**Towards Green Computing**

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Cloud computing has emerged in recent times as an efficient mechanism for the delivery of software, architecture of infrastructure and development models. Cloud Computing can be defined as “availability of system resources on demand without active management”. With an increase in the demand of cloud computing resources, there now exists a need for green cloud computing in order to minimize the environmental effects of the ICT industry.

**Architecture of Cloud Computing**
The cloud computing architecture is based on three types of service models:
- **Infrastructure as a Service (IAAS)**
- **Platform as a Service (PAAS)**
- **Software as a Service (SAAS)**

**Infrastructure as a Service (IAAS):** It forms the foundation of infrastructure for using the resources virtually. Here the cloud provider hosts several components present in a data centre along with servers, storage and a virtualisation layer. It provides a range of services which includes security, clustering, load balancing, backup and several others.

**Platform as a Service (PAAS):** Here the cloud provider hosts hardware and software on its own infrastructure. PAAS provides a complete deployment environment that provides a platform to develop, run and manage applications without managing and building the infrastructure.

**Software as a Service (SAAS):** Here the software is provided on a subscription basis making them available to the customers using internet. SAAS is centrally hosted in nature.

**Benefits of Cloud Computing**
Cloud computing has provided numerous advantages to businesses, including:
- **Flexibility and Scalability:** The cloud infrastructure is flexible in nature as it can be scaled according to the demand of the workload.
- **Cost Saving:** Cloud is based on “pay as you go” system, which means that you will only be charged for the period you are using the resources.

**Deployment of Cloud**
Cloud computing can be deployed for public, private, hybrid and community.

**Cloud Deployment Models**

- **Private Cloud:** Providing the computing services over the internal network or internet to selected users instead of offering them to the general public. It provides extra control and customisation of the onsite host computer infrastructure.
- **Public Cloud:** It is described as a computing service provided through the public internet by the third party vendors thus making it accessible to anyone who wishes to use it or buy it. They protect businesses from inflated cost of buying, managing and maintaining onsite hardware and application facilities.
- **Hybrid Cloud:** It utilizes a mixture of on-site personal cloud and third party services, public clouds providing an orchestration between the two platforms.
- **Community Cloud:** It is a cooperative undertaking in which infrastructure is shared between several organisations from a particular society with common issues. It can be managed directly or by the third party services.

**Service Models of Cloud Computing**

- **SAAS**
  - Packaged software, OS and application stack
  - Adobe, Atlassian

- **PAAS**
  - Server storage network, Operating system and application stack
  - Providers: Google cloud service platform, AWS, Oracle Cloud

- **IAAS**
  - Network Architects and infrastructure
  - Providers: Amazon AWS, Microsoft Azure
• **Security:** The encrypted data being transmitted over the network makes the data secure and less vulnerable to attacks. Moreover, the cloud service providers provide different security settings according to the requirement of the user. Along with encryption, virtual private clouds and API keys also keep the data secure.

• **Mobility:** The adoption of cloud services has made the data easily accessible and no matter where you are, you can easily convey the information to the fellow mates in a convenient manner.

• **Consistency:** All the documents are stored at the same place and in the same format in a cloud system. Every user is accessing the same information thereby maintaining the consistency of the data and thus avoiding human errors.

• **Collaboration and updates:** The cloud service providers update offerings in order to provide the user with the latest of the technology. Cloud also provides the feature of worldwide access, therefore teams can access the same resources no matter what their physical location is.

### Towards Green Cloud Computing

With the tremendous increase in demand for data storage, resources of information technology are using up large amounts of power and energy resulting in shortage of energy and at the same time producing changes in the global environment. To resolve the environmental problems in the IT field, the concept of green computing has come into existence to minimise the effect of carbon footprint in the environment.

Green computing is termed as “execution of policies and procedures to boost potency of the computing resources in order to scale back the energy consumption and environmental impact of their utilization”.

The ultimate goal of green cloud computing is to market the biodegradability of defunct merchandise and mill waste by reducing the utilization of risky materials and maximizing the energy potency throughout the products period of time. Green computing provides features such as online monitoring, live migration of virtual machines. While maintaining high performance, it is also important to optimize the need for energy efficiency.

There are several benefits of green cloud computing:

- Utilization of resources
- Risk management
- Sustainable environment
- Cost savings
- Improved brand image
- Better corporate image
- Encouraging recycling

In the term ‘Green Cloud’, ‘Green’ represents the ecofriendly environment whereas ‘Cloud’ represents the internet service delivery model. Individuals in IT industry are designing data centre strategies for determining the energy efficiency. Reducing the consumption of energy by data centres as well as lowering down the cooling and power cost are the primary point of concerns.

Huge amounts of energy are consumed by the data centres thereby increasing the operational cost and carbon footprint. Frameworks based on allocation algorithm have been designed for efficient energy management. Variable resource management and use of power scheduling algorithms can help in reducing the consumption of energy.

The approaches to make the cloud more green include:

- **Dynamic Voltage Frequency Scaling Technique (DVFS):** Adjusting power and speed settings of the controller chips and peripheral devices for optimisation of resource allotment to perform tasks and maximising power saving when the resources are not in use.

- **Resource allocation:** A number of virtual machines are being hosted by a physical machine in order to run the applications. Hence, the virtual machines are transferred in such a way that power increase is minimal. Power efficient nodes are selected in order to transfer the virtual machines.

A green cloud architecture typically consists of the following:

- **Consumers:** The requests are submitted by the brokers to the cloud spread worldwide.

- **Green Resource Allocator:** An interface designed for interaction between the consumer and the cloud infrastructure.

- **Virtual Machines:** Several virtual machines are started and stopped dynamically on a single physical machine in order to provide maximum flexibility for the partition of resources.

To reduce the carbon effect from the ICT industry, green computing has become the need of the hour. Green computing is producing solutions that are not only decreasing the consumption of energy but also providing minimal operational costs. Green computing needs to be the primary concern for organisations today.

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