A Hybrid Cloud for Smart City Management

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Abstract— Many Cities in various countries all over the world are developing into smart cities with significant adaptations in technologies such as IOT(Internet Of Things), Wireless Sensor Networking, Cloud Computing etc. The management of digital information for such cities and mining the essentials from such large amount of data is a big problem that can be resolved with the help of this Hybrid Cloud System. This system will provide efficient usage of resources and services provided by Cloud it also helps in improving the security of the vehicles and individuals in the city, management of traffic, increasing the comfort level of the citizens, minimize the usage of fuel and improve the fuel economy, avoid unwanted hazards and make it easier for the regulatory authorities to manage the city. There are many issues related to management of data over the cloud such as resource allocation, cyber security and scheduling of tasks etc. This system deals with managing resource allocation issues related to cloud and analyzing the data on the cloud to manage the city's resources more efficiently. In this system a Hybrid Cloud is formed by combining the Private cloud system of the automobiles and Public cloud system of the local resources of the city. Here the private cloud that belongs to the automobile companies is used for providing information of the vehicles such as its location, navigation information and there status (whether active or not) for analysis purpose. Whereas the public cloud handles the information provided by the wireless sensors, traffic control stations, and other modules (for information gathering) spread throughout the city in a shared network environment provided by various Internet and Cloud Service Providers. In this paper a centralized resource allocation model is used for private cloud with repetitive constraint analysis to improve the Quality of Service (QOS) of the private cloud and a dynamic priority based round robin scheduling algorithm is used for resource allocation for the decentralized public cloud system.

Key words: allocation, centralized, decentralized, Private Cloud, Public Cloud, QoS (Quality of Service) , resources, scheduling

I. INTRODUCTION

As the modernization of cities and internet services is taking place all over the world, the need for increasing the efficient use of cloud computing and its services is also growing day by day. Immediate access to distributed information, digital data and computational resources for improving the quality of life, security and comfort is required. There are many cloud based services already used by different individuals while driving in the city such as google maps, navigator, cloud based speed optimizer for improving the fuel efficiency etc. But still Cloud computing faces many challenges related to resource allocation, cyber security etc. Using a proper resource allocation scheme will help us to manage data on the cloud server (Google Cloud Platform etc) more efficiently and also give us the opportunity to enhance the response time of the services. The biggest challenge for efficient resource allocation over the cloud in such a system of smart city is to minimize delay and meet the deadline for time critical tasks by prioritizing them precisely. If the deadline is not met in such a task it can cause havoc in the city which will be very complex to manage. There are significant developments on cloud based systems for efficient resource allocation in which use of hierarchical and distributed computing algorithms is done to improve resource utilization on large scale cloud system. Here we can use such an approach to manage, analyze and compute information provided by the public cloud sensors, services and tools along with the information of the private cloud provided by each vehicle or individual companies that develop those vehicles. This system is a hybrid of both public and private cloud and it can allocate resources to the private and public cloud separately by using appropriate techniques. The Private cloud has a centralized resource allocation technique as the cloud belongs to individual automobile company it does not share information or data with any other system or device belonging to some other company. The various constraints essential for the safety of the vehicle, comfortable drive experience of the individuals and there security are repetitively analyzed on the cloud after resource allocation and then rearranged on the basis of their outcomes for further analysis. For example if we have an ambulance as a vehicle that is on the move and it needs to reach the hospital as soon as possible to save the life of a patient, then the information about its Speed, Shortest path to the hospital via Google maps, Traffic information of all primary and secondary paths to the hospital, deadline of data that is being transmitted to the cloud and delay will act as the constraints for cloud and will be rearranged repetitively on change in their values over the cloud giving less priority to speed related constraint in this situation.

The Private Cloud for automobiles:

n: the number of vehicles running on the streets of the city for i = 1 to n

t_i : tasks running on each vehicle

w_i : workload of the tasks running on each vehicle(w = workload(t)) p_i : distance to be covered on each path for each vehicle

T_i : no of automobiles active to provide traffic information of each path D_i : deadline for each vehicle

$Q_i (T_i , w_i , p_i , D_i) =$ {

$\sum \min(w_i , p_i , T_i)$, if D_i is not set to hard for that vehicle (1)

$\sum \min(p_i , T_i)$, if D_i is hard for the vehicle then neglect(2) workload on the system
}

For safety critical task only the information of shortest path and traffic will be considered and there will be no significance of workload experienced by the vehicle, if it increases it doesn't matter as reaching the destination in the least possible time is the priority in such a case but for task that are not critical such as video display or FM radio transmission, or gathering route information for some common vehicle there should minimum workload, no need of not considering excessive workload for such tasks and on the basis of this consideration we can also suggest the drivers to reduce the workload on the vehicle when it is too high.

The Private Cloud in such a system has resources which are already acquired with limited capability. It is up to the service provider whether to use these resources completely or waste them. The primary motive of using this private cloud for the automobiles is carrying out distribution of the resources to each task separately for each auto mobile. The information here is processed in an efficient manner and then refined for sharing purposes on the public cloud. Only selective information from each automobile is shared on the public cloud as per the norms defined by the automobile companies.

A. Public Cloud for local resources:

A weighted round robin algorithm is used to handle the processes running on the public cloud and manage resource allocation to processes on the public cloud. The information on the public cloud is gathered in a pipelined manner from the sensors and other information providing devices installed in the city. They follow a weighted round robin approach to minimize and avoid any idle time slice for processing on the cloud. Initially the information is gathered from these devices by the ISP and he categorizes it as per the different forms of resources available on the cloud such as communication utility resources, security utility resources, power or energy utility resource, fast computation utility resource and storage utility resources. Then this information is shared on the decentralized public cloud where it organizes this information on the basis of resource utility type to which it belongs where it can be analyzed. The analysis results and reports can be shared on the public network environment and also be provided to the automobiles that are the part of the private cloud. This enhances the management of the smart city as well as provides the users a more comfortable and pleasant experience when they drive in the city,

II. LITERATURE REVIEW

A. What is Cloud Computing?

It is a type of Internet-based computing that provides shared computer processing resources and data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services), which can be rapidly provisioned and released with minimal management effort. Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in either privately owned, or third-party data centers that may be located far from the user–ranging in distance from across a city to across the world. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility (like the electricity grid) over an electricity network. As per the information provided from the research paper on resource management in cloud computing by Swapnil M Parikh, Dr. Narendra M Patel, Dr. Harshad Kumar B Prajapati there are various types of cloud such as:

1) Private Cloud

All the cloud services are managed by the organization people themselves or any third party vendors that own the private cloud. In private cloud the services are not provided to the general public.

2) Public Cloud

All the cloud services managed by the organization are made available as in pay as you go manner to the general public. The business people can adopt such cloud to save their hardware and/or software cost. Public cloud may raise number of issues like data security, data management, performance, level of control etc.

3) Community Cloud

Here cloud is available to specific group of people or community. All the cloud services are shared by all these community people.

4) Hybrid Cloud

It is a combination of any two or more type of systems provided above.

The use of cloud computing is proving to be very efficient with development of new analytical schemes in various fields such as healthcare, pattern detection automation etc. explained in the research paper based on data processing and cloud survey by Katherine Hughes. These analytics can be very useful for faster analysis of large amount of data handled by the cloud.

The performance of the cloud and its response depends on the QOS (quality of service) provided by the cloud which can be improved by optimizing the resource allocation on the cloud. For better resource allocation and improved quality of service of the cloud it is necessary to minimize the communication delays and efficiently meet the deadline of critical tasks. This information was provided from a research paper on cloud resource management on automotive applications. Resource provisioning under both private and public cloud paradigms were also modeled and treated in this paper. Task deadlines and random communication delays were explicitly considered in these models. In particular, a centralized

resource provisioning scheme was used to model the dynamics of private cloud provisioning and chance-constrained optimization was exploited to utilize the cloud resource to minimize the Quality of Service (QoS) cost while satisfying specified chance constraints. A decentralized auction-based bidding scheme was used to model the public cloud resource provisioning. Best dynamics with constant bidding and constant time delays were first derived and a deep deterministic policy gradient was exploited to obtain the best bidding policy with random time delays and no prior knowledge on the random bidding from other vehicles.

The information regarding the constraints that should be used for improving the QOS was derived from a paper on Integrating QOS in cloud by Manar Abourezq and Abdellah Idrissi. The constraints that are to be considered are Agility, Risk, Security, Cost, Quality to improvise the QOS these constraints are to be minimized or maximized.

The following information was derived from a paper on RTS for scheduling of data and resources. Applications have different criticality levels, captured by their Safety-Integrity Level (SIL), and are scheduled using static-cyclic scheduling. Mixed-criticality tasks can be integrated onto the same architecture only if there is enough spatial and temporal separation among them. We consider that the separation is provided by partitioning, such that applications run in separate partitions, and each partition is allocated several time slots on a processor. Tasks of different SILs can share a partition only if they are all elevated to the highest SIL among them. Such elevation leads to increased development costs. The paper determines (i) the mapping of tasks to processors, (ii) the assignment of tasks to partitions, (iii) the sequence and size of the time slots on each processor and (iv) the schedule tables, such that all the applications are schedulable and the development costs are minimized. They have proposed a Tabu Search-based approach to solve this optimization problem. The proposed algorithm has been evaluated using several synthetic and real-life benchmarks.

The following information was derived form a paper based on resource management on the cloud in which challenges faced by resource management in cloud are elaborated and a probable solution to the issue has been provided. Resource management is always a major issue at various computing areas. In cloud computing various cloud consumers demand variety of services as per their dynamically changing needs. So it is the job of cloud computing to avail all the demanded services to the cloud consumers. But due to the availability of infinite resources it is very difficult for cloud providers to provide all the demanded services in time. From the cloud providers perspective cloud resources must be allocated in a fair manner. So, it is a vital issue to meet cloud consumers QOS requirements and satisfaction. Traditional resource management techniques are not adequate for cloud computing as they are based on virtualization technology with distributed nature. Cloud computing introduces new challenges for resource management due to heterogeneity in hardware capabilities, on-demand service model, pay per use model and guarantee to meet QOS. Resource management in cloud computing is a sequential process of various techniques with their research issues. Efficient cloud resource management should meet criteria's like efficient utilization of resources, cost reduction from cloud provider's perspective, energy / power reduction.

III. CONCLUSION

The paper focuses on the development of a hybrid cloud environment which includes Private Cloud System of various automobiles and Public Cloud System for local resources available in the smart city. The system permits the communication between the public and private cloud in a reliable manner for efficient performance of the system.

The paper also explains the two separate approaches for resource allocation on the Centralized Private Cloud that is based on repetitive analysis of the data provided to the cloud by the automobiles and resource allocation on the Decentralized Public Cloud based on weighted round robin approach which can be grouped and analyzed by the ISP (Internet Service Provider). The use of weighted round robin approach helps the ISP to categorize the time slot required for each set of task and alter it as per the requirements. Such a cloud system will increase the efficiency of the management paradigms related to smart city and also improve the quality of life of the individuals in the city by enhancing the drive experience, security of the individuals, easier access to available resources, precise information regarding the city traffic and routes etc.

IV. FUTURE WORK

The future scope of this paper includes practical development of such a hybrid cloud system on service platforms like Amazon EC2, Google Cloud Platform, and Amazon AWS etc. The future scope can also include improving the security standards of the hybrid cloud as various layers of security will be needed to protect data that is shared in a public cloud environment. The data redundancy reduction and concurrency control of data can also be improved by using appropriate algorithms to improvise the performance of the cloud.

REFERENCES

[1] S. Islam and J.-C. Grégoire, "Giving users an edge: A flexible cloud model and its application for multimedia," Future Generation Computer Systems, vol. 28, no. 6, pp. 823 – 832, 2012.
[2] ABADI, M., BARHAM, P., CHEN, J., CHEN, Z., DAVIS, A., DEAN, J., DEVIN, M., GHEMAWAT, S., IRVING, G., ISARD, M., ET AL. Tensorflow: A system for large-scale machine learning. In OSDI (2016).
[3] CANNY, J., AND ZHAO, H. Big data analytics with small footprint: Squaring the cloud. In KDD (2013).

[4] HETTRICK, S., ANTONIOLETTI, M., CARR, L., CHUE HONG, N., CROUCH, S., DE ROURE, D., EMSLEY, I., GOBLE, C., HAY, A., INUPAKUTIKA, D., JACKSON, M., NENADIC, A., PARKINSON, T., PARSONS, M. I., PAWLIK, A., PERU, G., PROEME, A., ROBINSON, J., AND SUFI, S. Uk research software survey 2014. https://doi.org/10.5281/zenodo.14809 Dec. 2014.
[5] F. Bonomi et al."Fog computing: A platform for internet of things and analytics," in Big Data and Internet of Things: A Roadmap for Smart Environments. Springer, 2014, pp. 169–186.
[6] An Analysis of the Cloud Computing Security Problem Mohamed Al Morsy, John Grundy and Ingo Müller.
[7] Cloud Resource Allocation for Cloud-Based Automotive Applications Zhaojian Lia, Tianshu Chub, Ilya V. Kolmanovskya, Xiang Yind, Xunyuan Yinc 2017.
[8] A Relative Study of Task Scheduling Algorithms in Cloud Computing Environment Syed Arshad Ali, Student Member, IEEE, Mansaf Alam, Member, IEEE.
[9] Z. Tang, L. Qi, Z. Cheng, K. Li, S. Khan and K. Li, "An Energy-Efficient Task Scheduling Algorithm in DVFS-enabled Cloud Environment", J Grid Computing, vol. 14, no. 1, pp. 55-74, 2015.
[10] Z. Qian, G. Yufei, L. Hong and S. Jin, "A Load Balancing Task Scheduling Algorithm based on Feedback Mechanism for Cloud Computing", International Journal of Grid and Distributed Computing, vol. 9, no. 4, pp. 41-52, 2016.
[11] C. Do, N. Tran, C. Pham, M. Alam, J. Son and C. Hong, "A proximal algorithm for joint resource allocation and minimizing carbon footprint in geo-distributed fog computing," Proc. of ICOIN, Jan. 2015.
[12] A Survey on Data Processing Methods and Cloud Computation Katherine Hughes1 Dec 2016.
[13] RSPP: A Reliable, Searchable and Privacy-Preserving e-Healthcare System for Cloud-Assisted Body Area Networks Lei Yang, Department of Electrical Engineering and Computer Science, The University of Kansas, KS, 66045; Qingji Zheng Bosch Research and Technology Center Robert Bosch LLC Pittsburgh, PA, 15222; Xinxin Fan Bosch Research and Technology Center Robert Bosch LLC, Pittsburgh, PA, 15222, Feb 2017.
[14] Integration of QoS aspects in the Cloud Computing Research and Selection System Manar ABOUREZQ and Abdellah IDRISSI 2015.
[15] Resource Management in Cloud Computing: Classification and Taxonomy Swapnil M Parikh, Dr. Narendra M Patel, Dr. Harshadkumar B Prajapati, Feb 2017.
[16] Transplantation of Data Mining Algorithms to Cloud Computing Platform when Dealing Big Data Yong Wang, Zhao Ya-Wei.