



Survey on Contribution of Agent Technology for Implementing an Application for Mobile devices

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Abstract — *Internet technology is spread widely in a short time span. With the growth of internet electronic data exchange is also increasing; which is responsible for the invention of e-business. The use of e-commerce is also suddenly increases with the upcoming technologies invented in the field of e-business. The traditional e-commerce system requires the human interaction for selling to buying process, but with the invention of intelligent agent technology the task become simpler. In a wide range of internet application new breed of software is used which is nothing but an intelligent agent. Intelligent agents are used as a supplement of human interaction, managing electronic mail and intelligent user interfaces. In the next phase of e-commerce trading mobile agent technology is introduced. Mobile agents are intelligent, pro-active and independent representatives of businesses. As we know stationary agents supports to automate trading capabilities and intelligent negotiation models; and mobile agents can easily connect with mobile devices such as PDAs and mobile phones. This paper investigates how mobile agents can be more beneficial in e-commerce society and their contribution in e-trading.*

Keywords — *E- commerce, intelligent agent, mobile agent, RPC, PDA,*

I. INTRODUCTION

With the rapid growth of Internet technology, the existence of data shared on the internet is continuously expanding. Now the big question is how we have gone a collect appropriate data from the pool of data resources available on the internet. The problem arises for providing a solution to efficiently locate, collect and retrieve the information has led to the research and development of systems. These systems and tools are based on the use of Mobile Agents (MA's) technology.

A. E-commerce and Mobile agents

As per the current trends the global used of internet is an increase in modern society. The importance of information sharing on a web is increasing day by day; and accessing the same by multiple resources available on internet becoming more important. Previously information accessing is done through non-mobility devices which always have restriction of time and place for accessing the information. With the increasing count of mobility users; in result it needs to being online and having information access all the time. The same trends of being online all the time is also transferred to the E-commerce world. For online shopping; user starts to use their mobile devices such as PDA's, mobile phones and laptops. But again these devices cannot always be connected to the internet because of the limitations of the battery and the cost of internet access. To overcome the limitation of mobility devices fortunately mobile agents are invented by researchers. To perform the tasks on the behalf of the certain user mobile agents can travel autonomously from host to host. Mobile agents are nothing but a software program which can communicate (and even migrate) with another agent, host... with the use of mobile agents we have lots of advantages: There are lots of possibilities that user cannot stay online all the time. In that case the user can be offline after sending out the agent to perform the task and can check the status of the work whenever the user is being connected next time. Another important advantage is: As we know mobility devices has limited computational power, with the limited resources. Also mobile agents can perform their task very efficiently by being online.

In contrast with all the advantages of mobile agents they are not used frequently in e-commerce because of the main reason of security.

II. SOFTWARE AGENT

In late 1970 the term 'agent' was already introduced in computer science with the research [1] of Artificial Intelligence; by Wooldridge & Jennings [2] (AI researchers)

An agent is defined as a piece of software used to automate specific tasks. [3] The software agents have following features:

- *Personalization:* It is the ability to customize the agent explicitly or implicitly through the provided information.
- *Proactive:* Agent should have a proper goal with the request-response cycle of the external events.

- *Autonomous or Semi Autonomous: The ability of task completion without user interaction is nothing but the autonomous feature of the agent.*
- *Intelligent / Adaptive: The intelligent agents are nothing but a “smart” agent. Intelligence of software agents is depending on the ability of developer to define the behavior of the agent. The predefined sets of “learning” rules are designed to make agent capable of analyzing their actions as per their surrounding environment. This is sometimes known as ability to be adaptive.*
- *Co-operative / Interactive: Agents can perform the operations in isolation or also can communicate with other agent and co-operatively solve the problem. By interacting with another agent problem solving mechanism becomes simpler and faster.*

For selling and purchasing process, buying agent can interact with selling agent and try to close the deal [4] also can exchange the user information for respective user in order to completion of their tasks. [5] For more effectively communicate with the agents globally with some protocols or languages are designed like KQML (Knowledge Query Manipulation Language) [6] and Ontolingua [7]. These languages are designed to allow heterogeneous agents and systems to co-operate their tasks.

- *Mobile:* Software agents are again classified in two types i) Stationary / Static agents ii) Mobile agents.
 - i) Stationary agents are traditional client server system agents resides either in client or server system.
 - ii) Mobile agents provide the ability to “Negotiates” through servers via mobile devices for the collection of information or performing other small actions in order to complete its tasks.
- *Information Overload:* While searching information on the internet or collecting information for making decisions lots of information is not useful. If the information is not filtered time taken for making decisions is increasing while going through the available data.

III. INTELLIGENT AGENT

The software agents with the power of finalize the decision it may known as intelligent agents. Because researchers have yet to reach consequence on how to define intelligent agent [8]. For at present we can define intelligent agent as a software application which has the capability of semi autonomous behavior and the power of decision making to represent the preferences and interests of its organizational principle context. [9]

The above definition has two operational aspects first is Technical and another is Organizational.

Technically, if the task is performed by the person to be classified as “Intelligent” that would be performed by agents such as possess sufficient knowledge and inferential capability.

Organizationally, in a social conforming enterprise context agent has sufficient authority to make commitments on behalf of the user. Organizational people should have to follow some cooperate rules, policies and procedure represent their principals; same properties should have to comprise in agents.

Intelligent agents can easily differentiate from other software application on the basis of their intelligent behavior and entrusted actions.

A. Problems can solve by Intelligent Agent

If we go through the practical problems can be solved by intelligent agents, we can better understand the technology.

The problems are listed below:

- Whenever we surf the internet or looking for the corporate data we don't know how to find the data or where the right information is stored; by *finding* and *filtering the information* intelligent agents can solve this problem easily.
- As we know day by day the amount of data to be shared on internet is growing and the rate of new data arrival is also increased, the data newly added to the pool is arranged in the order of its importance that is order of data is of paramount importance; now wade through information in “the world's” order takes lots of time. By *customizing information* to our preference, we can save our time with the help of intelligent agent.
- There are plenty of real world events are occurring on the web, but nobody takes action agents these events. These events could be competitive announcements or emergencies or could be computer events like a new version of the design document is ready. Instead of taking care of these events by human, intelligent agents can solve this problem by automating the things.

There are so many different ways to handle those problems. The *business value* of delegating intelligent agents to handle these three types of problems in that you get the *right information at the right time*, without having to do it all yourself or rewrite the base applications.

IV. MOBILE AGENTS TECHNOLOGY

With the development of distributed systems in early 1990s software agents brought into the context, along with the above mentioned properties of software agents. The special additional feature called *mobility* is added into the software agent era with the introduction of distributed computing.

Mobility is nothing but the ability of agents to move through a heterogeneous electronic network and autonomously deciding when and where to go. [10][11]

A. Definition of Mobile Agent

The intelligent agent with all above mentioned properties and additionally with the special feature of mobility is called as “Mobile agent”.

More specifically, a state of process that can be transported from one environment to another, with its integral data, and being capable of appropriately performing in the new environment.

Where and when to move that decision is taken by the mobile agent. The methods of RPC are often evolved for movement. A mobile agent accomplished move through duplication of data it is just similar to user commands to web browsers to “visit” a website (the browser merely downloads a copy of site or one version of it in the case of dynamic websites). Before a mobile agent decides to move; its own state is saved first, then this saved state is transported to new host, and execution is resumed from saved state.

B. Architecture of Mobile Agent

The architecture gives the structure of the system which consists of components, their interrelationship with each other and their individual functionalities. The basic architecture of the mobile agent can be thought of as a client sends out an agent who travels the network visiting servers in order to perform some required action.

The architecture consists of [12]:

- **Agent Manager:** agent manger has few responsibilities as its
 - Sends agents to and receives agents from remote hosts.
 - Prepares agents for transport by serializing the agent.
 - Reconstructs received agents and creates the agent execution context.

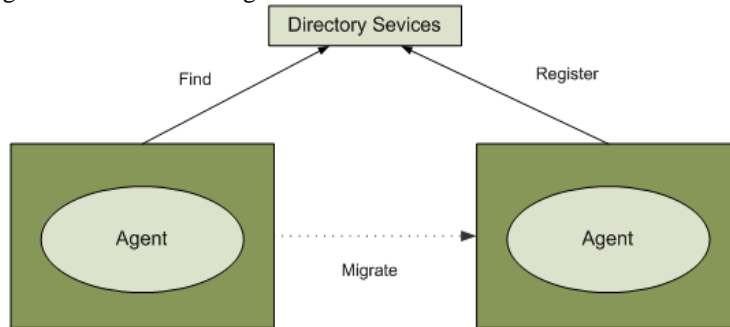


Figure 1: Architecture of Mobile Agent

- **Security Manager:** security manager is responsible for following things:
 - Before allowing execution it authenticates agents.
 - Whenever the agents try to use any system resource or tries for any unauthorized activity it automatically invoked.
 - Protects the host and agent from unauthorized access.
- **Inter-agent Communication:** it allows the agents to communicate through mechanism of message passing. This is still under research work where agents from different agent systems can communicate to each other. Till the current state all those agent systems which follow FIPA (Foundation for Intelligent and Physical Agent) standards [13] are able to exchange messages as they follow a standard format or sending and receiving messages. Intercommunication is still an issue among heterogeneous agent system.
- **Directory Manager:** Lists names and addresses of services and agents. As shown in Fig.1 shows the agent first migrates to remote container and registers itself to the Directory Services. When any other agent needs to find some agent it contacts the Directory Services for help.
- **Language:** the architecture of a mobile agent system describes the flow of information among the various components of the system. The language used for the efficient transfer of data and provides the developer with the tools to efficiently implements the system. Most current agent systems are implemented on top of the Java Virtual Machine (JVM), which provides object serialization and basic mechanism to implement weak mobility.

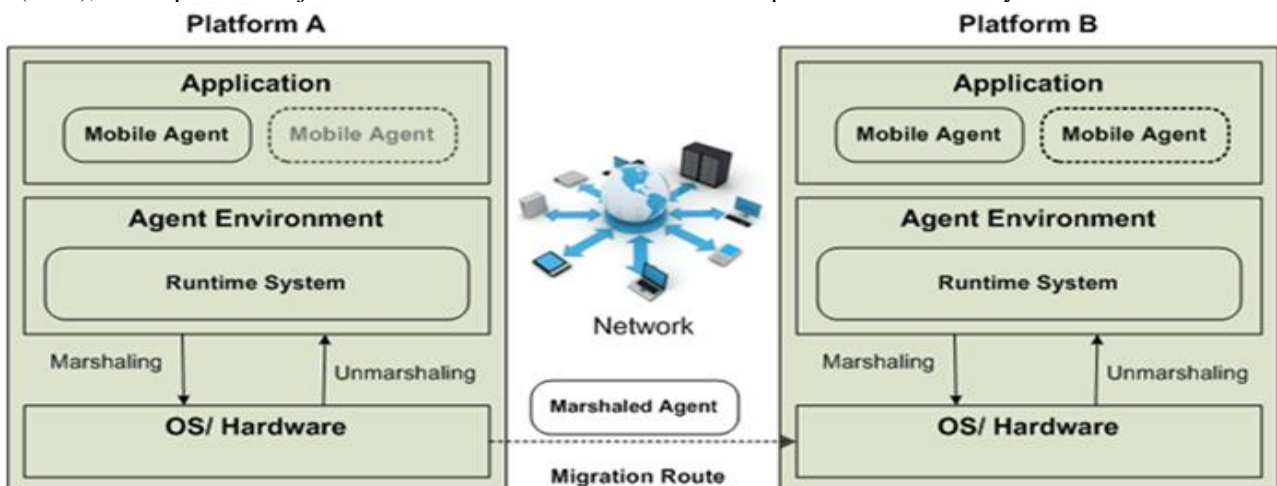


Figure 2: Mobile Agent Migration

C. Migration of Mobile Agents

Figure 2 shows the basic mechanism for agent migration between two computers.

Step.1 The runtime system on the sender-side computer suspends the execution of the agent.

Step.2 It marshals the agent into a bit-chunk that can be transmitted over a network.

Step.3 It transmits the chunk to the destination computer through the underlying network protocol.

Step.4 The runtime system on the receiver-side computer receives the chunk.

Step.5 It unmarshals the chunk into the agent and resumes the agent.

Most existing mobile agent systems use TCP channels, SMTP, or HTTP as their underlying communication protocols. Mobile agents themselves are separated from the underlying communication protocols.

D. Life cycle of Mobile Agent

1. In the Home Machine the mobile agent is *created*.
2. It is *dispatched* to the Host Machine A for execution.
3. On Host Machine at the agent executes.
4. After execution the agent is *cloned* to create two copies. One copy is dispatched to Host Machine B and the other is dispatched to Host Machine C.
5. The cloned copies execute on their respective hosts.
6. After execution, Host Machine B and C send the mobile agent received by them back to the Home Machine.
7. The Home Machine *retracts* the agents and the data brought by the agents are analyzed and then *disposed*.

The following events in its life cycle are observing from that a mobile agent experiences:

Creation: a new agent is created and its state is initialized.

Dispatch: Created agent travels to a new host.

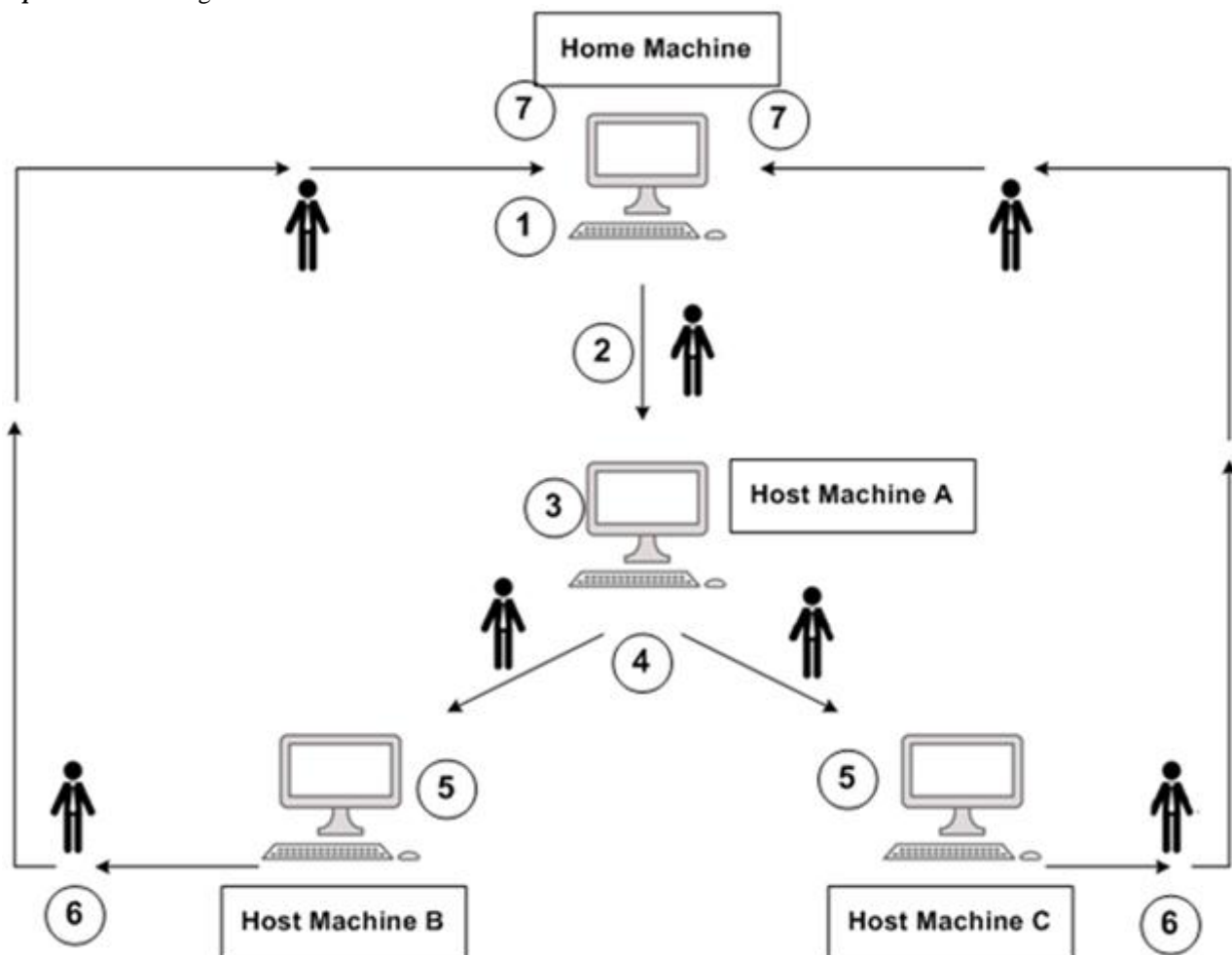


Figure 3: Life cycle of Mobile Agent

Cloning: Twin agents are created and the current state of the original is duplicated in the clone.

Deactivation: an agent is put to ideal state and its state is stored on a disk of the host.

Disposal: Its state is lost forever after an agent is terminated.

Retraction: an agent travels back from a remote host to the home machine along with its state.

Activation: Its state is restored from disk after a deactivated agent is brought back to life.

E. Advantages of Mobile Agents

Mobile agent architecture is now becoming more popular in market, to understand the necessity of using mobile agent we should have to go through the advantages of mobile agents. Following list is collected by Braun [11], which helps to form an idea about current mobile agent architecture:

- *Asynchronous*

Mobile agent has the ability of process the given task by visiting the host and processing task at host side. With the ability of processing data agents can even pay for the relative services; and most importantly no network connection is required for a mobile agent to do their work, which is very applicable to those mobile devices that are with the less memory and less computational power.

- *Reaction of remote events in real time*

On the behalf of the human interaction with mobile agent can perform the task on remote systems which eliminates the process of contacting centralized decision making authority, thus it saves the cost for network latency.

- *Robustness and failure tolerance*

Mobile agent has the ability to move another system in case of system failure or in routine shutting down. It makes mobile agents more robust.

- *State sensitive communication*

In RPC communication process never carries the intermediate data of state; in contrast with this the mobile agent has the ability of carrying own state and intermediate data within communication process which reduces the network traffic.

- *Scalability*

By executing remote process in local system mobile agents can reduce long network transactions.

- *Semantic routing*

The ability to autonomously find the server information and their services by exchanging keywords with the server.

- *Personalize services*

Mobile agents are designed to perform user specific task.

- *Security*

By encrypting sensitive data by their own keys, data can easily carry inside agent through the internet.

- *Mobile computing*

For sending and receiving data to an agent, it requires comparatively lesser time than traditional systems, because of the short connection period.

Connection period reduces because of a small amount of data carried by the agent, which is essential to perform the services and maintain the service state instead of carrying complete data for each request.

Mobile agents can automatically save the connection time because of connection is required only for request send and reception of results; on the behalf of user mobile agent can perform the task whenever user is offline, thus it eliminates the time period of staying online all the time till the result is not great.

Mobile users most probably own a slower network connection, therefore for increasing efficiency of mobile devices through an agent mediated pre-solutions and by the reduction of transferred data amount.

F. Applications benefited by mobile agents [14]

- *E-commerce*

Commercial transactions access the remote resources in real time to stock quotes and agent to agent negotiations. To accomplish different goals agents are designed with different strategies. Agents are designed as per the need of user and policies of creator which may take the decision on the behalf of a user or even can negotiate with the other.

- *Personal assistance*

On the behalf of user mobile agents can execute on the remote host and performs the task in the network. They can operate independently in their limited network even if the user's device is off.

- *Secure brokering*

In the limited network parties can let their mobile agents to communicate (negotiate) with each other on a mutually agreed secure host for the collaboration takes place.

- *Distributed information retrieval*

For searching for an internet search engines have to move large amount of data which increases the unnecessary load on the network and also introduce a delay in result collection. Mobile agents create a search index instead of moving large amounts of data, and dispatch the agent to remote locations where the remote information resources locally maintain their own indexes.

- *Telecommunication network services*

As we know mobile devices are moving by the locations it requires to dynamically manage the network and customize the user. Mobile agents can help to keep the system flexible by designing the agent on the characteristics of the physical size of these networks and the strict requirements under which they operate.

V. CONCLUSION

In today's world the mobile devices are becoming part of social life. As we discuss, mobile devices owns less memory, lesser processing capability and limited speed which limits the operational capacities of those devices; those devices also own lower connection speed which limits the time for being online.

Mobile agents solve this problem by the staying online for passing the request and go to offline; whenever we again connected to internet our result is ready to use. Which resultantly save the time and cost of being online throughout.

Mobile agents are just an implementation technique used in the development and operation of distributed systems, including smart environments, as other software agents, including multi-agents, are themselves not goals but tools for modeling and managing our societies and systems. Therefore, the future of mobile agents may not be especially as mobile agents. They will be used as essential technologies in distributed computing or ambient computing, even though they will not be called mobile agents. In fact, although monolithic mobile agent

Systems were developed in the past decade to illustrate the concepts of mobile agents, recent several mobile agent systems have been developed based on several slightly different semantics for mobile agents.

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