A Deliverable 1 Report On

Green Data Center Load Balancer

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Cover page should state deliverable number, course information, date, and team member names and IDs.

FYI, this logo is now outdated.

Colourful/glossy front cover is also nice, but clearly not important.

Abstract

Data centers are large scale networking infrastructures housing numerous servers that run round the clock and store huge amounts of data. As the world is constantly moving towards new technological advancements, the need for data centers is also increasing exponentially to accommodate the ever-growing number of users and their data, as well as enhance the user experience by reducing the amount of time it takes to service a request. Thus, making data centers a very critical technological advancement as they have economic, environmental and performance impact. The architecture of the Data Centers plays an important role in deciding how much the infrastructure is scalable, energy-efficient and environmentally sound (Dayarathna, Wen, & Fan, 2015). Since data centers run 24*7, the amount of electricity required is tremendous and so is the cost associated with it, which even though it is an economic boost for the country, acts as environmental adversity due to excessive carbon emissions (Bilal et al., 2014). Thus in this project, we have tried to remediate this issue by creating green data centers that will consume less power as a result of load balancing and traffic management of servers.

Keywords: *Data Centers, Load Balancing, Energy Efficient, Green Data Centers*

An abstract is a good idea; you can also call it “Executive Summary”. Same thing.

Don’t read this text, but squint at the page: it looks good. chunk of text, table with some data that supports whatever claims are made (plus reference to the source!). Page numbers (which should really be Arabic numerals not Roman). Text is justified, it looks neat.

Chapter 1

Introduction

Data centers are some of the biggest consumers of power in the modern world, and this has a huge impact on the environment, as the amount of fuel required to power them all is a major contributor to climate change. According to Sharma et al. (Sharma et al., 2017), each data center uses from 10 to 100 megawatts, which is roughly equal to the amount of power used by 10,000 households in the US, and about half of this energy is used to cool the equipment, transmit power, and other overhead. This is as a result of most cooling in data centers being done using coolers that have high energy usage.

Location	Year	Communication Infrastructure Electricity Usage (billion KWh)	Total Data Center Electricity Usage (billion KWh)	Total Data Center Electricity Usage (% of total worldwide electricity usage)
Worldwide	2000	3.8	70.8	0.53%
US	2000	1.4	28.2	0.82%
Worldwide	2005	7.3	152.5	0.97%
US	2005	2.7	56.0	1.53%
Worldwide	2010	15.6	271.8	1.50%
US	2010	4.9	85.6	2.20%

Table 1.1: Electricity Usage Within Data Centres(Bilal et al., 2014)

This table from Bilal, Khan, and Zomaya shows the electricity usage within data centers between the years of 2000 and 2010, and how much it has increased over time. Power usage from data centers is expected to rise rapidly over the coming years, which requires a solution that is environmentally friendly and reduces the consumption of electricity. This project is about designing a green data center, which saves power by balancing the load between servers and only keeping the necessary number of servers active at any one time. This means less power needed to keep servers running when some are deactivated, and less power needed to cool servers down as the work is spread between them to avoid them getting overworked and overheating, which in turn means less fuel consumption

Same here, page layout looks good. diagram (plus source) to support the case. Provide background information so that the reader knows the context.

and less impact on the climate.

1.1 Background

In the 21st century, every part of our daily life is somehow being supported by the internet and data centers. “The demand for data centers is derived, in large part, from the demand for internet services. Previous research has shown that increasing internet penetration helps drive efficiency and economic growth.” (Coyne & Denny, n.d.). More and more countries are using the internet and implementing the concept of IoT. When the internet becomes a part of our everyday lives and daily chores, the dependency on it increases multiple folds. In order to support the increasing demands of users like faster results and more

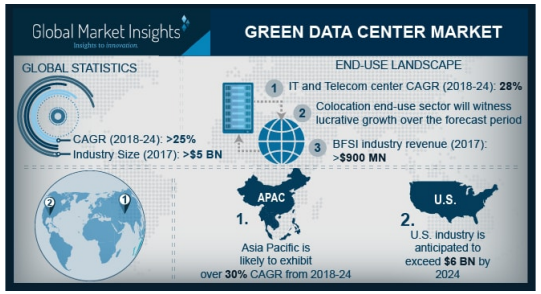

Figure 1.1: World Statistical Analysis of green data center market(Ankita Bhutani, 2018b)

complex design, the number of data centers being used goes up too.“Almost two-thirds (60pc) of Irish IT decision-makers believe data center hubs will need to be installed in every town due to the rising number of internet of things (IoT) devices. That’s according to a new survey by global data center giant Equinix, which owns and runs substantial data center facilities in Ireland.” (Kennedy, 2019) This drastic increase in usage of the internet in our daily lives, where the connectivity to the world is not only limited to the developed countries but to almost every nook and corner of the world has made the usage of data centers a basic need for everyday survival. Imagine being stuck in an unknown location in a city and your google maps don’t return the results immediately, for most people that’s a situation of panic and confusion. There is a very little alternative for us when it comes to using the internet. But at the same time, the effects of this dependency are visible in the climatic changes. “Ian Bitterlin, Britain’s

Figure 1.2: Statistical Analysis of digitization in 2019(KEMP, n.d.)

foremost data center expert and a visiting professor at the University of Leeds, says the amount of energy used by data centers is doubling every four years – despite the innovations in hardware that massively increase their capacity to store data. As a result, analysts forecast that data centers will consume roughly treble the amount of electricity in the next decade." (Bawden, 2016) The amount

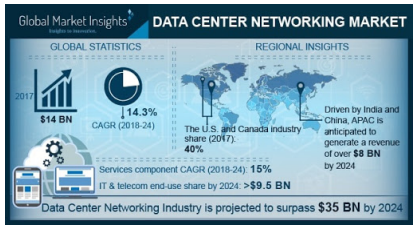

Figure 1.3: Statistical Analysis of Data Center Center Market(Ankita Bhutani, 2018a)

of energy consumption by data centers is not quite in line with the notion of sustainable development and therefore requires a transformation in terms of efficiency and conservation. There have been efforts by many enterprises to make data centers green for example 'Corporate Sustainability Programme' by Equinix (equinix, n.d.) but there is still a long way to go.

same again: diagrams with information; these don't have to be purely scientific/academic. They can come from other sources as long as they are somewhat reasonably trustworthy.

ALWAYS cite your sources (it's a big NO-NO not to do that and will lead to reduction in marks).

Chapter 2

Requirements and Functions

2.1 Functions

- Can activate or deactivate servers based on demand
- Can calculate response times
- Can reschedule jobs based on response time
- Can determine how much traffic is coming in
- Can redirect new requests to other servers based on threshold capacity
- Can turn the cooling system on or off depending on temperature
- Can split distribution over servers for big jobs
- Maintains a stack of jobs with their corresponding servers indicated
- Determines which job belongs to each server so it can remove them from the stack when they are done

The authors started off well in Chapter 1, but Chapter 2 doesn't have the same page lay-out; It would be better to have some introductory text; organize functionality, describe them, rather than just one-liners.

Also, NUMBER EVERYTHING so that it is traceable.

Do these requirements look SMART to you?

2.2 Requirements

- We have an E-Commerce website that is handled by a data center having a total of x servers dedicated to it.
- We also have the statistics for the past 5 years regarding the usage of servers based on the time of the year (This data has been hard-coded based on our research).
- The server will get input in the form of a request when any transaction takes place on the website. The response time for each request is 'y' (Where the value of y can range from some nano to milliseconds).
- According to our statistics, we know that our servers will be used to their full potential during the festive season (Oct-April).
- During the non-festive month, since the traffic load on the servers of the data center is less we will decrease the number of servers being used and increase it as and when the demand increases.
- Based on the number of servers that we are reducing, the response time will increase, and we will calculate the difference between the new response time and 'y'.
- Requests will be handled on a First come first serve basis where there would be threshold capacity (less than the full capacity) set for each server to avoid the heating issues. Once the capacity is reached, the system will redirect other requests to other servers.

This is better than Chap 2. I don't comment on the correctness of the diagrams, only the overall layout and shape. This requirements diagram looks a bit small to me.

Chapter 3

Design

3.1 Hierarchical Requirements Diagram

The requirements diagram shows the basic requirements for the green data center model, where Data center is responsible for servers, load balancer and timer. Load balancer gets input from user as a string of data packets with input time, it then decides the activation and deactivation of the server according to the load received from the user. There are n number of servers which are connected by coolers in some or the other form. The response timer gets time of data sent from user and the output time from the server, sending the response time as output.

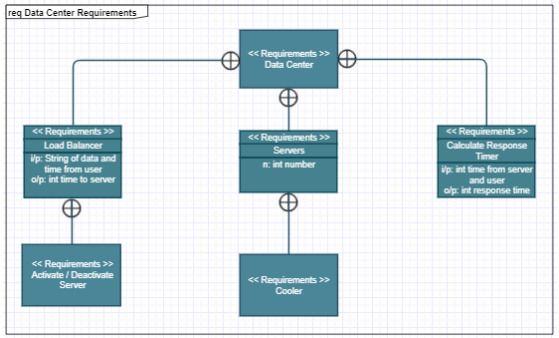

Figure 3.1: Hierarchical Requirements Diagram

Use-case diagram: this looks reasonable. Text is a bit short perhaps.

3.2 Use Case Diagram

This diagram is a more detailed version of the model, where the user sends request to the data center, the request is processed, which includes calculating the response time and load balancing the request. According to the amount of requests received, the server is turned off and on. A cooler is constantly attached to n number of servers. The response is received from the server and send back to the user.

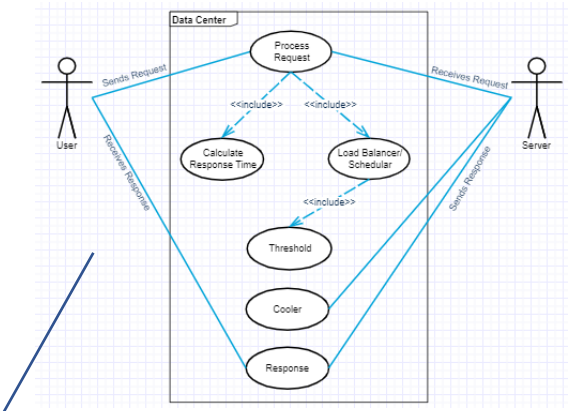

Figure 3.2: Use Case Diagram