Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 3159-0040
Vol. 2 Issue 5, May - 2015

Energy-Efficient Data Center Concepts Under the EXPO-2017 Astana

Akniyet Baiboz
Faculty of Information Technology
Kazakh-British Technical University
Almaty, Kazakhstan
baiboztegi@gmail.com

***Abstract* — The emergence of term of Cloud Computing has set huge demand of energy consumption. As this industry is becoming major consumer of resource consumption, giants of this industry take measures to increase high-efficiency of their datacenters. In case of Kazakhstan, where will be held world exhibition EXPO-2017-Astana with the theme of Sustainable Future Energy, must be built a new high-efficient datacenter. This paper provides solutions of designing high-efficient datacenter taking under consideration Kazakhstan needs and futures.**

Keywords—Cloud Computing, Data Center, Energy – Efficiency, EXPO

I. INTRODUCTION

The rapid growing of information leads to increasing amounts of datacenters worldwide. This trend made a new term called Cloud Computing. It is a way of how all these data efficiently provided by the datacenter owners and utilized by the end users. As every industry faces with necessity of data storing and processing, the cloud computing promises to solve their requirements. But the other side of this trend is that all these datacenters consume huge amount of energy resources. Therefore, reducing the energy costs of datacenters is highly interested by giants of this industry such as Google, Amazon and Facebook. They have built green and high efficient datacenters by implementing alternative ways of resource consumption. Good examples are datacenters built in recent years in developed countries such as US, Iceland, Netherlands, Germany, UK and Scandinavian countries. Among the developing countries, forward pioneers are China, south eastern Asian countries and Chili. It is justified by large population of nearest because transmission of data is also significant factor of cost increasing. In case of Kazakhstan, where is going comprehensive preparation for EXPO-2017 with the theme of Sustainable Energy, there should be a new, responsible and energy efficient data center. Talking about sustainable energy, world's datacenters has more pollution rather than world's airline industry. Thus, small improvements towards to reducing the energy consumption of datacenters leads reach essential environmental and economic savings. The question is how to get a high efficiency? This paper provides, comparisons of resource consumption of datacenters and provide solutions of reducing costs taking under consideration of Kazakhstan features and possibilities.

II. DATA CENTER'S ENERGY CONSUMPTION SCALES

Futurist and author Bruce Sterling has truly formulated about internet consumption in 1999 year, saying, "Every time you hit a return key, there ought to be a puff of black coal smoke showing up on your monitor" [1]. This statement is very topical in our days because every Google search is equivalent to about 0.2 grams of carbon dioxide. [2] That is to say, all datacenters consume 1 to 2 percent of all electricity. [3] It is a cost of being online. Under those circumstances, the data around as is growing exponentially by emerging social networks, mobile devices and cloud-based services for businesses. Henceforth, this is an inevitable trend. Thus, the goal is not to blame emerging of Cloud Computing itself, the goal is reducing its consumption and increasing efficiency. Effectiveness of datacenters is measured by PUE provided by The Green Grid non-profit organization in 2007. It is the ratio of total amount of energy by a computer datacenter facility to the energy delivered to computing equipment [4]. The Uptime Institute published a report of the results of the survey by 20 data centers, which showed that the average PUE was 2.2. It is clear that companies are not always interested to make the PUE to the minimum. It costs large financial investment and creates technical complexities in the construction of new datacenters. However, IT giants like Google and Facebook show good results towards effectiveness. Their data centers are characterized PUE near 1.2-1.3, which puts the company in the leaders of energy efficiency [5]. According to Amazon stats in 2009, the amortized costs of running datacenter were as follows: [6]

•58% for servers and their maintenance;

•5% for other infrastructures such as real estate and wan;

•19% for direct power consumptions used by CPUs, RAM, disk and networking;

•23% for cooling infrastructure;

From above, over 40% of the cost of running a datacenter goes into power, of which over 70% is spent on cooling. Therefore, all suggested improvements by this paper are aimed to reduce this 40% value. REST APIs provides programmatic access to read and write Twitter data. Author a new Tweet,

read author profile and follower data, and more. The REST API identifies Twitter applications and users using OAuth; responses are available in JSON. [4]

III. The Role of Cloud Computing in EXPO-2017 and Kazakhstan Economy

Talking about Kazakhstan, where held EXPO 2017, a worldwide exhibition in theme of future sustainable energy, the term Cloud Computing must be one of the major point. Under the EXPO 2017, there should be built a new and high-efficiency datacenter. This idea can be justified by several factors taking place in Kazakhstan's developing economy. Firstly, the emerging industry of Cloud Computing is being as one of the major consumer of energy resources. Therefore, it cannot be missed from exhibition program.

Secondly, as a developing country, Kazakhstan runs national industrial programs such as Forced Industrial Innovative Development, Nurly Zhol and Strategy-2050 with estimated costs tens of billions of US dollars. They are comprehensive development programs that consist of building and modifying of different industries such as petroleum, mining, chemical, nuclear and including agro, light, tourism and trading industrial.

Thirdly, going bake to EXPO term, authorities invited world's giant companies to deploy their huge projects built by alternative power supplying using latest technologies to show in exhibition. Obviously, all these infrastructures and their researches demand huge amount of data to be processed and stored. We repeat these steps until queue is not empty.

IV. Designing an Energy-Efficient Datacenter

First of all, one of the key factor of power costs is the location of datacenter. A good example is Google's new datacenter built in Finland which is cooled by ocean's cold conditions. In Kazakhstan, there are lots of areas with alternative energy potentials such as strong winds, areas with mostly sunny days annual in order to deploy solar energy.

Speaking about efficiency of IT equipment of datacenter, no less important point has a downtime of equipment. In another word this is underutilization of servers, CPUs and RAMs. In 2011, Microsoft found that average server utilization was still only 15-20% [7]. This is explained as coping with peak hours. However, virtualization technologies provided by software part make things better. Therefore, software part must be able to support popular algorithms of data searching and processing as MapReduce in order to get a high degree of parallelism and effectively balance the load among the computing nodes. Steps in this direction have already begun. World's cloud provider giants are focusing on implementing common open source software projects [8]. In case of processors, they can be powered down using technologies such as SpeedStep, PowerNow and Cool'nQuite. These use clock gating, which slows down the CPU speed, and power gating, which switches off parts of the processor. [6] Other IT infrastructure utilities are hard disks and wan networking. Solid-state flash disks are much more efficient rather that hard disks. However its price which is 16 times more expensive that hard disks, it is compensated by higher latency rather than hard disks. Also, networking facilities including both wired and wireless must support latest energy-saving protocols. For instance, there is a standard of IEEE 802.3az for Energy-Efficient Ethernet [6].

Next, as noted above, major consumption goes into facility infrastructure such as power and cooling. The power system includes the essential elements for delivering uninterrupted power to the IT equipment, such as the utility transformer, automatic transfer switch, back-up generator, distribution switchgear, UPS, and power distribution system. Failure in any of the components in this power chain would cause a loss of power, which would be disastrous to the data center [9]. To make the power grid more reliable and intelligent, there has been an industry wide effort to build the new power infrastructure often known as the smart grid [9]. Smart grid is equipped with advanced communication technologies, and helps to make efficient two-way communication integrations between energy suppliers and end users. End users can conduct energy consumption in response to the price changes, coming from real-time pricing of supply through smart meters equipped in the end users. This leads to effective coordination of demand and supply, by minimizing the danger of power halting and overloading.

The major consumer of power is cooling system. At around two-thirds of the power equation, cooling is the most significant single contributor to the cost of running a data center besides the actual IT load itself [10]. One of the latest practices of effective cooling system (Figure 1) is alternation of hot and cold air streams between server shelves.

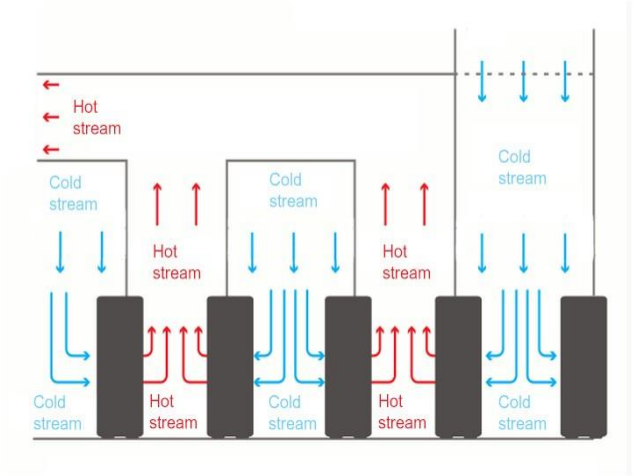

Fig 1. *Alternation of hot and cold air streams between racks.*

Another alternative way of cooling is called Water (Liquid) Cooling. This technology even used to ensure smooth operation of massive energy intensity computers of 1960s. Theoretically, the liquid may a

thousand times more effectively cool server shelves than it does air. However, this requires significant costs in term of changing existing infrastructure. A successful example of the use of liquid cooling can be datacenter of US National Renewable Energy Laboratory which was created in 2013. It is PUE value has reached unprecedented 1.06. In winter, heat air from equipment can be sent to heating its campus. Another delighting example is Google's datacenters built in Hamina, Finland and in Douglas County, Georgia. They use cold water from sea to cool their datacenters. This practice has reached the PUE value at 1.2. This kind of positive examples makes good impulse for widespread use of liquid cooling technology.

VI. Conclusion

Ultimately, the final goal is to prove stakeholders to build a new datacenter in Kazakhstan under the EXPO-2017. To do so, firstly, we have seen how the huge is resource consumption of datacenters worldwide with examples of industry giants. Of course, these statistics is very poor in Kazakhstan rather than US because there located these giants. However, this industry is a worldwide trend and one of the major energy consumer. Thus, EXPO-2017 must has at least one new datacenter in their plans. Next, I was provided solutions of designing high efficient datacenter taking under consideration Kazakhstan needs and futures. All things considered, as a further work, it is planning to research in detail hardware and infrastructure part of reaching high-efficiency and make deep analytics in economic aspects of running a datacenter. For now, this paper was as overview of provided solutions.We have crawled the Twittersphere and obtained 348030 user profiles and 9716175 tweets. And using our algorithm which correct for 65.8% found 18320 users from Kazakhstan. Using these numbers we can see that Twitter is very popular in Kazakhstan. Our work is the first step towards exploring the great potentials of this platform in Kazakhstan.

References

[1] The Interview with Bruce Sterling, http://news.slashdot.org/story/99/10/08/1147217/the-interview-with-bruce-sterling (1999)

[2] Powering a Google search, http://googleblog.blogspot.com/2009/01/powering-google-search.html (2009)

[3] Christian Belady: PUE: A Comprehensive Examination of the Metric, The Green Grid (2014)

[4] Uptime Institute, 2013: Data Center Industry Survey. (2013)

[5] Ross Horne: Infrastructure for Information Systems, Cloud Computing lecture # 6, Kazakh-British Technical University (2014)

[6] Aggar Mark: The IT Energy Efficiency Imperative, CDN, Microsoft (2011)

[7] Nicholas Davis: Green Data Centers & Critical Facilities: Aligning Costs, Performance, & Sustainability.

[8] Computer Weekly, Datacentres will need high-density power distribution within five years (2013)

[9] X. Fang, S. Misra, G. Xue, and D. Yang: Smartgrid-the new and improved power grid: a survey, IEEE (2012)

[10] Homewood, Fred .: As data center cooling costs rise, hot is the new cool: Podcast Q & A, SearchDataCenter.com (2012)