Components of Data Center Environment

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Abstract

The data center play an important role in now a days because of the prompt growth of cloud computing. This survey discusses datacenters of various organizations and the characteristics and hardware requirements of Data Center Networks(DCN). The service provided, factors affecting the performance and various maintenance issues of DCN’s are also discussed. The analysis of our survey can use as an overview of ongoing research in this area.

Key Words: Data center, DCN, production DCs.
1. Introduction

A data center [1][2]is a repository for storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business. A data center is a huge building consists of infrastructures to incorporate several applications such as social networks, supercomputing, and cloud service. DCN combines various physical components of data centers such as switches, servers, storage devices and racks using cables.

The following figure shows the entire proposed system architecture. English Sentence File Tokenization Grammatical Rules Tokens Positive Word Corpus Negative Word Corpus Figure1: Architecture diagram of proposed system The proposed system contains various phases of development.

Effectiveness[3] of a data center mainly rely on data center networks(DCN), which play a vital role in communication and computing. Most important and commonly using data centers are the production data centers of which green data centers[4][5] as the emerging trends. Several multinational companies constructed a number of production data centers to hold up their business while others are rented out to give services to companies which cannot manage to maintain their own data centers. Google, Microsoft, IBM owned their own data centers all around the world.

Globally around 40 production data centers were owned by Google all around the world. These data centers provides various Google services such as Google maps, gmail. Google DC’s were spread over more than 13 countries in worldwide, most of them uses advanced evaporative cooling system. Few important Google datacenters with cost and description is shown in Table 1.

<table>
<thead>
<tr>
<th>Location</th>
<th>Cost(In Million)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Dalles</td>
<td>$600</td>
<td>94000 square feet, two huge four-story cooling towers are used to low the water temperature</td>
</tr>
<tr>
<td>Georgia Douglas</td>
<td>$600</td>
<td>Provide services for gmail, maps, searching</td>
</tr>
<tr>
<td>Belgium Saint-Ghislain</td>
<td>$250</td>
<td>The first data center of google to run wholly without refrigeration.</td>
</tr>
<tr>
<td>Oklahoma Mayers</td>
<td>$700</td>
<td>Temperature is controlled by modular cooling units.</td>
</tr>
</tbody>
</table>

Microsoft owns their own data centers in Asia, Europe and America. Table 2 shown the details of data centers owned by Microsoft. Some of them used green technology and some achieves cooling by natural wind technology.
Table 2: Microsoft data centers

<table>
<thead>
<tr>
<th>Location</th>
<th>Cost (In Million)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quincy, WA</td>
<td>$200</td>
<td>93,023 square feet and utilizes green technologies</td>
</tr>
<tr>
<td>San Antonio, TX</td>
<td>$550</td>
<td>half a million square feet, costs 8 million gallons of recycled water each month as a part of the cooling system.</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>$500</td>
<td>biggest DC’s ever in the world, which covers more than 700,000 square feet</td>
</tr>
<tr>
<td>Dublin, IE</td>
<td>$220</td>
<td>The biggest over sea DC of Microsoft. It covers 303,000 square feet, and achieves cooling by natural wind for saving energy.</td>
</tr>
</tbody>
</table>

IBM owned over 440 data centers world wide have an overall 10 million square feet in size. Barrie Cloud Data Center, an IBM data center in Canada in collaboration with the government and the Universities. It uses emerging technologies to improve the power usage and cover around 100,000 square feet. Amazon owned their own data centers for improving their e-commerce business as well as to offer services to government, startup companies, enterprises by Amazon web service. HP’s Oklahoma Tulsa Data Center covers 404,000 square feet have reflective roofing system[6] for avoiding sunlight to increase the temperature and efficient cooling system to keep the smooth running of the data center. Dell’s Quincy Cloud data center covers an area of over 50,000 square feet and costs around $4 million. Apple owned their own data centers in Texas, USA, Ireland, Germany and Nevada.

2. Types of Data Centers

Data centers can be mainly classified as traditional, modular and green data centers. Traditional production data centers are held and operated in fixed buildings and takes years to construct. So it is unable to deploy and transfer to satisfy the flexible business requirements.

Modular data centers on the other hand is kept in shipping-based containers, which includes UPS, Servers, cooling systems, storage devices and network devices in racks. The advantage of Modular data center is easily deployed to meet the customer requirements. It is plug-and-play and directly connecting with the internet and the power water. It can support more servers than traditional data centers. Server compatibility[7][8] is the major drawback of these kind of data centers. Modification is difficult as they are produced by various vendors and equipped with exclusive servers.

A green data center uses energy saving technologies such as modular design, advanced power unit. Power Usage Effectiveness (PUE)[9] is the important factor of energy efficiency. Most of the data centers starts to use renewable energy resources to diminish carbon emissions and operating costs. Facebook and Apple already settled a huge array of solar panels as a supplement electricity usage, also use hydro, solar, wind, and geothermal
energy to power all data centers. Microsoft is assertively taking into account to purchase long-term renewable power, mostly invest in renewable energy projects and connect their data centers directly to energy sources.

3. **Hardware Requirements of Datacenters**

Hardware [10] refers to the touchable or physical parts, most important component for designing data center networks. With the invention of cloud computing, the performance needs of hardware’s in datacenter networks also need to increased. The important hardware’s used are server, switch, cables and storage racks.

**A. Servers**

Servers are the major component of data center network architecture, which store, analyse and transmit enormous data and directly determine the performance of data center networks. Servers can be classified into 3 categories based on the shape. They are, 

i. **Blade servers**

ii. **Tower Servers**

iii. **Rack servers**

**Blade Server**

Blade servers are high density, low-cost, stripped down servers. They follow a modular design optimized to minimize the use of physical space. They carry hot plug features which considerably reduces the maintenance time of cluster computing. They are mainly known as the next generation mainstream servers. A blade enclosure, an important component of blade servers provides services like networking, cooling, power, various interconnects and management, can grip several blade servers.

**Tower Server**

Tower servers are built in an upright cabinet, known as the tower having the shape and look like a tower-style personal computer. Performance and shape of tower servers are superior as compared to others. It is not suitable for cloud data center due to poor flexibility and large shape.

**Rack Server**

Modern data center Networks use rack server as the mainstream servers. In this the host located in a rack, which contain multiple servers, and a standard space consuming servers. Compared to other servers rack servers have better space occupation and management. The major drawback is its cabling complexity and poor heat dissipation.

**B. Switch**

Switches are connecting devices that connects multiple devices together. As far as DCN network is being considered switches are the backbone of the architecture. All switch processing is based on hardware addresses. Most commonly used core switches in data center environments are Cisco Nexus
7000 Series, Ruijie RG-N18000 Series, Huawei Cloud Engine 12 800 Series and Arista 7500E Series switches. The ToR switches used are Cisco Nexus 3064 Series and Arista 7050QX Series switches.

C. Cable

Switches, storage devices and servers were connected together with cables, which are the essential components of a data center Network. cables can be coaxial, twisted pairs or fiber optics. Selection of cable medium is mainly depends on the application used. A sample data center network cabling is shown in Fig 1[11].

![Datacenter Network with Cabling System](image)

**Fig. 1:** A datacenter network with cabling system

D. Storage

Commonly used storage systems in the data center environment are Network-attached storage (NAS) and Storage area network (SAN). NAS, which is a file oriented storage network where storage elements are directly connected to Local Area Network.SAN, a high speed storage network provides superior access to file or block level data for servers. The commonly used storage systems[12] are, EMC Symmetrix VMAX 40 K, HP 3PAR StoreServ 10 000 Storage, Huawei OceanStor N8500 , NetApp FAS6200 Series , and IBM System Storage N7950T.

E. Rack

Rack is an important component of data center network which supports various components such as server, storage devices and switches for space consumption and easy management. Open racks and cabinets are the two major kinds of racks. Open racks are flexible to manage and configure, can further classified as four post and two post racks. Cabinets are more stable and secure. Commonly used racks [13]in data center Network are Emerson Network Power DCF Optimized Racks, Siemon V600 Data Center Server Cabinet, Black Box Freedom Rack Plus with M6 Rails(a four post open rack), Dell PowerEdge 4820 Rack Enclosure , HP 11642 1075mmShock Universal Rack.
4. **Data Center Network Architecture**

A data center Network architecture comprises of 3 layers. It consists of core, aggregation and edge layers arranged in a multi rooted tree like architecture. The servers are connected directly to the switches in a top-down manner. Using edge layer with 1G link[14] [15]the servers are connected directly to the server. It is flexible, reliable, run steadily, and efficient. The main drawbacks of data center architecture are,

**Limited Bandwidth**

Limited bandwidth is due to multiple downlinks of a ToR switch can be routed to only one uplink.

**Poor Flexibility**

If the number of servers increased and the all available ports are occupied, the present switch is replaced with a new one with more ports. This is a time consuming process.

**Low Utilization**

Several resources are idle most of the times as data center networks are divided into multiple domains in layer 2, leads to multiple fragmentation of resources.

**Complex Cabling**

The number of cables required for communication expands to a very extent as the data center network expands.

**High Cost**

The cost of data center networks includes hardware and energy cost. Switches, racks, servers are highly expensive devices and consumes lots of energy.

5. **Conclusion**

This survey discusses datacenters of various organizations such as microsoft, google, IBM and the requirements and speciality of Data Center Networks(DCN). The service provided, factors affecting the performance and various maintenance issues of DCN’s are also discussed. Thea advantages and disadvantages of the architecture were also discussed.

**References**


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