

## Energy efficient data centres with NGS

\*<sup>1</sup>Sushil Kumar, <sup>2</sup>Nilendu Ghosal, <sup>3</sup>Dheeraj Kaushik

<sup>1</sup> Research Scholar, Maharaja Surajmal Institute of Technology New Delhi, India

<sup>2,3</sup> Undergraduate Student, Maharaja Surajmal Institute of Technology, New Delhi, India

### Abstract

In the modern era where the digital and virtual world is expanding itself, data storage is also becoming important. With the advancement of technology user wanted to access their data from anywhere in the world rather than carrying their actual physical drive and also they want to access their data as fast as possible. The fast access of data is done with the help of SONET and the problem of data storage was removed by the data centers and Cloud Computing. Cloud Computing represents the most efficient Information Technology (IT) standard that is used by almost every online user directly or indirectly. With cloud technology user could store and retrieve data much more easily from anywhere in the world with an active internet connection. Network-based cloud computing is rapidly going up as an alternate to orthodox office-based computing. As cloud computing becomes more common among the users, the energy consumption of the network and computing resources like hard drives server farms and data centers will grow. In this paper we will discuss about the problems that are faced for optimum resource utilisation for cloud computing and also the techniques used to overcome them.

**Keywords:** Cloud Computing; SONET/SDH: Inverse Multiplexing; Data Centres; Power Consumption; Resources

### 1. Introduction

Conventional storage is being replaced by the cloud storage in almost every field. The storage space required for the cloud data is referred as a data center. A single data center can host up to several thousands of server units spread across over 4500 square meters. A 500 square meter data center can reach power consumption of 38 megawatt-hours (MWh) per day, which is more than the power consumption of over 3500 households in EU [1]. From year 2000 to 2007, the total power consumption of data centres worldwide went from 70 billion kWh to 330 billion kWh, and is projected to grow over 1000 billion kWh until 2020 [2]. Furthermore, in 2014 merely 8.5% data centre managers estimated that their capacity will be sufficient beyond 2015, while over 75% will have to expand after 2020 [3]. Consequently, projection for data centre construction size until 2020 is almost twice than it was in 2010, reaching \$78 billion, which stress on the importance of dealing with the energy efficiency and the environmental impact of the Cloud Computing.

### 2. SONET/SDH and Cloud

SONET/SDH (Synchronous Optical networking) is the standard of American National Standards Institutes. Technology used by SONET is TDM (Time Division Multiplexing). It frames data in single wavelength in optical fibre which makes it more fast and efficient from the traditional Ethernet. SONET is widely used with SDH (Synchronous Digital Hierarchy) and is international equivalent of SONET.

SONET provides various transmitting rates such as OC-3(155.2Mbps), OC-12(622.08Mbps), OC-48(2.49Gbps, OC-192(9.95Gbps) and OC-768(39.81 Gbps) [4].

**Table 1:** SONET Transmission Rates

STS	OC	Raw (Mbps)	SPE (Mbps)	User (Mbps)
STS-1	OC-1	51.84	50.12	49.536
STS-3	OC-3	155.52	150.336	148.608
STS-9	OC-9	466.56	451.008	445.824
STS-12	OC-12	622.08	601.344	594.432
STS-18	OC-18	933.12	902.016	891.648
STS-24	OC-24	1244.16	1202.688	1188.864
STS-36	OC-36	1866.23	1804.032	1783.296
STS-48	OC-48	2488.32	2405.376	2377.728
STS-192	OC-192	9953.28	9621.604	9510.912

Next generation SONET/SDH enhance the application and usability of the present SONET/SDH network by updating the existing Layer-1 Transport networking and it will also use VCAT(Virtual Concatenation) technology, GFP(Generic Framing Procedure) and LCAS(Link Capacity Adjustment Schemes)

SONET provides most efficient protection and security schemes as compared to the existing data transmission methods. It includes N|1 protection, which is the most cost-effective protection. Hence SONET is widely used in cloud computing due to its fast, reliable, secure properties and most important factor is that it consume less power as compared to other transmission methods. The figure below shows the SONET and cloud architecture.

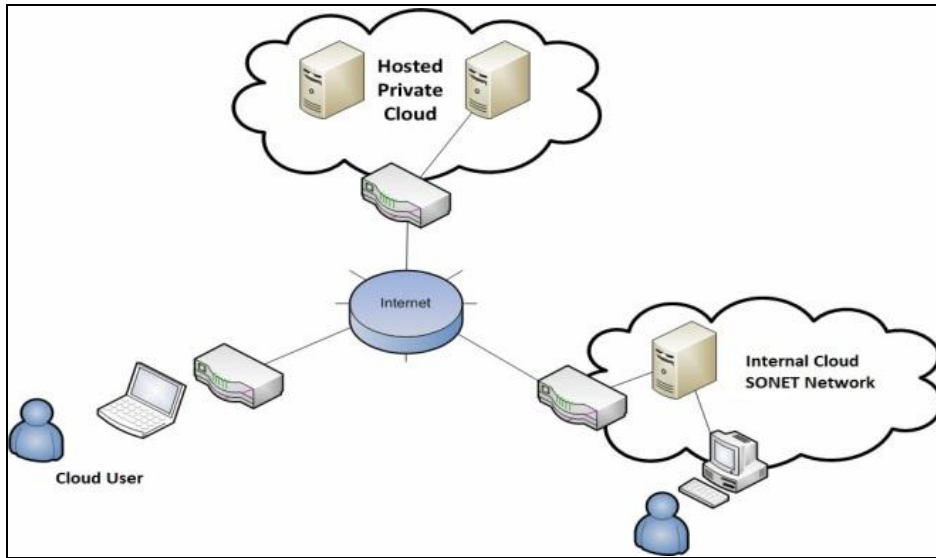


Fig 1: SONET and Cloud

**3. Data Centres and Cloud**

U.S NIST provides the standard definition of cloud computing as given below:  
*Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable*

*computing resources (e.g., networks, servers, storage, and released with minimal management effort or service provider interaction* [5].

The figure below shows the complete cloud architecture.

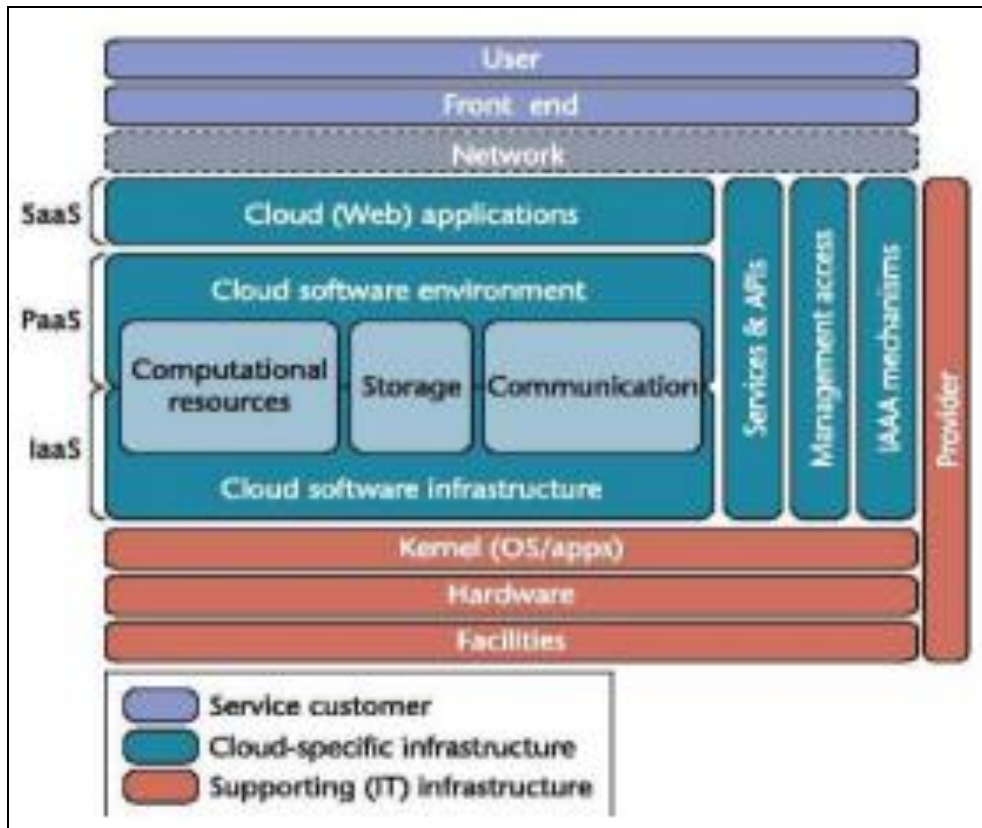


Fig 2: Cloud Architecture [6]

Cloud computing services are incorporated by huge data centres (A data centre also known as server farm is a centralized repository for the storage, management, and dissemination of data and information) [7].  
 Data center includes several IP protocols, backup power

supplies, air conditioning and various security components. Every cloud service providers have their own data centers where every cloud user have a privilege to store their data and process several data operations like data access, modification and uploading data as per their need.

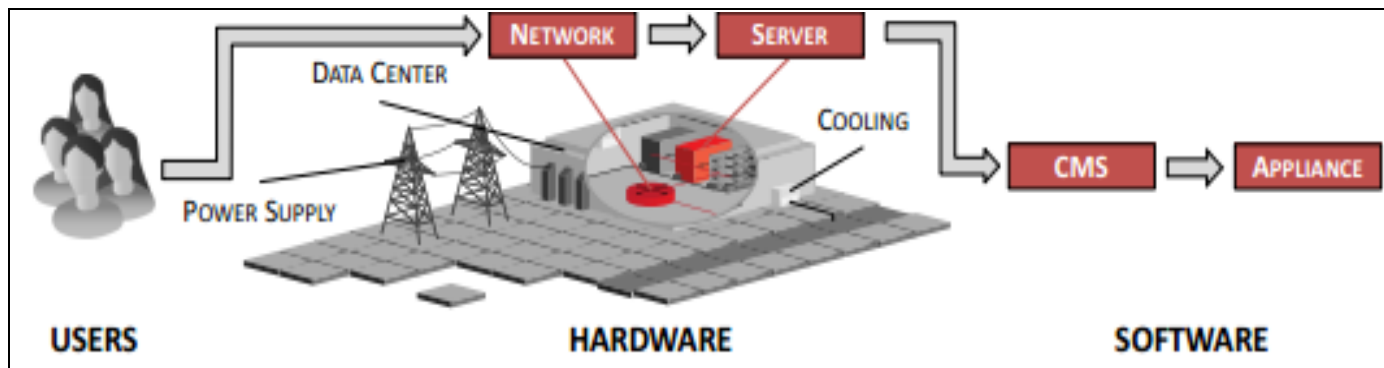


Fig 3: Cloud Computing Data Center Domain <sup>[8]</sup>

#### 4. Challenges of Data Centres

A data centre is a large group of computer networks that stores, process and manage the data of an industry. Data centre has three major components data storage, servers, and local area network (LAN).

**Data Storage:** Large volume of data storage in data center is fulfilled by Hard disk arrays that support several functionalities like cache memories disk array controllers, disk enclosures and redundant power supplies.

**Servers:** Data center servers consists of mainframe computational devices that keeps on monitoring large amount of data present in data center storage with security provisions. All the client-server architecture speed is totally dependent upon the speed of the servers

**LAN:** Popularly known as Ethernet provides connectivity between the servers. The data centre connects to the rest of the network through a gateway router and the connection is established by Ethernet. LAN is treated as the most secure and efficient way of communication because it have less packet loss and less prone to hacking.

Following are the major challenges that are faced by the data centers:-

- **Maximize Resource utilization:** utilizing the data center components such as hard drives, processors and network bandwidths to their optimum capacity.
- **Minimizing cost:** one of the major concerns of establishing and maintaining data centers is cost.
- **Heat dissipation:** These data centers dissipate high power in the environment and that is not good. So, it is yet another important challenge to overcome.
- **Minimize power consumption:** Using maximum resources with limited power source.
- **Satisfy performance requirements:** Cloud services are adopted by users as per their needs and they want to get maximum out of it as far as performance is concerned.
- **Efficient server consolidation and live VM migration:** Efficient use of Virtual Machines that can maximize the server traffic for maximum users.

#### How to Overcome Data Centre Challenges

- 1) **Workload Prediction:** Not all servers are working at same time but they still consume energy. An ideal server can consume 50% of the peak power of server which is a total wastage.<sup>[9]</sup>

This problem can be overcome by switching off the servers which are not active. Hence we need to analyse the daily server traffic so that we can predict the number

of active servers required at a particular time frame. Hence activating and deactivating the servers according to the traffic can significantly reduce the power consumption of data centers.

- 2) **VM placement and workload consolidations:** Managing servers in a way that powerful servers get more server traffic rather than the weak server will increase the data center efficiency. Also segregating the traffic among various servers at the time of peak network traffic will reduce wear and tear of server and will consume less power.
- 3) **Resource Over commitment:** Allocating more than the required memory space to a resource can be harmful for the system.
- 4) **Virtualizing Servers:** Using a single fast server in place of multiple servers can reduce the amount of energy consumption.
- 5) **Organize and improve stored data:** Reducing data redundancy can efficiently increases the storage space of data centers.
- 6) **Take advantage of the “Hot Aisle/Cold Aisle” layout:** Place the servers by facing each other therefore the backside of server facing each other. This placement will not allow the mixing of hot and cold air hence will reduce power consumption and efficiency of servers.[10]
- 7) **Enclose server racks:** Enclosing the server racks will further resist the mixing of hot and cold air hence improving server efficiency.
- 8) **Regulate Air flow:** Regulating the air flow of server will reduce the chances of wear and tear and hence lowering the maintenance cost of data centers.
- 9) **Adjust the temperature of data center:** More cold data centers can reduce the performance of servers whereas hot data centers are more prone to wear and tear of storage device and servers. Hence optimum temperature and control on humidity can save power consumption and maintenance cost.

#### 5. Conclusion

Green cloud computing is one of the most recent trends and field of research in IT industry. The most integral part of cloud computing is its data center which consumes most of the power and energy sources involved in cloud computing. In this paper we discussed about the SONET and its application in cloud computing and also the use of data center in cloud computing. Also, we had thoroughly stated

all the issues and challenges of data center and the techniques that can be used to overcome the challenges and how we can manage the data center for green cloud computing.

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