Region Based Data Centre Resource Analysis for Businesses

Govinda.K[1] Siddharth Singh[2] J. Mahendiran[3]
[1,2,3]Computer Science Department
[1,2,3]SCSE, VIT University, Vellore, India

Abstract— To meet up the needs of large-scale multi-tenant data centres and clouds, data center and cloud architectures are continuously forming modifications. These needs are primarily focused around seven dimensions: scalability in computing, storage, and bandwidth, scalability in network services, efficiency in resource utilization, agility in service creation, cost efficiency, service reliability, and security. This article focuses on the first five dimensions as they are related to networking. . Large data centers are handling thousands of servers, exabytes of storage, terabits per second of traffic, and tens of thousands of tenants. Data centres are interconnected across the wide area network via routing and transport technologies to provide a pool of resources, known as the cloud. High-capacity transport intra- and inter-datacentre are being achieved by High-speed optical interfaces and dense wavelength-division multiplexing optical transport. This paper presents data centre resource analysis based on region.

Key words: Resources, Rack, Region, Data, Cloud

I. INTRODUCTION

Due to the demands of society for faster and uninterrupted service, Data centres have experienced rapid growth in recent years. From 2000 to 2005 the energy usage due to data centers has doubled resulting 1.5-2% of the world's energy consumption [6]. Many analysts and researchers were expecting another similar increase to follow this growth, but due to the economic fall as well as increase in energy efficiency of the computing systems, and increased use of virtualization and cloud computing this did not met up the demanding needs [1, 4, 6, 8].

While reduced, the energy usage still continued to rise up at a 12% rate [6]. Innovation in the form of virtualization and cloud technology development is a greater factor in the slowing down of the expansion of data centers [5,6]. Virtualization is the ability to extract the power of many servers for numerous applications whereas because of virtualization one or a few applications were assigned to each server. Servers running without processing applications to the full potential of the equipment were a major factor that leads to the traditionally low utilization rates that wasted resources. A second factor that drastically increased utilization rates was the development and maturing of cloud technology. The shift to the cloud encourages economies of scale by running servers on a virtual platform that has higher utilization rates and these large cloud providers usually located in areas with lower energy costs. Generally the server farms for large technology firms such as Google, Yahoo, Amazon and Facebook have been locating their servers in areas where the electricity is provided from cleaner sources such as hydro-electric power [13]. All these factors motivate our work on analyzing utilization rates in data centers with a view For providing better energy management, these factors encourage our work on studying utilization rates in data centers. It fits into our goal of developing a decision support system for green data centers, a step towards achieving sustainable solutions for a greener planet.

A. Historical Trends in Utilization Rates

The current literature on data centers indicates that an area of improvement is the low utilization rates on servers. Recent research reported utilization rates below 25% suggesting that servers could be switched to idle for most of the time [2, 3, 10]. This situation leads to poor usage with respect to two areas:

- Energy consumed is not used for a productive purpose. This indicates that huge amount of unnecessary carbon dioxide are released into the air if coal is used to generate the power.
- A large amount of natural resources are being tied up in wasted resources.

B. Optimizing Performance of Data Centers

As described earlier, data centers are hugely energy intensive. When additional servers are added, it will increase the cooling and power costs. A common problem in data center operations is to add more servers without fully taking advantage of the potential computing power on existing servers, this is what we call servers prawl. The policy of optimizing servers with greater utilization rates will reduce server sprawl and have the following advantages:

- Lower electricity usage can lead to cost savings and a reduced carbon footprint.
- To maintain and service additional servers, lower the management costs
- On inefficient or phantom servers, it provides free up floor space
- It Provide greater efficiency in the use of resources,

e.g., less server web results to lower cooling costs, decreased electrical bills and less use of natural resources to build additional servers. Given this theoretical discussion, we now proceed to conduct analysis by proposing equations that pertain to various aspects of data center utilization rates.

II. LITERATURE REVIEW

A. Analysis with Mathematical Equations

We consider important issues in data center management and propose equations that can be used for analysis. The equations we formulate here serve as performance metrics for various aspects that are important for energy management and forecasting.

1) Equation for Utilization Rate We first state an equation (Equation 1) to determine the utilization rate based on its definition as:

$$Utilization\ Rate = \frac{\sum_{n=1}^{T}(\text{CPU Rate})}{\text{T}} \quad (1)$$

T In this equation the CPU rate is the extent to which the CPU is busy at any given instance of time. The utilization rate is thus calculated in this formula as an efficiency ratio that sums up each instance of the CPU rate over a total time span T and divides by the value of T. Utilization rate gives management an idea of how much of the time the data centre is being used. It is desirable to maximize the utilization rate to enhance performance.

2) Equations for Cost per Server: An important metric that we propose from an energy management perspective relates to a breakdown of the costs from a per server basis. We assert that by examining the data center from a per server basis we can gain further insight into performance analysis. Accordingly, we put forth a proposition to analyze the cost per server, which we define in terms of the following five components: Air conditioning cost per server, P cooling, is defined as a metric that can be used to estimate the air conditioning cost per each additional server added to the data center where:

$$P_{cooling} = \frac{\sum_{n=1}^{T} \text{cooling costs}}{\sum_{n=1}^{T} \text{servers}} \quad (2)$$

Here, ∑ cooling costs is the air conditioning power usage to cool the data center over a timec span T and ∑ servers gives the total number of servers over that time span. Since this metric represents an additional expense, is important to lower the cooling cost in order to get better performance.

3) The cost of running all the servers can be calculated on a yearly basis from historic records from the Power Distribution Units. We propose that the energy cost per server denoted as P server provides a general cost structure for adding each additional server where:

$$P_{server} = \frac{\sum_{n=1}^{T} \text{server energy costs}}{\sum_{n=1}^{T} \text{servers}} \quad (3)$$

In this equation ∑ server energy costs denotes the total electrical cost for the data center for time T and ∑ servers again represents the total number of servers. Hence, we argue that the energy cost per server needs to be reduced to maximize efficiency and thus enhance performance.

4) Another metric we formulate is the administration cost per server denoted as A staff which is attributed to running the data center. This provides a cost structure on a per server basis depending on the number of staff members working on the data center where:

$$A_{staff} = \frac{\sum_{n=1}^{T} \text{administration costs}}{\sum_{n=1}^{T} \text{servers}} \quad (4)$$

In this metric ∑ administration costs depicts the total cost for supporting the management and staff attributed to the data center over the time period T and ∑ servers, as in the other equations above, represents the total number of servers. It is certainly advisable to keep these administrative costs low as a step towards achieving better performance. In other words, it is advisable to reduce the number of staff members if possible.

5) An important performance metric is also the fixed cost related to basic utilities such as rent, heat and water needed to run the data center. This is denoted as F fixed and provides a general idea of the total fixed annual cost per server where:

$$F_{fixed} = \frac{\sum_{n=1}^{T} \text{fixed costs}}{\sum_{n=1}^{T} \text{servers}} \quad (5)$$

Here ∑ fixed costs gives the total fixed cost for the data center for time T (and ∑ servers give the total number of servers). Wherever possible, the fixed costs should also be minimized to serve as a positive indicator of performance.

6) Yet another significant performance metric that we propose is the replacement costs per server denoted as R server. This relates to the cost associated with replacing a server. It examines the fixed cost per year for owning the individual server where:

$$R_{server} = N_{server}/L_{span} \quad (6)$$

In this equation, N server is the average cost of a new server while L span represents the estimated product life span of the new server. It can be seen that this performance metric is a little different from the other metrics pertaining to server costs. While replacing servers is important, it is obviously desirable to minimize the replacement costs for performance enhancement. Thus, it is desirable to lower the costs of new servers and try to obtain replacement servers with greater life spans.

Considering all the cost components as formulated above, the total cost per server, C server is calculated as a summation of these five components. This IS an important performance metric given as:

$$C_{server} = P_{cooling} + P_{server} + A_{staff} + F_{fixed} + R_{server} \quad (7)$$

Since this cost is a summation of the individual costs, needless to say, it important to reduce this as a step towards performance enhancement. We can therefore keep track of this combined metric C server as a general indicator of performance. We claim that by gaining the full cost on a per server basis, data center managers can better determine the real cost of the addition or the retirement of the individual server. This is very useful.

B. Shift to Cloud

Based on our observation with preliminary evaluation and a study of the literature, we offer several suggestions to keep the utilization rates better in the future. Our main suggestion here is that shifting applications from the data center to a cloud provider does offer the potential to raise utilization rates as long as older servers are decommissioned or retired. The cloud is increasingly viewed a solution to process extra demand in activity, and an area to place some of the redundant applications. Therefore we can say that data centers of the future will incorporate more aspects of cloud computing.

C. Concerns with Cloud Computing

Currently, the main challenge is to become comfortable with running sensitive data over the cloud. While cloud providers claims that their data centers are more secure than the raditional data center, there have been cases of security breakage in cloud providers, and undoubtedly will be future risks due to bugs and hackers. Below are some of the main concerns of shifting to the cloud that should be considered prior to moving data to the cloud.

– Security of data is one of the most often cited concern by management and instead of shifting to the cloud the legal department should be consulted for possible holes of security and to fix it.

– The cloud provider has a unique format on the data that makes transferring the data challenging or costly that is called Data lock-in which is a real concern.

D. Advantages of the Cloud in Data Centers

There are some clear steps for shifting some data center applications to the cloud to moderate increase in utilization rates of traditional data centers. Some advantages are listed here.

- Flexibility is achieved by not having to worry about either over provlslOmng or under provisioning for services or user demand.
- Redundancy will always play a crucial role in running a data center; however data centers can be redesigned to include hosting and back up provided by the cloud.
- A relative low cost structure for computing and storage when compared to traditional data centers.

E. Trends in Cloud Technology

Cloud technology is an exampler shift in that it enables the ability to put together huge computer infrastructure on demand [7]. The cloud can be seen as a disruptive technology due to the huge impact it will have on the Information Technology sector. Many researchers are estimating that the cloud will be the next utility in the sense that an organization will pay for computing and storage capacity similar to an electric or other utility bill.

The shift of resources will cause adjustment of labor markets as smaller data centers are removed. Companies such as Greenqloud, Iceland [14] and CloudSigma, Switzerland [15] have implemented free cooling strategies, used renewable geothermal and hydropower energy, and adopted carbon neutral policies as steps towards greenness. They claim that due to such factors their cloud technologies are among the greenest in the world, as per GPUE (Green Power Usage Effectiveness) indicators. Use of virtualization that allows for efficient management of resources is an important advancement in cloud technology [5]. Presently, virtualization technology has significantly increased utilization rates; however there are challenges when assigning costs due to improper metering. We believe that this present challenge will be adequately solved in the near future.

A further development in cloud technology is the shift of placing more backup and storage on the cloud which saves on maintenance costs while providing offsite storage [11]. Disaster recovery is a main driver for organizations to backup or store data on a cloud provider. Combined with the economies of scale offered by cloud providers in the sense of labor and energy costs, we believe that there will be a natural shift by the market towards cloud technology. Also, a growing trend is the push for private clouds that provide the benefits of cloud technology while still maintaining control over security of data [12]. The issue of whether to use private or public clouds remains debatable as they both offer significant advantages but also represent trade-offs with respect to issues such as cost and security.

III. EXAMINED ANALYSIS

A. Latin America

In case of single site class, data centres have significantly increased from year 2010-2016 by 195547 to 253961.

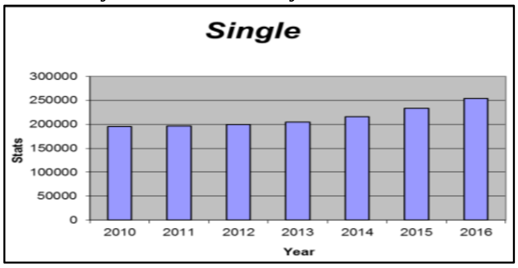

Fig. 1: Shows year Vs Single Data Center

In case of RACK/COMPUTER ROOM, it has increased from year 2010-2014 but decreased in last two years to 13774.

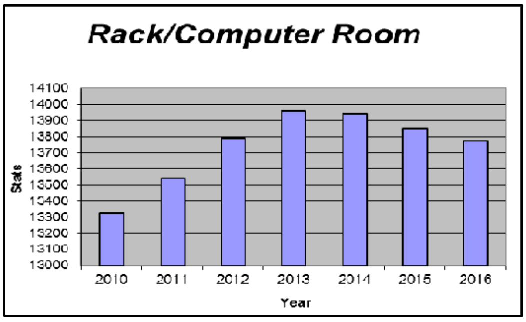

Fig. 2: Shows year Vs. Rack/Computer Room

In case of MIDSIZE DC, it has significantly increased from 821 to 899 during year 2010-2016.

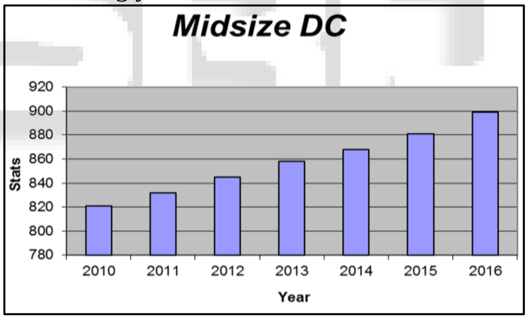

Fig. 3: Shows year Vs. Midsize DC

In case of ENTERPRISE DC, it has significantly increased from 2010-2016.

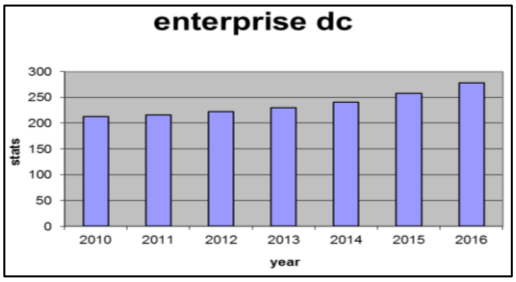

Fig. 4: Shows year Vs. Enterprise DC

In case of LARGE DC, it has slowly increased from 18 to 26 during year 2010-2016.

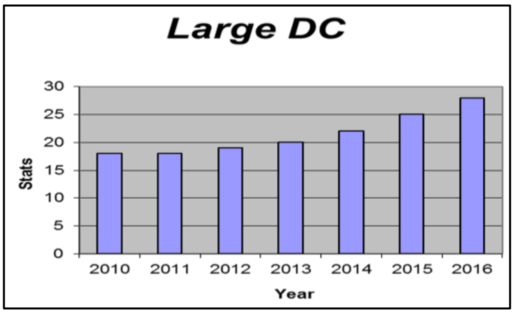

Fig. 5: Shows year Vs. Large DC

B. *Middle East and Africa*

In case of single site class, data centres have drastically increased from year 2010-2016 by 108868 to 207031.

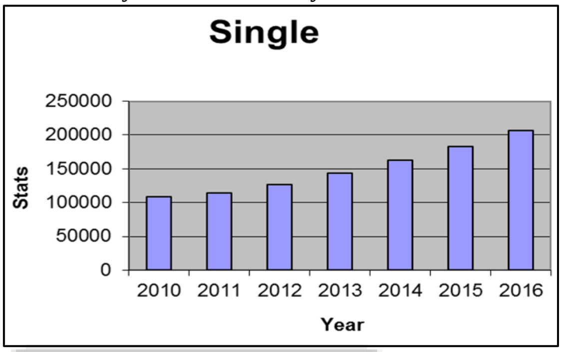

Fig. 6: Shows year Vs. Single Class

In case of RACK/COMPUTER ROOM , it has significantly increased from year 2010-2016 by 21549 to 22963.

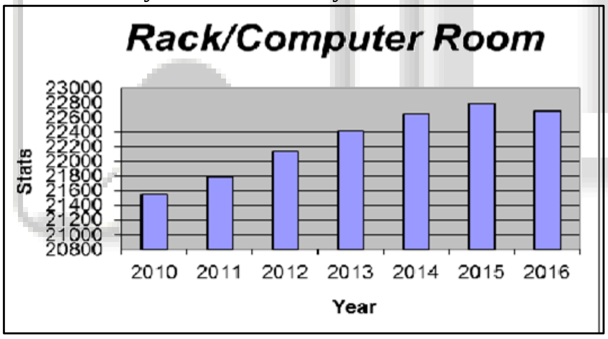

Fig. 7: Shows year Vs. Rack/Computer Room

In case of MIDSIZE DC, it has significantly increased from 871 to 952 during year 2010-2016.

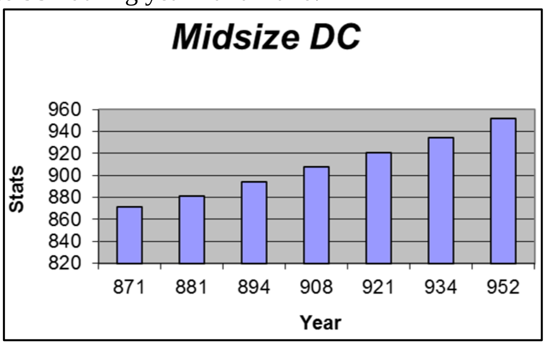

Fig. 8: Shows year Vs. Midsize DC

In case of ENTERPRISE DC, it has steadily increased from 120 to 159 during year 2010-2016

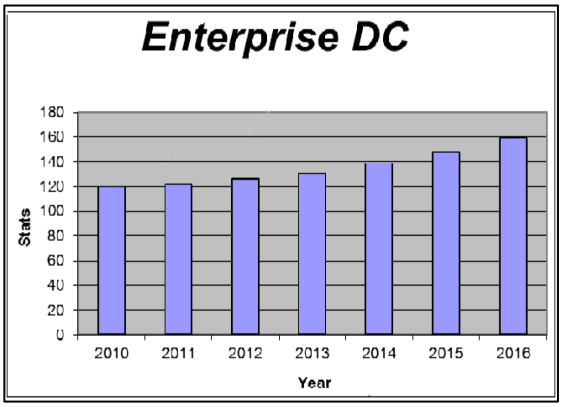

Fig. 9: Shows year Vs. Enterprise DC

In case of LARGE DC, it has slowly increased from 21 to 27 during year 2010-2016

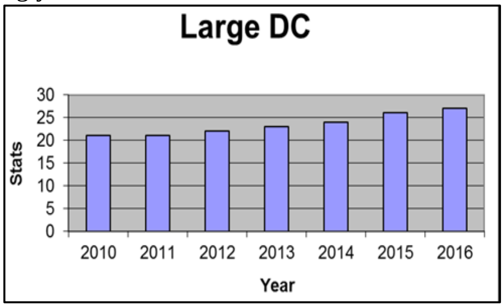

Fig. 10: Shows year Vs. Large DC

C. *United States*

In case of single site class, data centres have dramatically decreased from year 2010-2016 by 770925 to 660355.

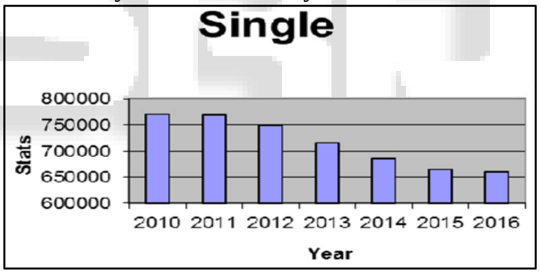

Fig11. Shows year Vs. Single Class

In case of RACK/COMPUTER ROOM, it has dramatically decreased from year 2010-2016 by 184457 to 154496.

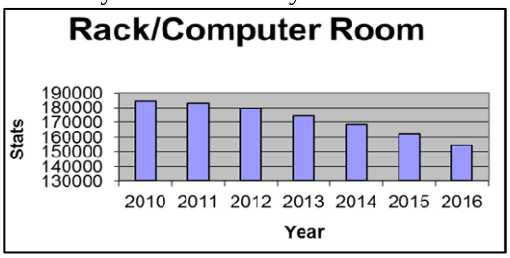

Fig. 12: Shows year Vs. Rack/Computer Room

In case of MIDSIZE DC, it has significantly decreased from 2506 to 2223 during year 2010-2016.

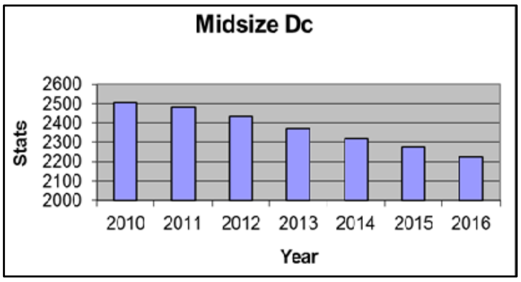

Fig. 13: Shows year Vs. Midsize DC

In case of ENTERPRISE DC, it has steadily decreased from 2404 to 2377 during year 2010-2012 but then increased from 2382 to 2660 from 2013-2016

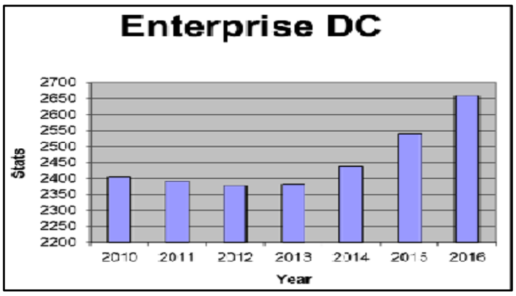

Fig. 14: Shows year Vs. Enterprise DC

In case of LARGE DC, it has shown a steady growth from 571 to 724 during year 2010-2016.

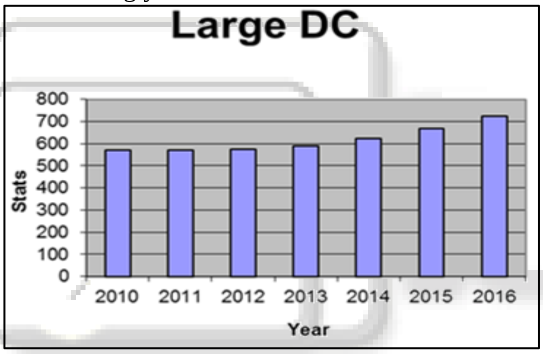

Fig. 15: Shows year Vs. Large DC

D. Western Europe:

In case of single site class, data centres has dramatically decreased from year 2010-2013 by 536090 to 525520 but increases gradually from 545062 to 647273 in 2014-2016

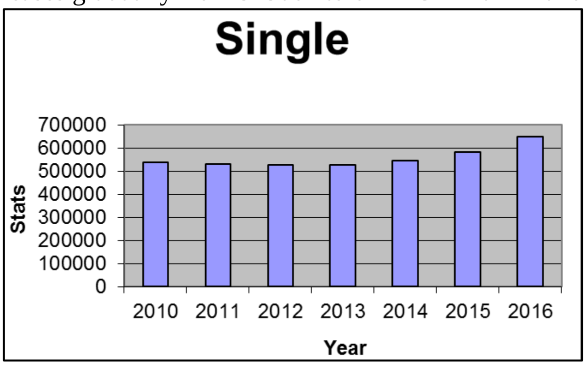

Fig. 16: Shows year Vs. Single Class

In case of RACK/COMPUTER ROOM, it has dramatically decreased from year 2010-2016 by 139790 to 105045.

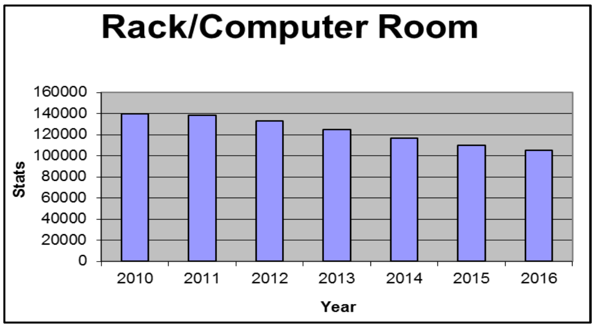

Fig. 17: Shows year Vs. Rack/Computer Room

In case of MIDSIZE DC, it has significantly decreased from 4860 to 3822 during year 2010-2016.

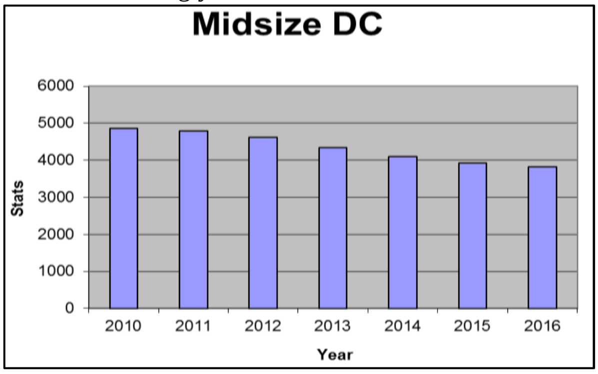

Fig. 18: Shows year Vs. Midsize DC

In case of ENTERPRISE DC, it has steadily decreased from 1196 to 1089 during year 2010-2014 but then increased from 1105 to 1153 in last two years.

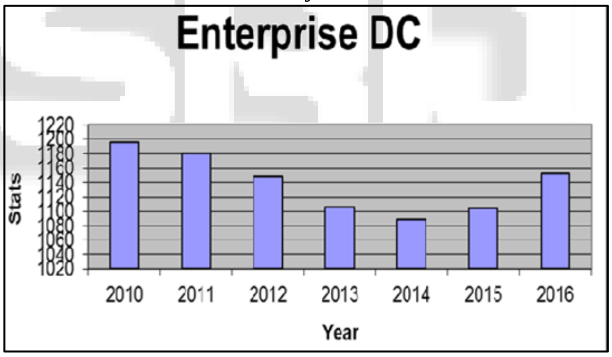

Fig. 19: Shows year Vs. Enterprise DC

In case of LARGE DC, it has shown a steady decline from 244 to 242 during year 2010-2012 but again show some increment from 244 to 313 in year 2013-2016.

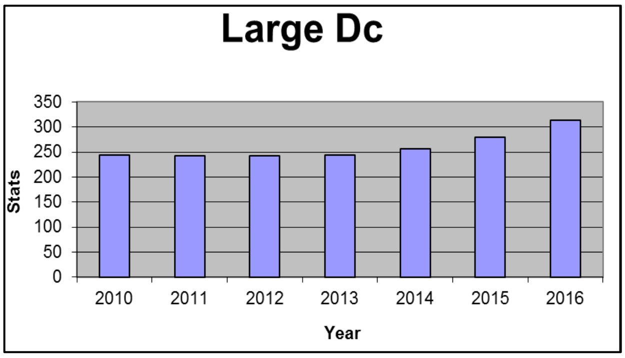

Fig. 20: Shows year Vs. Large DC

IV. Conclusion

Data centers have become a cost-effective infrastructure for data storage and hosting large-scale network applications.

However, traditional data center network architectures are ill-suited for future multi-tenant data center environments. Virtualization is a promising technology for designing scalable and easily deployable data centers that flexibly meet the needs of tenant applications while reducing infrastructure cost, improving management flexibility, and decreasing energy consumption. We observed that in developed countries, number of data centers has been decreased while in the case of developing countries is vice-versa. we offer several suggestions to keep the utilization rates better in the future. Our main suggestion here is that shifting applications from the data center to a cloud provider does offer the potential to raise utilization rates as long as older servers are decommissioned or retired.

References

[1] Anderson, S. (2010) Improving Data Center Efficiency, Energy Engineering, Vol. lO7, No. 5, pg 42-63.
[2] Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., Lee, G., Patterson, D., Rabkin, A., Stoica, I., and Zaharia, M. (2010) A View of Cloud Computing, Communications of the ACM, April, Vol. 53, No. 4.
[3] Forge, S. (2007) Powering Down; Remedies for unsustainable ICT, Foresight, Vol. 9, No. 4, pg 3-21.
[4] Judge, J., Pouchet, J., Ekbote, A., And Dixit, S. (2008) Reducing Data Center Energy Consumption, ASHRAE Journal, November, pg 14-26.
[5] Kansal, A., Zhao, F., Liu, J. Kothari, N. and Bhattacharya, A.A, (20lO) Virtual machine power metering and provisioning. ACM SOCC, pg. 39-50
[6] Koomey, J. (2011) Growth in Data Center Electricity Use 2005 to 2010, Analytics Press, Oakland, CA.
[7] Pedersen, T.B. (20lO) Research challenges for cloud intelligence: invited talk. EDBT/ICDT Workshops 2010.
[8] Ruth, S. (2009) Green IT -More than a 3 Percent Solution? IEEE Internet Computing, July/August, pg 74-78.
[9] Ruth, S. (2011) Reducing ICT-related Carbon Emissions: An Examplar for Global Energy Policy? IETE Technical Review, Vol. 28, Issue 3, May-June.
[10] Siegele, L. (2008) Let It Rise: A Special Report on Corporate IT. The Economist, October.
[11] Taft, D.K. (2011, December 5). IBM's Top 12 Tech trends for 2012. [Online]. Available: http://www.eweek.com/c/aiCloud-Computing/IBMsTop- 12-Tech-Trends-for-20 12-Include-CloudAnalytics- Mobile-221458/
[12] Robles, L. (2011, November 29). Four Trends that Shaped Cloud Computing in 2011. [Online]. Available: http://venturebeat.com/20 l1l11129/four-trends-thatshaped-c1oud-computing-in-20lll
[13] Cook G. & Van Horn J. (2011, May 24). How dirty is your data? [Online]. Available: http://www.greenpeace.org/international/enipublicatiovns/reports/How-dirty-is-your-datal
[14] Greenqloud (2012, January 26). Greenqloud [Online]. Available: http://www.greengloud.com/
[15] CloudSigma (2012, January 26). Why choose cloud servers from CloudSigma? [Online]. Available: http://www.cloudsigma.com/

