An Empirical Study of Traditional Data Center Shift Towards Green Data Centers

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Abstract: Environmental protection is one of the major part in the society now with advancements of technology. Most of the users depend on data centers to complete their tasks. Data centers cause emissions which cause the problems to the environmental wellbeing. It is required for the data centers to transform from traditional to green. Green data center can be designed by using renewable energy to conserve power and cooling the servers to avoid the heat emissions. Software considerations such as power management, green cloud, game based approach and neural network methods are discussed. In this paper, overview of green data center is presented with software contributions and renewable source utilization.

IndexTerms - **Green data center, Renewable energy, Natural cooling, green cloud, power management**

I. Introduction

Entire world is facing the challenge with environmental sustainability. There are many adverse effects on the environment with the increase of technology such as carbon emissions and Green house (GHG) gases. Now many IT organizations are alert with hazardous impact of emissions caused [1]. Data center hosts many servers, power backups, cooling unis and soon causing many emissions. Hence it is required to move towards green data center which can use renewable resources and other alternate approaches. Green Data Centre are repositories for storage and maintenance of data made of natural resources, one that produces fewer pollutants and consumes less energy. Some of the factors that drive data centers are reducing environmental impact in the form of design, waste recycling, low emission materials, alternative energy techniques, etc. This is based on the term sustainable development meaning "meeting the needs of the present without compromising the ability of future generations to meet their own needs".

Traditional Data Centers were made in accordance to the client company requirements. They were designed and built only considering data requirements and possible future data demands. As a result, a lot of the hardware will be kept powered on without utilizing fully and sometimes idle. A green data center would manage effectively and power off the hardware for better energy efficiency without compromising the performance and data needs. Transitioning from traditional data center to green data center is really a challenging task faced by many IT organizations. At this stage, it is realized by many IT firms to implement energy efficient and green data center.

Business depending on the Data Center administrations is now expanding and Data Center administrators confronting difficulties to deal with the Data Center assets, so as to provide food to the expansion request. Data Center administrators are introducing extra gear in the Data Center. Along these lines, many researchers have featured the expanding pattern of energy utilization in Data Center starts from the IT frameworks, such as server, stockpiling, and from the non-IT frameworks like cooling and power framework. Investigating IT framework, one of the arrangements that may diminish the energy utilization in the Data Center is to receive the Green Server farm utilizing the green registering. At the same time, Data Center administrators[2] are confronting numerous issues and challenges and the most highlighted one is about the dependability and execution, asset the executives and energy management.

Inspite of challenges, Green data center has numerous benefits towards environmental protection like less carbon emissions, pollution free environment, energy saving and power management.

Properties supplying such great amount of electricity are few today and will become even rarer tomorrow. A green data center design will help achieve greater power capacity of a property by improving the electrical efficiency of both the building and the equipment housed in it.

Owing to the large data demands of the modern world and the increasing environmental issues, there is a need to sustainably develop green data centers. In this paper the issues and challenges of green data centers are explored and provide a framework for the sustainable development of green data centers. Also walkthrough the different strategies that can be used to green a data center.

II. Background

lzan et al[2]., discussed that data center admins are facing many issues and challenges. The most prevalent presented by the authors are reliability and performance, resource management and energy management. These mentioned issues are interrelated which has to be addressed to improve the efficiency and performance. The challenges gave the admins an opportunity to work towards the green data center.

Santhanam et al [3], has expressed the concern about data center needs and presented a framework for green data center. Data center is the backbone for advanced economy, huge information, cloud, computerized reasoning and IoT innovation. It is critical to discover potential choices to advance framework and improve effectiveness and efficiency of data center. They have identified categories such as power savings, cost optimization and usage of renewable energy which add energy efficiency. The authors have explained how information technology can contribute towards all the categories mentioned above.

Archana et al [4]., has presented benefits of green cloud computing towards environmental friendliness. With green cloud some of the advantages such as energy efficiency and power utilization are well discussed. Multitenancy and consolidation can contribute towards the implementation of the green cloud. Resource utilization can be improved by the multitenancy feature for cloud computing. Consolidation of servers will give positive benefit with load balancing.

Virtualization technology [5] also helps in saving the energy. Servers are categorized in to three pool of resources as innovation, critical and production. As per the applications, servers are classified. Innovation servers can be scalable as per the demand of the applications. In Production servers there are fewer chances of addition of servers and critical servers need powerful servers as many important applications run. After server consolidation it is observed the improvement in the energy saving.

III. OVERVIEW OF GREEN DATA CENTER

Usually in the data center services requests are raised by clients and servers hosted will have to give response to the request. At the datacenter, priority should be given to the client requests. Green data center has to be designed with the cooling and renewable resources. The data center shown in the fig.1 depicts how the renewable wind energy and solar energy are used for server power management. Cooling devices are used to avoid heat emissions.
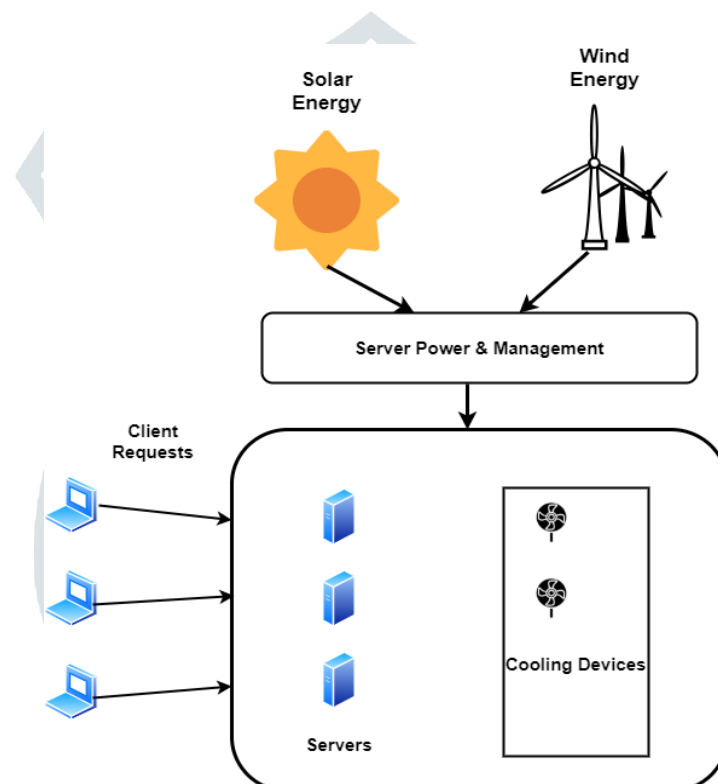

Fig.1 Green Data Center

Energy Considerations
With the expanding interest for information administrations and the quick improvement of data innovations, the size of server farm has acquired a fast advancement. The requests of hardware and storage are developing strongly alongside the supporting offices. Hence, the issue of energy saving of server farm has ending up more truly [6].Concentrating many devices in the data center utilizing the energy as there is a growing demand of users for their computations.

Renewable Energy
Users are using the services provided by the internet through geo-distributed data centers across the globe. Data center admins have the issue to minimize the carbon footprint. The best way out of this problem is use renewable resources. Now most of the data centers have adopted to use the renewable energy such as wind and solar energy.

Considering current propelling advancement and the way in which data is developing, IT guiding jend redistributing industry is required to be a key associate for development headway despite help continuous business along with reduction in cost of operations. Data center has become an important factor for cutting edge economy, immense information, cloud, automated thinking, IoT or wearable advancement. Data improvement and data based on demand get the opportunity to change the point of convergence of server ranch is limit and fiasco recovery to get the data in a brief instant through cloud with proper security and quality of data [7].

Utilizing the renewable resources to the data center is really a challenging task. The open doors offered by geological load balancing, scheduling of tolerant outstanding burdens and thermal storage administration in server farms to encourage efficient power vitality coordination and diminish the expense of dark colored energy use. Besides, transmission capacity cost varieties among client and server farms are considered. In particular, this issue is first planned as a stochastic program, and thereafter, an online control

calculation dependent on the Lyapunov enhancement method, called Stochastic Cost Minimization Calculation (SCMA), is proposed to settle it [8].

Natural Cooling

Controlling heat emissions from the servers in the data center is one of the vital issue [9]. This can be fulfilled by regulating the airflow. Airflow can regulated using techniques like excess heat generated by the devices are to be controlled by proper ventilation, planning of flooring depending on temperature and segregation hot and cold air.

Electrostatic Discharge (ESD)

The high energy utilization of cloud servers has attired extraordinary worry on ecological ramifications, inspite of the fact that a large portion of power is produced by consuming petroleum products. In perspective on this, some Web administrators like Google and Yahoo attempt to assemble their own sun oriented or wind ranch. It is clear with the viewpoint that carbon discharges can be reduced by the sustainable power source. Comparatively it is less when it comes to investment cost [10].

Considering the utilization of ESDs to store the irregular sustainable source of power aiming to reduce energy cost and carbon emissions. ESDs store energy from the framework provided during the less cost and release when cost is high. Anyhow, it was difficult to choose the amount to charge energy of each sort into ESDs and the amount to release from ESDs in each availability. It relies upon the supply of inexhaustible sources, postpone time of solicitations, and power costs in various areas.

Cloud server farms contribute extraordinarily to unnatural weather changes, on the grounds that a large portion of the energy is produced by consuming non renewable energy sources. With this idea many cloud server farms are attempting to control their data center using sustainable power. To reduce the energy cost and carbon discharges every datum focus has its own breeze turbines and sun based boards. The created sustainable power source can be utilized to control server farms straight forwardly or put away into ESDs for later use, or sold back to the power network. In any case, it is difficult to settle on choices on the utilization of each kind of energy thinking about the dynamic approaching solicitations of clients, fluctuating power costs, and discontinuous vitality supply in each schedule vacancy.

Given the entry of approaching solicitations, plan the solicitations, servers and the use of various vital   sources, to each an extent that the complete energy cost can be limited while fulfilling QoS prerequisite inside certain carbon outflow level. Their simulation depends on the follows from genuine world. Tests demonstrate that their technique can fundamentally let down the vitality cost for green cloud server farms by utilizing ESDs and vitality exchanging

Making Decision[11] on the charging required for each type of ESD and discharging amount of ESD is not easy. Directly there is a dependency of renewable energy resources, request delay and cost incurred with electricity.
In order to obtain sustainability, hybrid fuel method which is comprised of gas turbine and fuel cell is used. To energize the devices compressed natural gas approach is utilized to advance towards the greener environment. Carbon emissions can be overcome by adopting CO2 appropriation method so that entire structure can be transformed to green generation [12].

IV. SOFTWARE CONSIDERATIONS

Data Center Power Management

    Now a days to facilitate the energy efficient data center, virtualization technology and to enable the load balancing migration techniques are used [13].
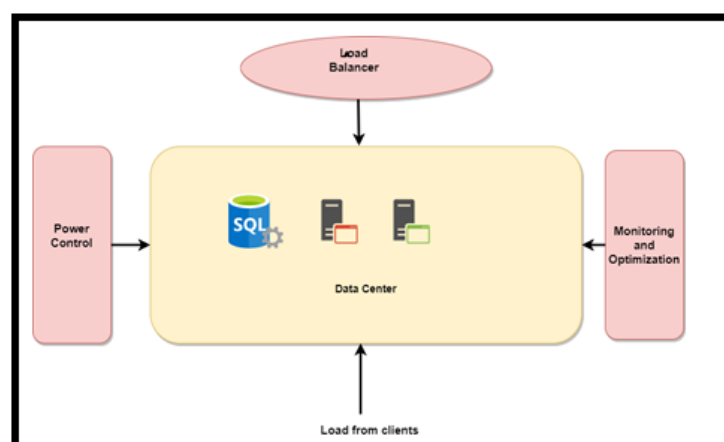

Fig.2. Data center power management

An energy efficient data center is the one which takes care power management and optimizations of any unused devices. The idle logic approach permits decreasing force utilization of system gadgets by quickly killing sub-parts when no exercises are performed and re-awakening them when they get new tasks. By this it is observed that energy consumption is reduced by server's upto 50% as per the load and optimizations carried out.

Precise scheduling of the server farm task and utilization of sustainable power sources present themselves as promising answers for this issue. The issue of planning work processes of errands in dispersed heterogeneous server farms which are mostly fuelled by sustainable power sources [14].

Green Cloud Computing

The emergence of distributed computing has enabled towards the development of whole thing as an administration. This has prompted multiplication of cloud benefits in each processing field. It has expanded the heap on cloud facilitating server farms[4], bringing about extreme utilization of power. A cloud server farm can figure out how to spare power by diminishing asset misuse through either or both of the effective use based and warm based planning and observing. There is a gigantic financial potential in pay-as-you-go sort of charge and is one of the primary reasons of quick move of processing patterns to distributed computing. A user in cloud needs to pay nothing for support and care of the processing assets on cloud. It just takes a couple of mouse clicks for simple web based provisioning and the board of virtual registering resources on cloud.

Game Theory models

Game theory models[15] are exhaustively used for trading of remaining task at hand/traffic among server farms inside a system as indicated by the accessibility of efficient power energy assets. Both homogeneous and heterogeneous server farms are considered so that they can have comparable or distinctive taking care of abilities separately.

This prompts a non-helpful game model for homogeneous server farms while heterogeneous server farms structure an agreeable diversion model to trade their remaining task at hand/traffic. Numerical outcomes are introduced which show a decrease in vitality costs utilizing the two models with a noteworthy improvement in normal utility for the server farms.

Further, the brilliant network advances the utilization of inexhaustible and efficient power vitality assets, for example, wind and sunlight based power.

Neural Network Based Approach

Everyone are moving towards the renewable energy such as solar and wind energy. As there are many tasks to be solved using IT. Neural network [16] gives the solution for task scheduling. Energy is assessed first by the neural network algorithm, then using Analytic hierarchy process (AHP) to estimate the tasks load Completing task load, energy requirement is analyzed. This approach can be used for green data center.

V. CONCLUSION

Technological change has given rise to the requirement of using the resources efficiently and saving the environment. Cooling the datacenter is one of the major step towards the green data center which reduces the heat discharges. Monitoring and optimizing the usage of power contributes to the increase in the environmental sustainability. Central monitoring of data center is the holistic approach of the green data center. Data centers are the vital part in producing the emissions, hence it is required to implement sustainable methods to make them greener. In this paper, some of possible considerations are explored and presented. In this way contribution green data center contributes towards the sustainable environment.

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