A Detailed Survey On Mobile Agents And Its Functionality In Data Mining Domain

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Abstract : In past few decades, evolution of mobile agent is an exciting and emerging paradigm in the field of mobile computing applications. The significant cause of this emerging growth is the inefficiency of traditionally distributed systems like client server application with regards to mobility, bandwidth, latency, vulnerability, network disconnection and so on. The emerging mobile agent technology assist in the design of extensive range of flexible, adaptive applications with temporary connections by including code mobility, improved network, machine intelligence and database possibilities. This work provides an extensive review of mobile agents in its corresponding protocols, advantages, design challenges, future direction. Along with this the role of mobile agents in the field of data mining is also discussed in brief. This work lays a platform for designing of novel methodologies in data mining using mobile agents, as well mobile agent usage, architecture, applications, challenges like standardization, scalability, portability are also addressed in this work.

IndexTerms - Mobile agents, data mining, architecture, applications, challenges and so on.

I. INTRODUCTION

In general, the origination of data mining is promoted from knowledge discovery in databases (KDD). Distributed data mining extracts data from various sources despite of considering its corresponding physical locations. The necessity of these characteristics arises while data generated at every site locally is not transferred over the network because of the excessive amount of privacy and data issues. However, internet growth gradually rises from businesses to generate huge data every time [1]. Even though the data attained from business firm, it should not be transferred or shared owing to its privacy or security concerns where system architecture and legislation of particular locales involved. In recent times, distributed data mining turns to be crucial element of knowledge based systems as its decentralized architecture should reach every business network.

Data mining algorithm produces knowledge from the data provided. Usually, data mining is used for various purposes like 1) classification 2) clustering 3) regression 4) association rule mining. Classification process categorizes data into pre-defined categories. For instance, web pages are classified under reading category, that is, finance, technology and science. Classification algorithm attained from labelled examples to discover data patterns. In clustering phase, similar data will be grouped without knowing its pre-defined categories. Here there is no labelled instance for this clustering algorithm, indeed it attempts to identify clusters that describes the data. Regression identifies a function that posses lesser error, this comprises of statistical methods and multiple regression. At last, association rule learning investigates the relationships amongst data features. For instance, title of reading content is associated with title of web page. In distributed data mining, rules will be constructed from data sources and data related to it. Rules may be merged and pruned to offer more effectual outcomes to users. As well, data mining needs to face various challenges like high dimensionality data, distributed data source and some related process. So as to overcome this mode, an agent based approach is essential.

1.1 What is an agent?

As discussed in previous section, agent computing has turned out to be a solution for complex system because of its ability to learn and adapt with computing environment. Some agents involved in complex computing system known as Multi-agent system which offers opportunities to extend system performance to certain extent in numerous ways. An agent possesses certain opportunities like decentralization, autonomy, limited system view. Usually, agents are partially autonomous or autonomous based on how it is programmed, initially it is depends on global design perspective of a system [2]. For instance, an agent anticipates resource availability; therefore it can be utilized when needed. Moreover, while resources are still unavailable, agents may make use of other available resource than that of waiting. An autonomous agent analyzes computing environment and executes based on the characteristics where human intervention is extremely reduced. In this investigation, mobile agents are considered as baseline for examination along with the available protocols and design structure.

1.2 Mobile Agents

In general computing perspective, an agent is a program where it operates in an autonomous environment and can move around heterogeneous network under its control, migrating from one host to another, interacts with agents. Mobile agent determines when and where to migrate. It can be executed in any form or terminate its execution, and moves to subsequent host and continuous its execution on that host. Mobile agents possesses certain features like mobility, autonomy, goal driven, intelligence, temporarily

continuous, learning reactivity, co-operation and so on [3]. Due to the above mentioned features, it can be adopted in any mobile computing domain. For example, mobile agents move from PDA to Internet to aggregate certain information for users. As this happens over internet and it does not wants to transfer multiple responses/request in lower bandwidth connection, as well it can access necessary resources effectually. Furthermore, sudden connection loss will not influence agent as it does not possess continuous connection with mobile device. An agent can carry out its tasks even if mobile devices disconnect from network. Over mobile device reconnection towards a network, agent will attain its results. Subsequently, network application can transmit mobile agent to other mobile device as in fig 1. Agent acting as an alternative to application, it interacts with users whether the mobile devices are connected or not.
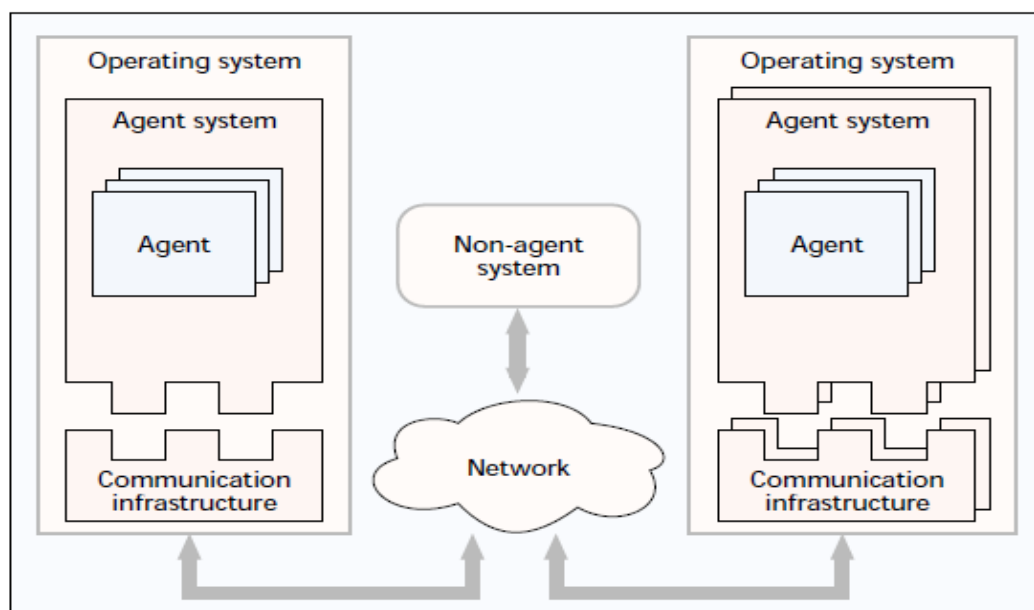

Fig 1: Mobile agent architecture

Usually mobile agents simplify its development, testing and execution of distributed applications as its ability to conceal communication channels and to depict its computation logic. It can be re-distributed or distribute them to network and functions like either servers or clients are based on their goal. It can as well increase application scalability due to its ability to traverse work to appropriate location.

II. AGENT BASED DATA MINING APPLICATIONS

Data mining applications include intrusion detection system, credit card fraud detection system, security related applications, health insurance, market segmentation, distributed clustering, customer profiling, sensor networks, evaluation of retail promotions, credit risk analysis and so on [4]. Enormous amount of sophisticated applications are published along with the evolution of internet gradually, huge amount of free services are also provided. In exchange, customers and service subscribers are encouraged to satisfy its profiles which are utilized to match the delivery of affiliated advertisements side-by-side with services to attain better advertisements for available online customers [5]. Learning from customers profile is an effectual instance that uses data mining techniques. These sorts of tasks are accomplished merely by database operations, numerous data mining characteristics can be improved with these autonomous (mobile) agents.

III. OUTLINE OF AGENT BASED DATA MINING

Agent based data mining is a baseline foundation as it is simulated by agents: henceforth the data mining approaches can inherit powerful properties of agents and acquire desirable characteristics [6]. Usually, developing an agent based data mining system provides three key factors: system configuration, interoperability and performance. These factors are discussed below:

3.1 Interoperability

In agent based data mining, interoperability is not only relies on system collaboration of agents but also with external interaction which facilitates new agents to move towards the system seamlessly. The system architecture should be flexible and easier to handle these interactions, such as integration policy, communication protocol and service directory. Communication protocol in co-operates message encoding, transportation amongst agents, encryption, nonetheless these are standardized by publically available access and Foundation of Intelligent Physical Agents (FIPA). Most agent platforms like JACK3, JADE2 are based on FIPA, as interoperability is possible between them.

In general, policy that relies over integration shows how a system behaves while an external component like data site and agent requests for entering or leaving the system [7]. This policy is recognized by identifying system components and maintained by versions as it can be revised in a timely manner. Document updation, for instance, policy leads to system inconsistency because of the current document version and it must be known by each component. Service directory offers system documents like system configuration, policy, where all components may check document version to guarantee system consistency. Future direction shows how service directory can be published, maintained and propagated.

3.2 System Configuration

In addition to interoperability characteristics of agents, dynamic system configuration is also a confronting approach due to planning complexity and mining algorithms. Mining task comprises of numerous data sources and agents, where agents are configured to equip algorithm effectually and handle the dataset [8]. Modification of data influences mining task as agents still carries out the algorithm. In this constraint, task priority is considered and it is restarted. An ideal algorithm is pre-emptive where it pauses during dataset updation and continuous its execution after updation. Moreover, addition of agents necessitates increase in mining task speed as it is ideal and agents has to share instances of agent memory.

3.3 Performance

Performance of agents can either be impaired or improved as data distribution is a major constraint. In case of distributed environment, task executes parallel; moreover parallelism originates from concurrency constraints. Henceforth, agent based data mining system has to guarantee system performance which is acceptable and seems to be effectual. Subsequently, performance crises are also considered. For instance, based on the algorithm characteristics discussed previously, system may enhance user experience which optimizes mining performance. An agent may specify user with corresponding profile.

Agent based data mining should validate user profile prior to data analysis. User profile comprises a query pattern where the agent has to deal with query caches or certain performance enhancement approaches. In this manner, agent may sometimes disregard certain redundant queries by reproducing the previous query outcome from query cache. Subsequently, an agent depicts the data source with a profile. Heterogeneous data source offer diverse processing requirements and also query specifications.

Less efficient data source may degrade the entire data agent system performance; moreover, an agent should determine alternative data source to acquire input data for query. So as to do this, agents should maintain service directory or information exchange with peer to peer by introducing communication set, specifically with cost, to search and determine an alternative data source. This provides a certain extent in cost benefit analysis amongst communication and query processing.

IV. AGENT BASED DATA MINING COMPONENTS

The following are the components of agent based data mining system:

4.1 Data

It is the fundamental baseline for agent based computation. Over distributed environment, data is hosted in diverse forms, like online relational databases, web pages, data stream and so on. where the data purpose is varied.

4.2 Communication

System selects some related resources from directory service, which preserves list of data sources, data schemas, data types, mining algorithms and so on [9]. Communication protocols vary based on system implementation like client server, peer-to-peer communication and so on.

4.3 Presentation

User interface interacts with user to receive and respond to user queries. Interface reduces complex distributed systems to user friendly message like visual reporting tools, network diagrams and so on.

V. MOBILE AGENTS BASED ROUTING PROTOCOL

This section discusses in detail about some basic communication protocol for mobile agents who should provide an effectual degree for location transparency, efficiency and reliability. Even though there are enormous communication protocols have been anticipated for mobile agent systems, most of them are based on location transparency [10]. These protocols generally comprises of certain aspects of efficiency and reliability. Existing investigation tries to resolve certain problems with agent based remote procedure call, which is considered as analogous to conventional RPC. With ARPC, investigators have to deal with message delivery and agent allocation explicitly.

Another routing protocol is home-server schemes, which is a most utilized communication protocols specifically for multi-agent systems as they are compatible to the present internet protocol. In this scheme, every mobile agent is related to stationary agents, which is termed as mobile agent based home agents [11]. Every home agent possesses a database to maintain addresses of all agents which uses this host as home agent. A central naming server is termed as home server which preserves binding amongst home agents address ad mobile agents name.

Next protocol is forwarding proxy protocol which deals with forwarding approach strategy for location management and forwarding approach for message delivery. Location information of forwarding proxy is maintained at nodes where the mobile agent visits. During the migration of mobile agents to diverse location, forwarding proxy has to maintain information of next location at every node. Message delivery is carried out by proxy chain which is referred as path proxies.

Shadow protocol uses Forwarding pointers and location server approaches for forwarding of message delivery and location management. Shadow protocol utilizes placeholder termed shadow that maintains locations of all dependent agents, alike of location server [12]. It as well utilizes forwarding proxies at nodes that mobile agent has visited. Mobile agent updates current location to related shadow in accordance to Time To Live (TTL). If TTL is still maintained, mobile agent is performed behind forwarding proxies at nodes that is visited. When TTL expires, it updates current location to shadow.

Search-by-Path-Chase (SPC) protocol also uses Forwarding pointers and location server approaches for direct forwarding of message delivery and location management. SPC protocol considers multi-region mobile agent computing environment. Location information is maintained in a distributed manner at Site Agent Register (SAR) and Region Agent Register (RAR). RAR is responsible for preserving location information about all agents inside computing region. SAR preserves information regarding node agent or reference, i.e. forwarding pointer about agents that visits the node.

Adaptivity and Reliable Protocol (ARP) protocol uses Forwarding pointers and location server approaches for mailbox approach of message delivery and location management. ARP protocol transmits message with mobile mailbox. An agent generally tracks the location information of its corresponding mobile mailbox [13]. When the agent intended to migrate, mobile mailbox moves from one node to another node in accordance to message delivery cost. In general, message is initially transmitted to mobile mailbox. Mobile agent retrieves messages from mailbox whenever required. ARP protocol has higher overhead while transmitting data to mailbox. If node has mailbox failure, messages may lose.

Message Delivery Protocol (MDP) provides a technique to track agent location concurrently. It preserves the addresses of all agents in tree like hierarchical structure. Agents are classified into groups; each will come under a domain. Every domain possess gateway and all domain gateways at the top is considered as root. Every server inside the domain revises agent address when it moves/migrates to another domain. This process is simple logically. Moreover building a hierarchical tree is a complex task, specifically in extremely huge distributed network like internet.

VI. ADVANTAGES OF MOBILE AGENTS

Mobile agents comprises of numerous advantages over conventional client/server model. Some includes reduction of network traffic. In distributed environment, carrying out a simple task comprises of multiple interactions, which outcomes in raised network traffic [14]. In mobile agent paradigm, the ultimate goal is to perform data computation rather than computation design computation, thereby consuming lesser network resources and thus increases efficiency.

6.1 Reduced latency

Managing the critical real time difficulties with substantial network size produced delay/latency which cannot be acceptable. Mobile agent deployment has to overcome this crisis as these agents can carry out local execution over central controller directions.

6.2 Protocol Encapsulation

In general, newly designed communication protocol will enhances improved efficiency and security, business has to upgrade its protocols; else it is considered as legacy problem. This entire process is known as cumbersome. Mobile agents are helpful in resolving this crisis, as it may migrate to remote host and launches channels sourced on proprietary protocols.

6.3 Asynchronous execution

When a task requires constant open connection, mobile agent deployment results in saving cost. A mobile agent with task embedded to it is dispatched into network where it operates asynchronously and independently.

6.4 Dynamic adoption

Mobile agents can determine and perceive surrounding environment and operates dynamically as in fig 2.

6.5 Seamless system integration

From the hardware and software perspectives, mobile based network computation is heterogeneous [15]. Mobile agents can offer seamless system integration, as they are dependent only on environment in which they can be executed.
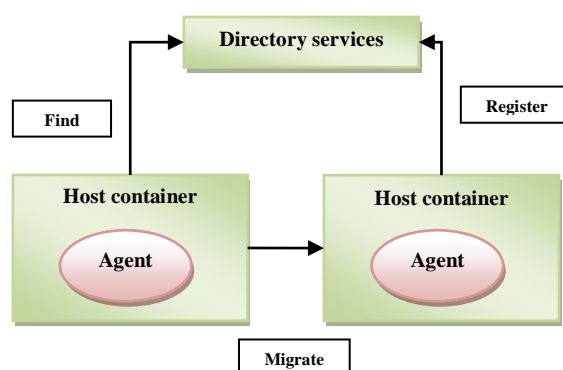

Fig 2: Agent communication

6.6 Robust and fault-tolerant

Mobile agents can dynamically react and act during the occurrence of unfavourable conditions; it is easier to construct fault tolerant and robust distributed system with mobile agents. Some alternative techniques are proxy servers, RPC and so on and can offer enormous above mentioned advantages. Moreover, these techniques are appropriate for some applications. Distinctively, mobile agent with single unified framework is appropriate for extensive range of distributed applications, therefore considering it as an appealing solution for distributed applications.

VII. APPLICATIONS OF MOBILE AGENTS

There are several applications that benefit the usage of mobile agent technology. Some of them are discussed below:

7.1   Commercial transactions

In recent times, commercial transactions have to access real time resources. Mobile agent has the ability to characterize researcher intentions to operate and negotiate them to make them appropriate for electronic commerce.

7.2   Personal Assistance

An agent can also plays the role of a personal assistant to user and to carry out tasks for users on remote host in spite of considering whether the user is connected to network or not [16]. For example, so as to schedule a meeting, user can dispatch mobile agent over the network to communicate with agents that belongs to other users. Agent can negotiate its time conveniently with other agents for all mobile users and can plan the meeting.

7.3   Brokering

Mobile agent technology is considered as an attractive solution to brokering, specifically to the context of untrustworthy collaborators. In those situations, willing parties can generate an agreed impartial alliance form and secure host by negotiation.

7.3 Information retrieval

Mobile agent technology offers effectual information retrieval. While dealing with huge amount of data, in spite of moving the entire data to search engine to generate a search indexes, user can easily dispatch mobile agents to remote sources to offer those indexes locally and to move them back to its origin later.

7.4 Telecommunication services

Mobile agent gives an effectual and flexible solution to advanced telecommunication management services by offering user customization and dynamic network reconfiguration.

7.5 Workflow applications and groupware

Due to its characteristics like autonomy, mobility and so on. Mobile agents offer autonomy to workflow item and assist information flow amongst co-workers.

7.6 Monitoring and notification

A mobile agent as a local representative for remote services, it carries out the task as a representation of user, in regardless of considering whether the user is connected to network or not [17]. For instance, user can distribute mobile agent via internet to sense stock prices and to notify them while a specific threshold is attained.

7.7 Information dissemination

Mobile agents demonstrates Internet Push model which distributes information like software updates and news for vendors. Mobile agents carry installation and up-gradation process directly to personal computers of users and without user intervention manage and update software on computer.

7.8 Parallel processing

Mobile agent technology can offer parallel processing tasks administration. If computation needs huge amount of processing power to distribute data amongst multiple processors, mobile agents assist in attaining the process over there.

VIII. MULTI-AGENT SYSTEM (MAS)

Programmers have the ability to decompose a system to perform multiple tasks and allocate those tasks to diverse agents. Thus from programmers' point of view, it can be extremely simple to program those systems. Multi-agent system architecture is more appropriate for systems like e-commerce where certain criteria changes over time by the agents. Multi-agent system works in various forms. They are:

8.1   Homogenous non-communicating MAS

In these systems, all available agents are configured with same objective, probable actions, knowledgebase and decision process. The major differentiation relies on how it receives input from them, where it is located and how it takes essential actions. Even though these agents are alike in its actions, knowledge of agents in internal state is restricted. Henceforth, one agent cannot recognize the actions of other agent. Most information filtering agents utilizes this architectural type.

8.2   Heterogeneous non-communicating MAS

Agents involved in this type of architecture will be configured with diverse goals, domain models, decision procedures, actions and so on. These agents acts either as competitive or benevolent, that is, it can integrate with one another to attain its mutual objective or to actively produce obstacles to one another. Co-operation is an important crisis, which plays a role of constructing trust model to other co-operating agent. In heterogeneous system, devoid of any communication, agent does not hold any knowledge base, goal and decision procedures of other co-operative agents. Henceforth, it has to model itself through observation.

8.3   Heterogeneous communicating MAS

In this type of communication, the agents involved in this functionality may vary in its objective, actions, domain models, decision procedures and so on. Moreover, communication between those agents can assists in effectual resource allocation and co-ordination [18]. Agents with similar goal and diverse abilities are grouped into one team. In that team, every agent is allocated with a role if it is a specialist. Team organizations along functional lines are dynamically formed for task allocation. Architecture for an e-commerce application should be flexible. It wants an agent with co-operative and trustworthy knowledge to attain its task inside larger problem solving framework. This can be attained by involving heterogeneous communicating multi-agent architecture.

IX.   NON-TECHNICAL HURDLES

9.1 Lack of a killer application

The most essential hurdle considered here is that there is no killer application specifically for mobile agents. Therefore, mobile agents are self-efficacy, when any specific application is measured as isolated. Instead of considering an entire system, set of applications can be executed with less effort.

9.2   Evolutionary path

A complete mobile agent system considers all the research issues and also considers the more restricted mobile code systems, investigators should be aware of illustrating the switch amongst mobile agents that can be made incrementally [19]. For instance, applets, mobile codes migrate from server to client for effectual interaction with user and for general use, and as well related commercial technology is also enhanced rapidly (quicker Java Virtual machines with one time compilation). In case of applets, next stage is proxy sites that recognizes mobile code and transmit from mobile user. Similarly, those proxies are initially provided to prevailing Internet Service Providers (ISP). As the primary function of those proxies are available in host mobile code, and ISPs will receive their payment directly from proxy service (in user subscription format, and not fixed rate), ISPs is willing to receive perceived security risks of mobile code. As mobile code security is tested over proxy sites furthermore, services themselves starts to receive/accept servlets, mobile codes are transmitted directly from client to server (proxy to server).

9.3   Revenue

The last significant hurdle is revenue flow problem and commercial images. For instance, it is not obvious that whether advertising is a feasible economic foundation for web sites, numerous web sites earn enormous money specifically from those advertisements [20]. If those sites facilitates mobile agents to easier access of site content, amount of humans visiting those web pages will be decreased presumably, and advertisements will not been provided. An improper implementation agent provides a negative perspective towards the services, although services are blameless.

X. CHALLENGES IN IMPLEMENTING MOBILE AGENTS

10.1. Security

Security is one amongst the major crisis that should be considered essentially during the implementation of mobile agents [21]. The significant properties of mobile agent are that, it can roam over the network intergalactic and can carry out its code over a foreign server system. This property makes it susceptible to malicious attacks from other servers or from other agents. There are two extensive areas to be studied in mobile agent security: 1) Host node protective from malicious agents and 2) agent protection from destructive hosts.

10.2. Host node protective from malicious agents

As mobile agent systems are open system, it can be easily captured by attackers. Attackers exist in the form of resource stealing, tampering, leakage and vandalism. Host performs mobile agent codes. Henceforth, mobile agents can handle access to host resources. This access provides power to mobile agents to handle attacks and other local agents, to deal with worms, viruses or deny services to other agents and so on. Numerous researchers in this field have been offered with a partial solution. Some solutions

provided are verification, authentication, authorization, hooks provision, digital signatures where an encryption system can be added, access restriction enforcement like sandbox architecture, proof carrying code and other limitations like memory or CPU usage. Moreover, to attain higher level security, agent has to surrender flexibility level or gain the expenses. System designers have to equalize this trade off carefully.

10.3. Agent protection from destructive hosts

It is extremely complex to safeguard an agent from malicious hosts that to specifically protecting a host from malicious agents. As hosts deals with mobile agents, they can verify agents' data and code. Therefore, it is very simpler for host to tamper agents' code or terminate it [22]. Some general methods to protect agents from host in co-operates limiting confidential data amount which is supplied to agents' routing in a secured environment, utilization of cryptographic algorithm or tamper proof hardware, providing effectual host behaviour and so on. Moreover, utilizing these techniques ay compromises open mobile agent system concept.

10.4. Portability and Standardization

Mobile agent technology facilitates program to freely migrate from one host to another in a heterogeneous environment. Code compiled in any platform independent representation, like java bytes codes are either compiled in native code or executed inside an interpreter, while it arrives in target machine. The usage of mobile agents is limited if code is not portable amongst mobile code systems.

Standardization is essential to make this code portable over mobile code systems. In recent times, certain standards addresses cross system communication and administration crisis, where an agent is compelled to migrate nearby machine that executes appropriate agent system indeed of desirable machine. Standards, formats, encoded migration state under certain execution environment has to be addressed.

10.5 Performance and scalability

For security and portability reasons, most recent agents are written in slow interpreted language. As an outcome, these agents accumulate network bandwidth and latency at an expensive high loads over service machines [23]. For example, if a mobile agent works faster in an inconsistency state, there are no network disconnections. Mobile agents generally takes longer time to carry out a task than conventional counterparts, as time is saved by eliminating intermediate traffic, which is much lesser in time involved for execution and migration overhead. With one time compilation surfacing like java, software fault isolation and so on. Some problems with slow execution of mobile code are improved. Moreover, numerous other problems included slow execution, migration overhead are to be addressed.

XI. MOBILE AGENT DESIGN GOAL

The concept of mobile agents is utilized in various application fields, from that diverse fields are specifically identified for electronic auctions, e-commerce and stock market. These fields require higher money transactions. The user will deposit money into a mobile agent when the agent is considered to be more confident about the security of money and agents should be trusted and aware of who is dealing with the money or while broadcasting some secure information [24]. This is one amongst the major cause which leads to higher investigational efforts in mobile agent security which has its own advantages while used in this field. As the name specifies, these agents remains to be mobile in nature, which leads them to travel over the network autonomously. Due to this nature, agents are more susceptible to diverse malicious attacks. These attack projects the mobile agent limitations in security field. Until all these attacks are resolved, mobile agent utilization will seems to be constraint without its potential fulfilment as in Table I.

XII. MOBILE AGENTS PROPERTIES

Mobile agents possess following properties:

12.1 Adaptive Learning

Mobile agents face diverse experiences and learn it to adopt them to certain environment. It can sense large network traffic and learn the trouble spots in network. With the experience encountered in network agent, agents can choose superior routes to reach its next host.

12.2 Autonomy

Mobile agents have the authority to take decision of its own. For instance, mobile agents are free to select next host and can decide when to migrate to next host. These decisions are obvious to users and decisions are considered to be an interesting fact to users.

12.3 Mobility

Mobile agents possess an ability to migrate from one host to another in the network.

Table I: Mobile agent systems and its advantages and disadvantages [24]

Mobile Agent System	Advantages	Disadvantages
ARA	➢ Concurrency is attained with fast thread package. ➢ Cloning facilitates duplicating their internal state. ➢ Cores act as 'service points' for agents in communication.	➢ No authentication process. ➢ No protection from remote failure. ➢ Supports only TCP protocol for transmission.
Agent TCL/D' Agent	➢ Extensive support for migration. ➢ Robust security mechanism.	➢ TCL is highly inefficient programming language compared to C or Java. ➢ No support for code modularization or debugging
Concordia	➢ Flexible mobile agent ➢ Support for agent persistency and collaboration. ➢ Robust security mechanism	➢ Large overhead generated for an agent since it has two images in storage. ➢ Synchronizing name services is a problem because of a large number of agents present.
Mole	➢ Runs on any JVM. ➢ Sessions allow for proper communication amongst the agent.	➢ Supports only Java. ➢ Support for only strong migration. ➢ Programming is not easy.
Voyager	➢ Is not syntax dependent hence, IDL is not required. ➢ Support for distributed computing platforms such as RMI, CORBA and DCOM.	➢ Only supports Java programming language. ➢ Not a strong message passing system.
Mobility-RPC	➢ For single, thread request 9% higher throughput than RMI ➢ For single thread request, 8% lower latency than RMI	➢ Only compatible with java.

XIII. SECURITY ATTACKS ON MOBILE AGENT ENVIRONMENT

Various security attacks encountered in Mobile agents are given below:

13.1. Masquerading

Masquerading attack platform attempts to mislead/misdirect the agent, by developing a trust as an original platform and attempts to alter or extract agent information, code and agents' state. Moreover, masquerading agent tries to handle confidential data or tries to manipulate management policies of this platform and can damage other agents with the damaged messages they manipulate. Masquerading any mobile entity either afflicts to the agent or platform of corresponding genuine platform or agent and trust that is ripened in any agent society.

13.2. Eavesdropping

Malicious nodes/agents constantly attempts to convert the ascertained data, flow control or code held by those agents. The task of identifying and eliminating this sort of attacks is onerous as in fig 3, as agent platform not out predicts communication but also recognizes every instruction that an agent carries out, all unencrypted data or public data that was carried out agents to platforms, and all the related data generated over the platform.
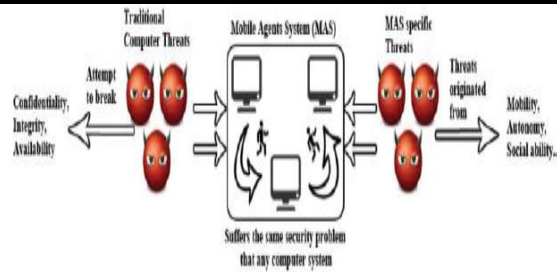
Fig 3: Conventional threats in MAS

13.3. Alteration/Tampering

While visiting any platform, an agent initially exposes its code, data and state to platform. Malicious platform wants to alter code of an agent, so agent carry out other task than the task intended by the originator, or else it attempts to modify the data available in the agent.

13.4. Unauthorized access

Access control methods are utilized to prevent unauthorized agents from accessing any resources of agent platform and services from which it is not utilized by any security policies. Else, it can sabotage other agent and platform over it.

13.5. Denial of Service (DoS)

Malicious platform may unintentionally or intentionally deny the agent services, when an agent arrives. This may occur due to following cause:

Deny an agent service abandoning agent to complete its task.

✓ Deny the service of agent by preventing agent to finish its task.

✓ Deny an agent request for time sensitive task and also prevent agent to fulfil its task by deadline.

✓ Terminating the agent services.

Mobile agents also initiates DoS attacks by exhausting excessive computing resources of agent platform by eliminating platform to offer services to other agents. These sorts of attacks are made intentionally by executing attack scripts or unintentionally through programming errors. In addition, agents can introduce attack against other available agents with firing messages, that is, useless information or false information, to other agents continuously and spamming mobile agents with constant messages.

13.6. Man in the Middle Attack

There are higher chances that an agent that rolls over the network can be attacked by other malicious agents or malicious platforms during itinerary. This attack is alike of Tampering or alternation attack. Moreover, alteration is carried out by agent platform or agent that executes over that platform during man in the middle attack. This attack happens without the knowledge of remote platforms and agents' data, code and its compromised state.

13.7. Copy & Replay Attack

A platform that is malicious to block any agent or message itself during its passage, or place a copy of it by generating its clone. The clone is then retransmitted to it.

13.8. Multiple colluded Attacks

This is one type of attack, where two or more platforms are collude either by generating data stream amongst platforms or dumps single data or dump the agent itself. Numerous investigators anticipate that 'k-response' model for recovering mobile agents when it is killed by other colluders.

13.9. Colluded Truncation Attack

It is alike of multiple collude, where some outcomes are gathered by agents from various platforms and dumped by more than one colluding malicious platforms.

This is also a security threat, where certain malicious mobile agents senses the gentle mobile agents and moves to the machine along with it. They trespass over vicious code with gentle agent or invalidate those gentle agent, thus it affects the entire system. This attack is categorized as 1) fake stem attack 2) Interleaving attack.

Fake offers are appended and genuine offers are truncated by attackers; where attackers break encapsulated chain provided by preceding platform. Thereby it offers slot for injecting fake offers.

13.10. Blocking Attack

Here, mobile agents are killed by venomous platform and therefore, it is not appropriate to move to its original state with accumulated outcomes or malicious nodes are not willing to broadcast mobile agent to next host. Blocking attack results in generating obstacle in mobile agent execution owing to malicious host or agent communication failure.

XIV. CONCLUSION

In recent times, mobile agent paradigm is measured to be an effectual paradigm in the data mining field. Even though the recent trends in internet technologies specifies the extensive utilization of mobile agents in near future, there exists certain technical and non technical constraints/challenges like security and it has to be resolved [25]. Moreover, if these challenges are fulfilled, some internet sites recognize these mobile agents and multi agent mobile system. The utilization of mobile agents are extensively spread therefore provides a rapid evolution of mobile computing.

14.1 Future direction

The role of mobile agents and its corresponding applications are still in an immature state. The conventional host orientation towards security is also to be considered, and focus towards protection mechanism in mobile agent concept is intended for protecting agent platform. Moreover, importance is given for developing techniques that are provided towards agent protection, which is a complex crisis. Providentially, there are huge amount of applications for agents where traditional and currently introduced security approaches should validate adequacy, till further progress is made. Subsequent wave of security enhancement for agent system is probable to starts from baseline of protection approaches, either with incremental refinements that decrease storage overhead and processing time or simplify usage mechanism or combination of complementary methods to construct effectual composite protection strategy. An opportunity for users is also provided to concentrate on these agent security frameworks; security designing tool; Management execution and anonymity.

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