Chapter 128
Advances in Green Cloud Computing

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ABSTRACT

Cloud computing is witnessing tremendous growth at a time when climate change and reducing emissions from energy use is gaining attention. With the growth of the Cloud, however, comes an increase in demand for energy. There is growing global awareness about reducing greenhouse gas emissions and healthy environments. Green computing in general aims to reduce the consumption of energy and carbon emission and also to recycle and reuse the energy usage in a beneficial and efficient way. Cloud data centers consume inordinate amounts of energy and have significant CO2 emissions. This chapter gives an overview about green cloud computing and its evolution, surveys related work, discusses associated integrated green cloud architecture (green cloud framework), innovations, and technologies, discusses green cloud computing scenarios, and highlights future work and challenges that need to be addressed to sustain an eco-friendly cloud computing environment that is poised for significant growth.

1. INTRODUCTION

To know what Green Cloud Computing is let's split the words and understand the meaning of each word. The word "Green" implies living friendly to the environment and contributing towards maintaining ecological balance and preserving the planet and its natural resources. The word "Cloud" is used as an analogy for network of servers accessible over the internet that provides a service to its users. So Green cloud computing refers to use of computers and relevant resources in an environmentally responsible manner through implementing energy efficient computer systems and their peripherals (Rouse, 2010).

It is known that global warming emitting greenhouse gases and other toxic gases are harmful to mankind and the environment. Moreover, human activities like burning of coal, natural gas and oil

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causes emission of more greenhouse gases results in change in climate and average temperature of the atmosphere. On the other hand, IT technology keeps advancing and is extensively used globally due to the tremendous growth of the internet in the past decades. Industries like medical, telecommunication, business, and financial are predominantly dependent on applications that are developed and serviced by information technology systems.

The demand for internet bandwidth has been accelerated by the advent cloud computing technology. Cloud computing is helpful in providing services like software, infrastructure, and platform to its clients in an efficient manner. The cloud computing network provides a shared infrastructure which includes large data centers to store and service the client's data. Energy consumption is the key concern in distributed cloud computing systems. This cloud's cooling system consumes more energy and power and results in major energy costs and high carbon emission.

It makes sense to save energy and recycle or reuse as much as possible for the wellness and preservation of the environment. Lot of research is going on in every field to make the environment pure and healthy. Safety measures have also been taken by many organizations to support eco-friendly environment. Nowadays industries and companies in various fields like science and technology, medical, manufacturing, research etc. have started transforming their innovations and developments towards green technology. Because of the utilization of inordinate amount of energy in cloud computing, it has become a necessity to find a way for reducing energy consumption and promote reusability. Green cloud computing technology has evolved to fill this need.

Green cloud computing aims in reducing energy utilization and promote a sustainable and eco-friendly environment in cloud computing field. This paper discusses how green cloud computing plays a vital role in reducing energy usage and carbon-di-oxide emissions in the cloud data-center setting.

The remaining sections in the paper are organized as follows, Section 2 provides an introduction to cloud computing technology Section 2.1 is about green cloud computing and section 2.2 is its relevant terminologies. Section 3 provides a Literature Survey. Section 4 describes organizations that support Green Cloud Technology. Sections 5, 6, 7, 8 and 9 discuss the latest architecture – Integrated Green Cloud Computing, simulators, algorithms of green cloud computing technology, benchmarks, challenges it faces towards sustainability in environment, and the green cloud computing scenarios. Lastly, Section 10 provides conclusions and suggestions for future work to improve this technology to a greater extent.

2. CLOUD COMPUTING

The ideas and concepts behind cloud computing have existed for many years. It was started in 1950's along with mainframe computing. In the 1970's virtualization concept was created in which one or more operating systems can execute simultaneously in an isolated environment. In the early 1990's, telecommunication companies were offering virtualized private network services to its users. In the late 1990's the term "cloud" signifies the computing space among provider and end user. Later on, the cloud providers like salesforce.com, amazon.com, Google gained the major internet marketplace and proved the power of cloud computing to the real world.

According to United States National Institute of Standards and Technology, Cloud Computing is defined as "A model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". Cloud