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Cloud Management Support System Using Multi-Agent

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Abstract

This research work examines the management of the infrastructure-level resources or services available in the private cloud by making use of an multi-agent architecture. The objective of this research is to design and develop the automated system for the selection of the best services for the end users, to show coupling of intelligent agents and internet of things for developing highly reconfigurable software approaches that incorporate domain knowledge and provide decision making capabilities, to make use of Mobile Agent technology to be able to engage in high-performance distributedwork. The system should be able to detect the type of service and best suitable services available with it. Due to their mobile and dynamic nature, utilizing multi-agent systems (MAS) has become preferable for researchers in finding solutions that tackle the different concerns raised during performing the compositions and selection. The object oriented methodology followed is system analysis, system design, object design and implementation.

Keywords: *Cloud computing, multi-agent, artificial intelligence, distributed constraint optimization problem, dynamic programming optimization protocol.*

I. INTRODUCTION

The tremendous advances in cloud computing, artificial intelligence and internet of things over the years past has led to the increased the use of these three technologies. The combination of these technologies has changed the Information Technology world drastically and has the potenetial to change the way in which data storage and processing was done earlier. By doing things in an automated manner has significantly reduced the human efforts and attains the ability to solve problems beyond the capacity and knowledge of humans.

The usage of multi-agent, cloud computing and IoT is proving to be beneficial for many organizational firms and research centers that are trying to handle the management of the cloud resources in an automated manner.

To design a system that will automatically extract and process the requisite information will make use of IoT in order to monitor and control the necessary information that is extracted, which will help in making better decisions.

The emergence of the distributed constraint

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optimation problems (DCOP) as an important agent model for governing the autonomous behavior of agents.

The structure of this paper is as follows: Section II presents the literature review followed by the system architecture in Section III. In Section IV the results and analysis is emphasized.

II. LITERATUREREVIEW

The system that exist works at the infrastructure layer and uses the infrastructure as a service paradigm which presented a method for cloud infrastructure management that aimed at overcoming the issues that were encountered while managing the on demand requests for the infrastructure resources [1]. The similarity is that it used agents to gather information, to annotate the information, to process the information and to store the information.

The agents in the proposed system will work in an integrated environment to provide the information extracted from the file system to the cloud server, that is, the information will be flowing from the clients to the server. For this information to be processed it is important that this information is annotated sematically. The on-demandrequest

for a particular resources needs to be handled correctly so as to avoid congestion in the network. This requires proper management of the on-demand requests.

The utilization of a multi-agent system should satisfy the user with good and enhanced quality service. The load on the system needs to be distributed evenly during the management of the on-demand requests for the system resources. The system should help benefit the organizations to better manage their resources to achieve efficient and optimistic results. Cloud computing in [1] is used in the creation of a backbone infrastructure that would be beneficial to various centers and companies that are trying to connect to a huge number of people as there is no upgradation required neither any maintaining is required.

The paper [1] examined the resource allocation and management at the infrastructure layer, they emphasized for infrastructure audit for getting proper insight of the resources used, allocation of the resources that are supplementary. They also emphasized on the security audit to understand the impact of having distributed multi-agent architecture to handle lot of different devices.

The paper [2] presented an distributed data mining approach using cloud computing and multi-agent systems. They proposed a system based on agent that would work under a software-as-a-service paradigm.

The DCOP framework is a prominent paradigm for solving combinational problems that arise in the multi-agent environments for the purpose of optimization. DCOP techniques builsupon the class of distributed constaint satisfaction problem by finding a complete assignment to the decision variables that not only satisfies the problem constraints but also optimizes the relevan objectives. The algorithm into consideration is the dynamic programming optimization protocol (DPOP). It is linear in terms of number of agents. Thus, the algorithm performs better in terms of the number of exchanged messages, the execution time, and the number of cycles.

To understand how constraint processing can be used to address optimization problems in Multi-Agent Systems we consider DCOPs where a set of agents must come to some agreement via negotiation about which action each agent should take in order to jointly obtain the best solution for the whole system. This framework is frequently in use in the MAS literature to address problems such as meeting scheduling in human organizations, where agents must agree on a valid meeting schedule while maximizaing

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the sum of individual preferences about when each meeting should be held, or track sensor networks where sensor must agree on which target the should focus on. A key aspect of DCOPs for MAS is that each agent negotiates locally with just a subset of other agents that are those that can directly influensit's behaviors.

The DCOP is defined by the 6-uplet (X,D,C,A,ψ,φ) with:

1) X the set of distributed variables{x1,x2,...,xn};

2) A the agents set{A1,A2,...,Ak};

3) ψ : X → A the mapping function that maps each variable of X to an agent ofA;

4) D = {D1,D2,...,Dn} a set of finite sets, where Di is the domain of the variablexi;

5) C = {cij : Di × Dj → R+, where i,j = 1,...,n and $i \neq j$}a set of constraints, corresponding to the local cost function for each couple of variables xi andxj.

Only the agent owner of a variable knows the variable domain and has the control on its value. φ(Af) is the objective function to optimize (maximize or minimize) and Af is the assignment function, which associate to each variable xi a value di ∈ Di.

The DPOP algorithmcan be divided into three phases:

1) Arrangement of variables into a DFStree;
2) Propagation of Util messages bottom-up along the DFStree;
3) Propagation of Value messagestop-down.

DPOP guarantees that the optimal solution can be obtained with a linear number of messages, resulting in messages whose size is exponential in the DFS tree ordering. It can operate on a pseudo-tree ordering of the constraint network. This specific arrangement is prominent as it ensures that during the optimization process, agents have knowledge of and can control only their own variables and they communicate with their neighboring agents.

III. SYSTEMARCHITECTURE

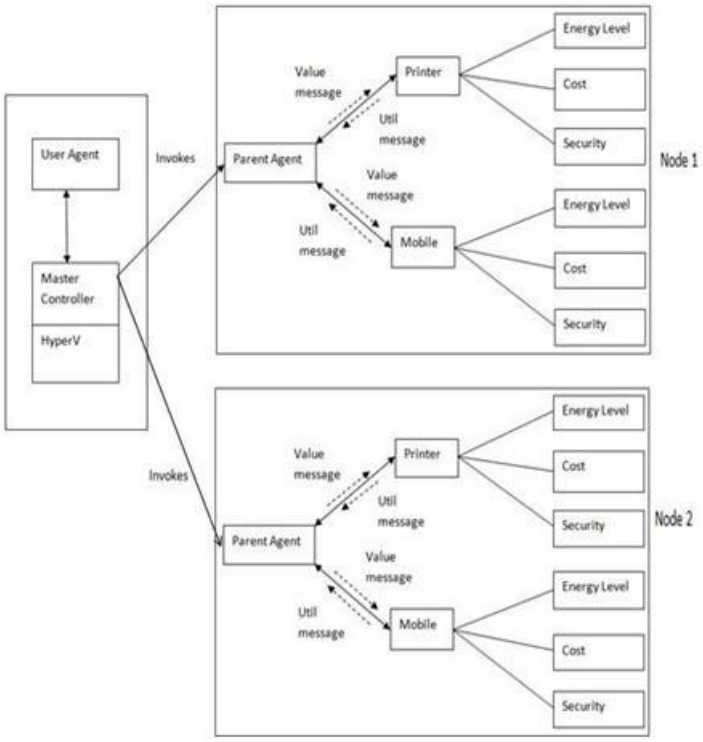

Figure1: Multi-Agent Architecture for Platform as a service

The architecture that is proposed for the multi-agent system makes use of different agents to perform different roles in collaboration with each other but still act as independent entities capable of moving from one system to another which will help solve different problems in the system and perform numerous tasks. The agents work towards gathering the information from the client system, tries to annotate this information semantically, and then display it to the user foruse after the processing step iscompleted.

The agents work in an integrated environment aiming at achieving its goals of extracting, annotating, processing and displaying the information to the end user. The on-demand request for the system resources should be taken care of to make sure that it does not affect the other under-going operations of the system. This

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requires proper load sharing to be achieved amongst the requestingclients.

The User Agent requests the system to access the cloud resources that are available on the cloud. This request is handled by the Master Controller which is responsible for invoking the agents of necessary nodes that will get the information of the available resources. The HyperV framework is used for creation of virtual machines. The agents work in a distributed environment and work towards integrating the cloud services. After invocation of a Parent Agent in a node, it follows the DPOP algorithm for message exchange between this agent and its subsequent children.

The child agents of the Parent agents extracts the data about its resources and sends it to their Parent agent as Util messages. Each agent computes messages for its parent considering both the messages received from its children and the constraint the agent is involved in. After all Util messages reach the Parent Agent, the Value phase of the DPOP begins, in which the value message is the optimal assignment for the resource that was requested by the enduser.

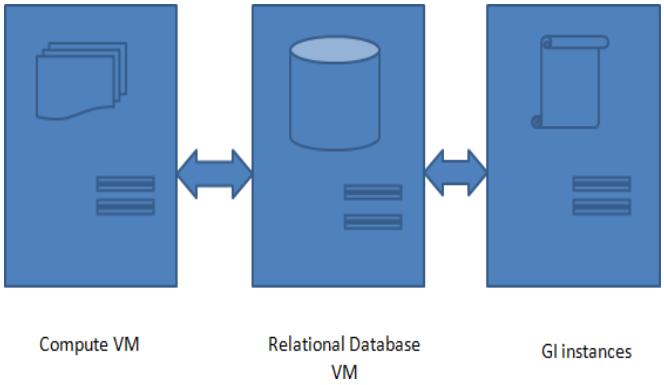

Figure 2: IoT Set-up Architecture.

The virtual machines required for accomplishing the tasks in the system for an Internet of Things architecture are of three types; namely; compute virtual machine, relational database machine and the graphical instances.

The compute virtual machine is required for computing the instances of the information that is to be gathered, the number of connections that are possible to be handled by the cloud server. The registration of various agents in the different client machines. This virtual machine should be able to compute the on-demand request and depending on the load must be able toperform load sharing task. The platform-level audit operations are valuable to better understand the load on the system, the utilization of the cloud resources, to keep track of the machines, services and resources being added or removed to or from the system. It will also provide the necessary information during any failure that might occur in the system and this would help in taking appropriate decisions and recovery measures.

The relational database virtual machine is used to manage the data storage and to provide access to the information stored. The instance pattern of the utilization of the resources and/or services of the cloud will be shown by making use of the graphical instance virtual machine.

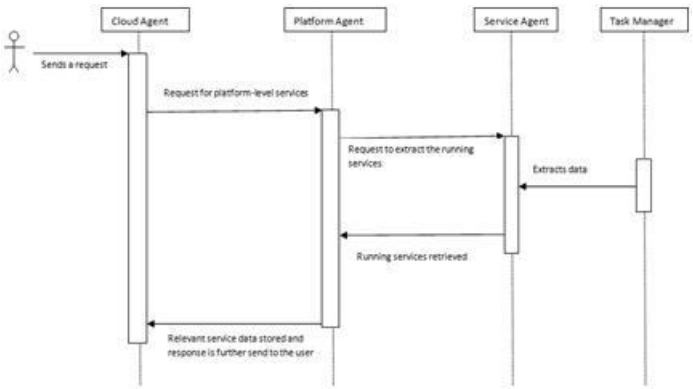

Figure 3: Sequence diagram

The sequemce of tasks is as follows:

1. The user sends a request through the user interface to the Cloud Agent depending on the platform-level service or resource needed by theuser.

2. The Cloud Agent which acts as the parent agent forwards this request to the PlatformAgent.

3. The Platform-Agent further sends the request to extract the information about the

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runningservices.

4. The Service Agent extracts the information requested for from the TaskManager.

5. This information is then sent back to the Platform Agent which then cleans and optimizes the data based on the user'srequest.

6. This filtered data is stored in a temporary storage of cloud and the response is conveyed to the user, i.e, the services or resources requested by the user are provided to theuser.

IV. CONCLUSION

In this research, we address the problem of global and decentralized cloud based resource and service selection for an IoT environment. The proposed system is based on the multi-agent paradigm and the DCOP formalism. We revisited a DCOP algorithm to develop an efficient solution that uses thedynamic programming optimization technique and generates only a linear number of messages.

This paper presents an approach for the management of the cloud services and resources using a multi-agent architecture and the DPOP solution of the DCOP framework. The solution aims to design and develop the automated system for the selection of the best services for the end users, to show coupling of intelligent agents and internet of things by extracting the information about the available cloud resources andservices.

As future work, we aim to optimize the system to work for developing highly reconfigurable software approaches that will incorporate domain knowledge and provide decision making capabilities and to make use of the Moile Agent technology to be able to engage in high-performance distributedwork.

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