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Efficiency and Green Attributes of Cloud Computing

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***Abstract*—"Green computing" idea started in 1992 when the United States Environment Protection Agency (EPA) launched energy star, an approach to recognize electronic equipment's energy efficiency characteristics. EPEAT- another popular green IT bench mark- is associated with IEEE standards for computers, laptops etc. But the requirement of personal computers, laptops and other IT equipment's increasing day by day and also they are reproducing more and more carbon dioxide (CO_2) which is affecting the environment. The Information and Communication Technology (ICT) community is researching how to ensure that communication systems absorb less energy and thus conjointly have a essentially smaller carbon foot print. Here we are suggesting how we can use green clouds (private as well as public) so that we can reduce existing network that does not affect the existing need, so we can reduce energy and CO_2 also.**

***Index Terms*—Clouds, Green, ICT, EPA , PUE, E-Waste.**

I. Cloud Computing

Cloud is a collection and interconnection of utilities (mail, storage, computer power, databases, social networks, banking, software, applications, infrastructure, other commodity services and future commoditize'ble services) that follows and serves the human being on subscription. Cloud computing can offer enterprises many benefits in terms of financial savings, scale, speed, management, and flexibility. However, it also raises concerns about trust, control, security, compliance, management, data location, and data availability. Furthermore, cloud computing represents a huge transformation in the way enterprises provide and use IT services [1]. Cloud is expensive for customers who "like" it and useful for customers who "need" it on demand .Cloud computing is a highly scalable and cost-effective infrastructure for running HPC, enterprise and Web applications [2]. Cloud computing has been envisioned as the next-generation computing paradigm for its major advantages in on-demand self-service, ubiquitous network access, location independent resource pooling, and transference of risk [3].

II. Green Computing

Green computing is the environmentally responsible use of computers and related resources such practices include the implementation of energy-efficient central processing units (CPUs), servers and peripherals as well as reduced resource consumption and proper disposal of electronic waste (e-waste) [4]. Green computing includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling [5]. The key role of green computing is to make the use of computers as energy efficient as possible with minimal or no impact on the environment. As for the businesses it means to find the methods of cutting the consumption of power resources and IT waste recycling.

III. Green Clouds

Green clouds mean lower power consumption, cost and e-waste with high profit. Green cloud refers to the potential environmental benefits that information technology services delivered over the Internet can offer society. The term combines the words green - meaning environmentally friendly - and cloud, the traditional symbol for the Internet and the shortened name for a type of service delivery model. A new report released by the Carbon Disclosure Project in London has found that blue-chip companies can reduce their carbon emission by 50% if they move their data storage operations to the clouds. Cloud computing services are simple to use, and can decrease both trade costs and ecological loads [6]. Quick flexibility and measured service [7] are highlighted for cloud computing
scenario.

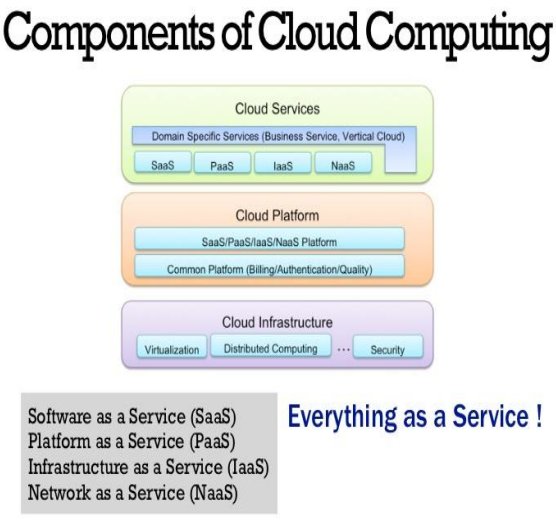

Fig.1

I. Benefits of Green Clouds

Forrester estimates that worldwide spending on public cloud computing services will grow from $25.5 billion in 2011 to $160 billion in 2020, a 22% annual growth rate. Businesses are increasingly substituting cloud-based for internal resources

to capture benefits like faster scale-up/scale-down of capacity, pay-as-you-go pricing, and access to cloud-based applications and services without buying and managing on-premises infrastructure. But we have heard little so far about the efficiency and green attributes of cloud computing. That is starting to change as we hear from cloud or as-a-service providers about the architecture and power sources behind their cloud infrastructure, and as we all start to analyze customer implementations of cloud resources vs. on-premises alternatives.

Cloud infrastructure addresses two critical elements of a green IT approach: energy efficiency and resource efficiency. Whether done in a private or public cloud configuration, as-a-service computing will be greener for the following reasons.

A. Resource virtualization, enabling energy and resource efficiencies.

Virtualization is a rock-bottom technology for deploying cloud-based infrastructure that allows a single physical server to run multiple operating system images concurrently. As an enabler of consolidation, server virtualization reduces the total physical server footprint, which has inherent green benefits. From a resource-efficiency perspective, less equipment is needed to run workloads, which proactively reduces data center space and the eventual e-waste footprint. From an energy-efficiency perspective, with less physical equipment plugged in, a data center will consume less electricity. It's worth noting that server virtualization is the most widely adopted green IT project implemented or planned, at 90 percent of IT organizations globally into 2011.

B. Multitenancy, delivering efficiencies of scale to benefit many organizations or business units.

Whether an IT organization is going with public or private clouds, it's important to understand the nuances of multi-tenant architecture. For public clouds, IT managers need to understand the degree of multi-tenancy supported by whichever vendor they are looking at. For private clouds, the entire responsibility of designing a multi-tenant architecture rests with the IT managers. By combining demand patterns across many organizations and business units, the peaks and troughs of compute requirements flatten out. Combined with automation, the ratio between peak and average loads becomes smaller, which in turn reduces the need for extra infrastructure

C. Reduce energy consumption and reduces paper waste.

Cloud computing can help us reduce energy consumption, which results in reduced greenhouse gases, in addition to keeping old hardware and deceptive materials out of landfills. Another hidden benefit of cloud computing is that it reduces paper waste because PDFs, word documents, and other information can be shared quickly and easily over the Internet, instead of needing paper to print them before sharing. Furthermore, rather than using hardware in your office dedicated to a single function, companies can share collective resources and services to reduce the amount of data centers and to better utilize the networking system.

D. Less equipment packaging required for server and networking hardware

In-house data centres require multitudinous servers, storage devices networking equipment etc. and these typically arrive from the IT suppliers in large, over packed boxes containing cardboard, wood, plastic and polystyrene. Once these pieces of equipment have been delivered then the packaging needs to be disposed of carefully or recycled. In addition, the software installed on the servers will typically arrive on a CDROM and via an extensive paper based installation and setup manual. Cloud computing based environments remove the need for buying and running extensive computer servers and other associated infrastructures. Therefore there is an opportunity to minimise the amount of wasteful packaging materials that are used to transport these pieces of equipment to an office or manufacturing location.

E. Minimises travel requirements for IT implementation teams.

Many companies have globalised their operations over the years and in a bid to reduce operational costs many companies have established a presence in emerging markets such as China and India. However one thing that is often overlooked is that when entering a new emerging market you will need to secure local IT implementation resources in order to help setup your IT or B2B environment. However due to the limited availability of skilled IT resources, many companies deploy their own implementation resources which means that companies must fly personnel into the region and perhaps keep them onsite for a few weeks. However typically these employees will be seconded to the new plant to not only get everything setup but to also cross train local staff in the future maintenance of the equipment. So if a North American manufacturer sets up a new plant in China, how many people will it have to fly across the world to support the operation?, how many tonnes of green house gases will the planes burn to carry staff and equipment to the new plant? As Cloud computing environments are hosted by an outside provider and are typically very easy to deploy, you can, in most cases, remove the need to send employees half way around the world as these environments can be brought online and monitored remotely.

F. Increased availability of information improves supply chain efficiency.

Many companies typically store their business information in multiple enterprise systems across many different servers located in different countries around the world. Trying to track down the information that you require and then access via some form of networked computer system can be difficult at the best of times. This is made more difficult if you are working remotely and you need to connect into a business system via a laptop computer. Over the past couple of years smart phones and Tablet devices have changed the way in which users can get access to enterprise information on the move. Whether you are using an office based desktop PC or a laptop, they will either need to be connected to a power supply or charged up in order to be able to do any lengthy or meaningful work. An Apple iPad on the other hand is extremely eco-friendly from a power consumption point of view, especially when you consider that on a full charge the iPad's battery will last for ten hours. In addition, the very fact that information is held in a central location and is accessible anywhere in the world via the internet means that logistics carriers for example can process shipping information a lot quicker, minimizing border control related delays and thus ensuring that shipments reach their destination in a much shorter period of time.

G. Dynamic Provisioning

Dynamic provisioning is the concept of setting up resources in an on-demand fashion to be available only when required. I can schedule resources to be available short term or long term without involving system administrators or any other manual process [8]. Dynamic provisioning is a simplified way to explain a complex networked server computing environment where server computing instances or Virtual Machines (VMs) are provisioned from a centralized administrative console or client application by the server administrator, network administrator, or any other enabled user. The server administrator or network administrator has the ability to parse out control of the provisioning environment to users or accounts in the network environment (end users, organizational units, network accounts, other administrators). The provisioned servers or VMs can be inside the firewall, outside the firewall, or hosted depending on how the supporting pool of networked server computing resources is defined. From the perspective of the end user/client the requested server is deployed automatically.

II. Minimize E-waste and Investing in Energy Saving

Electricity consumption of datacenters is among the fastest growing sources also the produce a big amount of e-waste.By using green clouds we can save energy as well as we can minimize e-waste.

A. Power Usage Effectiveness.

Power usage effectiveness (PUE) is a measure of how efficiently a computer data center uses its power; specifically, how much of the power is actually used by the computing equipment.

$$\mathrm{PUE} = \frac{\text{Total facility power}}{\text{IT equipment power}}$$

PUE was developed by a consortium called The Green Grid. An ideal PUE is 1.0.

B. Minimize the e-waste.

By pushing the limits of consolidation and utilization, cloud-based infrastructure minimizes the e-waste footprint upfront by requiring less physical equipment. While all organizations dispose of their end-of-life IT equipment in some shape or form, e-waste policies have long been an afterthought and are the least mature IT asset life-cycle management process. Just because cloud minimizes e-waste upfront, don't assume those managing cloud-based infrastructure have policies to ensure e-waste is redeployed, resold, donated, or recycled.

C. Renewable energy sources

If cloud providers are truly going to position their services as green, they must invest in renewable energy sources. The reality is that even the most energy-efficient data center can have a significant carbon footprint because they are typically getting 70 percent of their electricity from greenhouse-gas-emitting fossil fuels, like coal. Ideally, centralized cloud data centers would be powered by renewable sources of energy, like wind, solar, or hydroelectricity. To date, however, cloud providers have prioritized other factors in designing and locating their data centers, including the cost of land, cost of power, property taxes, data privacy regulations, and access to power, bandwidth, local skills, and customers.

I. Conclusion

Cloud green computing is the latest trend today. Balancing energy consummation and hibernating money form saving costs by leaving the purchase of servers, software, data center space or network equipment, make the businesses more efficient and attractive. Energy and resource efficiency, design-for-environment policies and renewable of energy and much more are the benefits of green clouds. Cloud computing can play an important role in a IT organization to be greener. And the green clouds can also contribute to meeting critical operational goals: reduce cost, comply with regulation, improve resiliency etc.

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