Energy-Efficient Data Centers and Smart temperature control system with IoT sensing

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***Abstract*— The population is increasing every day and hence leading to increasing demand of energy consumption. Data center being one of the crucial aspect of IT organisational operations consumes several tens of MW of power. Some facilities consumes power which is 100 times more than a typical office building. One main concern is business continuity and if any single rack of the data center fails then that might result in impairment in company operations which may also stop completely. In this growing demand of energy consumption and huge requirement of power by a data center, we provide a balanced method to run these data centers smoothly without any interruption. In this paper we propose an energy efficient method to meet the power requirement for these gigantic power consuming data centers as well as techniques of efficient air conditioning system to reduce power consumption. The Data Center air conditioning system include environment monitoring, air conditioning, ventilation and temperature control. The algorithm to monitor and control temperature changes is provided and its implementation is also discussed below. Here we have discussed how the power consumption can be significantly reduced without compromising with the cooling performance of these data centers.**

Keywords—DC; Server Farm; Zigbee; Power Utilisation Effectiveness; Cloud-Enabled; Temperature Sensor

I. INTRODUCTION

If we use an object then that object can be made more useful and smarter if it is a part of Internet of Things.

Internet has made everyday's life much smoother. Internet of Things is being dealt upon by the scientists in recent years. This technique has become an important factor all around the world for economic growth and development. With increasing growth in number of mobile networks, the number of devices connected to internet is also increasing every day. These mobile networks generate a huge amount of data demanding the need of storage facilities. In a recent study it was found that about 9% of total internet traffic is contributed by Facebook only. Apart from that, Facebook requires a huge storage to house enormous photos and videos uploaded by 1.65 billion of monthly active users. In addition, the company's infrastructure must support platform services for more than 1 million web sites and 550,000 applications using the Facebook Connect platform. To support these huge activities Facebook has set up various Data Centers. These Data Centers are scattered in an area of about 147,000 sq feet and few as high as 307,000 sq feet in Oregon[1]. For smooth running of these DCs (Data Centers) and hence for smooth running of Information Technologies infrastructure. These DCs have a large number of generators to meet the huge power requirement. These DCs need power as high as 2.5 MW to 6 MW. Giant Exhaust Fans, Ventilation and Air Conditioning etc. contribute towards this power requirement[2]. The equipment present in these Server Farms generate so much of heat that they will result in burning down all those servers and equipment. The temperature inside the Server Farms must be maintained to a significant level to protect the hardware from malfunctioning. It needs huge amount of power requirement to throw all generated heat out. Any breakage in the maintenance of these hardwares may lead to impairment in business continuity. With the growing demand of energy, it is becoming difficult to provide such a huge amount of power to these Server Farms.

In this paper we have proposed an idea to minimise the use of power requirement by this gigantic power consuming Data Centers using Internet of Things. We have mostly worked on Energy-efficiency of these Data Centers i.e. minimising the consumption of power without compromising with the cooling efficiency. We have basically provided the following contributions:-

1)Reducing the power consumption by these Server Farms using cloud-based approach.

2)Updating and simplifying the management of cooling techniques being used.

3)Setting up an temperature control algorithm to make these Data Centers a human less place.

The contents of this article is as follows :

Section 2 will mention about the related works in this field, Section 3 will explain the updates in these models, Section 4 will explain about Smart Data center and make it human-less and finally we have concluded this article in Section 5.

II. RELATED WORK

1)Distributed DCs : With the unstoppable development of IT enterprises ,the DCs must be established in different regions

978-1-5090-0996-1/16/$31.00 ©2016 IEEE

but unfortunately these DCs fail to address data sharing to provide continuity in the business.

2) Centralised DCs: For integrating business data and applications, reducing management complexities and for better information sharing these DCs are centrally managed.

3) Cloud Enabled DCs : With the help of advanced cloud computing and vertualisation techniques ,DCs can meet the dynamic business demands and reducing the power consumption[3].

Therefore, a lot of studies and researches are being done in cloud-enabled techniques to reduce energy consumption and not to add extra headache in the growing energy crisis. Jetsadaporn and Chawalit designed a simulation system to simulate DC cooling system to reduce energy consumption[4].

Though there are lots of work but they need huge capital investment to implement in practical DCs. Through this paper we provide a smart energy efficient Data Center using IoT and cloud techniques.

III. Update in Cooling Techniques and re-ducing power consumption

Facebook has invested more than $1 billion in the infrastructure that powers its social network. It spent $210 million to build 28 MW of data center space in Prineville, which works out to be $7.5 million per megawatt. The most efficient providers are building scale-out data center space at around $5 million and $9 million per megawatt. Facebook's Prineville Server farm operates at a Power Utilisation Effectiveness (PuE) measurement for the entire facility of 1.06 to 1.08. The foremost concern of a Data Center builder is to throw out the heat effectively and reduce the power consumption as much as possible.

3.1 Setting up the Data Centers on a high plain and in cold places has got several advantages. If the servers at Data Centers use the top half of the facility to manage the cooling supply, the cold air enters the server room from the top and hot air having the tendency to rise up can easily get out. One more advantage of using this technique is that we don't have to use any side ventilation or exhaust or to use air pressure to blow the air out.

3.2 A temperature sensor will be installed inside the DC and outside the DC to monitor the temperature of the environment and the DC. If the environment temperature is lower than the DC temperature then a few exhausters will be reversed to draw some cold air inside the DC.

3.3 With the same temperature monitor, if the outside temperature will be found lower than the inside DC temperature, then few air conditioners can be switched off and few ventilations can be opened letting in the cold air to enter the DC, hence reducing the unnecessary power consumption.

3.4 Facebook have started using Greenpeace techniques i.e. to avoid using dirty coal power and only use clean energy like solar energy, hydro-electricity etc. But some time the solar energy cannot meet the power requirement of these Server Farms because of cloudy weather and hydro-electricity is not available at every place. In such a situation they have to rely upon Diesel Generators or dirty coal powers[5].

But if a sensor is placed on the solar power metre which will monitor the output, then in accordance with the output only that number of Generators will be switched on which will just meet the need of the Data Center and thus a lot of diesel will be saved ,thus causing less harm to environment and as soon as the entire power will be met by the solar power alone then all the generators will turned off immediately ,making the Data Center completely human-less.

3.5There are generally two types of technology installed in most of the Facebook Data Centers for air conditioning which are Chiller based cooling and evaporative cooling (especially for summer days)to reduce power consumption. Now using an IoT sensing technique which will monitor the environment temperature will automatically turn on the evaporative cooling method on summer days and switch it off during winter and will cool the DC using fresh cool air of the environment by opening some ventilations.

3.6 The Data Centers have so many racks which keep the data. There are thousands of racks of this kind placed one after the another. If some of these are accessed frequently then most of the heats are generated by these racks. If a temperature sensor is placed within every rack then we can get a heat map of entire Server Farm. The heat map will give us an idea about the rack generating maximum heat and then cooling system of that particular rack will be turned on instead of turning on the entire DC cooling mechanism.

Using these smart sensing devices will significantly reduce the power consumption without compromising with cooling performance of the Air Conditioners and continuous function of Data Centers.

IV. A smart DC room

We are on the run to make everything smarter, from biometric earphones that track the wearer's heart rate to a coffee mug that doubles as a baby monitor. We have done something similar. We have proposed a smart temperature monitor and hazard alert system that will control several actions inside the DC as alert through an sms/email and alarm in critical situations.

A temperature sensor will be present outside the DC and one will be present inside the DC which will be communicating with each other by a short radio technology, ZigBee[6] and data will be sent continuously to the cloud. Whenever the temperature outside will get lower than inside then few air conditioners will automatically go off and few ventilations will be opened[7].

These IT devices need a very stable environment to function. If any environmental parameters like temperature, humidity etc. gets altered then the device might get damaged. So one humidity sensor will also be placed to monitor the humidity inside the DC and if it goes below the specified level then a fine mist will be allowed to mix in the air , thus saving the costly devices. Once the humidity level crosses the threshold value, the mixing of mist in the air will terminate. So basically all these actions will be monitored and performed by a simple algorithm thus making the DC human less.

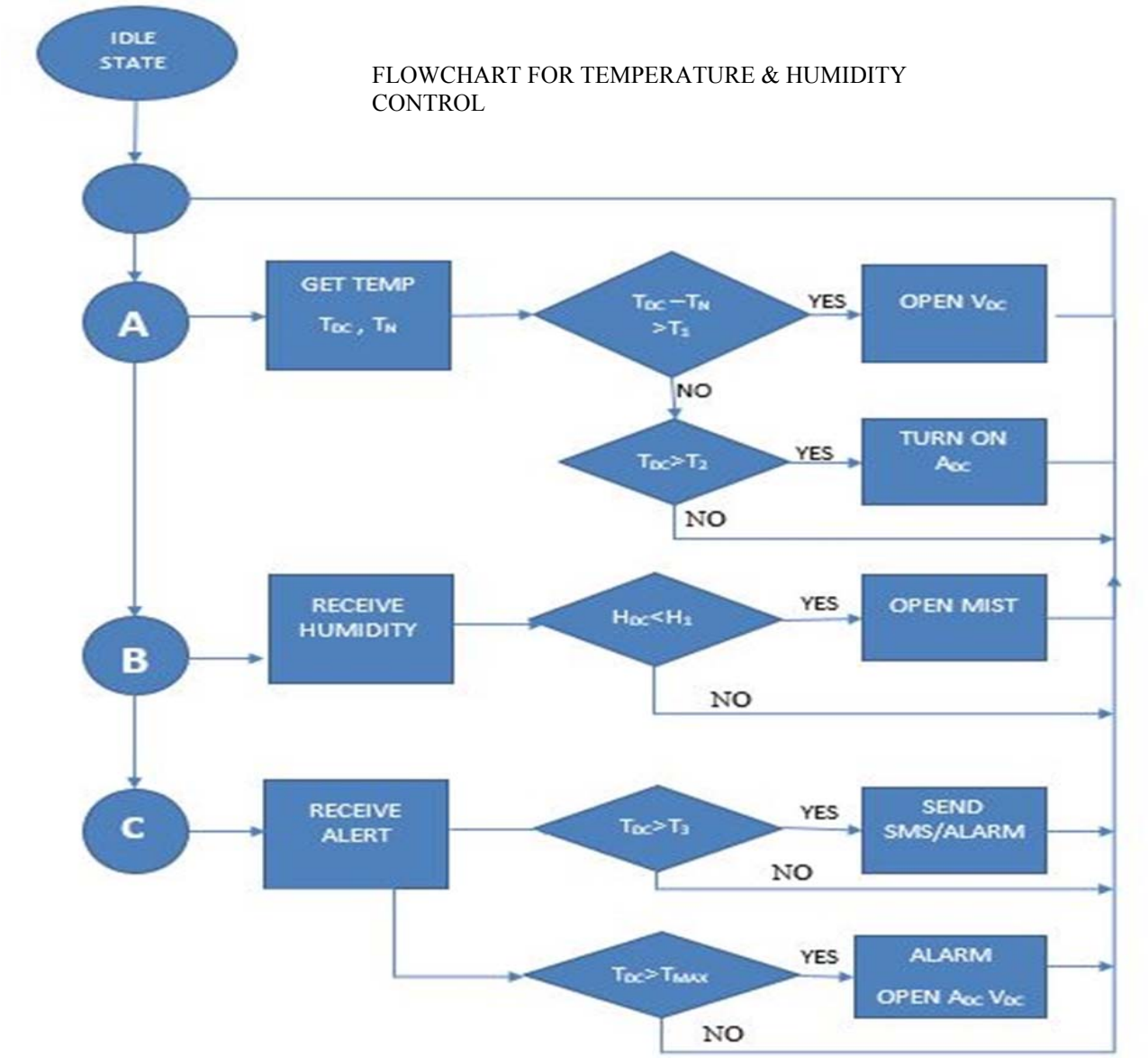
V.Conclusion

We have proposed a method to reduce the power consumption without degrading the cooling efficiency using IoT. In this paper we provided other methods also which will effectively reduce the power consumption and we have primarily focused to insist maximum use of clean energy.

Acknowledgment

The authors are highly acknowledged to Professor Himadri Nath Saha, Institute of Engineering & Management, Kolkata for his keen support in completing this paper. He deserves our deepest gratitude.

FLOWCHART FOR TEMPERATURE & HUMIDITY CONTROL



T_1 : Threshold Relative Temperature
T_3: Alert Temperature
T_{MAX}: Max Allowed Temperature
T_{DC}: Temperature inside DC
T_N : Environment Temperature

A_{DC}: DC Air Conditioner
V_{DC}: DC Ventillation
H_1: Threshold Humidity
HDC: Humidity inside DC

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