ON TRUST MODELS INVESTIGATION IN CLOUD COMPUTING SERVICES

Aderonke F. Thompson
Department of Computer Science, Federal University of Technology, Akure.
Email : afthompson@futa.edu.ng

ABSTRACT

In Cloud services, trust establishment has become an integral and a critical trademark feature. Therefore, Cloud users should be endowed with a systematic approach that helps users of these services to find an unequivocal trust model that best suite organization trust policy at all levels. Hence, this study reports the analysis of existing trust models in cloud services in a Cloudsim environment Simulation results obtained with several experimental scenarios depict their respective performances and the most secured trust model in cloud services. Consequently, cloud computing organizations and end-users can without difficulty select tools that best suite***d*** and adopt it to meeting their respective organizations incidents response vis-a-vis trust concerns and security issues in cloud computing services.

***Keywords* -**: cloud services, CloudSim, trust model,

1. Introduction

The world is a connected world. Cloud Computing is an evolving technology that has been acceptable by users in the Information Technology community in similarity to the trend recorded with the emergence of the Internet, that is, the World Wide Web, client-server architecture and networks [1], Cloud Computing, as defined by Zhiguo *et al*. [2] “is a set of principles, standards and policies” employed in system analysis by service providers; on the fundamental principles of “virtualization, distributed computing, utility computing and service-oriented architecture”. Cloud system is characterized with front end and back ends with the connection platform as the Internet. Client coupled with its associated tools and Cloud refer to the front and bank ends respectively. Consequently, the client and cloud are variants of cutting-edge techniques; these features of cloud computing components extend its heterogeneous capacity. The heterogeneity feature enables various services; an instance is Web-based e-mail programs leverage on existing Web browsers such as Google chrome, UC and so on. Internet Explorer or Firefox including robust clients accessing the network access. Back end instances among others are servers, data storage as well as other perimeter security tools form the computing services in the "cloud".

According to Ravish *et al*. [3], usually, each application owns a dedicated server; however, a cloud computing system may perhaps comprise any computer program imaginable: data processing to video games or other programs. As stated by National Institute of Standards and Technology (NIST), a vital characteristics of cloud computing include: on-demand self-service; which simply requires that the service must be always available and easily changed by the client without contacting the service provider.

With the exciting returns of cloud services, it is worthy to note that trust remains the contest in cloud computing with the customer’s data and business logics residing in the remotely situated servers which could be ***are*** far away from the end-users. Thus, with the aim of catering for these issues, different security policies, mechanisms, techniques and protocols generally called trust models were projected to assess the trust level invariably addressing the cloud security challenges. The agitation created by trust issues have propelled professionals and researchers, both from the industry and academia, to propose various trust establishment solutions ranging from simple mechanisms of SLAs to complex trust evaluation models. These trust models are supported by different features sets of secured data and quality of service (QoS). Nonetheless, the continuous rising attention in Cloud trust domain; and existing literature on trust models largely remains unstructured. Hence, it turns out to be difficult whenever cloud consumers have to opt for the most secured trust model from an extensive variety of alternatives. This is because the best of the trust models in terms of its security requirements is yet to be identified.

2. RELATED WORKS

Trust is found to be one of the major challenges in the cloud computing concepts as distrust prevents the consumers from its wide use and distrust due to the fact that most consumers do not have a direct control over their data lying on the cloud. The component of trust is a critical factor in the wide usage and deployment of cloud services. Trust is established between the two parties, that is, the trustor and trustee. Kavita and Sudesh [4] explains the trustor as a person or entity holding confidence, reliability, belief, integrity and ability, belonging to the third party or thing as trust object, that is, the trustee. To this end, a reliable services offer depends on trust as a critical factor in the cloud environment to its customers. It has enhanced services acceptance among cloud consumers. Therefore, trust should be established between cloud service provider and cloud consumer; and as stated in Priya and Jaisankar [5], trust management is widely deployed in online services, E-commerce and social network

Talal and Quan [6] presented the analysis of trust management perspectives and classify trust management techniques into four different categories. The work proposed a generic analytical framework sought to compare different trust management research prototypes using assessment criteria. overview and compares of 30 representative research prototypes on trust management in cloud computing vis-à-vis the relevant research areas was carried out.

A Trust Evaluation Model for QoS Guarantee in Cloud System was proposed by Hyukho *et al.* [7], The work presented a trust model for efficient reconfiguration and allocation of computing resources satisfying various user requests. Probabilistic Latent Semantic Analysis (pLSA) methodology was employed to estimate the availability of each service/resource provision from the history of statistical usage data. Using pLSA, the system availability was estimated during specific periods and resources were allocated with a minimum failure rate and hence, it supports a more reliable cloud computing environment. A Trust model was developed which collects and analyses reliability based on historical information of servers in a Cloud data centre. Efficient utilization of the proposed trust model can be realized by cloud providers. In addition, provision of trusted resources and services to many users are s. Also, it increases the reliability of overall Cloud system by providing highly trustable computing resources. But the model only deals with reliability without considering other quality of service and trust issues.

Li *et al.*, [8] proposed a trust model that enhances security and interoperability of cloud environment. The aim of the work is to develop a novel trust model which ensured the security of cloud entities both customers and providers in cross-clouds applications. Analysis of various trust models deployed in distributed environment was done. Thereafter, a novel cloud-based trust model that solves security issues in heterogenous environment coupled with incorporating customers' choice enablement in services provision with resources availability in a given domain was developed. The model was domain-based, which divides one cloud provider's resource nodes into the same domain and sets trust agent. Experimental result showed that the model can efficiently and safely construct trust relationship in cross-clouds environment and also establish trust relationship between customer and provider. The limitation of the work is that a cross-clouds security prototype system was not established.

A Method for Trust Quantification in Cloud Computing Environments was done by Li *et al.* [9]. The aim was to propose a method for trust quantification based on fuzzy comprehensive evaluation theory for cloud computing to protect user data through trust quantification of cloud services. Fuzzy comprehensive evaluation method and information entropy theory were applied to determine the best combination of weights of various factors in the design of a preference trust quantification algorithm. Trust ontology and user preference definition of trust values were introduced for clouds services. Thus, by enhancing the existing trust concepts, based on dynamic requirements, some cloud service attributes layered service representation for trust preference was introduced and then the fuzzy comprehensive evaluation theory to perform trust quantification was applied. In addition, simulation experiment to demonstrate that the proposed approach can help users achieve more benefits and protect privacy effectively were performed. The proposed work was opined to be deployed to protect cloud users' data and contain services providers' malicious behaviour.

3. METHODOLOGY

This study employed Simulation method of performance evaluation with the existing trust models using Java NetBeans integrated development environment (IDE) and evaluating their performances, the work involves 2 steps: algorithm description and trust evaluation. The simulation results were obtained using several experimental scenarios, exported in a csv file and imported into a R Environment where the results are presented. Experiments are needed to be performed on a repeatable, dependable, and scalable environment, which is not possible in the already existing world cloud because of the differences in the trust models being evaluated. So, to obtain a holistic platform used in software for modelling environment in cloud computing and perform testing, a simulator called CloudSim is used. By using CloudSim, specific system design issues were focused on that was used in investigating, without being bothered with details as relating to low level-based infrastructures and services in cloud.

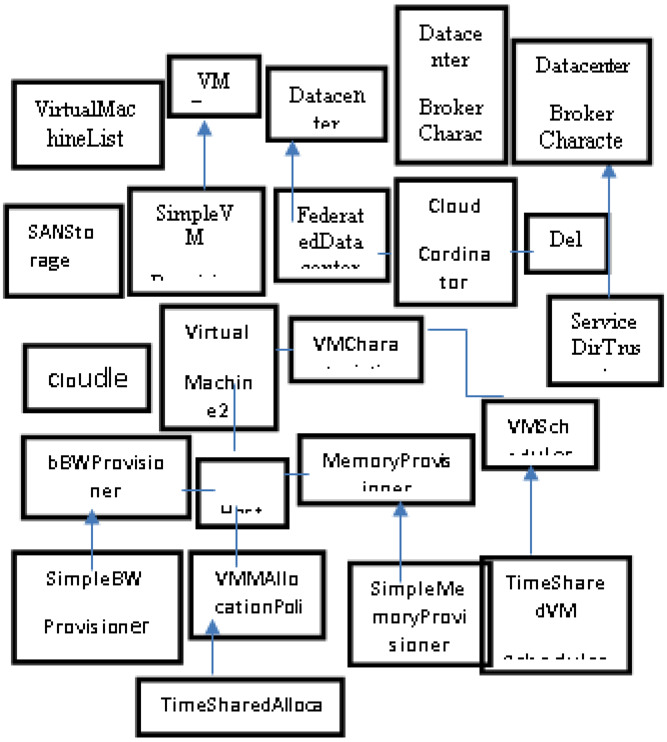


Figure 1. Shows the Cloudsim Class diagram (Adapted from Buyya *et al.*,[10])

3.1. Datacentre: The core infrastructure level services were modelled by (hardware, software) which is being offered in Cloud by resource providers. A set of compute hosts which could be either homogeneous or heterogeneous are covered regarding with their configurations of resource (capacity, memory and storage). Furthermore, every Data centre has a component where a generalized resource provisioning component were instantiated in order to implement set of policies that allocates bandwidth, memory, and storage devices.

3.2. Data centre Broker: A broker is being modeled by this class, which mediates between service providers and users which depends on users' QoS requirements and deploying tasks used in services operated across Clouds. The way VM provisioning requests are submitted to datacenters and the way cloudlets are submitted was modified and it was enhanced by adding the Service Dir Trust simulation entity class were performed thereby allowing us to define cloud users, configure their trust values, specify trust weights and other essential trust parameters.

3.3. SANStorage: A storage area network is being modeled by this class which is available to Cloud-based datacenters in clouds large portions of data are stored. In SANStorage, a simple interface is implemented that could be used to simulate storage and retrieval of data regarding of the amount, which is subjected at any time to network bandwidth is available. Accessing files used by SAN during processes for task unit execution incur delay which be additional., due to time elapsed for transferring the required data files through the datacenter internal network.

3.4. CloudCoordinator: This abstract class monitoring the internal state of a datacentre occurs periodically in terms of simulation time. The specific event that triggers the VM_migration is implemented by a delay. The delay field contains the estimated time for the completion of the migration, after which the VM is available in the destination host.

3.5. BWProvisioner: This class is extended by Allocate Bandwidth method; the function of this method is to undertake the allocation of network bandwidths to set of competing VMs deployed across the datacenter.

3.6. MemoryProvisioner: This component models policies for allocating physical memory spaces to the competing VMs.

3.7. VMProvisioner: This abstract class represents the provisioning policy that a VM Monitor uses for allocating VMs to Hosts in a datacenter meets the memory, storage, and availability requirement for a VM deployment. The default strategy is to allocate the host with less running VMs receives the next VM. To change this behaviour, extend VMAllocationPolicy implementing optimizeAllocation method in order to allow VM allocation to the first available host that meets the aforementioned requirements for achieving optimized allocations.

3.8. VMScheduler: VmScheduler Time Shared was used as the scheduling policy which means that the fraction of processor elements is shared among the VMs and the VMs run simultaneously.

4. Simulation Entities Relationship

The DatacenterBroker is responsible for mediating between users and service providers depending on the users' requirements in the cloud. D2atacenter are resource providers; it is composed of a set of hosts which is responsible for managing VMs during their lifecycles. Host is associated to a datacentre, it executes actions related to management of Virtual machinelike creation and destruction of VMs, it has defined policy for providing memory and bandwidth. VM runs inside a Host sharing the Hostlist with other VMs. Processing of task units (Cloudlets) is handled by the respective VMs, each VM has a host which can submit cloudlets to the VM to be executed.

Tasks or Jobs in Cloudsim are called Cloudlets submitted to cloud; the allocation of VMs for specific applications to Host in a datacentre is the responsibility of the VM Provisioner.

5. Entities Communication in the Simulator

The Figure 2 depicts communication flow between core CloudSim entities. At the beginning of a simulation, each Datacentre entity registers with the CloudInformationService (CIS), the CIS is an entity that provides resource registration and indexing which allows entities to register themselves with the CIS.

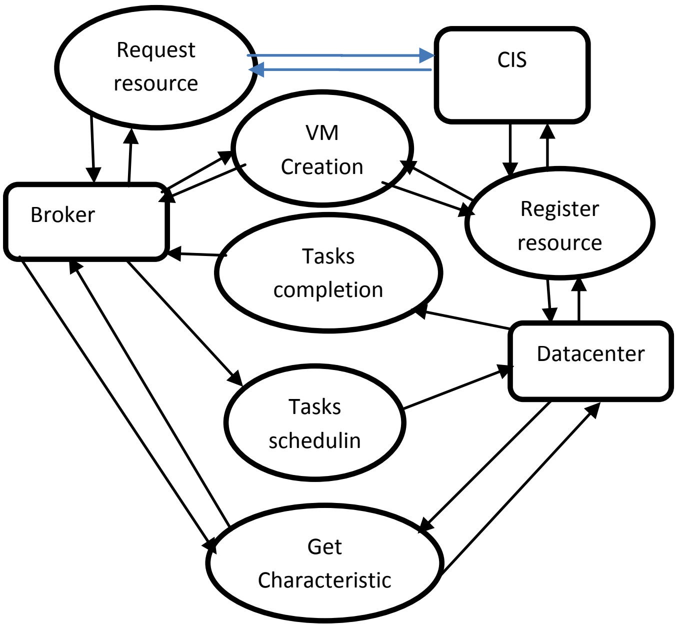


Figure 2. shows the data communication flow among entities during the simulation.

Next, the Datacenter broker acts on behalf of the users to identify suitable Cloud service providers through the CIS and negotiates with them for the allocation of resources that the application's hardware and software requires. The CIS selects the available Host in a Datacenter that meets the application's requirements, the Broker then access a component in the datacentre that stores characteristics that is used by the Virtual Machine (VM) such as storage capacity and memory capabilities. The Host component is responsible for the instantiation of a VM and the set of Hosts are housed in a Datacenter, the Broker request for creation of VM from the Host component in a Datacenter. A method then is called that request that the VMs return the least completion time of the task units they are currently managing to the datacentre entity and the completed tasks are directly returned to the CloudBroker. Then, the CloudBroker requests that the datacentre destroy the VM. The data communication flow among entities during the simulation

6. Algorithm Description

The adopted algorithm is:

Step 1: Input to the algorithm is a set W, which includes the weights of trust metrics. These weights are assigned by the Cloud consumer according to the level of impact specified.

Set W= {0.8, 0.4, 0.1, 0.6}

Set P= {C, PC, D, A}

where W is weight of parameters according their impact level, P is the parameters namely data confidentiality, process execution control, detection of malicious behaviour and data availability respectively.

Table 3. 'Level of Trust features' range.

Level for trust features	Range for specific impac level
High	0.7 < value 1.0
Medium	Value
Low	Value
Very Low	Value

The essential trust requirements, the required trust levels and their corresponding desired weights are set. The four main levels for these requirements which are 'High', 'Medium', 'Low' and 'Very Low 'are defined and any of the four options against each trust requirements are selected. The 'High' level corresponds to the specific range of values that lie between 0.7 and 1, which means if the Cloud consumer has very high priority for a trust requirement, the cloud user will select the 'High' level and assign a weight to this feature between 0.7 and 1. Similarly, 'Medium' level lies between 0.4 and 0.7, 'Low' level has the range from 0.1 to 0.4 and the 'Very Low' level corresponds to the values between 0 and 0.1.

Step 2: The second step calculates the trust features supported by all the trust models.

These features calculated for each trust model separately.

Step 3: A cumulative value is calculated for all the trust models.

Step 4: After this, by comparing the calculated Cumvalue of all the trust models, the largest cumulative value is found. This particular trust model will be selected as the most suitable model according to the level of trust features which is deduced by its cumulative trust value and weight.

Step 5: The one with the highest weight and having the largest numbers of elements is selected as the most secured trust model for cloud services.

The proposed algorithm comparing these models for trust would be simulated on the java version of CloudSim v4.0.0, using NetBeans IDE.

7. System Implementation and Results

Figure 4 The Simulation Parameters

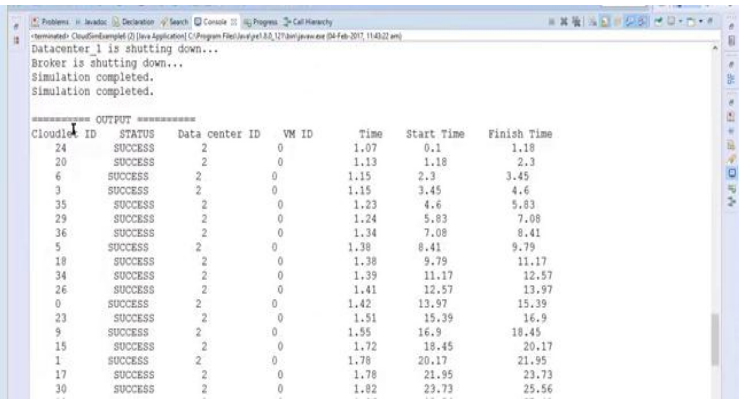
S.NO	ENTITIES	PARAMETERS	VALUES
1	Users	No of Users	1
2	Cloudlets	No of Cloudlets	100-1000
		Length	2000
3	Host	No of Hosts	2
		RAM	512MB
		Storage	1000000
		Bandwidth	10000
4	Virtual machine	No of VMs	5
		Type of Policy	Time Shared
		RAM	512MB
		Bandwidth	1000
		MIPS	1000
		Size	1GB
		VMM	Xen
		Operating System	Linus
		No of CPUs	1
5	Datacentre	No of Datacentres	2

8. TRUST MODEL EVALUATION

Tests and evaluation undertook are presented in order to select the most secured trust model for cloud services. The tests were conducted on an Intel system having configuration: 1.60GHz with 1 GB of RAM running a java version 8.0.2 and JDK 1.8.

Trust evaluation was achieved with a simulated Cloud computing environment consisting of two data centers, a broker and a user, with series of experiments performed. The number of hosts in the data center in each experiment was varied from 100 to 1000 where each host was modelled to have a single CPU core (1000MIPS), 512MB of RAM memory and 1GB of storage. Scheduling policy for VMs was Time-shared, which meant all VMs were allowed to be hosted in a host simultaneously at a given instance of time. Users were modelled (through the DatacenterBroker) to request creation of 5 VMs, the VMs have the following constraints: 512MB of physical memory, 1 CPU core and 1GB of storage. The application unit was modelled to consist of 5 task units, with each task unit requiring 1000million instruction per second. As the goal of these tests were to evaluate the trust requirements directly in the trust models, no attention was given to the user workload.

The total delay in instantiating the simulation environment is the time difference between the following events: (i) the time at which the runtime environment (java virtual machine) is directed to load the CloudSim program; and (ii) the instance at which CloudSim's entities and components are fully initialized and are ready to process events.



Problems
Javadoc
Declaration
Search
Console
Progress
Call Hierarchy
<terminated> CloudSimExample6 (2) [Java Application] C:\Program Files\Java\jre1.8.0_121\bin\javaw.exe (04-Feb-2017, 11:43:22 am)

```
Datacenter_1 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

========== OUTPUT ==========
Cloudlet ID    STATUS    Data center ID    VM ID       Time    Start Time    Finish Time
    24        SUCCESS        2               0          1.07      0.1          1.18
    20        SUCCESS        2               0          1.13      1.18         2.3
    6        SUCCESS        2               0          1.15      2.3          3.45
    3        SUCCESS        2               0          1.15      3.45         4.6
    35        SUCCESS        2               0          1.23      4.6          5.83
    29        SUCCESS        2               0          1.24      5.83         7.08
    36        SUCCESS        2               0          1.34      7.08         8.41
    5        SUCCESS        2               0          1.38      8.41         9.79
    18        SUCCESS        2               0          1.38      9.79         11.17
    34        SUCCESS        2               0          1.39      11.17        12.57
    26        SUCCESS        2               0          1.41      12.57        13.97
    0        SUCCESS        2               0          1.42      13.97        15.39
    23        SUCCESS        2               0          1.51      15.39        16.9
    9        SUCCESS        2               0          1.55      16.9         18.45
    15        SUCCESS        2               0          1.72      18.45        20.17
    1        SUCCESS        2               0          1.78      20.17        21.95
    17        SUCCESS        2               0          1.78      21.95        23.73
    30        SUCCESS        2               0          1.82      23.73        25.56
```

Figure 4: The working algorithm snapshot

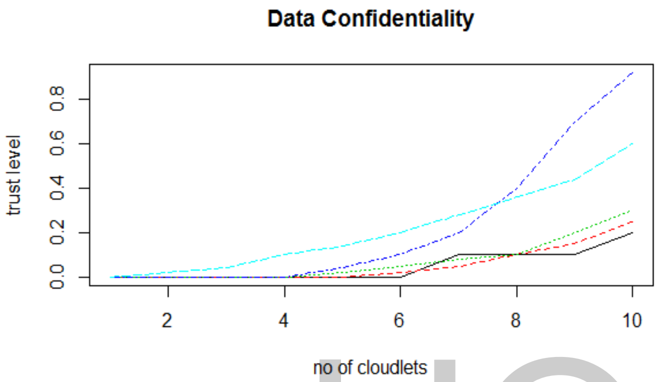


Figure 5. shows comparison of data confidentiality

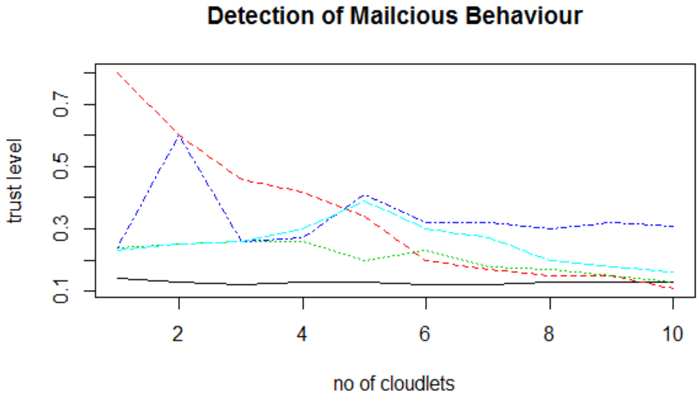


Figure 6. shows the comparison of detection of malicious behavior

This shows the comparison of detection of malicious behaviour between Agreement based, Certificate based, Feedback based, Domain based and Subjective trust models without using workload traces. Horizontal line signifies number of cloudlets and vertical line signifies the. The comparison results show that theDomain based model gives better detection of malicious behaviour than other trust models in simulation homogeneous environment.

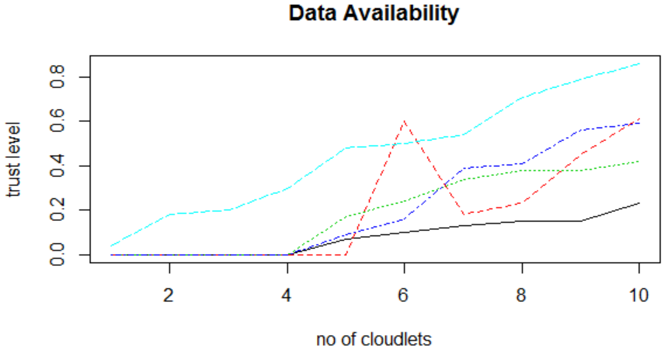


Figure 7. shows the comparison of data availability

This shows the comparison of data availability produced is shown between Agreement based, Certificate based, Feedback based, Domain based and Subjective trust models without using workload traces in homogeneous environment. The x-axis indicates the number of cloudlets and the y-axis indicates the data availability. When the numbers of cloudlets are less, then Certificate based and Agreement based model, give enhanced data availability. When the number of cloudlets is increased, Certificate based model produces better data availability in simulation homogeneous environment without workload traces.

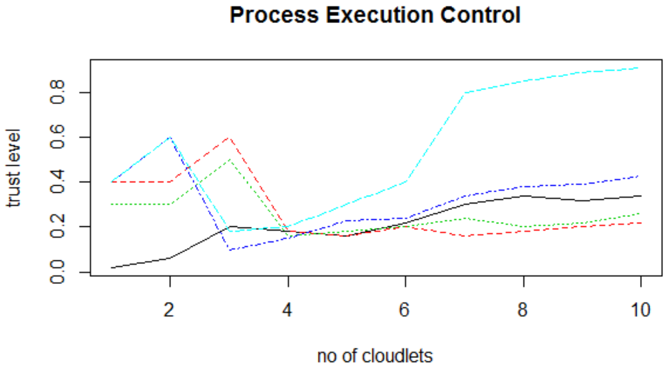


Figure 8: shows the comparison of process execution control

This shows the comparison of process execution control produced is shown between Agreement based, Certificate based, Feedback based, Domain based and Subjective trust models without using workload traces in homogeneous environment. The x-axis indicates the number of cloudlets and the y-axis indicates the process execution control. The comparison outcomes show that the Certificate based model gives maximum weight in process execution control than other trust models without using the workload traces in simulation environment.

9. CONCLUSION

The important trust features of the Cloud-based trust models were identified and presented. These features helped in identifying a reliable and secure trust model for the Cloud environment that completely met all the important trust requirements. In conclusion, the comparison of trust models in cloud computing services executed with the help of CloudSim simulator without the user workload traces was presented.

These models were compared with each other based on four trustworthiness parameters which are data confidentiality, detection of malicious behaviour, data availability and process execution control. The trust models evaluated in this work, overall Certificate based trust models performs better than other trust models, while Agreement based and Feedback based trust models give good results. These analyses will help the Cloud consumers and the IT professionals in selection of an appropriate trust model in their trust evaluation requirements. The limitation is that this work did not feature all the security and trust issues in cloud services as it was too much to cover but the important ones with high severity were covered. It is recommended that Cloud computing should be fully embraced despite its security and privacy breaches.

REFERENCES

[1]. Hrishikesh Trivedi (2013). Cloud Computing Adoption Model for Governments and Large Enterprises, Composite Information Systems Laboratory (CISL) Sloan School of Management, Room E62-422 Massachusetts Institute of Technology Cambridge, MA 02142 page 11.

[2]. Zhiguo, W., Jun, L., & Robert H., (2012). A Hierarchical Attribute Based Solution for Flexible and Scalable Access Control in Cloud Computing, IEEE Transactions on Information Forensics and Security, 7(2), 743 – 754.

[3]. Ravish Saggar, Shubhra Saggar and Nidhi Khurana (2014). Cloud Computing: Designing Different System Architecture Depending On Real-World Examples, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (4) , 2014, 5025-5029

[4]. Kavita Rathi and Sudesh Kumari (2015). Analyzing and Surveying Trust in Cloud Computing Environment, IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 17, Issue 3, Ver. 1 (May –Jun. 2015), PP 66-70

[5]. Priya Govindaraj and N Jaisankar (2017). A Review on Various Trust Models in Cloud Environment, Journal of Engineering Science and Technology Review 10 (2) (2017) 213-219

[6]. Dhu, L., and Arundathi., S. (2014). Providing Privacy and Security for Cloud Data Using Data Mining, 268-270.

[7]. Hyukho Kim, Hana Lee, Woongsup Kim, Yangwoo Kim (2010). A Trust Evaluation Model for QoS Guarantee in Cloud Systems, International Journal of Grid and Distributed Computing Vol.3, No.1.

[8]. Li, Wenjuan, and Lingdi Ping (2009). Trust model to enhance security and interoperability of cloud environment. IEEE International Conference on Cloud Computing. Springer Berlin Heidelberg.

[9]. Li Xiaohui, Jingsha He, Bin Zhao, Jing Fang, Yixuan Zhang, andHongxingLiang (2016). A Method for Trust Quantification in Cloud Computing Environments, Hindawi Publishing Corporation International Journal of Distributed Sensor Networks Volume 2016, Article ID 5052614, H.

[10]. Buyya R., C. S. Yeo, S. Venugopal, J. Broberg, and I. Brandic (2009) “Cloud computing and emerging it platforms: Vision, hype, and reality for delivering computing as the 5th utility”, Future Generation Computer Systems, vol. 25, no. 6, pp. 599 – 616.