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Green Data Center

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Abstract*— *Green is the hot topic these days. Green within Technology is a term that describes an innovative way of how ecology and technology converge together. To achieve this global agenda of going green Energy efficiency (EE), energy consumption cost and environmental impacts are vibrant challenges that IT industry faces. Reducing energy consumption and emissions of carbon dioxide in data center highlights open areas for research work on green data centers. This paper involves review of the technologies and strategies for improving data center energy efficiency. Such practices include the efficient implementation of server and peripherals as well as techniques for reducing the power consumption. The energy efficient green data center requires increasing the utilization of existing and new resources, improving equipments power and cooling usage requirements, reducing the data center's carbon footprint, reducing IT maintenance and administrative costs. Section I contains introduction about green data centers. Section II contains the challenges and issues being face by the traditional data center which serve as a direct cause for transitioning towards green technology. Section III reveals the various strategies that when implemented can lead to the generation of an ecofriendly data center. Section IV contains conclusion.

Keywords*— *green data center, energy efficiency metrics, green design, green disposal, green operations, green procurement

I. INTRODUCTION

Data center is a facility for hosting computing resources grouped or networked together using communication infrastructure for application hosting and data storage .To fulfill the escalating user and application demands the data centers have witnessed an exponential increase in their growth. With the rapid increase in the capacity and size of data centers, there is a continous increase in the rate at which energy is consumed . Data centers, apart from their ongoing high energy consumption, also produce carbon dioxide which is known as the greenhouse gas . This calls for an urgent transition from power greedy data centers to environment friendly green data centers.

A green data center is the one which operates with maximum energy efficiency and minimum ecological impact. The main focus of green data centers is driven primarily by an earnest need to reduce the huge electricity costs that are associated with the working of data center. Therefore, going green is recognized as an alternative for reducing the operating expenses considerably for the IT organizations.

The two driving forces for efficient and green data centers are:

- Various opportunities to realize significant and long-term financial benefits.
- Tendency to reduce environmental impact of existing inefficient data centers.

II. CHALLENGES FACED BY THE DATA CENTERS

Replying to the customer's demand for better performance at lower rates, the IT industry has delivered faster servers, low cost storage and more flexible networking equipments. While these new resources can deliver greater performance per unit of power, they can even be increasingly power greedy. Typical data centers provide approximately two to three times the amount of power required for the IT devices because traditional data center designs are oversized for maximum capacity and older components can be very inefficient. The cost related to this level of power consumption can noticeably effect the total cost of ownership for data center and IT systems. The increasing cost of a kilowatt of electricity has further complexed the problem. Cooling and electrical costs presently represent upto 44 percent of a data center's total cost of ownership.

The global economy has made the world more competitive and cooperative. As organizations are adapting for sustainability is a business imperative. Concerns of organizations that call for a green data centers are:

- Managing the increasing cost of the energy. The cost of a kilowatt of electricity is constantly rising. With the growing demand for less expensive and more powerful high-performance computer clusters, the problem is not just paying for the computers but also determining whether the budget is available to pay for power and cooling
- Running out of power capacity. Some companies cannot deploy more servers because additional electrical power is not available. New server, storage, and networking products give better performance at lower prices but can also be power hungry.

- Running out of cooling capacity. Many customer data centers are now 10 to 15 years old, and the cooling facilities are not adapted to the present needs. Traditional cooling methods allowed for 2-3 kW of cooling perrack. Today's requirements are 20-30 kW per rack. Heat density is many times past the design point of the data center
- Running out of space. Each time a new project or application comes online, new servers or storage subsystems are added.
- Obsolete equipments. The aging data centers are having a hard time keeping up with today's demands. their critical infrastructure equipment is likely to be growing inefficient and reaching the end of its useful life. High-density rack-mounted servers can increase hot spots and tax cool-ing systems, making it difficult for aging data centers to keep up with today's demands.
- Improve Server Utilization. The underutilized equipment not only has a significant energy draw but also is a constraint on data center capacity. There are many factors that directly contribute to low server utilization. They include: vast over-provisioning of IT resources; limited deployment of virtualization despite itsbroad penetration; unused servers;under-deployment of server power-management solutions; lack of a common, standardized server utilization metric.

III. TRANSITIONING TO A GREEN DATA CENTER

Energy costs are rising, supply is limited, the data center infrastructure is being taxed, and its ability to meet business demands is at stake. This calls for an urgent requirement for developing an energy efficient data center. Although there is clearly no single "right way" to create a green data center but the best results can be achieved by integrating power and cooling changes with advanced technologies such as virtualization, energy efficient hardware and software, and power and workload management initiatives.

A. The basic step towards this conversion can be generation of best practices assessment and energy audit- Through this approach it is possible to pinpoint areas of high energy use, while establishing a baseline for further planning. A proper assessment can produce the following outputs: Identification of problem areas, recommendations for quick, inexpensive solutions and Recommendations for organizing a long term energy efficiency strategy.

B. Calculate data center infrastructure efficiency- Measurement of energy consumption of data centers can be performed using various metrics. Energy efficiency metrics are tools that are used to measure energy efficiency of data centers. The review on common energy efficiency metrics which are presently being used by data centers are:

- PUE (Power Usage Effectiveness): Created by the members of the Green Grid, it is a parameter for determining energy efficiency. PUE is calculated by dividing the degree of power entering by the power that is used to run the computer infrastructure. Data center PUE generally lies between 1.3 to 3.0 with an average case of 2.5 .
- DCE (Data Center Infrastructure Efficiency): Created by the Green Grid, DCiE is metric for determining the energy efficiency of a data center. It is the reciprocated form of PUE. It is calculated by division of equipment power with total facility power. A data center's DCiE particularly ranges from 33% to 77% with an average of 40% .
- LEED Certified: LEED is an internationally recognized building certification system . It gives third party verification that a particular building or community was designed and built employing methodologies aimed for improving performance considering the metrics that matters the most: energy saving, carbon dioxide emission reduction, the quality of internal environment.
- Green Grid: A non-profit global collaboration of companies, government organizations and educational institutes dedicated to development in energy efficiency of data centers . The Green Grid do not promote vendor specific products but seeks the provision of recommendations on best practices that will enhance overall data center energy performance.
- Telecommunications Industry Association (TIA): It is the leading association that represents the Information and Communications technology industries. It helps to generate standards to provide certification and to promote environmental regulatory compliance. TIA improves business environment for companies related to telecommunications, mobile wireless, broadband, information technology, networks, satellite, communications and greening of the technology

C. To build a list of opportunities to drive maximum energy efficiency in the data center. They can range from major infrastructure upgrade projects such as upgrading chillers or uninterruptible power supplies (UPS) to simple and inexpensive measures, including:

- Blocking cable openings to prevent cold air waste in the hot aisle
- Removing under-floor cable blockages that impede airflow
- Turning off servers that are not doing any work
- Turning off computer room air conditioning (CRAC) units in areas that are over provisioned for cooling

D. Follow the standards: Several initiatives are taken to help users identify and buy the most energy efficient IT equipment. These include the 80 Plus program for power supplies, as well as a planned Energy Star certification program for servers.

E. By following green practices: The following recommendations of green data centre stratergies which are to be implemented for attainment of ecofriendly data center.

1) Green Design

For IT systems: Deployement of new or replaced systems:

- Server virtualisation should be considered for the installation of new or replaced IT systems. Virtualisation enables multiple systems to run on single server. It helps lessen the number of physical servers and to reduce the power consumption in server operations. According to the Green Grid, virtualisation can save upto 10%-40% of energy.
- Energy and temperature reporting hardware should be considered whenever possible so as to assist in the implementation of temperature and energy monitoring across data centres .

Data Management:

- A framework for management of data life cycle should be used for deciding which data to be kept and at what level of security protection. This management helps to organize the flow of data from creation and early storage to the time when it becomes old and should be deleted. This ensures that minimum set of information is kept to support various requirements and to prevent the wastage of storage resources simultaneously.
- Replicated files and data should be eliminated to save data storage.

For data centre facilities: Air-flow management

When building a new green data centre or rebuilding an existing data centre

- A technique of hot and cold aisles should be employed. Hot aisle layout requires the equipment racks to be installed back-to-back while in cold aisle layout the racks installed front-to-front. This kind of design avoids mixing of hot and cold air which in turn optimises airflow .
- A design involving hot or cold air should be adopted. This design is used to separate hot and cold air by the installation of physical partitions like vinyl plastic sheeting for the enhancement of uniformity of air temperature from top to bottom of racks.
- A structured cable system involving a standardised wire infrastructure or system such as centralised patch panel or cable tray should be used for improving air-flow . A structured cable system provides more space within racks to enhance air-flow .Grouping of equipment with different environmental needs should be deployed in a different areas.
- Equipment should be chosen with heat outflow matching the airflow design of the rack which is to be installed.
- Measurement of power consumption by installation of devices capable of calculating total energy consumption of data centres and also capable of measuring total energy delivered to various systems in data centres.

2) Green Procurement

Procurement of IT equipment:

- Energy efficiency performance needs like Energy Star must be included in procurement of equipment.
- Large ranges of operating temperatures and humidity must be taken into consideration for procurement of IT equipment in order to save energy in data centres. As the ranges of operating temperature and humidity in data centre for different equipments usually varies causing these equipment to be able to operate within worst case ranges of the data centre.
- Power management features should be included in the procurement specification of equipment. Power management features aims to facilitate optimal usage of energy in accordance to the workload of IT equipment. As an example low-power "sleep" mode of equipment that will be activated after a long period of inactivity. The servers may be switched off automatically when there is no workload .
- Variable speed fans must be used. These optimise power consumption by adjusting air speed according to the surrounding temperature.

3) Green Operations

- Power usage efficiencies of the centre should be estimated. It measures the energy-efficiency of a data centre by comparing the total power consumed to the amount of energy which is effectively consumed by a particular equipment, depicting how effectively the energy is used for operating the equipment and the extent that is needed for operating the supporting facilities.
- Server utilisation should be calculated to identify underutilised servers for the purpose of consolidation and virtualisation .Storage utilisation must be known for consideration of consolidation, network utilisation should be calculated for identification of inefficient data transfer.
- Unused systems must be decommissioned within a given period of time, equipment that is free for a prolonged period of time should be closed, various power management features on equipment should be enabled, unmanned monitors should be switched off.

For air flow management :

- Hot and cold aisles should be adopted in data center.

- Any clutter under the data centre floor, involving cables that might interrupt airflow must be cleaned up.

For equipment racks:

- Gap containing no equipment should be covered by installing blanking plates so as to lessen cold air passing through gaps in the racks, cable cut-out tiles should be covered to prevent any anticipated air leakage conditions. Perforated rack doors should be used as they allow efficient in-take of cold air and dissipation of hot a in hot and cold aisles arrangement.

Cooling management:

- Unwanted cooling equipment should be closed to save energy.
- Cooling air should be transferred nearer to the load to minimize cooling demands.
- Cooling load should be revised before any replacement of equipment like reviewing flow of vented tiles before change of IT equipment.
- Cooling techniques should be reviewed on periodic basis to ensure effective delivery of cooling air and maintain the system reliability, and achieve economic operational and environmental benefits.

Temperature and humidity settings:

- Reduction of cooling requirement in data centre should be explored by increasing the ambient room temperature
- Humidity range should be reviewed to increase the upper humidity set point of the data centre to decrease the dehumidification loads within the facility.
- Chilled water temperature setting should be reviewed to reduce the compressor energy consumption
- Cooling system operating temperatures should be reviewed to improve efficiency

4) Green Disposal

- Disposal of old IT data centre equipments.
- Equipments should be refurnished or dismantled for reuse , while disposal of old equipment should be in accordance with relatable environmental regulation such as Waste Disposal Ordinance
- Environmental-friendly toners such as refillable toners, toners that can be recycled after disposal must be used

IV. CONCLUSION

This paper specifies the urgent need for the management of energy use of a data centre. It specifies requirements for an organisation to establish energy efficient management system, which enables the organisation to follow systematic approach, in order to achieve continuous improvement in energy performance.

Through this paper the conclusion can be derived that the essence of improvement lies in accurate measurement of energy being consumed so that a baseline for improvement can be established. Once consumption is measured, management techniques and new technologies can then be deployed which significantly reduce energy costs throughout the electrical and mechanical and IT room of the data center techniques, such as hot aisle / cold aisle orientation for racks, can begin the process of improved energy efficiency.

On the end note it can be concluded that data center can be upgraded to green data center by following the "4 R's":

- Regaining power and cooling facility
- Recapturing resiliency
- Reducing energy costs
- Recycling end-of-life equipment

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