A Mobile Agent Architecture for Courseware System

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Abstract: **The cumbersomeness of tasks associated with the preparation of courseware system in our tertiary institutions is worrisome, that it takes a lot of man hours to design a good courseware system. Also many institutions face a lot of problems in managing their courseware system ranging from inability to generate a very effective course material that will be of high standard to a good delivery system. A system that will be effective in acquiring real-time update for respective courses on the courseware becomes imperative, hence a mobile agent architecture for courseware system. The system is developed using an open source database which is Mysql. Java programming language is used because it is the predominant language for mobile agent systems both for the implementation of mobile agent and for the development of mobile agent applications. The agent relies on the courseware database for its input. The system has been implemented in a network environment and tested by some selected lecturers who affirmed its robustness.**

Keywords: **Courseware, Architecture, Mobile, Agent, Tertiary**

I. INTRODUCTION

Mobile agent is a programming model for developing complex applications because it is one the few technologies that is used to implement applications with special requirements such as huge data aggregation, distribution and pervasive computing. It is the technology that is used to design application with wide range of adaptive, flexibility, improved network and database possibilities [1]. A mobile agent is a program that is autonomous and can navigate through a heterogeneous network under its own ability, migrating from a host to host and interacting with other agents [2]. It is designed to make the decision of when and where to migrate and it can operate at any node or suspend its execution, move to another host and continue its execution on that host [3]. The features which differentiate them from other programs are autonomy, mobility, goal driven, temporarily continuous, intelligence etc. It has wide applications in computing which include reducing susceptibility to network disconnection, improvements in latency and bandwidth of client-server application.

Mobile agent application is used in areas such as industry, government, academics to drive telecommunication systems, e-commerce, robotics, mobile computing, grid computing and grid services, distributed data mining, service brokering, contract negotiation and computer simulation among others [4]. It is employed in many applications design because of its power to handle complex operation with the use of minimal resources [5].

In [6], courseware is an educational material used as kits for students or as tutorials for students, usually packaged for use with a computer It can also be referred to computer programs or other material designed for use in an educational or training course. It makes learning easier and stress-free for both the instructor and students.

Courseware development is not merely a simple process of converting lecture notes or even a module with exercises into electronic form [7]. Lecture notes and textbooks are often supplementary to face-to-face sessions with an instructor. It also includes the preparation of all necessary materials such as quizzes, multimedia, interactive conversation between students and their tutors. It facilitates easy learning process. Courseware in tertiary education is of high importance. It is a supplement to traditional lectures. [8] defines "Courseware" means content-specific instructional software that function to generate instruction with the support of instructional delivery systems. A courseware product is made of five elements: the content and the learning/pedagogical methods as its main components, the medium as its attributes the learning objectives and the architecture which organizes the courseware in a way convenient to use [9]; [10]. It is aim at providing on-line hypermedia book, assignments, team projects, study guide, past exam papers, on-line library repository (links to related on-line course material).

Many people are motivated but the inexperience among them is not aware of the great amount of planning, revision and coordinating of resources that are required in the process of courseware development project. There are several misconceptions about courseware development project [11]. Some of them are to get a text, module or book in print and convert it into electronic format: many instructors do not pay good attention to this because they are not aware of what it takes to prepare materials for courseware. Courseware development is not merely a simple process of converting lecture notes or even a module with exercises into electronic form [7].

The objective of this research is to develop a mobile agent system that will roam and accumulate materials from courseware database. This work is limited to the providing of a reasonable courseware for Federal Polytechnic Ede.

II. LITERATURE REVIEW

Mobile agents are autonomous program that can migrate through the machines of a network to accomplish task on behalf of some user [12]. They are endowed to work intelligently on their own and mobilize around the system.

They can coordinate task effective among the user, system and other systems which are involved in the network. Mobile agent is able to migrate to some remote machine on the network they reside where it is able to execute some function as instructed by the user. They collect relevant data and then migrate to other machines in order to accomplish the task assigned to them. The basic concept is to distribute processing throughout the network i.e. send code to the machine with data instead of bringing data to the code. Mobile agents provide a solution for the dynamic environment of the mobile devices because they do not rely on server operations [13]. A mobile agent is a program that is autonomous and can move through a heterogeneous network under its own control, migrating from a host to host and interacting with other agents [14]. It decides when and where to migrate. It can execute at any point or suspend its execution, move to another host and continue its execution on that host.

Mobile agents are processes (e.g. executing programs) that can migrate from one machine of a system to another machine (usually in the same system) in order to satisfy requests made by their clients. Mainly, a mobile agent executes on a machine that hopefully provides the resource or service that it needs to perform its job. If the machine does not contain the needed resource/service, or if the mobile agent requires a different resource/service on another machine, the state information of the mobile agent is saved in pre-defined manner, then transfer to a machine containing the necessary resource/service is initiated, and the mobile agent resumes execution at the new machine [15].

A. Mobile Agent Lifecycle

However, when developing and implementing the mobile agent code by using any capable language (e.g. Java), mobile agents should be able to perform the following operations in order to build a robust system; Creation, Cloning, Dispatching or Migration, Retraction, Activation, Deactivation and finally Disposal [16]. These are presented below:

1). Creation: is the first period in the mobile agent life cycle. For example, when a system requests a service to be done by the mobile agent, the system must create a mobile agent instance in the first place before any work can be done. During this creation stage, the mobile agent will be equipped with the desired parameters in order to achieve its goal.

2). Cloning: basically creates a copy of the original mobile agent object. This operation is used when the need for another agent with the same features and properties to do the same or other job in conjunction with the original one arises.

3). Dispatching/Migration: The dispatching or migrating is another main function in the mobile agent life cycle. This function is responsible for moving the agent from one node to another within the network environment by specifying the destination

4). The *Retraction* function is done where the agent's source node requires its agent to be returned to the original host or node.

5). Activation *and Deactivation* are operations done when the mobile agent is required to start or to stop only within certain time of its lifetime.

6). Dispose: Finally, the dispose operation is done where the agent life comes to the end.

B. Overview of Courseware System

The development of teaching and learning environments has always been a challenge. Learning itself is a difficult subject, often not entirely understood. The needs of different groups of users, such as learners and instructors, but also other stakeholders that play a role in administration and management, are often difficult to determine and to integrate. The development of software systems for teaching and learning adds an additional complexity. Substantial progress in computing technology has boosted computer-supported teaching and learning. A variety of courseware systems are widely and successfully used. This makes it now an appropriate time to investigate a systematic way of their development deeply rooted in the educational context that will address the problems that still remain in the area. Some effort has already been made in this direction. [17] focuses on the reusability of learning objects while [18] address the aspect of pedagogical modeling in this context. The integration of all groups involved in courseware development and their active participation throughout a courseware lifecycle is paramount [19]. The participative style of development, as well as openness and flexibility of the courseware architecture are important.

In [6], courseware is educational material intended as kits for teachers or trainers or as tutorials for students, usually packaged for use with a computer. Courseware can encompass any knowledge area, but information technology subjects are most common. Courseware is frequently used for delivering education about the personal computer and its most popular business applications, such as word processing and spreadsheet programs.

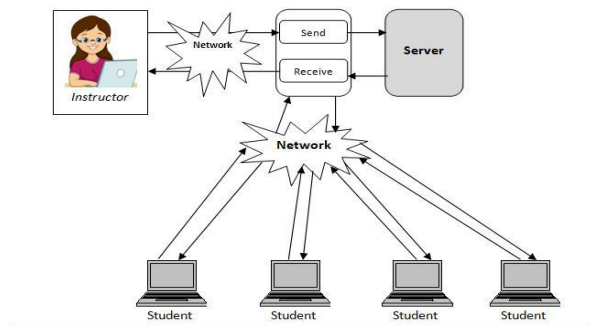### III. METHODOLOGY AND SYSTEM DESIGN

Fig 1 Mobile Agent for Courseware Architecture

Methodology and System Design Research methodology indicates the logic of development of the process used to generate to theory that is procedural framework within which the research is conducted [20]. It provides the principles for organizing, planning, designing, and conducting research. The research style does not only guide the selection of data gathering and analysis methods but it is also the choice of competing methods of theorizing [21]. This study is based on how we can implement a mobile agent platform for course ware. System analysis entails the understanding and specifying what a system can do. Design a system, on the other hand, is how the system will be implemented. A system like course ware mobile agent requires the interaction of both tutors and learners to have direct access to the system. The most common and amicable platform for a system of this nature is designing a mobile agent web platform which incorporates object-oriented module as well as easy to use API (Application Mobile Interface). This system is useless if it cannot be used conveniently by both users of the system. Mobile agent technology is world on its own. It is aim at solving complex problems which are cannot be solved by the usual technology used in solving problems.

A. Mobile Agent Environment

A mobile agent is a computer entity capable of reasoning, use the network infrastructure to run in another remote site, search and gather the results, cooperate with other sites and return to his home site after completing the assigned tasks. In [22], Mobile Agent based applications research activities are increased and are applied in a wide range domain areas : network management, electronic commerce, energy efficiency and metering; Wireless Multimedia Sensors, grid computing and grid services, distributed data mining, multimedia, human tracking, security, effective computing, climate environment and weather, e-learning, location, recommendation and semantic web services [23]. It is seen as a model of workstations connected to a server. The server has keeps information that each workstation has to keep. Each workstation has an environment built within them to accommodate incoming agents. Server can consist of a number of other facilities such as database which will be a central database for the entire system.

B. System Architecture

The interaction between the courseware agents assumed by the lecturer and how the students also receive response from the system is presented in Figure 1. This is a robust implementation compared to other implementations. One of the advantages of mobile agent is that is relieves users from many stresses of using a system. It can also be used to create a secure layer where users don't have direct access to the system. There is a central server connecting instructors and student together. It is equipped with necessary resources to make mobility of code possible. The student node (workstation) has the ability to migrate code and data to the server without the intervention of the student. It is sensible

enough to decide how to serve the student. Little or less effort is required by student's workstation to get what they want from one workstation or the other while carrying along intermediate results. The results obtained by the mobile agent after successful visits to a set of target workstations are transferred to the server, which are displayed on its screen or printed out for the purpose of external analysis, interpretation, policy formulation and decision-making as the case may be. This is also applicable to the lecturer's workstation [24]. There are three major components required by an agent platform; Input: this is used to detect the sender of the message. It consists of all basic futures of the sender e.g. id of the sender, data to send, targeted machine or rep address. Agent: this is the agent itself. Agents are equipped with codes that are compatible to both the place they are migrated from and as well as the targeted machine environment. Output: this is the response returned by the agent.

C. Mathematical Model for Agent Based System

A mathematical model presented in [25] and modified in [22] using push migration was the strategy adopted for the design of the mobile agent, whereby when an agent migrates to a new location (node). It carries all its code, data, and state information along. The main idea behind of this approach is to remove some unwanted parts from the agent load (L) that will make it accessible to other nodes or workstations

If the MA starts from home, the home node is represented by B_h and the migration can be represented as:

$$I = \{B_h, +, n_1, n_2, n_3, \ldots \ldots n_m\} \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

where B_h is the home node and n_1 ($I \geq 1$) is the ith node to be visited in the network. We define I_j as the migration of MA and when the number of nodes to be visited are large (m), the number of MA needed to visit the network is denoted by N

Assume that the length of the state information (bytes) is B_s and this is constant throughout the agent life span. Then, initial load B_h of MA from home to the first target node is calculated as: $$B_h = B_c + d_h + B_s \cdots \cdots \cdots \cdots (2)$$

In the schematic configuration of the basic structure of a node that has the database, a controller and an output MA of reduced size is presented. The load after collecting information on security applications on the first target and the removal of its unwanted contents by the controller attached to the node through regression, whereby reducing its load is $B_{h1.}$

And the new load B_{h1} of MA from home to the first target node is; $$B_{h1} = B_c + d_{h1} + B_s \ldots \ldots \ldots \ldots \ldots (3)$$

The load of Migration to the next node is;

$$B_{h2} = B_c + d_{h2} + B_s \ldots \ldots \ldots \ldots \ldots (4)$$

With this model, the load at each node is further reduced because of the effect of the controller, hence a migration from n_k to $n_{k+1 \text{ with } K} = 1, 2 \ldots, \ldots \ldots \ldots \ldots m\text{-}1$ has a network load of:

$$B_{m1} = B_c + d_{m1} + B_s + \sum_{k=1}^{m-1} d_k \quad \dots\dots\dots \quad (5)$$

The load when the Agent returns home (Mobile Agent base) is

given by: $\quad B_f = d_h + B_s + \sum_{k=1}^{m} d_k \quad \dots\dots\dots (6)$

The sizes of the MA load in the visited nodes are represented by: $\quad B_{h1} \le B_{h2} \le B_{h3} \dots \le B_{hm} \dots\dots\dots\dots\dots\dots(7)$

Let the load of the output of the first node be denoted as B_{h1}, which is smaller than the load of the Second output B_{h2}; B_{h2} is smaller than the load of the third output; that is: B_{h3} and $B_{h3} \le$ the load of the last Node B_{hm}.
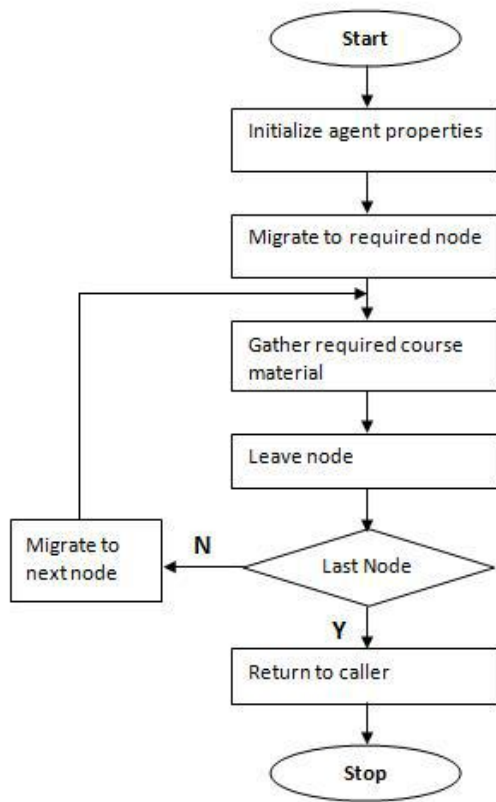

Fig. 2 Migration of the Courseware Mobility

IV. SYSTEM IMPLEMENTATION

A. Test results

The resulting system test results states exclusively the output gotten from the implementation and testing of the Mobile agent system on a computer system using Visual Studio Code as an Integrated Development Environment. The new system was tested with various input device, valid test data were used to test the workability, reliability and efficiency of the system, sampled courses, lecturer, department and course material were inputted into the system. Some of the interfaces obtained from the system during testing are shown below.

B. Registration screen

The registration interface is used to create new authorization for navigating the system for use. The authorization detail is stored in the database and is cross-checked to prove validity of the user. Figure 3 shows the registration page for signing into the system (Fig.3).
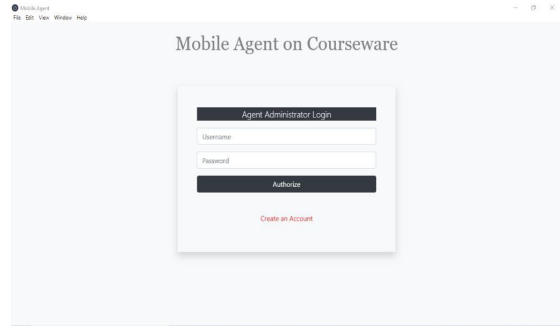

Figure 3   Registration screen

C. Host network screen

The network details of the a remote computer system is shown at a section to show the connection properties individual workstation. Figure 4 shows the Host network detail of the system (Figure 4).
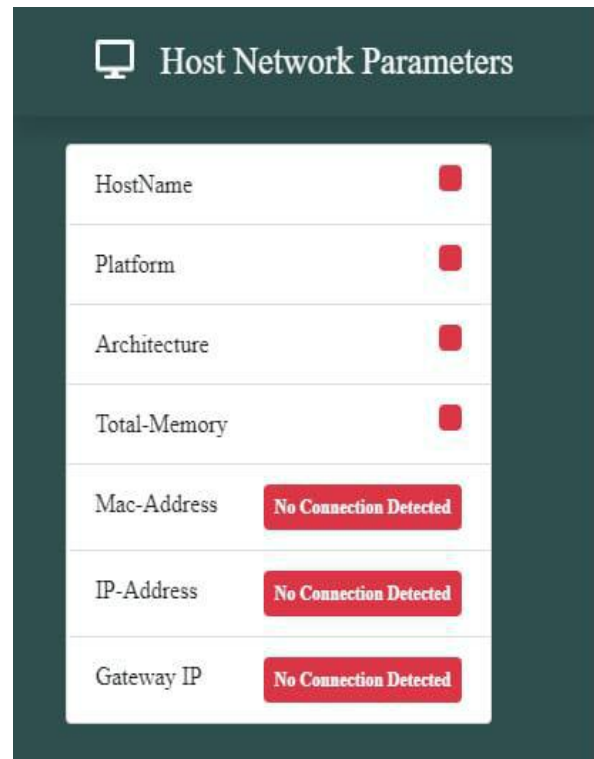

Fig. 4   Host network screen

D. Agent Dispersion page

This is the most vital part of the system where the mobile agent is put to work to sent across the network to specified addresses. Figure 5 shows the agent dispersion page
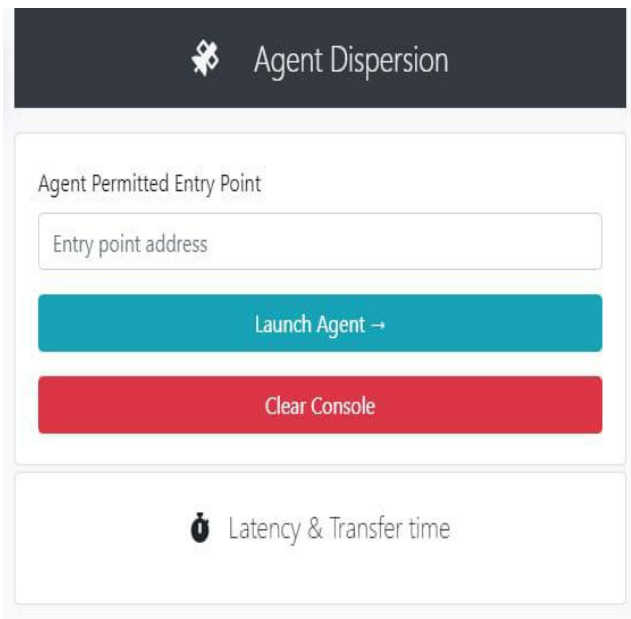
Fig. 5 Agent Dispersion page

F. Retrieval page

Information collected from each database is displayed in a table in the system interface. Figure.7 shows the information retrieved from a database.
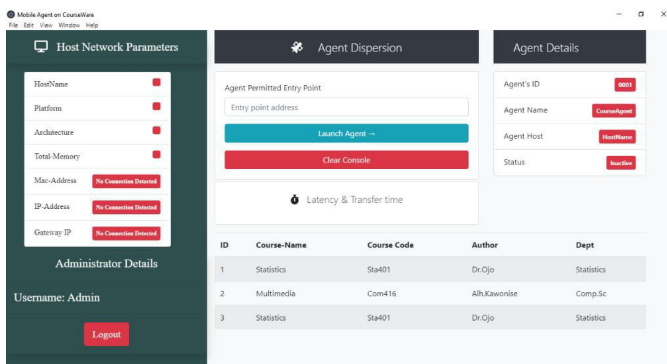

Fig. 7 Retrieval page

V. CONCLUSION

In this research, we have presented how the performance of mobile agent can be used in courseware acquisition. The focus of the model is to reduce the user man hour period on the system. The model will make the mobile agents visit all the available places during the migration. During migration, information needed are retrieved from the database and displayed to the user as they are gotten. With the recent exposure to the diverse and mobile society, new technologies and expanding opportunities, the developed system shall help to ensure that the students are prepared to become the future generation of parents, leaders, workers, and citizens. Students need to utilize the tools in relation with the constant development in the society and apply them to their general learning process. Adolescents face unique and diverse challenges, both personally and socially, that have an impact on academic achievement. The importance of an agent for courseware in schools includes bringing to the students an increased understanding of the educational and social information needed for excellence.

As multi-agent system paradigm promises to be a valuable software engineering abstraction for the development of computer system; it might be advantageous to invest some time in further research in this field of the mobile agent. The scope of this research is limited in the sense that, it has concentrated on courseware acquisition using a mobile agent. users based on advantages of the system.

REFERENCES

[1]. Prabhu, C.S.R (2001) Mobile Computing: A Book of Readings . Paper presented at the National Conference on *Mobile Computing*, held at Hyderabad during 11-12 December 2001
[2]. Prabhu, C.S.R (2003) Mobile Computing: A Book of Readings . University Press. Hyderabad, India
[3]. José Gaviria de la Puerta, Iván García Ferreira and Pablo Garcia Bringas (2014) Technology & Engineering. International Joint Conference SOCO'14-CISIS'14-ICEUTE'14: Bilbao, Spain
[4]. Pooja Arora and Rita Gupta (2010) Applications of Mobile Agents: A Canvas. International Journal of Advanced Research in Computer Science. Vol.1, No 3, pp131 – 135
[5]. Luís Moura Silva (2012) Performance Evaluation of Mobile Agent Platforms and Comparison with Client–Server Technologies. Wiley online Press. https://doi.org/10.1002/9781118135617.ch12
[6]. Margaret Rouse (2019) Courseware https://whatis.techtarget.com/definition/courseware Accessed on 12/11/2019
[7]. Norhayati Abd Mukti and Siew Pei Hwa (2004) *Journal of Educational Technology & Society* Vol. 7, No. 4, Ontologies and the Semantic Web for E-learning (October 2004), pp.143-152
[8]. Zhixin, T (2013)" A mobile Agent-Based Server System for Server Resources Monitoring". Cybernetics and Information Technologies Vol. 13, No4, 2013, pp. 104-117.
[9]. Retalis, S.(2007) A courseware development methodology for Open and Distance Learning http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.51.7027&rep=rep1&type=pdf
[10]. Nik Siti Hanifah Nik Ahmada, Tao Ruan Wana and Ping Jiang (2011)Immersive environment courseware evaluation. Procedia Social and Behavioral Sciences Vol. 15 (2011) pp. 1667–1676. Available online at www.sciencedirect.com1877–0428 © 2011 Published by Elsevier Ltd.doi:10.1016/j.sbspro.2011.03.350
[11]. Mee Ling and Sii Ling (2012). "The Influence of Transformational Leadership on Teacher Commitment towards Organization, Teaching Profession, and Student Learning in Secondary Schools in Miri, Sarawak, Malaysia" in *EDUCARE: International Journal for Educational Studies*, Vol.4(2) February, pp.155-178.
[12]. Jiannong Cao and Sajal K. Das (2012) Mobile Agents in Networking and Distributed Computing. John Wiley & Sons, Inc.
[13]. David Kotz ,Robert S. Gray and Daniela Rus (2002)Mobile Agents: Future Directions for Mobile Agent Research article (PDF Available) *in* IEEE Distributed Systems Online 3(8)
[14]. Mohit Mittal (2012) MOBILE AGENT. International Journal of Engineering and Technical Research 1(8):7 · October 2012
[15]. Adel Aneiba, S. J. Rees (2006)MOBILE AGENTS TECHNOLOGY AND MOBILITY. Proceeding of the 5th Annual Postgraduate Symposium on the Convergence of Telecommunications, Networking and Broadcasting. Pages 14-20 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.105.3152&rep=rep1&type=pdf
[16]. Lange, D & Oshima, M. (1998). *Programming and Deploying Java Mobile Agents with Aglets*, Addison Wesley, ISBN: 0 201 32582 9.
[17]. Boyle Tom (2003) Design principles for authoring dynamic,

reusable learning objects. Australasian Journal of Educational Technology Volume 19, Number 1

[18]. Pantano Rokou, F., Rokou, E., & Rokos, Y. (2004). Modeling Web-based Educational Systems: process Design Teaching Model. Educational Technology & Society, 7 (1), 42-50.

[19]. Virvou Maria and Tsiriga Victoria (2002) An Object-Oriented Software Life Cycle of an Intelligent Tutoring System. Journal of Computer Assisted Learning 17(2) DOI: 10.1046/j.0266-4909.2001.00172.x

[20]. Remenyi, D. (1998) *Doing research in business and management: an introduction to process and method*, Sage.

[21]. Colin Wight (2006) Agents, Structures and International Relations: Politics as Ontology. Cambridge University Press

[22]. Amosa Babalola; Onyeka Ndidi; Olaniyi Busayo; Babafemi Olusola (2017) Mobile Agent for Monitoring and Evaluation of Security Applications in a Network Environment. International Journal of Computer Science and Network, Volume 6, Issue 6, December 2017. Pp 826 – 834. ISSN (Online) : 2277-5420

[23]. Elaine McGovern, Rem W Collier and Eleni Mangina (2006) Object Oriented vs. Agent-Based Oriented Ubiquitous Intelligent Mobile Managed e-Learning Environment. Ubiquitous Intelligence and Computing: Third International Conference, UIC 2006, Wuhan, China, September 3-6, 2006 , pp.1102-1113. DOI: 10.1007/11833529_111

[24]. Ahmed E Kosba, Ahmed Abdelkader and Moustafa Youssef (2009) Analysis of a device-free passive tracking system in typical wireless environments. IEEE International Conference on New Technologies, Mobility and Security (NTMS), pp 1-5.

[25]. El-Gamal, Y., Khalid E., & Magdy, S. (2007). "*A Comparative Performance Evaluation Model of Mobile Agent Versus Remote Method Invocation for Information Retrieval*." World Academy of Science, Engineering, and Technology: pp. 286-291.