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A Multi Agent Architecture for IT Infrastructure Diagnostic

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ABSTRACT

IT infrastructure refers to all the underlying elements that necessary provide technological services to an end-user. Besides, it allows an organization which delivers IT solutions and services to its employees, partners and/or customers. In an IT infrastructure, the interruption service can result in significant financial penalties and/or a loss of users trust. So to ensure that our IT equipment (hardware, software, network...etc) is available to perform the expected level, we need to be proactive in detecting incidents that disrupt the proper functioning of the company. The main objective of our work is to propose an efficient diagnostic platform for an IT infrastructure called (**MAITD**) in order to assist the company technicians to have a pertinent solution(s) in a short time face to decision-making problem.

Keywords: Decision Support, Multi-Agent System, IT Infrastructure, Corrective Maintenance.

INTRODUCTION

IT infrastructure maintenance is the key that ensures business continuity which can be divided into several areas: server, storage, network, security, virtualization...etc. There may be some specific maintenance requirements for particular IT(Information technology) infrastructures that should be defined by the organization itself. In addition, most of the maintenance operations are conducted through preventive methods with fixed time [1] or corrective [2]. In recent years the purpose of the maintenance task is to calculate the maintenance needs before the equipment failure, i.e. a continuous monitoring [3]. Several proprietary software solutions around IT infrastructure environment have appeared in this context such as: Solar Winds[4], Manage Engine[5], Zenoss[6]. However, in overall are preventive solutions and can't produce solution if infrastructure is affected. Additionally, decision supports systems have been developed to assist decision makers to solve their problems in a preventive or corrective manner. Our study is a part of a corrective approach in order to find a better solution to a problem in a short time. Moreover, the description problems have never been considered perfect according to the user expertise level and also around the

database structure that will be interrogated (keywords, structured query language, dictionary...etc). Nevertheless, this fact leads us to find unsatisfactory solutions, as consequence, we must treat the entered data by the user differently before starting the solution process.

This paper is organized as follows: Section two presents the different strategies for maintenance with some related works. Section three describes the proposed approach by introducing our general architecture. Section four shows some implementation examples of the case study during troubleshooting task. Finally, section 5 summarizes the paper and offers directions for future work.

RELATED WORK

There have been many works related to the information technology maintenance operations such as: the works presented in [7], which propose the taxonomy to outline modern intrusion detection systems IDSs. In addition, the work in [8] presented a Web and Agent Technologies in monitoring and maintenance condition of mechanical and electrical systems.

The multi-Agents systems have been used successfully in many application areas as with maintenance field. Indeed, several searches have been realized for example: the work described in [9], which used a hierarchical Multi-Agent System (MAS) for monitoring and reporting policy violations within the security environment. [10] proposed a decentralized multi-agent security system (DMASS) as a scalable solution for the collection and analysis of cyber security and network forensic data. Authors in [11] introduced an agent framework for forensic information gathering by using three types of agents for data collection, analysis and alert generation.

All these researches are preventive in a special way to take a fundamental step to avoid any breakdowns.

On the other hand, there are some surveys dealt in corrective maintenance but only for a security point of view like Work in [12], proposed algorithm considering multiple attributes of user keystroke dynamics, which in addition of traditional authentication has applied in an organization for distinguishing one user than another.

Our approach is a corrective one based on the support basically focus on corrective information technology infrastructure maintenance as with [13], which proposed a decision support framework in an IT environment which was essentially based on agents' mobiles and web services. However, the main problem with mobile agent is security which is still an area of research on its own. Indeed, the latter work is limited to ensure a secure access management. In this paper, a multi agent system is proposed as able to coordinate and cooperate his action in order to have a corrective decision method for IT infrastructure maintenance as it is shows on the next section.

PROPOSED APPROACH

Our **MAITD** architecture is a multi-layered architecture namely: Presentation, Interpretation, and Data Layer. The highest layer is constituted of two agents' categories, specifically the participant and expert agent who act as interface with the system in order to treat all input or output data. Additionally, the middle layer contains the rest of agents which is considered as kernel in our architecture with their functions and methods that are implemented in java environment. Finally, the lowest layer groups together all data source which are requested. In the following, we described main tasks of each agent:

Participant Agent: Treats the input information of the user through breaking down the problems in pertinent terms (Bags of Words) by using a Tree Tagger tool and our knowledge

bases. Also, it is responsible for forwarding all system notifications to the corresponding participant.

Expert Agent: Represents a corresponding expert with his agenda, preference, and profiling information. So, it is able to accept or refuse any meeting invitation. Furthermore, it plays an important role during the weight domain ontology construct [14] through validation of classification terms in their assigned taxonomy context.

Solution Agent: Allows us to filter and select from Universal Description Discovery and Integration (UDDI) registry the published solution or solved problems, which are available in the knowledge bases. This latter is important for our problem by applying a corresponding specific aggregation function. This functionality is not presented in the present paper.

Analyzer agent: This agent allows us to filter and select similar candidate problems [15] from deferent information source to construct our corpus and to assign it to the issue problem in order to generate our performance matrix via applying a set of algorithms and functions [16].

Meeting agent: Is responsible for preparing a collaborative session when no solution has been found trough the UDDI and in case where the problem is considered as incorrectly expressed or newly encountered as shown in the figure 4.

Other important components are presented in our architecture such as: the UDDI registry, Tree Tagger Dictionary, and knowledge base which are described as below:

Tree Tagger Dictionary: Is a tool for annotating text with part-of-speech and lemma information. In our approach, it is used during data pre-processing task as lemmatization tool, the latter one i.e. collects together the different forms of the same word.

Global Knowledge Bases: It includes the various interventions and scenarios that are used as similarity for the posed problems. It is the global data base whose information is accessible to all agents.

UDDI: It is an independent framework platform for describing, discovering, and integrating services. It provides a single location where services agents can dynamically find the stored solutions in UDDI which are published by different organizations.

Domain Ontology: Is developed to calculate the assigned weights to each criterion in our associated decisional performance table, and it used in measure similarity task.

The figure1 is an overview of a described architecture with some numbered flows to illustrate actions sequencing and relationships between all components that's contain.

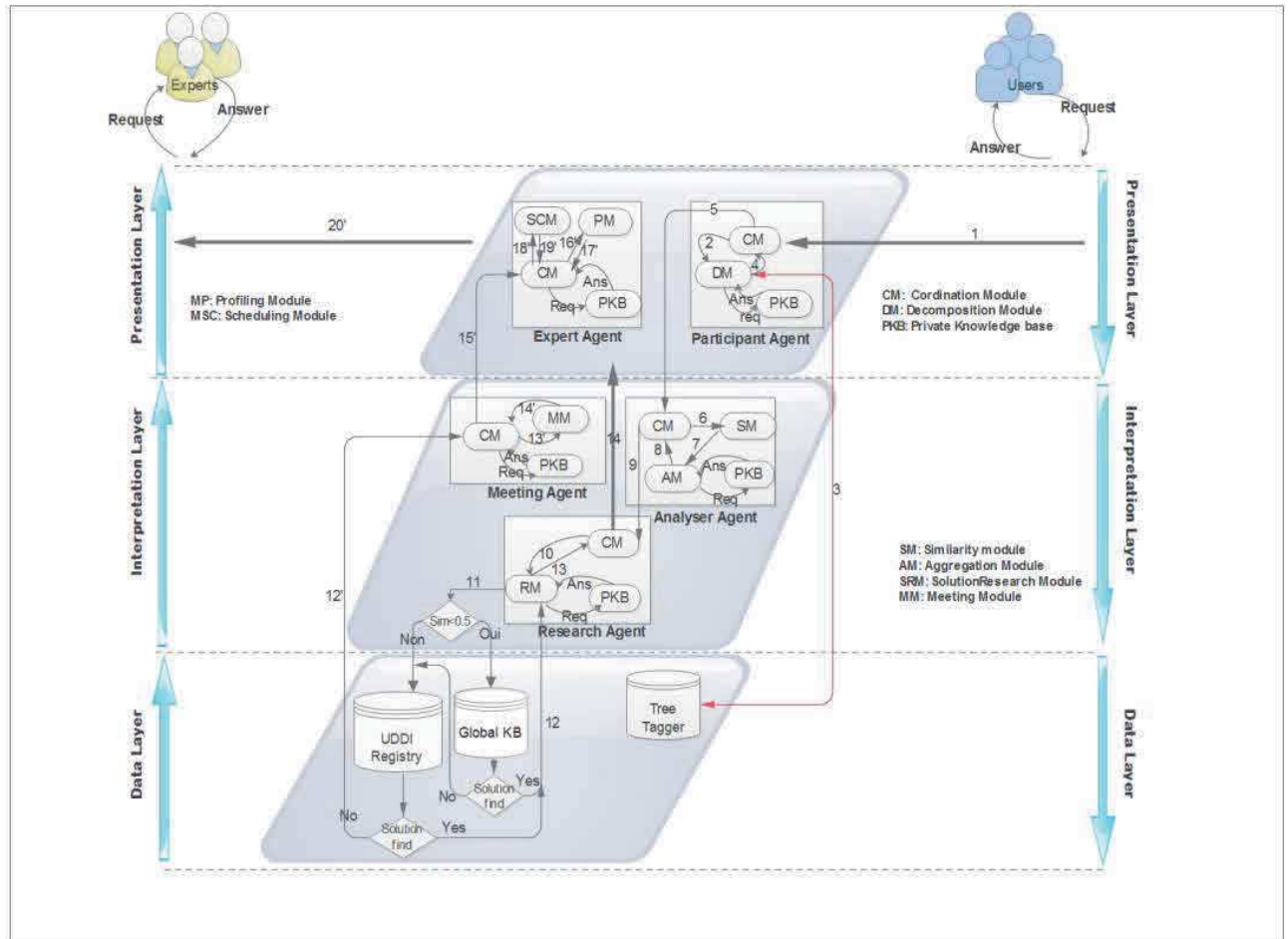


Figure 1: Multi Layers Agents based Architecture

This multi-layer architecture provides an ease of maintenance. Indeed, it allows monitoring of posed problem life cycle. However, a problem is considered solved if it contributes in all defined layers (layer1, layer2, and layer3). Moreover, it adds reliability and more independence to the involved agents and it gives us the ability to update the components of one layer without impacting the other layers. Indeed, to implement this we use Java NetBeans environment and Jade Platform for algorithms implementation and multi-agent deployment. In addition, Wamp server for data base deployment, Tree Tagger as dictionary and Protégé tools to develop domain ontology. In the following, we will describe the functionality of some modules that fulfill the structure of our agents:

Private knowledge Base (PKB): It contains knowledge that refers to tasks like processing function, aggregation methods parameters, and indexes on the shared domain ontology.

Similarity Module (SM): It resides with the expert agent in the fact to search and select all interested cases in the shared knowledge base using text similarity measure.

Aggregation Module (AM): is a part of analyzer agent task, is used in order to have an efficient solution rank with implement a specific function introduced in [16].

Coordinate Module (CM): This module plays an important role to control the whole mechanism of decision-making by coordinating between all agents that constitute the tree layers of our decentralized architecture in order to achieve the intended goal.

Decomposition Module (DM): Is responsible to generate all pertinent terms for each problem which are necessary to optimize and to accelerate the information retrieval in order to obtain

the best solutions.

Other modules are present in our approach such as profile module that resume overall expert profile and his preference. In addition the scheduling module that aims to organize a collaborative sessions with take account experts availabilities information's.

ILUSTRATION EXAMPLE

This section describes some interface of the MAITD defined in the latest section. Our corpus as a source information is constructed from real IT infrastructure data base problems.

Description Problems (Layer1): As first step, the participant describes a problem in his specific private space as shown in the figure2.

Figure 2: Problem Description Screenshot

Data pre-processing (Layer1):

Before implementing any method, it is initially necessary to transform the problems into an efficient manner, so that they can be analyzed. In this second step, we present the data after being formatted by using an adequate way to be dealt with by next phase as shown in the figure 3. This step is executed by participant agent and is a part of the first layer (presentation layer).

Num.	Problems	Pertinents Terms
1	I can't start my VMware virtual machine	start, vmware, virtual, machine,
2	Vmkernel service stop and no response from the virtual machine	vmkernel, service, stop, response, virtual, machine,
3	Vcenter vmware does not communicate with Esxi	vcenter, vmware, communicate, esxi,
4	I can't migrate my VMware virtual machine from one Esxi to another, problem with vmkernel	migrate, vmware, virtual, machine, esxi, problem, vmkernel,
5	No pool resources are assigned to this virtual machine	pool, resources, assigned, virtual, machine,
6	No increase of the memory capacity of the my virtual machine	increase, memory, capacity, virtual, machine,
7	No memory space available on esxi	memory, space, available, esxi,
8	Problem with vcenter and virtual machine	problem, vcenter, virtual, machine,
9	No start of virtual machine on schell mode	start, virtual, machine, schell, mode,

Figure 3: Data Pre-processing Screenshot

Preparing collaborative session (Layer2):

The meeting agents intervene to prepare collaboration sessions. Basically, there are two important points to note here. First, the meeting agent collaborates with all participant agents and expert agents to determinate this session. Second, this session will be scheduled if no solution is generated.

Reference	Description	Stat	Domain
59	impossible to create raid 5 in mi Blade UCS with raid software manager	0	Storage
60	F.interconnect with low flow trafic.	0	Storage
61	ASR(Cisco), Cisco IOS : Update	0	networking
62	informations missing from vmotion and vstorage into my vcenter	0	Virtualization
63	OS(Windows/Linux), Windows service, LINUX	0	Applications
64	no access with ma active directory account name to my private session	0	Applications
65	all catalyst power link are down	0	Networking
66	no access to my local area network with my catalyst switch.	0	Networking

Meeting Id	Forum Id	participant Id	Prb Id	Start Date	Start Time	End Date	End Time
4	1	5	67	2018-04-20	23:29:24	2018-04-20	23:29:24

Figure 4: Preparing Collaborative Session Screenshot

Monitoring Problem Possessing (Multi Layers):

The participants can monitor all problems progress in the same interface and the different tasks performed by the agent's trough their private spaces as shown in the figure5.

Num.	Processing	Agent type	Time
1	Problem decomposition completed...	Participant Agent	00:00:06
2	Generate similar problem completed...	Analyzer Agent	00:00:15
3	Agregate problem completed...	Analyzer Agent	00:00:20

Figure 5: Participant Monitoring Screenshot

CONCLUSION

This paper presents multi-layer architecture for **MAITD** in which a decision support framework has been proposed to provide the expression and enforcement of corrective operational maintenance constraints among a set of agents that are allowed to communicate, coordinate, and cooperate to meet the goals of their particular users. In addition, a multi agent system aims to seek the best solution by taking into account the dynamic representation of the treated problem and their complexity. Moreover, it is able to analyze the traces of all agents in a continuous way (corrective monitoring) and it is also capable to react independently to the problem owner. For future work, we are going to improve our system, so that it moves from corrective maintenance to a preventive one. On the other hand, we will also show how the domain ontology is used to calculate the criteria weight and how the solutions are generated from the UDDI. Also we will discuss how similarity methods and solution aggregation functions are involved and implemented in our approach.

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