernet joins in LANs is under 5% [46]. Notwithstanding, a private cloud would essentially increment network traffic by use of 33%.

Table 2. Energy consumption in networks of a cloud [10]

	Equipment	Capacity	Power Consumption
Ethernet Switch (small)	Cisco 4503	64 Gb/s	474 W
Ethernet Switch	Cisco 6509	160 Gb/s	3.8 kW
BNG	Juniper E320	60 Gb/s	3.3 kW
Provider Edge	Cisco 12816	160 Gb/s	4.21 kW
Core router	Cisco CRS-1	640 Gb/s	10.9 kW
WDM (800 km)	Fujitsu 7700	40 Gb/s	136 W/channel

As per a survey review conducted by [13], green cloud computing limits energy utilization by 45% as compared to cloud computing with no compromise in its latency.

6. Green Cloud Computing Technologies

The following technologies can be integrated into the existing cloud models in order to make them Green.

6.1. Virtualization

The concept of virtualization is intended to run various virtual computers on a solitary actual computer (physical equipment) utilizing the process of abstraction. Virtualization permits the production of various virtual machines to run two or more errands at the same time two or three errands.

For the most part, the cloud frameworks are planned with very good quality setup parts like Disks, Processors, Routers and so on. Conventional (sequential) handling techniques will apportion the whole asset set to the running tasks before they start. The apportioned assets of an errand cannot be traded with some other running errands. In this manner, the apportioned assets are underutilized, hindered for certain assignments and the execution takes longer to finish. To conquer the consecutive handling limitations, VMs based on hypervisors are planned later on to run different tasks parallelly on the same machine with asset sharing facilities.

Removing High execution from assets, diminishing the successive ventures on foundation and productive asset usage are the primary benefits of virtualization. Rapid handling, low power utilization, very good quality asset usage and cost reserve funds are the accomplishments of virtualization and help in planning the green clouds a great deal. Dynamic load balancing along with VM, asset sharing across VM's, plan of secure VM and energy enhancement methods for virtualization are the emerging exercises for green clouds.

6.2. Data Centre Efficiency

In Green Cloud Computing, the idea of consolidation can be defined as the way of employing various data centres related information handling applications on one server with virtualization. This is the principal sub-task gotten from virtualization

and it is resolved to carry out the cycle stage load balancing, better use of virtual frameworks and lessening the power utilization.

So, it is smarter to unite a few jobs in a solitary actual server for example moving server jobs from various underutilized actual servers onto virtual machines. This decreases the number of equipment and energy utilization.

6.3. Load Balancing

Load balancing is the way of circulating workloads across computer assets in a cloud computing climate and cautiously adjusting the traffic in the network to get to those assets. Load balancing empowers associations to fulfil workload needs by directing approaching traffic to various servers, networks or different assets, while further developing execution and safeguarding against disturbances in services. Load balancing makes it conceivable to circulate jobs across many geographic areas.

Cloud load balancing assists associations with accomplishing superior execution levels for possibly low costs than customary on-facility load balancing innovation. Cloud load balancing exploits the cloud's adaptability and spryness to fulfil the needs of disseminated jobs with large quantities of client associations. It likewise works on general accessibility, increments throughput and lessens idleness.

6.4. Multitenancy

Multi-Tenancy is defined as an instance of cloud overhauling to numerous tenants of the same class, to stay away from the extra ventures (making another cloud instance for each tenant) and using the accessible assets effectively. Multi-tenancy is a primary quality of green cloud since it helps to save the assets by facilitating numerous occupants with one instance of cloud.

To get acknowledged by the cloud customers, the multi-tenancy has the obligation to demonstrate it as a secure climate for information exchange and handling. Secure Multi-Tenancy advancements, Multi Tenancy Optimizations, Privacy saved secure admittance to multi-occupancy clouds are the moving advancements in this green cloud research region.

6.5. Dynamic Provisioning

Dynamic Provisioning permits capacity chiefs and framework heads to design and dispense storage to clients or applications productively. It gives a stage to the cluster for dynamic control of information and actual limit without recurrent manual contribution. It is a volume management operation.

Dynamic Provisioning gives three significant abilities: depending on the situation provisioning of storage, improved volume execution and bigger volume sizes.

Dynamic Provisioning is more proficient than conventional provisioning systems. It is executed by making at least one Dynamic Provisioning pools of hardware storage utilizing different LDEVs.

6.6. Power Optimization

The term power optimization is an essential structural block of green cloud computing. It assumes an imperative part in the development of eco-accommodating green clouds. Energy proficiency in cloud implies conveying proficient power strategies to diminish the power utilization at each cloud level (servers, switches, data centres, processors and so forth), which were proposed in the DPM framework. This framework begins with just the necessary cloud assets at starting, gauges the power wants and supplies the sufficient power voltage in light of interest. Assuming any cloud asset is provided with the surpassed power (voltage), will be recognized and rectified quickly utilizing the dynamic power managing procedures, known as dynamic power optimization [14-15].

7. Hosting a Static Website on Cloud Using Virtualization

Amazon S3 or Amazon Simple Storage Service is a service under the Amazon Web Service that gives storage of objects through a web interface. The project aims to demonstrate Green Cloud technology as S3 is a DaaS model which utilizes the concept of virtualization to form a separate cloud for resources available as per the client's request. Thus, all the resources required to host the website are available from the cloud through virtualization.

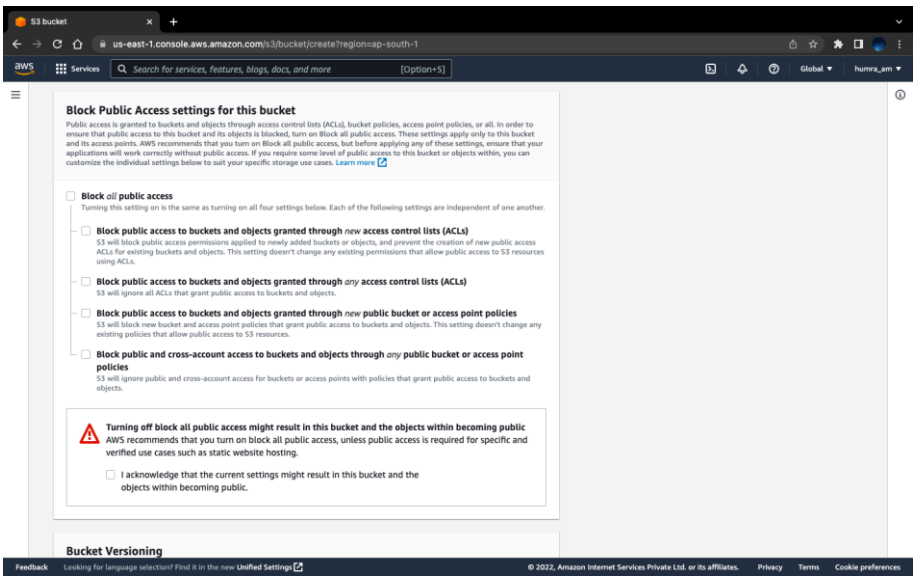

Figure 2. Creating a Bucket in S3

After uploading all the source code files in the bucket, navigating to index.html would provide all the information about the website and also provide the link for hosting the website.

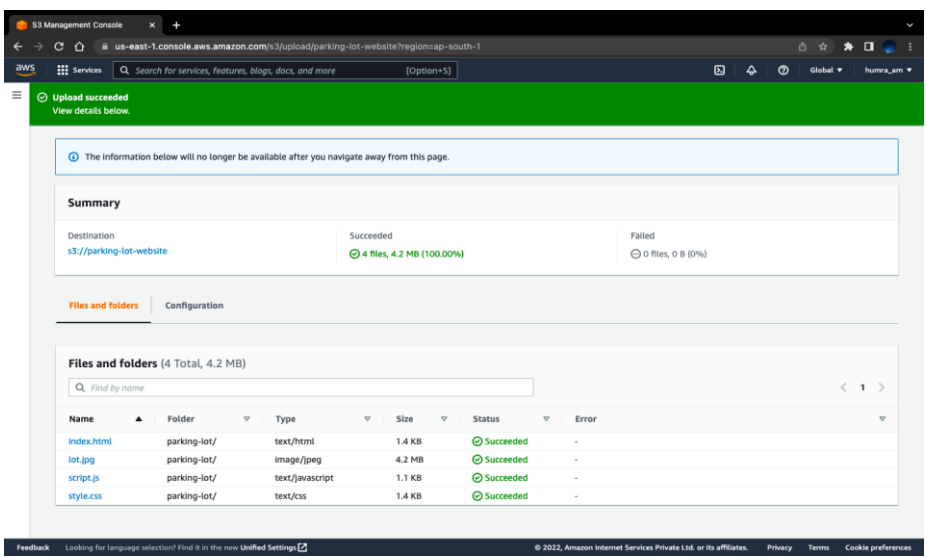

Figure 3. Uploading the Website folder in the Bucket

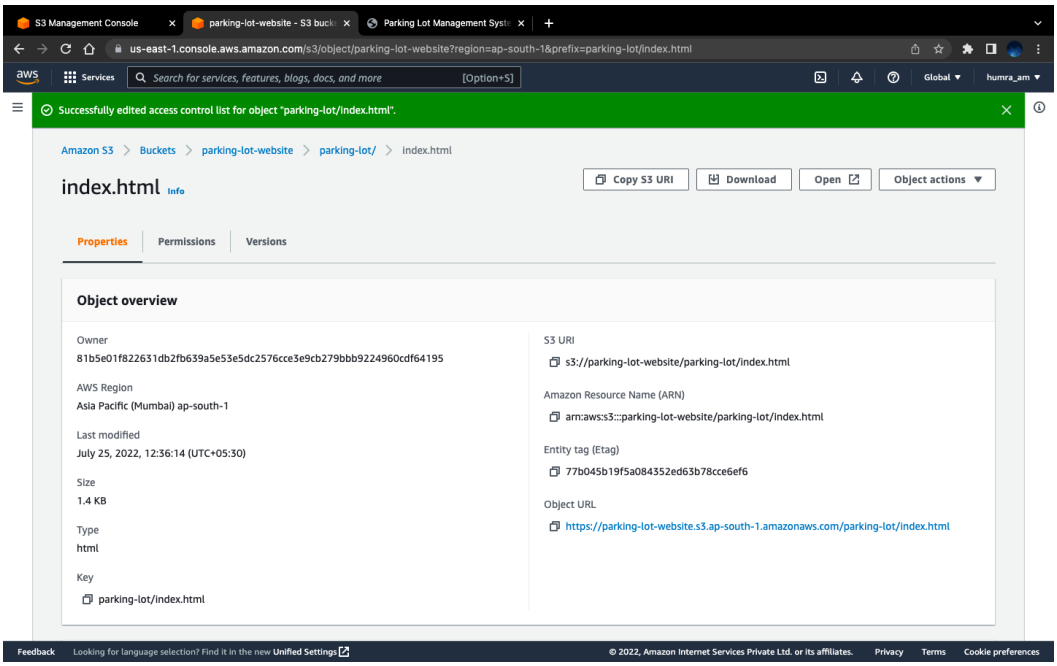

Figure 4. index.html of the Website

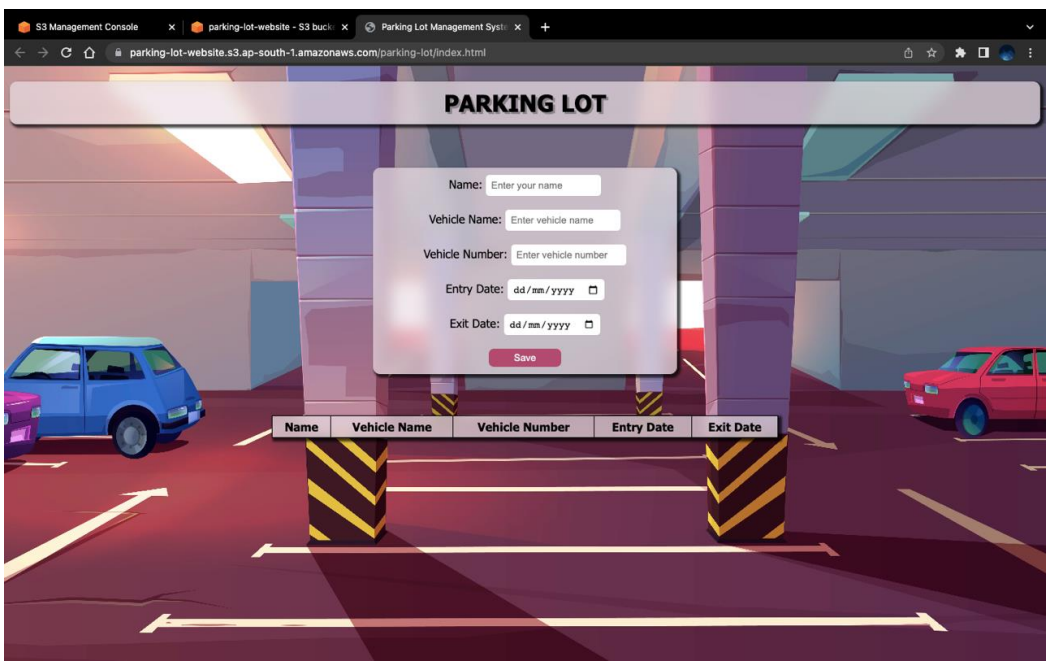

Figure 5. Parking Lot Management Website hosted on Amazon S3

As shown in Figures 5, the Parking Lot Management website hosted on the Amazon Web Service (AWS) S3 which is DaaS cloud service model using the concept of virtualization.

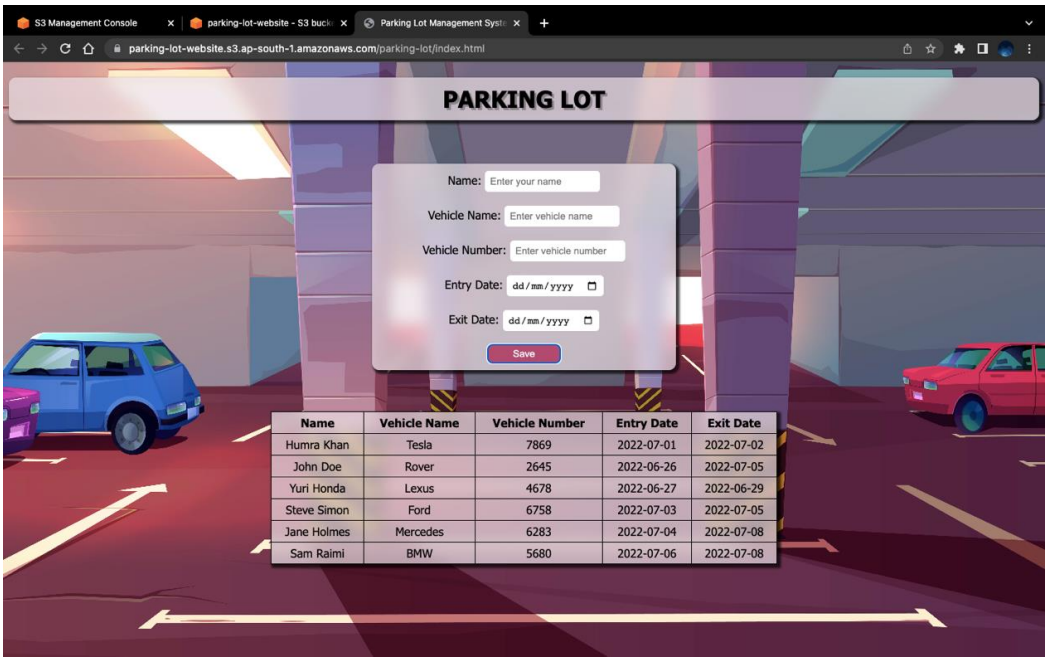

Figure 6. Parking Lot Management Website hosted on Amazon S3

The website accepts the name, vehicle name, vehicle number, entry and exit date from the user and simultaneously updates and displays the data entered in the table as seen in figure 7. The website is constructed using HTML and CSS for the design and JavaScript for data manipulation.

Advantages of hosting website on AWS S3 over other hosts-

i. Huge platform support
ii. Elastic in nature
iii. Availability of data centers at a worldwide scale
iv. Low flexible cost models
v. Less energy and cost consumption than other hosts, thus supporting green cloud computing through virtualization
vi. Provides security, smooth data transfer and management

8. Conclusion and Future Scope

In this paper, we have provided a few progressive thoughts for domestic customers in addition to for cloud data centres to lessen energy intake and carbon emissions. There is a necessity for green computing in present-day times, it gives ecologically safe computing energy that relies on green computing, particularly it is targeted at the cutback of carbon outflow to make the tech enterprises free of pollutants. Various power-efficacious techniques ought to be carried out in data centres to make them environment-friendly facilities. Cloud computing is powerful if power consumption in servers is reduced as much as possible. Power-saving techniques save an ample quantity of energy and gradually reduce the carbon footprint of clouds.

As of now, clouds are planned with multi-processor CPUs. There is a requirement of planning the power improvement and executive strategies to help the power management with multi-processor CPUs. Another colossal power-consuming piece of the cloud is the server farm, which is an assortment of information stockpiling parts and information. A productive power utilization checking framework, dynamic power framework and savvy power supply dynamic frameworks are in the examina-

tion challenges currently. By taking into account today's speed of technology industry, there should be a thorough and wise system to handle the whole cloud engineering level energy streamlining issues.

Eco-Friendliness of cloud focuses on climate-based instruments plan for example fossil fuel by-product calculator instruments to quantify the impact of the cloud on nature. Requirement of planning a thorough system to ensure the clouds with positioning, in view of various parts of Green Cloud Computing.

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