Mobile Agent Based Knowledge Management in Education System

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ABSTRACT

This paper looks into delivering a Mobile Agent Based Knowledge Management System in Education System. Firstly the paper looks at reviewing the issues that are occurring in Knowledge Management System. A proposed system structure is made to show how a mobile agent works and is used in education system. XML Metadata with Aglet is used here for faster retrieval of data. A security framework is also presented to look at protecting a distributed network from malicious mobile agents. We also recommended an intelligent search module for the agent to search the required data.

Keywords

Knowledge Management, Mobile Agent, XML, Aglet

1.0 INTRODUCTION

Knowledge Management (KM) is a method of obtaining the right knowledge to the right people at the right time as well as helping people share and put information into action in ways that will improve organizational performance (Dignum, 2002). Knowledge also includes both the experience and the understanding of people in the organization as well information such as documents and reports. Effective knowledge management requires an appropriate combination of organizational, social and managerial initiatives along with appropriate technology (Wills, 2002). KM also addresses on the continuous learning process as well as the management process that govern the creation, dissemination and utilization of knowledge by merging technologies, organizational structures and people to create an effective learning, problem solving and decision making in an organization (Ubon, 2002). There are two common viewpoints on KM – the human-oriented and the technology-based approach. From the human-oriented point of view, KM can be interpreted as methodologies to gain, share, keep and manage knowledge. From the technological point of view KM might be seen as the development of information management systems.

2.0 KNOWLEDGE MANAGEMENT IN EDUCATION

The rapid growth of the Internet has brought a large number of changes in our education system. Educational information on the web has been increasing dramatically and a large number of it is being utilized as supplementary teaching materials (Sun-Ju and Ju-yeon, 2000). Students can study whatever they want through the Internet regardless of the geographical location. However most of the existing teaching material on the web has its limitations such as too much information presented to the user. As a result of their extensive quantity, it has become a big task to sort out the right material at the user's request. The material may be offered to users in the form of home pages. It is difficult to renew the existing material or to offer appropriate material to each student at his or her particular level, as the students may use the same material, regardless of their learning abilities. It is therefore required to offer a comprehensive learning environment in accordance with different types of students (Sun-Ju and Ju-yeon, 2000). In order to offer a spontaneous learning environment, which understands the learner's characteristics we propose an agent based KM system.

2.1 Types of Agents

There are several types of agents use in the system such as teacher's agent, learner's agent, learning agent, user interface agent and host agent. We have used two types of agents in the system i.e Mobile Agent and User Interface Agent. The mobile agent is an agent that takes the tasks of a user from the agent interactions. The user interface agent is responsible for launching, monitoring and controlling a user's mobile agents, for pre-processing any results from a mobile agent into a form appropriate to the user and for being available at all times so that a user's mobile agent can always get in contact. This is normally presented to the user in a Graphical User Interface. The teacher's agent acts as the teacher who composes appropriate teaching content for the learner's agent to access. Teachers include teachers and specialists in each field of the teaching-learning contents. The learner's agent acts as the student who accesses the learner's agent contents. The learning agent is the learning materials. An agent server manages the operations of agents including their generation, movement and operation. The host agent acts as the web server for the user interface agent which also enables learners to search the web through communication with other agents. The host agent allows users access to the system through authentication codes. Agent Database helps in generating of the next agent, recording the process of the generation and operation of the Mobile Agent. The mobile agent originates from the Manager's agent server, is a processor conducting the allocated tasks of its own accord. It is constituted by sections of saved information about the agent itself, by controlling its movements, saving the results of operation and communications, which allow it to correspond with other agents.

2.2 Mobile Agents in Education

A mobile agent is a software program that can migrate from machine to machine in a heterogeneous network, searching for and interacting with services on the user's behalf. Under the mobile agent paradigm, any host in the network is allowed a high degree of flexibility to possess any mixture of service code, resources and CPU time (T.S Quah et.al, 2002). Mobile agent is used in a distributed computing environment as it improves performance as compared to the conventional client-server method (T.S Quah et.al, 2002). Figure 1 illustrates a mobile agent paradigm.

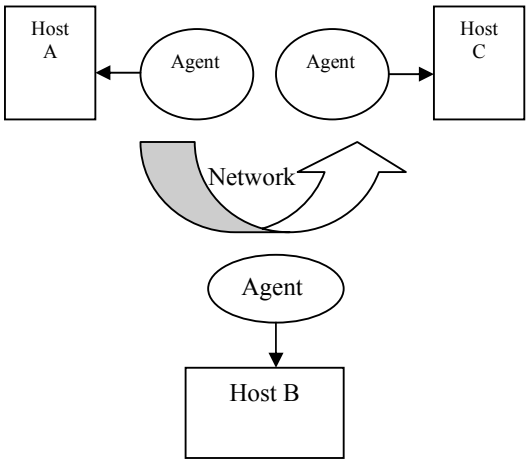

Figure 1: Mobile agent paradigm (extracted from Sun-Ju and Ju-yeon, 2000)

Agents based KM in education is used to manage loosely coupled information sources to provide unifying presentation of distributed components and to personalize knowledge presentation and navigation. The agent based KM in education would usually include the following characteristics: (Dignum, 2002)

- Search for, analyze, integrate and archive information from multiple heterogeneous sources.
- Inform students when new information becomes available.
- Explain the relevance, quality and reliability of information.
- Learn, adapt and evolve to changing conditions.

2.3 Comparing Similar Systems

A comparison is made with an Agent Based system for distance evaluation (MADE). It contains an examination process, distribution testing, evaluation and result compilation. MADE consist of a mobile agent that allows examiners to set exam questions remotely. The question paper is distributed to different examination centers and presented to students. The answer papers are collected, evaluated and the results compiled. MADE uses the following types of agent's - Install Agent, Fetch Agent, Courier Agent, Question Agent and Answer Agent. Install Agent installs the paper-setting interface and application on the nodes belonging to the different paper-setters. The fetch agent collects the partial papers from the paper-setters. It also enhances the paper-setter application's functionality at run-time. Courier agent delivers the question papers to

all examination centers. The question agent presents the question to the students. The answer agent represents the answer-paper of a student and moves to an Evaluation-Center to get its answers evaluated. MADE was developed using Voyager ORB (Jamwal, V and Iyer, S, 2000). Another similar system compared is the Mobile Agent-Based Teaching-Learning System. This system aims to design an interactive teaching-learning system, which can offer learners a dynamic education so that learners do not loose their bearings on the web. As a number of users connect to the system, a user interface agent carries its operations. A user interface agent helps the users in all kinds of required tasks for their learning through communicating with a Manager in the system. A Manager is composed of an Agent Server and an Agent Database. An Agent Server manages the operations of agent, recording the process of the generation and operation of Mobile Agent (Sun-Ju and Ju-yeon, 2002).

2.4 Advantages of Wireless Agents for KM in Education

The use of mobile agents has several advantages to education institutions. A mobile agent enables adaptation to go both on line and off line mode or even in unreliable network connections. Mobile agents can be used to pre fetch the domain content that will be requested by the student and report the student's performance to the central server. This is ideally suited to the web-based learning environments that usually consist of a range of different systems and platforms (Hong and Kinshuk, 2002). Creating a mobile agent to handle transactions and sending it from client to server would eliminate the respective response request handshaking that usually takes place at the client and server method. The agent handles the transaction and sends the transactions directly from the client to server. Therefore the intermediate results and information passing is reduced, therefore the network bandwidth consumption is reduced and the efficiency is improved (T.S Quah et.al, 2002).

Agents do not require a continuous connection between machines. The client can dispatch an agent into the network when the network connection is stable, then it can go offline again. The network connection needs to be reestablished later only when agents returned the result from a remote host. Hence it provides a more reliable performance with intermitted or unreliable network connection (T.S Quah et.al, 2002).

The mobile agent operates asynchronously and autonomously; as such the user does not need to monitor the agent as it roams in the Internet. This saves the users time, reduces communication costs and moreover it supports a decentralized network structure (T.S Quah et.al, 2002). Furthermore with adaptive learning and automation added to agents, the mobile agent can be configured together with artificial intelligence for better information retrieval and filtering (T.S Quah et.al, 2002).

2.5 Issues in Agent Based Knowledge Management

The issue in mobile agent is the use of XML in order to know how to extract the right key words and intangible information. Arranging knowledge in a structured manner in order for all universities that can have a knowledge web where all universities can share information. This will therefore improve the collaborative learning environment.

At the security point agents do pose as a security threat. Network firewalls do not filter malicious mobile agents. Therefore if an agent carries a malicious code it will by pass the firewall of an organization and harm the internal networks.

We also need an agent-based system that will tag keyword search on a search engine. Presently search engines cannot narrow down the scope of a users search based on the keywords. Usually the search engine will display resource with less priority.

3.0 SYSTEM STRUCTURE

This section explains about the working of the overall system. When the user connects to the system, a user interface agent carries out its operations. A User Interface Agent helps the users in all kinds of required tasks for their learning through communicating with a Manager in the system. A Manager is composed of an Agent Server and an Agent DB (Database) as shown in the Figure 2. An Agent Server manages the operations of agents, including their generation, movement, and operation.

An Agent DB helps the generation of the next agent, recording the process of the generation and operation of mobile agent. When a learner accesses the system, the learner should register

first; at that time the system measures the learner's learning level, even before learning begins. Information about the learner is managed and used for the modeling of the learner by the Learner Knowledge Host. A mobile agent, created by the Manager, then, uses the information about the user in the system.

The Manager creates learning content at the level of the learner, on the basis of the user information. When there are more materials required to prepare learning contents, other agents connect to the Internet and gather more knowledge for learning content.

The Teacher Knowledge Host manages each specialist and teacher. Educators/academicians also register in the system and are managed by the system. Teachers and specialists compose appropriate teaching content through cooperation. Agents always renew the Learning Knowledge Host through cooperation among themselves (Sun-Ju and Ju-yeon, 2000).

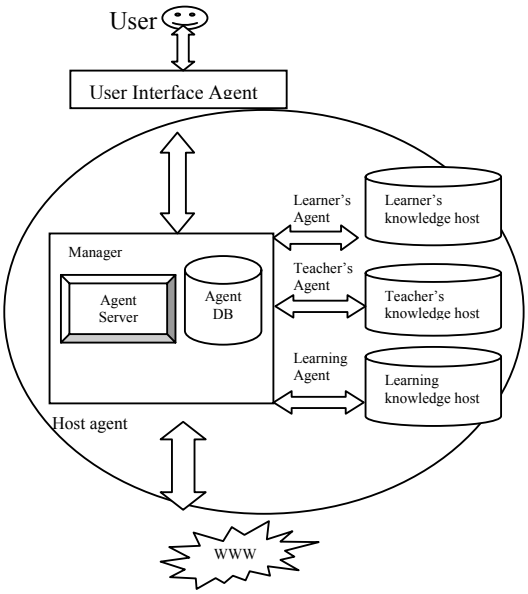

Figure 2: Mobile agent based knowledge management in education system (extracted from Sun-Ju and Ju-yeon, 2000)

3.1 Manager

The Manager is composed of an Agent Server and an Agent DB, and manages the life cycle of agents through generation, interpretation, operation, and abolition.

3.1.1 Agent Server

An Agent Server creates agents and manages them so that they can operate. It creates agents when it has received the call of generation from the Agent DB, gives operational orders to agents, and puts the result of the agents' operations together. An Agent Server also abolishes the agents, whose operations are completed and sends the changed value to the Agent DB.

3.1.2 Agent DB

An Agent DB preserves and manages information about agents. When an agent is needed, the Agent DB calls the Agent Server for the generation of an agent, and grasps the situation of agents in operation. It calls the Agent Server for the abolition of an agent, which has completed its operation, and records the set value of agents or any changes. Because of the Agent DB, it is possible for agents to carry out various operations, and for the system to manage agents efficiently.

3.2 Learner Knowledge Host

To offer a dynamic web-based education to learners at various levels, the system should be able to judge the learner's ability, as well as be adaptable enough to bring the learning content together and predict the further learning progress. For these functions, the Learner knowledge Host preserves knowledge about the registered learners, and helps the generation of appropriate learning materials. It also diagnoses learners' learning processes, and preserves the information for their further learning. The Learner Knowledge Host diagnoses learners' interests, learning levels, and demanded materials, and exchanges this information through agents to help create a more efficient and adaptable instruction. Learner modeling should precede this process.

3.3 Teacher Knowledge Host

The Teachers include teachers and specialists in each field of the teaching-learning contents. Each teacher register in the system receives help in generating teaching materials. The Teacher knowledge Host manages the knowledge of each teacher independently, whenever they require materials to plan their instruction. It preserves the contents of all work, and helps them to use the materials efficiently. When more material is demanded, the Host enables users to search the web through communicating with other agents.

Each teacher can receive advice in planning their instruction through cooperation with other teachers. The Teacher Knowledge Host offers convenience to teachers in the composition of their teaching content.

3.4 Learning Knowledge Host

The Learning Knowledge Host preserves appropriate materials for learning, and offers them to users. Through the agent, the Host exchanges information with each Learner Knowledge Host and Teacher Knowledge Host in order to compose more dynamic learning materials. An agent created by the Manager helps the exchange of information. It also arranges, modifies and renews the materials changed by learners during their study. When a learner finishes studying, the Learning Materials Host evaluates the learner's efforts, and suggests supplementary materials, for more efficient and adaptable work by the learner

3.5 Operation of a Mobile Agent

The mobile agent, which originates from the Manager's agent server, is a processor conducting the allotted tasks of its own accord. It is constituted by sections of saved information about the agent itself, by controlling its movements, saving the results of operations, and communications, which allow it to correspond with other agents. A scenario of a mobile agent's operation occurring when the learner connects to the system and begins to study will be presented by sequence of stages.

Stage No.1: Once the learner connects to the system, the interface agent of the user requests the information about the user.

Stage No. 2: The manager creates the mobile agent by request and starts to connect the host of the user's information. Then, the newly created mobile agent collects information about the user and revises it, and the information is deleted when the user finishes studying. The agent encodes the user and revises the information concerning the user through a specific certification. Also, it sets up a model of the user according to the supervising factors of the users by communicating with the user information host. If it is the first time for the learner to connect to the system, the agent will make relevant examinations to obtain the user's information.

Stage No. 3: Thus, the information about the user by the agent will be reported to the manager and will interact with the interface agent of the user. If the learner is already registered, the manager will organize learning materials by referring to the previous learning level. At this time, the other agents are able to organize learning materials properly through the other learning knowledge host.

Stage No. 4: Once the learner starts to study by learning the material, the manager dynamically forms the material through the interaction with the learner, and for this, the agent for the teacher's knowledge host will be created.

Stage No. 5: The learner asks for further information during study. The manager connects to the Web and creates an agent to search the information requested by the learner. This agent searches the scattered information on the Web, moves, depending upon priorities, and interacts with other agents to retrieve the information appropriately and accurately.

Stage No. 6: After finding the proper information, the agent will report it to the manager. When the agent ends its cycle, the manager sends the information to the agent for study, and saves not only the revised information of the user knowledge host, but also the learning knowledge host through the agent for the learning materials revised.

Stage No. 7: When the learner finishes studying, the agent for the learner requests materials to diagnose the level of the learner, and the manager requests relevant diagnosis materials from the teacher's and learning material agents.

Stage No. 8: As the diagnosis is over, the agent of the learner's knowledge sends the results to its host. Then, the information of the learner will be deleted.

4.0 KNOWLEDGE ELEMENTS IN EDUCATION SYSTEM (XML METADATA)

In any education institute, ranging from high school to tertiary level, knowledge plays a key role as an enabler to promote research and development. As research and development grows, more knowledge is being initiated. The current problem faced is that there is a gap, where there is a difficulty in sharing knowledge among other education institutes.

In today, learning environment, collaboration is being given the greatest emphasis to promote effective learning. Effective learning and collaborative learning can only take place when a proper mechanism is set.

By developing an XML based system, which can extract the information from a central repository, information, could be indexed, and then will be interpreted as to how the users requires the information.

Tangible electronic documents may be available in different formats such as HTML, PDF's, WORD Document and etc. Our aim here is to use XML to extract the information from these documents and present the information to the user in a way the user can understand. Other users may not understand knowledge from one user. By using XML, information will be extracted and presented based on argument passing (Van, 1999).

In a learning environment there are four cognitive processes. There are known as creating, arranging, transmitting & linking. In the creating process, knowledge will develop as research takes place in new areas. Knowledge will expand as this knowledge needs to be quantified by arranging them in a structured and hierarchical form. Knowledge needs to be shared with other varsities and this takes place in transmitting process where request from one varsity will be traveling to another varsity and this could be referred to as a knowledge web. The final cognitive process is the linking process. In this process metadata will be used to structure the information and XML will be used to format the structured data for appropriate viewing. The ultimate goal is to form a collaborative learning environment by exchange knowledge rather then having teaching environment, where most of knowledge travels in a single direction (Hampel and Slawik, 2001)

4.1 XML Data Repository

All research documents will be tagged. Each file on the repository will contain important index information such as area of research paper, keywords, publisher and version release. XML together with Distributed Object Modeling was used to describe the document. Each index file of a document will be mapped to a XML file and will be used to define how information about the index file will be formatted. Below is the XML for the index file, which will be used to tag the documents, which allows a much more easier searching capability (Van, 1999).

```
<!DOCTYPE PAGE [
<!ELEMENT PAGE (PAGETITLE,
PRESENTATION, ARGITEM*) >
<!ELEMENT PAGETITLE (#PCDATA) >
<!ELEMENT ARGITEM ((LINK, ARGID,
FILEID) | ARGITEM*))>
<!ELEMENT ARGTITLE (#PCDATA) >
<!ELEMENT LINK (#PCDATA) >
<!ELEMENT ARGID (#PCDATA) >
<!ELEMENT FILEID (#PCDATA) >
]>
<PAGE>
<PAGETITLE>A System For Knowledge
Management In
Bioinformatics</PAGETITLE>
<ARGITEM> <!-- Begin of item Week 2 -->
<ARGTITLE>Week 2</ARGTITLE>
<ARGITEM> <!-- Begin of item Chapter
One -->
<ARGITEM> <!-- A terminal item -->
<ARGTITLE> Knowledge Management
</ARGTITLE>
<LINK>\\research\KM\Kmbioinformatics.do
c</LINK>
<ARGID>2113</ARGID>
<FILEID>12</FILEID>
</ARGITEM>
<ARGITEM>
<ARGTITLE>Processes</ARGTITLE>
<LINK>\\research\KM\Kmbioinformatics.do
c </LINK>
<ARGID>2114</ARGID>
<FILEID>13</FILEID>
</ARGITEM>
</PAGE>
```

4.2 MOBILE AGENT IMPLEMENTATION

Mobile agents will be implemented in a platform-independent language in order to provide collaboration in a heterogeneous education environment. This is because agents may travel from one machine platform to another machine platform. The ideal implementation language for mobile agents will be Java. For agents to be executed, only the Java interpreter is required. An agent written in Java is small in size, enabling an increase in performance. A number of key elements must be taken into consideration when selecting the implementation language for agent programming. The basic requirement an implementation language must provide is communication, knowledge representation, mobility and the most important is security. There are number of implementation languages available for agent programming such as Odyssey, IBM Aglets, Concordia and Obliq.

We have adopted IBM Aglet as the development tool for developing the mobile agents. Aglet is a Java object that transports itself from one host machine to another host machine. Aglet supports independent execution with individual thread of control.

Currently we are still carrying out the research on implementation for the searching and filtering component. There are many types information available on the education network. Collecting required information from a number of sources requires a significant amount of time. Upon collecting information, filtering un-necessary information could be time consuming, but with the Aglet mobile agent, the agent will visit other hosts and build a dynamic index file in XML format at shown in section 4.1. The agent will be used store the knowledge of user preferences in terms of search criteria's.

5.0 INTELLIGENT SEARCH ASSISTANT MODULE

As mentioned in section 2.2, the agents are able to find resource request by the user based on certain search criteria. The search process by the user's agent will list all the related resources. This will cause the user to manually select the specific resource in the search list. This might burden the user if the agent's search list is too long. Therefore this process can be tedious, time consuming and sometimes will cause the user to switch to other alternative to find the desired resource. In this paper, there is a search assistance module to assist the user to find the best resources based the search criteria provided by the user to the agent (Koch, 1998).

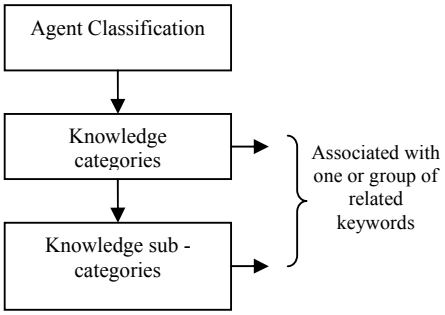

Figure 3: Search Assistant Module

The search assistance module acts as recommender for the agent resource searching process. In this paper, each resource is organized according to certain main knowledge domains (field of study, e.g. computer, biology & etc.). Each main knowledge domain has a certain level of sub-categories where each sub-category is associated with a keyword. In another word, the resources under a certain sub-category associated with one or more keyword. The keywords associated with the resources reflect a certain field of knowledge. Therefore, keyword becomes the search criteria for each resource.

When the user sends a search request for certain resource, the keywords provided by the user will be used in the agent's search process. The search process will produce a result that lists all the request results. Then search process will filter and short list the resources found in the result list. The process of filtering the search result is done by intelligent search assistant module based on certain pre-defined knowledge on that particular search knowledge domain.

The intelligent search assistant module is a question based expert system. This module will ask the user about a certain search knowledge domain as requested by the user. These questions are generated based on knowledge in the search knowledge domain. The module will ask the series of specific user at each sub-category level to narrow down the search list. This will allow the module to analyze search criteria and guide the search mechanism to focus on a more detail knowledge domain. So as the guided search process goes on, the will be more specific a level until the exact list of resources are found.

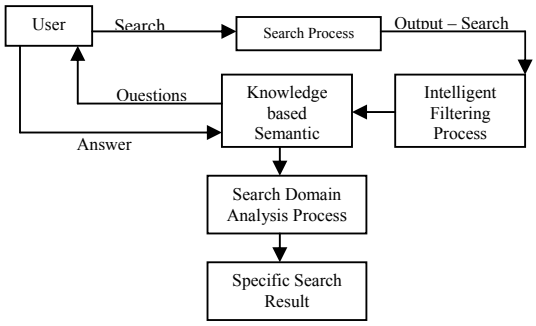

Figure 4: Intelligent Search Model

The knowledge semantic network is an embedded expert system in the Intelligent Search Assistant module. It can be considered as an expert system that asks question based on certain knowledge domain at each level of the semantic network. It consist a knowledge base and set of rules for the entire knowledge domain in the system. The set of user friendly ask to the user are to navigate through the semantic network. This navigation process will lead to a specific level of the semantic where a specific match according to the search criteria is found (Koch, 1998).

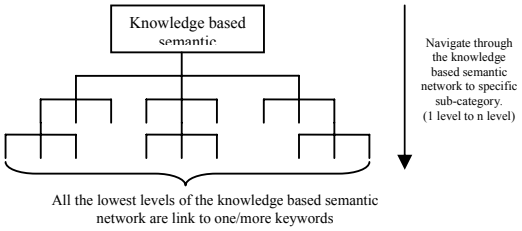

Figure 5: Knowledge based semantic

In a knowledge base, the agent's knowledge based network navigation semantic may lead to several situations. These situations respond to various results that cover various domains and sub-categories. Therefore the results list consist inter-domain specific recommendations that cover more than one knowledge domain. Later on, the system may verify and narrow down the recommendation list based on detail requirement on of the user based on certain knowledge domain.

Besides that, the expert system should be able to modify the semantic network according to new situation and knowledge domain. It should consist unsupervised learning mechanism that is able to learn and derive new knowledge/ without any user intervention. This will make our recommender module intelligent and able to adapt new environment. It is because the knowledge is variable and fast changing entity. Therefore our recommender module will be able to assist the agent to perform efficiently in new and ever changing knowledge domain.

6.0 PERFORMANCE MATRIX IN USING MOBILE AGENTS

The benefits of using mobile agents are it gives better performance in terms of access speed compared to client server. Some of other benefits of Mobile Agents (MA) are it reduces network load and overcome network latencies. Mobile Agents can also support disconnected network operations. Significant performance improvements can be obtained due to mobile agents when an agent moves to a server site. Performance cost is higher in a client server (CS) network as it takes more time to deliver a task on the network as compared to using MA. Multiple servers are needed in client server where every node is a server in MA. There is no application-level protocol needed for MA thus lower overheads. As compared to client server or static agents, the performance of MA remains the same for different sizes of learning materials accessed while the performance of CS reduces with the increase of learning materials. (Jha and Iyer, 1998). Table 1 shows the basic cost of using static agents on a client/ server architecture.

Table 1: Basic costs of using static agents (extracted from Ismail, L and Hagimont, D, 1997)

Latency on the local network	0.6ms
Latency on the Internet	20ms
Bandwidth on the Internet	1.032 Mbits/s
Local Java method invocation	1 μs
Remote Java method invocation on the local network	3.1 ms
Remote Java invocation on the Internet	44 ms

Table 2 shows the execution times of using mobile agents.

Table 2: Basic costs (extracted from Ismail, L and Hagimont, D, 1997)

Agent Serialization	3.2 ms
Agent transfer on the local network	8 ms
Agent transfer on the Internet	121 ms
Agent installation with the Java class loader	4.3 ms
Agent installation with a private class loader	23.8 ms

The comparisons shows that the cost incurred by Java are restricted compared to the cost of the agent transfer on the local network, but become acceptable when compared to the cost of the agent transfer on the Internet. This is achieved using Aglet as opposed to Voyager.

7.0 SECURITY ISSUES IN MOBILE AGENT-BASED SYSTEMS

The Internet has changed the way we live, work, and play. It has also changed the way we view, use, and store information. Security issues are important consideration for organizations that are increasingly leveraging the power of the Internet for business operations. The usage of the Internet has increased to the point where it is an additional channel of commerce. The commercial use of Internet gives birth to the development of

mobile agent technology, which over time, has proven to be a useful application in distributed computing (Linghau, Drobnik et.al, 1995).

7.1 Security In Different Computing Environment

Security means different things to different people. The approaches to security vary from environment to environment. Any discussion on security generally touches on the brief definition of what is a "secure" system. Suffice to say that making a computer system 100% secure is going to be a difficult task indeed. Approaches to security can be done in a layered method (Singh, 2003). Security is partitioned in several layers ranging from physical security to system security, from network layer security to perimeter security and right up to application security.

Firewalls protect the network from outside attacks. Here the assumption is made that all the programs are running based on the requests of internal users. Here in lies a flaw. Firewall rules often allow downloads from the Internet. Often these documents are not only in ASCII text but could contain programs or are programs themselves. They could very well be "plug ins" or "applet". In other words, these are mobile codes. Mobile codes that are mobile and that move around the network are also known as mobile agents.

These mobile agents offer a security problem that throws the firewall assumption out of the window. With mobile agents, an attack can occur within the network. These agents could very well attach themselves to attachments via email or web pages or even archive files. Standard security mechanisms such cryptography may not work well in this dynamic environment. Disabling mobile agents will have an effect on the functionality and productivity vital to certain services. Other approaches at securing the behavior must be considered (Kun, et.al, 2000).

7.2 Security Mechanism for Mobile Agents

Threats in mobile agent systems come from agents that are malicious as well as hosts on which those malicious agents have migrated to. This issue needs to be addressed (Kun, et.al, 2000) describes a mechanism that addresses the security issues. The approach involves considering two different aspects. i.e. the host 's security methods and the security mechanism of the agent. The host's mechanism is done via three methods i.e. authentication, verification, authorization and payment of fees. The security of the agent is a trifle more difficult to handle. Security techniques on the agent side can and should include authentication, where it validates the identity of the host the agent migrates to, encryption algorithms to protect the data as it travels through the network.

7.3 Mobile Agents in Security Domain

Other aspects of security involving agents need to be considered. Firstly we need to classify the threats in a distributed environment. Typical scenarios to be taken into account are agent base attacking agents, agents attacking other agents, agents attacking agent bases and attacks against agent traversing the networks. The migration of a mobile agent from one host to another also needs to be secured and protected from unauthorized interference. Mobile agents can also launch denial of service attack to consume large amounts of network resources.

7.4 A Security Model for Mobile Agents

Other approaches include using a security-enhanced agent for mobile code. This approach assumes that every agent base has a security management component (SMC). This model proposes to allow authentication of agents by agent bases, authentication, privacy and integrity of agents in communication. This model is based on the assumption that there is a trusted SMC in each host that has agents. The security that is handled by this component includes signing, encryption, timestamps and checksums.

7.5 Security Solution to Mobile Agent

We propose to introduce a Key Server into our system which provides a public key infrastructure for agents and hosts in the system. Each agent or host should have a public key certificate registered to the key server for encryption or decryption purposes. We introduce a Launch Server that will generate a pair of keys for each agent created and registers the public key of the agent with a unique agent identification number to the key server during runtime. Each host must identify itself and register the public key to the key server. This establishes a closed set of hosts registered and known to the key server. Agents are then confined to travel among a closed network form by these hosts (Chan H.W et.al, 1999).

To protect the query integrity, an agent can digitally sign its private key, before it is launched. A host receiving the agent should verify the learner with signatures. Since the Launch Server possesses the private key for the agent, malicious hosts would not be able to forge the signature of the learners and teaching materials agent (Chan H.W et.al, 1999).

The agenda of an agent is a variable hidden by the Aglet system and not accessible. Hosts can actually have access to the agenda of an incoming agent by controlling the execution of the Aglet agent transporter. We propose by making the agenda of an explicit attribute of an agent. When the agent arrives at a host the host should read the agenda of an agent and encrypt the agenda using its own private key (Chan H.W et.al, 1999). When the agent returns to the Launch Server, the Launch Server will decrypt the chain of encrypted agenda using public keys of the hosts to check the consistency of all agendas and check with a copy of the original agenda it saves before launching the agent. If a malicious host ever changes the agenda of the agent, it is likely to be reflected in the encrypted agenda chain and detected finally.

8.0 CONCLUSION

In conclusion we have proposed a mobile agent system that can be useful in education systems as well as help learners to gain knowledge without being time boxed or location dependant. The system can be used to retrieve data systematically using Aglet and XML technology and provide learners to access data in a secure manner. Using Mobile Agents reduces network load and overcome network latency. It executes asynchronously and autonomously. It can adapt dynamically and be heterogeneous. It is also fault tolerant.

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