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Green Cloud Computing :Emerging Technology

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Abstract - *Cloud computing is a highly scalable and cost-effective infrastructure for running HPC, enterprise and Web applications. However, the growing demand of Cloud infrastructure has drastically increased the energy consumption of data centers, which has become a critical issue. High energy consumption not only translates to high operational cost, which reduces the profit margin of Cloud providers, but also leads to high carbon emissions which is not environmentally friendly. Hence, energy-efficient solutions are required to minimize the impact of Cloud computing on the environment. In order to design such solutions, deep analysis of Cloud is required with respect to their power efficiency. Thus, in this chapter, we discuss various elements of Clouds which contribute to the total energy consumption and how it is addressed in the literature. We also discuss the implication of these solutions for future research directions to enable green Cloud computing. The chapter also explains the role of Cloud users in achieving this goal.*

Key Words: Cloud, Data centre ,Energy consumption

1. INTRODUCTION

With the growth of high speed networks over the last decades, there is an alarming rise in its usage comprised of thousands of concurrent e-commerce transactions and millions of Web queries a day. This ever-increasing demand is handled through large-scale datacenters, which consolidate hundreds and thousands of servers with other infrastructure such as cooling, storage and network systems. Many internet companies such as Google, Amazon, eBay, and Yahoo are operating such huge datacenters around the world.

The commercialization of these developments is defined currently as Cloud computing [1], where computing is delivered as utility on a pay-as-you-go basis. Traditionally, business organizations used to invest huge amount of capital and time in acquisition and maintenance of computational resources. The emergence of Cloud computing is rapidly changing this ownership-based approach to subscription-oriented approach by providing access to scalable infrastructure and services on-demand. Users can store, access, and share any amount of information in Cloud. That is, small or medium enterprises/organizations do not have to worry about purchasing, configuring, administering, and maintaining their own computing infrastructure. They can focus on sharpening their core competencies by exploiting a number of Cloud computing benefits such as on-demand computing resources, faster and cheaper software development capabilities at low cost. Moreover, Cloud computing also offers enormous amount of compute power to organizations which require processing of tremendous amount of data generated almost every day

2. CLOUD COMPUTING

Cloud computing is an evolving paradigm which is enabling outsourcing of all IT needs such as storage, computation and software such as office and ERP, through large Internet. The shift toward such service-oriented computing is driven primarily by ease of management and administration process involving software upgrades and bug fixes. It also allows fast application development and testing for small IT companies that cannot afford large investments on infrastructure. Most important advantage offered by Clouds is in terms of economics of scale; that is, when thousands of users share same facility, cost per user and the server utilization. To enable such facilities, Cloud computing encompasses many technologies and concepts such as virtualization, utility computing, pay as you go, no capital investment, elasticity, scalability, provisioning on demand, and IT outsourcing.

2.1 Cloud computing characteristics

Virtualized: Resources (i.e. compute, storage, and network capacity) in Clouds are virtualized and it is achieved at various levels including VM (Virtual Machine) and Platform levels. The most basic one is at Virtual Machine (VM) level where different applications can be executed within their containers or operating systems running on the same physical machine.
Service-Oriented: Cloud is implemented using Service-Oriented Architecture model where all the capabilities/components are available over the network as a service.
Elastic: Resources (i.e. compute, storage, and network capacity) required for Cloud applications can be dynamically provisioned and varied i.e., increase or decrease at runtime depending on user QoS requirements.
Dynamic and Distributed: Although Cloud resources are virtualized, they are often distributed to enable the delivery of high-performance and/or reliable Cloud services.

3. FEATURES OF CLOUDS ENABLING GREEN COM PUTING

Even though there is a great concern in the community that Cloud computing can result in higher energy usage by the datacenters, the Cloud computing has a green lining. There

are several technologies and concepts employed by Cloud providers to achieve better utilization and efficiency than traditional computing. Therefore, comparatively lower carbon emission is expected in Cloud computing due to highly energy efficient infrastructure and reduction in the IT infrastructure itself by multi-tenancy.

According to Accenture Report [2], there are following four key factors that have enabled the Cloud computing to lower energy usage and carbon emissions from ICT. Due to these Cloud features, organizations can reduce carbon emissions by atleast 30% per user by moving their applications to the Cloud. These savings are driven by the high efficiency of large scale Cloud data centers.

Dynamic Provisioning: In traditional setting, datacenters and private infrastructure used to be maintained to fulfill worst case demand. Thus, IT companies end up deploying far more infrastructure than needed. There are various reasons for such over-provisioning: a) it is very difficult to predict the demand at a time; this is particularly true for Web applications and b) to guarantee availability of services and to maintain certain level of service quality to end users. One example of a Web service facing these problems is a Website for the Australian Open Tennis Championship [3].

Multi-tenancy: Using multi-tenancy approach, Cloud computing infrastructure reduces overall energy usage and associated carbon emissions. The SaaS providers serve multiple companies on same infrastructure and software. This approach is obviously more energy efficient than multiple copies of software installed on different infrastructure. Furthermore, businesses have highly variable demand patterns in general, and hence multi-tenancy on the same server allows the flattening of the overall peak demand which can minimize the need for extra infrastructure. The smaller fluctuation in demand results in better prediction and results in greater energy savings.

Server Utilization: In general, on-premise infrastructure run with very low utilization, sometimes it goes down up to 5 to 10 percent of average utilization. Using virtualization technologies, multiple applications can be hosted and executed on the same server in isolation, thus lead to utilization levels up to 70%. Thus, it dramatically reduces the number

of active servers. Even though high utilization of servers results in more power consumption, server running at higher utilization can process more workload with similar power usage.

Datacenter Efficiency: As already discussed, the power efficiency of datacenters has major impact on the total energy usage of Cloud computing. By using the most energy efficient technologies, Cloud providers can significantly improve the PUE of their datacenters. Today‟s state-of-the-art datacenter designs for large Cloud service providers can achieve PUE levels as low as 1.1 to 1.2, which is about 40% more power efficiency than the traditional datacenters. The server design in the form of modular containers, water or air based cooling, or advanced power management through power supply optimization, are all approaches that have significantly improved PUE in datacenters. In addition, Cloud computing allows services to be moved between multiple datacenter which are running with better PUE values.

6. Conclusions and Future Directions

Cloud computing business potential and contribution to already aggravating carbon emission from ICT, has lead to a series of discussion whether Cloud computing is really green. It is forecasted that the environmental footprint from data centers will triple between 2002 and 2020, which is currently 7.8 billion tons of CO2 per year. There are reports on Green IT analysis of Clouds and datacenters that show that Cloud computing is “Green”, while others show that it will lead to alarming increase in Carbon emission. Thus, in this chapter, we first analyzed the benefits offered by Cloud computing by studying its fundamental definitions and benefits, the services it offers to end users, and its deployment model. Then, we discussed the components of Clouds that contribute to carbon emission and the features of Clouds that make it “Green”. We also discussed several research efforts and technologies that increase the energy efficiency of various aspects of Clouds. For this study, we identified several unexplored areas that can help in maximizing the energy efficiency of Clouds from a holistic perspective. Irjet template sample paragraph Irjet template sample paragraph. Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph. Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph. Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph Irjet template sample paragraph.

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