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Investigative approach for consequences of computational delay of cloud data centers towards eco-friendly green computing paradigm

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***Abstract*---**Green technology is the emerging new sustainable technology which paves the way for lowering the raise in the earth's temperature. The increase in toxic waste from the electronic devices in every level of usage increases the global warming and thus the need of green technology is inevitable. The contributions towards green computing in global community will save the environment by minimizing the energy consumption. Emerging technologies in Internet of things, pervasive applications, cloud computing provides effective consumer, scientific and business domains. Due to the massive data storage and computation of cloud computing, there is an exponential increment in the demand of cloud computing. The growth of enormous amount of data brings a huge challenge to the cloud computing environment. Data centers are the main module of the cloud computing environment, but the major issue is the management of power computing in those data centers. Green data centers are established with limited power consumption and carbon-di-oxide emission. The research work mainly focusses on the delay time of the data centers in Internet cloud which in turn increases the usage of power consumption in data centers. The analysis is simulated with Internet cloud and data centers.

***Keywords*---**computational delay, cloud data centers, computing paradigm.

Introduction

Cloud computing is providing variety of services to the users worldwide. It enables hosting of vast number of applications and pay-as-you-go model meets the need

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of the demanding challenges in all the sectors. Remote execution and mobile cloud computing is possible with software services. In platform as service, focus is on the deployment and management of the applications rather than handling the underlying infrastructure. Main advantage of moving to IaaS is purely to reduce the maintenance of on-premises data centres and gain real-time business insights.

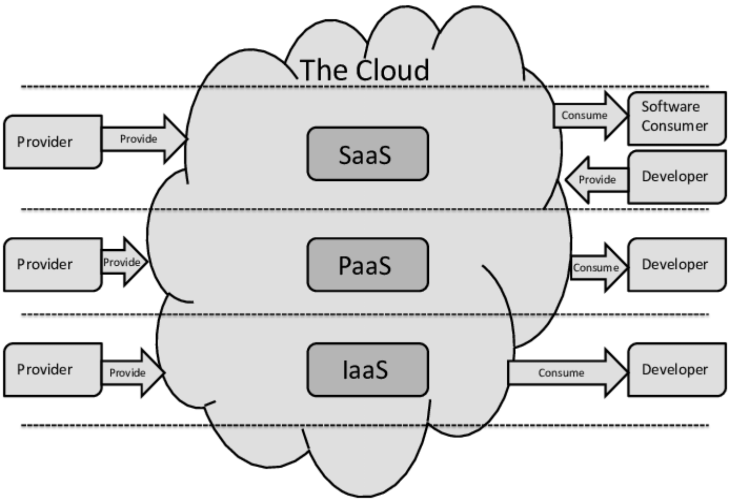

Figure 1. Cloud Architecture

But the quality of service which depends on throughput, delay and energy consumption is a challenging issue in cloud platform. In cloud computing, green data centers progressed with good quality coolant systems. Data centres all-around the world employ generator as a backup power, which implies high CO_2 emission [9]. Reduced operational costs for the data centre implies reduced energy consumption and reduced greenhouse emission. Data centers provide centralized access of data by maintaining large access of data and load balancing services. Data archiving, server messages, controlled access and virtual servers with grid computing environment are the different functions of the data centers. Going green with a data center is a critical role based on infrastructure, functionality and working of the algorithms. Functionality and availability of the data center with a managed power efficiency depends on various factors. The greenness of the data center depends on two important metrics Power Usage Effectiveness (PUE) and Data Center Efficiency (DCE). PUE is ratio of total amount of power entering a data center by the power used to run the computer infrastructure within it.

$$PUE = \frac{Total\ Facility\ power}{Energy\ used\ by\ IT\ Equipment} \qquad \text{Equation 1}$$

For an ideal data center, PUE value should be 1 which implies the power going into the data center is optimally used. PUE is a dimensionless quantity. DCE is the reciprocal of PUE.

Literature Review

SNMP logs collected at 19 data centers to examine temporal and spatial variations in link loads and losses are analysed in [1]. The packet traces collected at a small number of switches in one data center is presented. Detailed study on multiple issues prevalent in power modeling of different levels of data center systems are analysed with key factors stated such as i) few modeling efforts targeted at power consumption of the entire data center ii) many state-of-the-art power models are based on a few central processing units (CPU) or server metrics iii) the effectiveness and accuracy of these power mode ls remain open questions is discussed in [2]. In [3] authors deployed Green Cloud architecture, which aims to reduce data center power consumption, while guarantee the performance from users' perspective. Green Cloud architecture enables comprehensive online-monitoring, live virtual machine migration, and VM placement optimization. This research paper [4] discuss about several performance metrics and how it is evaluated to analyze the behaviour (utilization, availability, waiting time, and responsiveness) of a cloud data center. It is stated that Proper load balancing aids in minimizing resource consumption, implementing fail-over, enabling scalability, avoiding bottlenecks and over-provisioning etc in [5]. In the work [5] “Central Load Balancer” - a load balancing algorithm is proposed to balance the load among virtual machines in cloud data center in a large-scale cloud computing environment.

Measuring Power Usage Efficiency

Data centers consumes energy in all aspects such as storage, server communication and power distributions. Eventually challenges faced are optimization of data centers both in software and hardware components, virtualization with independent workload equal distribution and load balancing. Workload performance can be improved by integrating and optimizing with integrated APIs and utilization rates. Besides providing security, virtualization provides green design of servers. As data centers have software designed technology, the nucleus of our research work is delay time in data centers. Energy efficiency of a data centre is measured by power usage efficiency. It depends on delay time, usage time and idle time. Typical value of PUE lies between 1.2 and 2.5.In the proposed work, the delay time is investigated and found that the power efficiency of the data centers have a direct impact on the delay time with respect to the number of senders. Delay tolerant networks may reduce the power efficiency of the data centers to some extent. The proposed work is carried out with omnet++ simulator with 1 sender, 2 senders and 10 senders.

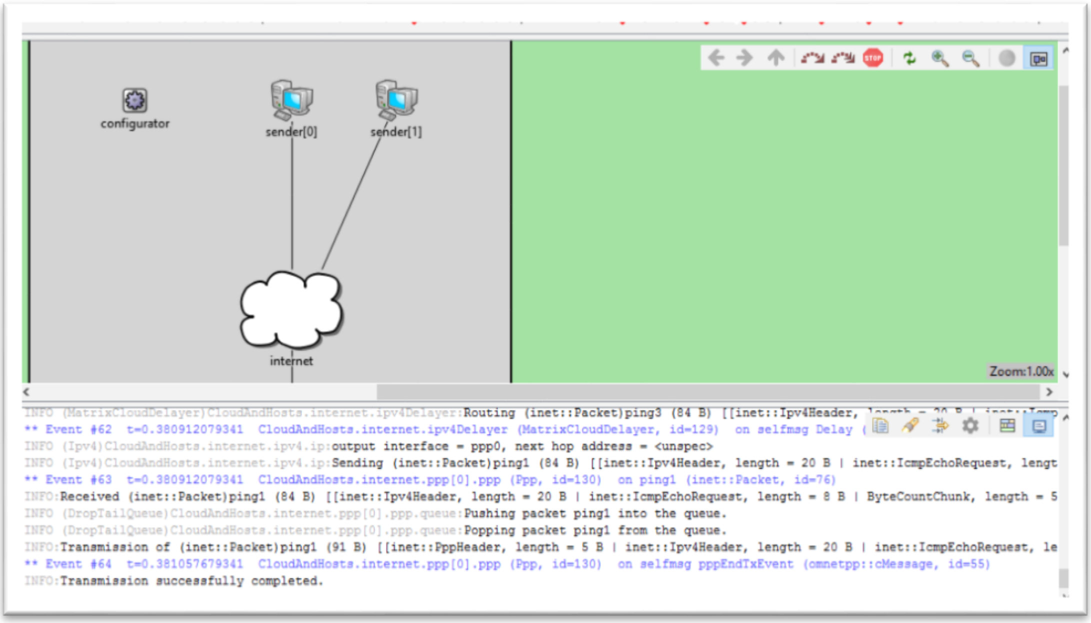

Figure 2. Cloud Model-2

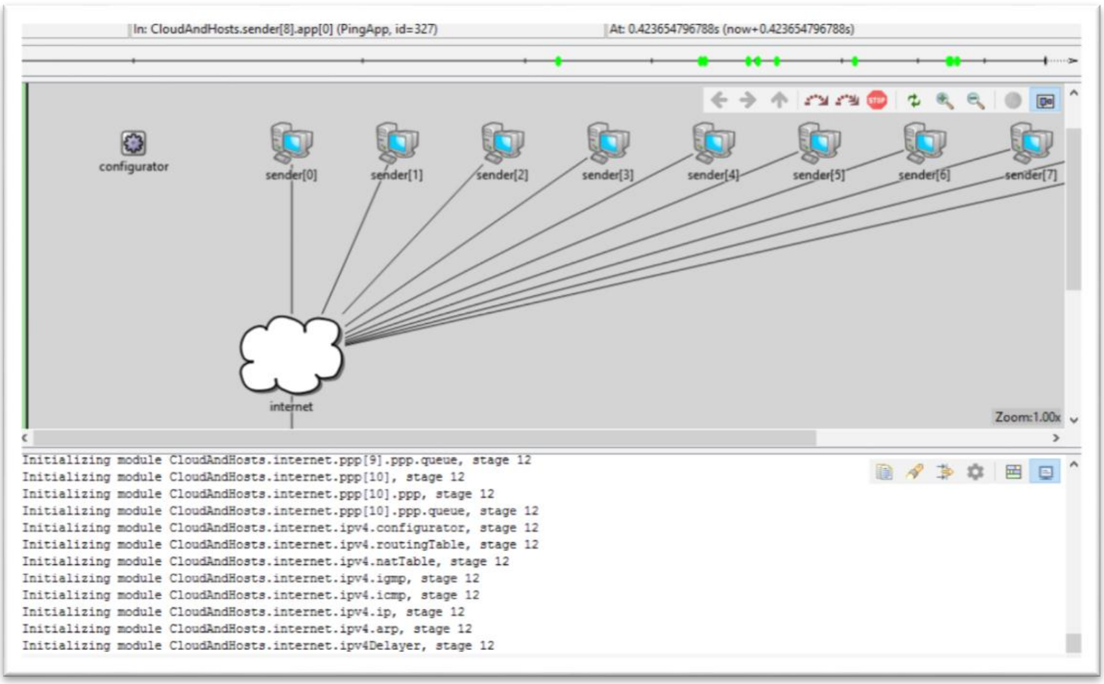

Figure 3. Cloud model-3

INET Framework is used in Omnet++ simulation environment. It provides protocols and models for the cloud architecture. The Matrix Cloud Delayer, delayer module configure the drop and delay packet flows. The Internet

Cloud module is used to model between hops and to build complex network. The delay time is calculated with different simulation duration and was found that the delay increases when the number of sender increases but the transmission is successfully completed. The internet cloud model in Omnet++ is used to calculate the delay between the hops.

Source Code for Internet Cloud Connection:

```
package inet.examples.internetcloud.cloudandhosts;

import inet.networklayer.configurator.ipv4.Ipv4NetworkConfigurator;
import inet.node.inet.StandardHost;
import inet.node.internetcloud.InternetCloud;
import ned.DatarateChannel;

network CloudAndHosts
{
   parameters:
      int numSenders;

   types:
      channel C extends DatarateChannel
      {
         delay = 10ms;
         datarate = 5Mbps;
      }
   submodules:
      configurator: Ipv4NetworkConfigurator {
         parameters:
            @display("p=100,100;is=s");
      }

      sender[numSenders]: StandardHost {
         @display("p=250,100,row,100");
      }
      recip: StandardHost {
         @display("p=250,500");
      }
      internet: InternetCloud {
         @display("p=250,300;is=vl");
      }
   connections:
      recip.pppg++ <--> C <--> internet.pppg++;
      for i=0..numSenders-1 {
         sender[i].pppg++ <--> C <--> internet.pppg++;
      }
}
```

Algorithm used in Internet Cloud

Module Internetcloud

{

No. of interfaces = default;
Input Interfacetable path;
Set networkprotocolmodule=ip4;
Find delay using matrixclouddelayer module;
Connections allowunconnected;
}.

The IP4 router can delay or drop the packet depending on the interface table. In delay channel, the delay will represent the propagation delay in milli second. Send delayed () will have the parameters gate name, message and delay value. The data rate channel will drop or delay the packets based on rule. The following parameters are used such as delay as 0.012s +exponential (0.2s), data rate from 500kbps,1mbps and drop values between 0 and 1. For each packet the delay is calculated. In XML file in the module, the parameters can be configured. The delay time is given as:

$$\text{Transmission delay}=\frac{size\ of\ datapacket}{bandwidth\ of\ network} \qquad \text{Equation 2}$$

$$Propogation\ delay = \frac{\text{Distance between sender and receiver}}{\text{Transmission speed}} \qquad \text{Equation 3}$$

Delay in Internet cloud with 1,2 and 10 servers is shown in table 1.

Table I
Delay in Internet Cloud

S.No	Delay (in ms)		
	1 server	2 servers	10 servers
1.	16.67	13.472	51.03
2.	73.45	109.69	97.56
3.	87.66	111.90	274.24
4.	108.89	145.60	307.12
5.	112.30	152.14	395.47
6.	134.67	188.03	399.40
7.	145.67	192.113	443.43

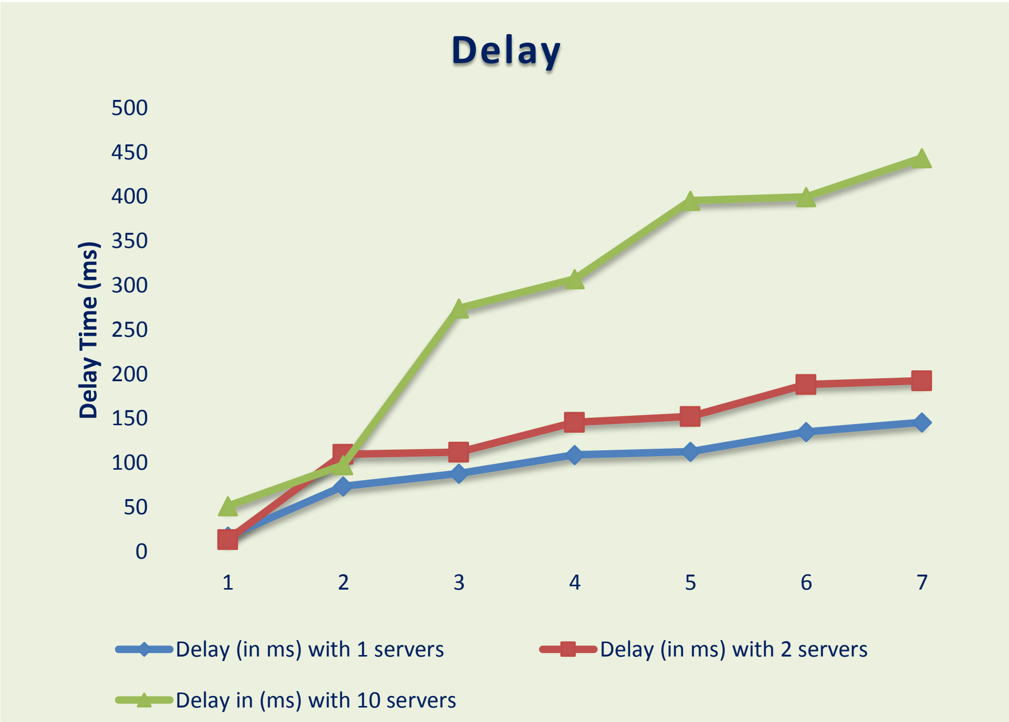

Figure 6. Delay values in Internet Cloud

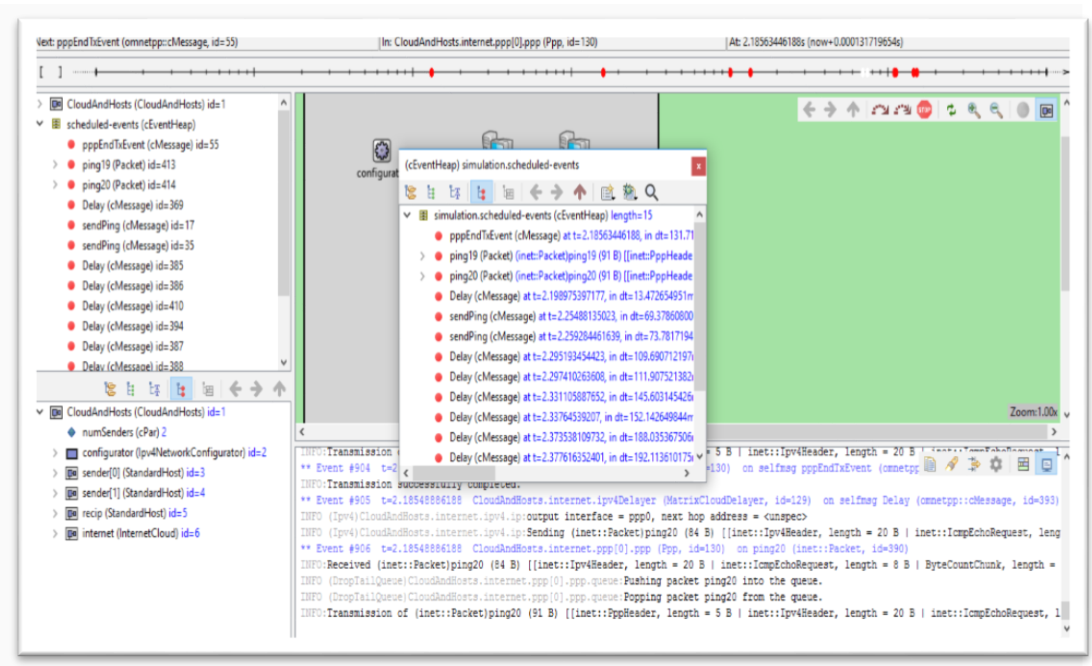

Figure 4. Delay Time with Two Senders

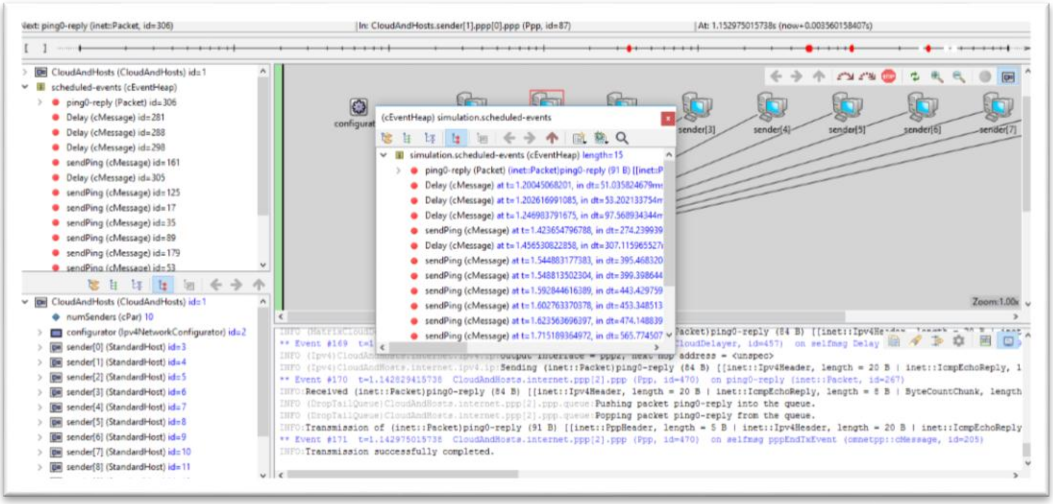

Figure 5. Delay Time with Ten Senders

Conclusion

This work focuses on the delay time of the Internet cloud with data centers. The delay time is calculated and was found that the delay is increased with the increase in the number of senders. This analytical approach focuses on the need of the green data centers with less power consumption as the delay time may increase the usage of data centers with high power consumption. The study and the simulation have to be further extended for optimization of data centers to go with green technologies or algorithms to reduce power consumption in cloud computing.

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