Chapter 5

INTRODUCTION TO MOBILE AGENT
Chapter 5 Introductions to Mobile Agent

5.1 Mobile agents

What is an agent? In fact a software program is containing an intelligence to help users and take action on user’s behalf. \[S98\] [SC98] [SDAS13]

An agent is a software lines of code to assist user, do the work task on user’s behalf. Allow user to hand over work to MA is how agents function \[D97\] [D98] [RMS99].

An Agent is a software element which is autonomous with intelligence, mobility, while having ability to collaborate well by other users, Intelligent Agents, and Systems. They hold responsibilities without constantly consulting the user with a dedication, on their behalf. They can effectively co-ordinate among agents, users and software hosts. A searching agent that is competent to retrieve preferred information on behalf of the users. The agent is sent away to carry out the look for off-line as well, after being told what to search for. Eventually, the agent can move back with needed output \[C98\] [V97] [SDAS13].

Generally, MA has the following properties \[BK06\].

MA are taken as entity like an object encapsulating code along with the state

It performs a distinct operation on user’s behalf, the user who assigned that task to the MA, attempting in the completion of that task with no additional involvement of that user (in case of some unexpected operation occurs then only the user will be involved in the operation).

MA independently transmits itself from one AP to other AP on which MA will communicate like a local agent with other object, data.
For many applications, MA becomes an efficient solution, for several points.

Intelligence: Agents has an ability to learn, search with a domain knowledge that is the reason they are called as intelligent agent to possess a degree of domain knowledge. The ability of understanding determines the learning and adapting to the requirement behavior of agent in the logic so as to handle new situation very effectively [WGC02]. Thus in this research multi database in catastrophe healthcare system, agents plays an important role in making critical decision on behalf of the patient, paramedic in order to select the hospitals.

Autonomy: Autonomous means, agents are not only unreceptively motivated by outside actions initiated by the user or systems, but also an agent has internal events witch decided the agent performance and behavior. The mobile agents take an autonomous decision while selecting a perfect hospital in an emergency situation, is proven by research. [AMAZZ11][ARHS97]
Mobility: Intelligent agents possess some degree of mobility. The agent is not limited to its home node. Migrating to host platform where it can carry out tasks locally is its capability, thus reducing processing load on its home platform, and reducing communication overhead. This is an attractive capability, in the context of distributed processing and balancing a load. Adding to this, there is another benefit that is the opportunity that even after the location it had originated from having gone offline; the agents will still keep functioning. Movable agents are called mobile agents. In the study, it is demonstrated that it is the hospital agent which is launched from an ambulance node, migrates itself from original node to the different hospital to gather the relevant information needed for the ambulance node. [CHK94][CHK95]

Communicative: Communicating effectively with other agents, users and systems is a capability of Intelligent Agent. An Agent Communication Language (ACL) (for example KQML) helps carry out inter-agent communication. The KQML language assumes the specific anthologies for specific agent systems. For example, to locate a required hospital needed by particular patient an ambulance agent and hospital agent must understand the concept of hospital and medical terms. [C98][CHK97]

There are several categories of agents, as given below.

Fig. 5.2 Properties of Mobile Agents

Software Agents: the agent which are implemented using software programs are called as a software agent. With the software program can be feed to make agent autonomous and to act
and communicate with other software components. Remaining all different agents are actually kind of a software agents. Often, when they say “agent” it mean a software agent.

Autonomous Agents: Agents who act in response to the situation are called autonomous agents. They respond as per their interpretation of that environment. To do this, it takes decision on its individual. FIPA observes this as an important property. Agents are a dynamic unit, which means that they can their individual decisions at various degrees. The agents no longer possess their dynamic behavior if there is no autonomy. A practical agent shows advanced level of autonomy, it depends on agents’ state and external input given. By taking the help of neural networks, they use memory for this purpose. In case of searching a hospital, an agent which is launched may or may not come up with appropriate hospital depending on its availability.

Intelligent Agents: Agents who have the capability of learning and adaptation the situations are called Intelligent Agents. To achieve these abilities, they use artificial intelligence. Intelligent agents are able to choose one situation out of given number of situations to go one step near to its goal. Its every action takes it nearer to its goal. This is demonstrated in case of selecting a perfect hospital for a catastrophe situation in this research.

Adaptive Agents: Only in its environment is an adaptive agent, means if the environment is changed, you might or might not have the agent. The agents that can cope with the changing of an environment are called adaptive agents. They can settle themselves to the changing environments. Neural networks, are used by the agent are used to exhibit this sort of ability. Thermostats, simple search bots or robotic sensors are examples of adaptive agents.

Mobile Agents : mobile agent, consider as a software program which moves from one node to other to get the work done, while doing this, it carry its state and data along with it and start a its execution again from the same state it had left on the previous host. The improved performance which can be achieved by moving the agent closer to the new host, where it can use the services locally, is the reason for using mobility. We take an illustration where a hospital mobile agent needs data from different hospital host situated on different nodes. It makes use of remote procedure call (RPC), to request the desired information and gain the outputs by calling
the remote methods. The client-server paradigm is followed by this RPC. However it can create bandwidth and network traffic problems, if the volume of data is large. In such cases, the mobile hospital agent can transport itself to those remote hospital hosts and fetch the relevant information which are needed locally and go back with the desired outcome (list of hospitals having a particular medical facility, availability of resources doctors and nurses. Thus it is a very efficient technique to development the data. Agent hood does not require an agent to migrate from one environment to another. But mobility is still an important property for many agent based applications. [HCS12]

Co-ordinate Agents: The agents which work with some degree of co-ordination among them are called coordinate agents. Agents belonging to different systems can make use of similar outline, just like humans working in coordination. Supply chains, scheduling, problem solving, contract negotiation are some application using coordinate agents. Some degree of coordination amongst themselves is needed in these applications otherwise these kinds of systems are not possible. We take heterogeneous population of agents when we talk about coordination therefore we need extra care while designing these kind of agent system as some concepts like how will they discuss, administer, co-operate, contend.[O01]

Other forms of agents: Of every agent based system, the predominant forms of the agents are mentioned above. Identification of other forms of agents like broker agent, manager agent, facilitator agent etc. can be identified by detailed work on the applications.

5.2 Traditional model vs. Mobile agent

An extremely commanding consistent technology is provided by MA for network computing. MA can revolutionize the design as well as development of distributed application. Following is a comparison of different distributed computing perspective namely code on demand, client/server and mobile agents. [D98]

Code on Demand- as per this technique as shown in Figure 5.3, clients get the knowledge whenever needed. For example a Node (A) initially is not able to perform its work task because of a need of code. Providentially, another node (B) gives the required coding (Know-How).
Working is carried out in node (A), once A received a code. (A) Node has a computing power along with the assets.

Client Server Model: a set of services are advertised by the server which gives permission to use resources are shown in the client server paradigm, Figure 5.4 depict this. The server hosts the code that implements these services locally. It is known principle of client server architecture is the server has the computing capability (Know how) that is why the server executes all service. If the client is wants to gain any kind of access of any some resource hosted on the server, it will have to gain access permission from the server. The client has an intelligence to decide exactly which services to be used. The server contains all, the knowledge, property, and processor. Up to now, the majority of distributed systems are client-server based. A broad variety of technology support this paradigm like object request brokers (CORBA), Java remote method invocation (RMI) and remote procedure calling. [D98]
Fig. 5.4 Client Server Model
Fig 5.5 Comparison between two technologies client server and MA

Mobile Agent Technology: This technology gives a facility that a simple host can have an elevated level of elasticity to hold combination of expertise, assets. That is the main feature of the MA technology, as depicted Figure 5.6. Its computing power and local resource capability can be combined together.

Fig. 5.6 Mobile Agent Technology

In order to compare these three techniques, the sequential development toward superior flexibility is studied first. A host is made up of a combination of client and server. [D98]

5.3 Major Characteristics of Mobile agent

A number of characteristics have been identified [M98]. Mobile agent is autonomous in nature and should be having the capability to operate with no straight external input. In other words, some degree of control over their data and states should be held by them. While communicating with the environment and other agents, MAs should be interactive and adaptive. In other words, they should have the ability to respond to other agents or their environment. Mobility is the center possessions in mobile agent theory, is where the agent having talent to transfer it to various host within the same platform or on different environment autonomously. [G09][KGGR00][JH98]

Proactive: Agent must be an objective-oriented entity, and acquire a proposal in respond to a situation.
Proxy: Mobile agents may perform on user’s behalf or for the assistance of users (e.g. hospital mobile agent in the thesis). Mobile agents must have at least a minimal degree of autonomy so that they can act on behalf of others. [LMP03]

Intelligent: Based on knowledge in order to act efficiency, mobile agents posses a degree of intelligent.

Co-coordinative: Data transfer activities should be performed by MAs while sharing with other agents within the given environment.

Learning: Mobile agents are capable enough to gaining information about the current environment; because of this MAs can adapt the new behavior. To achieve a common purpose, MAs should be able to coordinate with other agents.

5.4 Models of Mobile agent

Before explaining a Mobile agent model, let’s see that MA is nothing but a software code which transmits itself to other platform in order to get the task complete, for doing so it take a state and data with itself and restart its execution from the current state. [SS97]

We can take an example of the agent application in a Jade based Multi-Database decision making in a catastrophe healthcare system; there are three different hospital database searches. In this example the person on ambulance node wants to access the three different hospital database situated at the remote locations from the accident location. The paramedic need some information(availability of hospitals, nurse, special facility in a particular catastrophe situation) as the best preferred hospital list from the three different hospital’s databases, because of a far location a paramedic not able to access the information from the database directly and even so there could be a difficult problems of the network communication links(like am ambulance is going through a tunnel where no network is accessible) so they cannot guaranty availability of best suited hospital for that particular patient at the time of emergency. Now, this trouble could be solving by making use of a technology called mobile agents. The research comes up with a
way out, which is making a use the mobile agent technology, for this an ambulance agent will be installed as a remote and mobile ambulance host (can be a laptop, palmtop).

Following are the applications of mobile agent technology

• In monitoring distributed data sources resource availability, discovery, monitoring: agents are extremely constructive. They are helpful in such applications as they don’t amplify network load, they can check the resource availability on network, they can monitor the system load etc.

• Information Management activity: means searching for information, information elicitation, information monitor. Agents when acting as a search agent must have field understanding about various information sources. This knowledge of kind of information available with source, search agents are helpful because they find exact information from each source. The problem of information overload to a user is also dealt with by limiting the information coming to a user

• Dynamic deployment: in a distributed environment, the deployment of an application is merely a complex work, especially when the nodes are not manageable. Mobile agents can to perform this job more successfully, mobile agent are employed because without users intervention they can take decision in an emergency situation extremely fine.

• One can have a Personal agents sort the emails and news for them, as well as for designing a personnel schedule management is also possible without the users intervention. Not only can this but a mobile agent be used more effectively as personal automatic secretary.

• Mobile agents are used in a variety of ways in Business applications too. Starting from Market making for different kind of services like goods and services, Brokering services and managing the team also can be handling by mobile agents.
A life-cycle Model

In accordance with FIPA specification, APLC i.e. Agent Platform Life Cycle, of JADE agent fall in any of states; Figure 5.7 shows the various life cycle states which are explained below.

- INITIATED- Even if the object agent is created, doesn’t get a name and address unless it is registered with the AMS, and not able to talk other agents or systems.
- ACTIVE - After registering with the Amsted agent object get a regular name and address and now able to use all JADE features which are FIPA compliant.
- SUSPENDED - this is state which indicates that Agent object is stopped at present. So agent behavior is not executed.
• DELETED - the Agent is definitely dead. The MA will not remain registered with Agent Managing Service and the internal thread has terminated its execution.

• WAITING - when the object agent wants some resources, it is blocked. This is called as a waiting stage.

• TRANSIT – while migrating, it within different node of same AP, the MA is enters in this state. All the buffered messages will be sent to the new place of agent by the system. To perform transitions between the various states, Agent class comes with public methods. For example, the method named do Wait() is used to put an agent into a WAITING state when it is in a state ACTIVE. [G+97]

![Fig. 5.8 Mobile agent models](image)

**Computational model**
When the MA is in a running state how it executes is shown with the computational model. The computational capabilities for MA are defined by this model. If the computational model is powerful, then its effect will be on the all the remaining models of MAs life-cycle as well as security, navigational aspects and communication of a mobile agent.

**Navigation model**

MAs are very famous for this feature called mobility. Navigation model helps the MA to find the destination host, moving the MA to the destination and after finishing the task finding the route of home node and coming back to the host node. This is achieved because every MA in the agent Platform has a unique identity. Figure 5.9 depicts navigation Model of MA.

![Navigation Model of MA](image)

**Security model**
It is very essential to have a secure model when working on an internet. MA security has two areas like a protection host from other MAs and second is Protecting MAs from malicious host. The scope of this the doesn’t allow to contribute more on security model of MA. For the purpose of this thesis, author utilizes the basic security model provided by a JADE, as per in FIPA specification.

**Communication model**

We call MA as an intelligent program because they are able to communicate on user’s behalf with no interference by that user for small information. MA can communicate with users, other host, and other agents in a computing situation. So this is how a MA collaborate and co-ordinate within the agent platform

**5.5 Agents and Object**

Both the technologies, Agent and Object have their benefits which helps the user to develop an application. Both are very alike to each other because many thing an object do, an agent can also perform that task, which is reason the agent gives additional benefits of using the agents than using objects. The similarity and differences between agent and object technologies are disused below.

**Similarities:**

- Agent and object are similar in numerous ways. Both can carry their execution state and data along with. They can communicate with each other with their own interface [CKSL06].

**Differences:**

The autonomy of the agents is one of their most important properties. They can take their own decisions and decide which messages they will respond to. Objects don’t possess this property; they only do what they are asked to do.
Intelligent Functionality: agents are always having more intelligence than an object. A multi-agent activity can communicates with each other on user’s behalf; they are having more functionality than a single object.

ACL: A powerful language is used by the agents to communicate with each other. They are able to represent the complex desire-belief-intention information. After the results are observed, they can draw inferences and can even manipulate the behavior or functionality. On the other side objects use a fixed set of messages while communicating.

These are the few basic differences which differentiate an agent to an object, which show the benefits of agents over the objects.

5.6 Current Position of Agent Technology

Agent technology is an integrated form of multiple technologies. It adds additional capabilities or functionality to the existing technology but does not actually provide a new set of capabilities.

The current state of agent technology is as follows [505]

• It is active research region.

• Unavailability of the full set of technologies.

• No integration is done yet with the other technologies.

Agent technology is neither a very widespread technology yet nor has it been widely accepted.

Agent’s Usage:
As discussed earlier, the agent technology is still emerging. There is less usage of agent technology, but it is increasing day by day. Agent technology’s some of the major usages are given below [505].

- User assistance agents provide services to the user, at the user, for giving information or advice to the user.
- Organizational structure agents, in this thesis an agent perform various roles like a paramedics, patient, hospital, ambulance maintaining the organization structural information.

5.7 Advantages of using mobile agents

Some major advantages of using mobile agent technologies are given in this section of the thesis.

- With the use of mobile agent, it becomes a reduction in network traffic, because a mobile agent transfer itself with a state information, which is often very small than a data so reduces the network traffic.
- Even in case of disconnected operation mobile agent can perform in an asynchronous autonomous, as an agent can act on behalf of the user when the user is not present.
- It is possible for a mobile agent to interaction in real-time systems, which may prevent delays caused by network failure.
- MA can execute on single node at a time, CPU consumption is limited thus it saves an Efficiency.
- Mobile agent always Support for heterogeneous environments:
- A mobile agent can be exchanged virtually, so it is very easy software upgrades.