AGENT BASED TRUST MANAGEMENT FRAMEWORK IN DISTRIBUTED E- BUSINESS ENVIRONMENT

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ABSTRACT

In e-business environment, Trust Management is an important factor that is necessary for all transactions. The basic e-business requirements like non-reputation of both trustee and of trustier are found to be problem arising due to lack of trust information. Many environments use relatively simple mechanism to calculate trust, for example, e-bay is a typical example for reputation based system built on centralized model of trust. Several frameworks have been designed by researchers based on reputation models, but all these mechanisms failed in preventing users from producing false information while making a reputation. Also sufficient information regarding the new users who have just started doing business online is not available.

To overcome the drawbacks of the existing system, a new trust management framework is proposed in this paper for a distributed e-business environment. The model offers the merits of previous trust management systems based on Trusted third parties namely Policy-based and Reputation based models. It also ensures trustworthy business transactions between the business entities and provides a more appropriate trust rating value calculated on the basis of mathematical model taking into account the feedback of peers and direct experience and access policy. The implementation using Agents is found to be more efficient with respect to time and trust calculation when compared to the model which works under non Agent environment.

KEYWORDS:

Trust management, Trusted transactions, policy based, repudiation based

1. INTRODUCTION

In recent years, electronic market places have been used to facilitate trillions of dollars in trade in the world economy. Traditional commerce activity during olden days took place through face to face interaction. In those commerce activities trust was not a major factor as sellers had direct

faith on the buyers based on the frequency of transaction which they made and through signing of some legal documents between the two parties. But in current e-business environment trust plays a vital role to identify person trustworthiness. Basically trust is a binary value with the choice whether to trust or not. Trust is a very basic entity for all e-business transactions. Usually, trust is assessed based on reputation recommendation through feedback or on previous history.

Generally two sets of mechanism are used to evaluate trustworthiness of a person using either the policy based or the repudiation based model. In policy based model a certified third party like verisign will issue the digital certificate and the trustworthiness of the client will be identified by checking the proof of identity. In repudiation based model usually customer feedback is used for calculating the trustworthy of a person. The lack of trust management leads to many fraudulent and collusive attacks. For example, e-bay follows a transitive trust model in which the recommendation of trustee is used to calculate trustworthiness. Current e-business trust models have some flaws, one of which is storing trust as an incremental value where the factors like period of duration of the previous transactions compared to current transaction will not be taken into consideration. Moreover, the current e-business trust models will not take the behavioral changes of a person into account while calculating the trust. Our current model focuses both on policy based and repudiation based mechanisms where factors like behavioral changes and time factor related to transaction are taken into consideration.

2. RELATED WORK

A Trust management framework has been designed for both policy and repudiation by A.Kannammal and N.Ch.S.N.Iyengar[1] . Here the Trust calculation based on the reputation models are built on direct feed back and are also based on the previous history of experience from others and from one's own experience. A model based on reputation is described by Shmatikov and Talcott [2], which analyzes a user's behavior and categorizes him/her for calculating Trust. A reputation based trust management for P2P networks is designed by Selcuk [3]. A reputation based trust management framework is designed for sensor networks where direct trust values are given by Ganeriwal and Srivastava [4]. This framework formulates a community of trustworthy sensor nodes based on their behaviors and also evaluates the trustworthiness. Though many systems and frameworks have been designed based on reputation models, these mechanisms do not prevent users from giving false information while making a reputation. Also, sufficient information is not available regarding the new users who have been

not in business for a long period of time or those who have just started the business online.[9] provides the description of current trust calculation and management procedures. Trust is considered as a binary decision which is determined either by reputation or recommendation methodologies. The trust model has been discussed by prescribing its credentials and policies by Sini Ruohomaa and Lea Kutvonen [9].

Based on access control rights and policy rules on hand, the users are allowed to access resources or to conduct business[10]. Security in e-commerce is enabled by authentication and non repudiation. Authentication provides the proof of identity whereas non repudiation, the proof of evidence. Public key infrastructure is the basis for both the techniques as mentioned above by Dr. Audun Josang, Nam Tran et.al.[10]. A public key which is certified by the authority will be provided to the owner. Trust is calculated based on evidence. Cheng Su et. al [8] combined P2P trust model and e-transaction characteristics based on experiences, recommendation from peers, risk factors and the transaction period of duration which is the difference between previous and current transaction history when predefined algorithms are used to calculate the trust value of each and every client who is involved in the e-business activity.

3. FRAMEWORK

The framework of the proposed system consists of different components like ITA (Intermediate Trust Authority), CTA (Central Trust Authority), CA (Certificate Authority).The architecture offers the merits of previous trust management systems by combining the approach of trusted third parties, Policy based and Reputation based models. It also facilitates real-time management in a globalized manner. This model has a component called Central Trust Authority (CTA) which maintains the trust information of all the entities involved in the electronic business. The different kinds of entities present in the system are: the customer with different roles as buyer and seller, the organization which does business electronically acts as a Intermediate Trust Authority (ITA), and the Certificate Authority (CA).The main functionality of ITA is to retrieve trust information from the Central Trust Authority (CTA) on behalf of individual customers. The CTA is assumed to have members from different countries to formulate the rules and policies. The Certificate Authority (CA) is an independent body that issues digital certificates and keys as an authority. The entities that want to do electronic business should get a digital certificate from CA. The details of digital certificate issued are maintained by CTA along with the rating value for trust information. The customers do transaction with ITA. The ITA's update the trust rating information in the CTA for the

corresponding entity. The ITA can also request information from CTA to analyze the trust rating of an entity along with the information that is available in its own database. This is the kind of peer to peer based

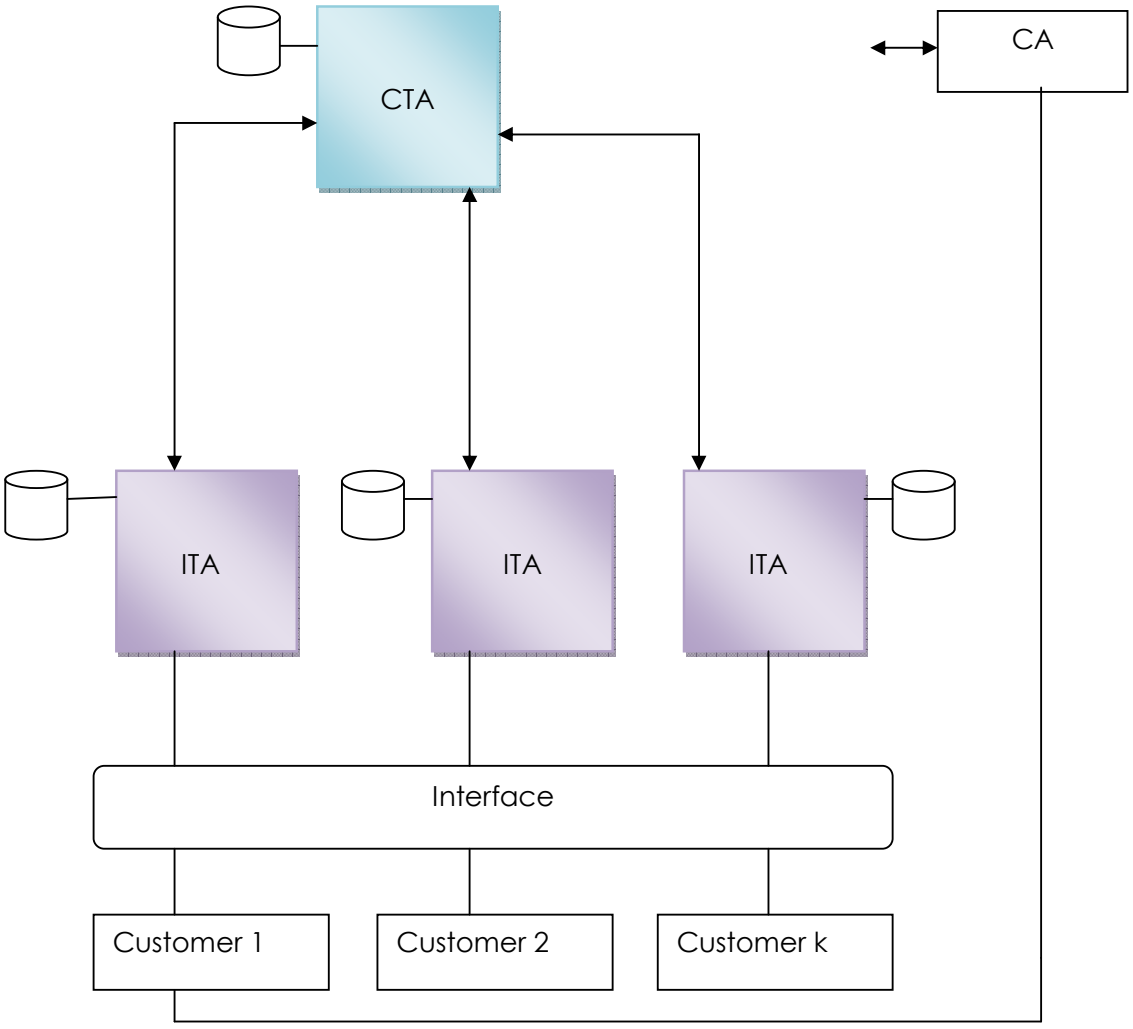

Figure 1: General Architecture of Trust Management without Agents [1].

model of trust management that combines with the centralized mode. CTA also holds the certificate information within the database. For example when customers makes a request to a ITA for doing transaction, customers will attach a Digital certificate along the request they send. If the Trustee wants to know about the customer, he can send the attached certificate to ITA. ITA will transfer the request to CTA where a copy of the certificate is already stored in the centralized database will be there. CTA will compare both the certificates and respond to

ITA whether the person is trusted one or not. ITA then intimates the person who requested for checking of trustworthiness. Later on he can proceed with the process of e-business transactions

The architecture shown below with agents is the same as the general architecture as above but has the advantage of scalability, as agents take care of doing the task independently. The agents used in this architecture are Certificate Authority (CA) Agent and Intermediate Trust Authority (ITA) Agent**.**

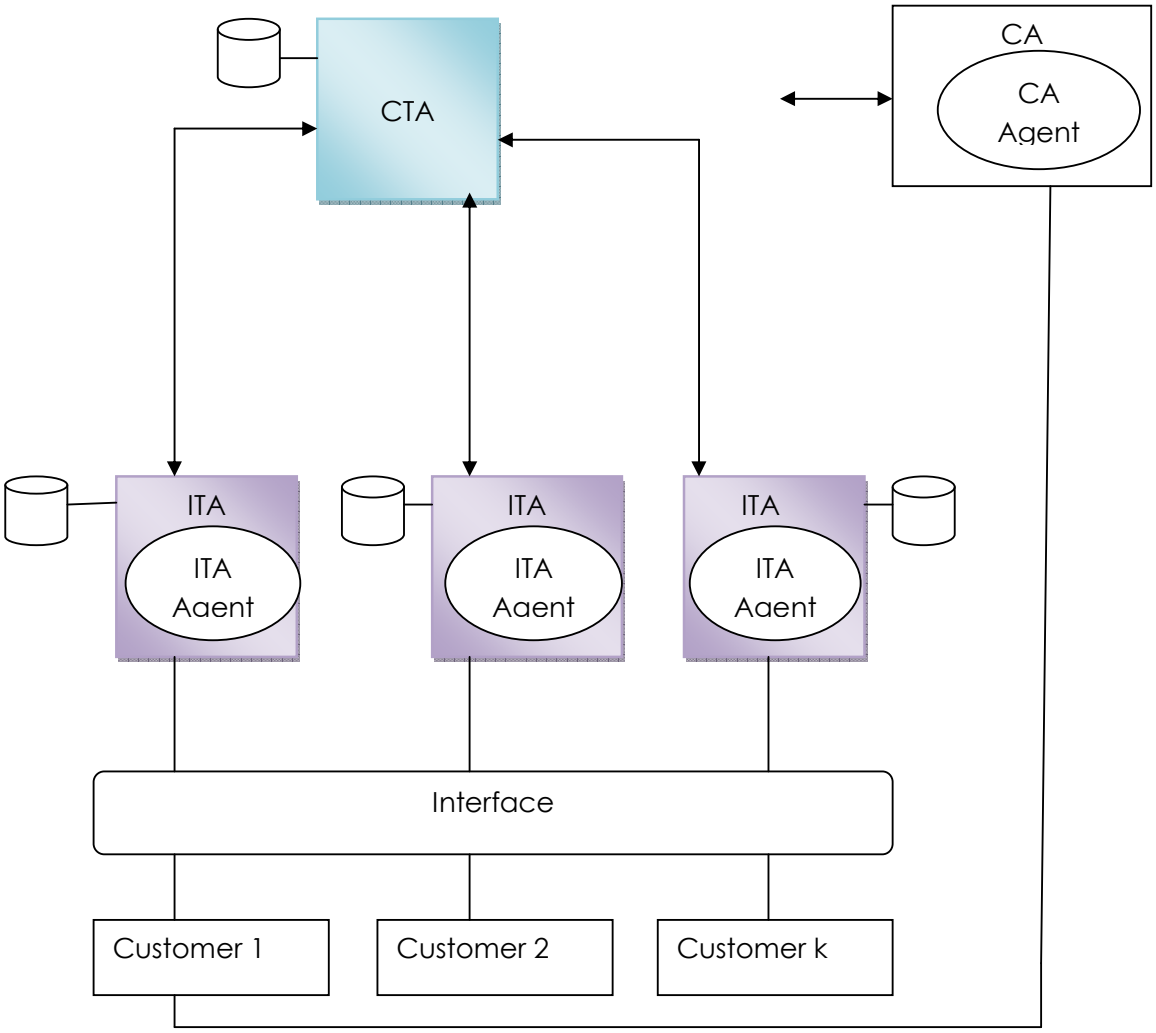

Figure 2: Architecture for Trust Management with Agents.

The Certificate Authority is responsible for creation of digital certificate in encrypted format and delivery of certificate by mail to intended customer. The Intermediate Trust Authority is responsible for providing platform for electronic business and retrieves trust information from the Central Trust Authority. The ITA Agent in Intermediate Trust Authority (ITA) is initiated

for every customer who interacts with ITA, and its responsibility is to retrieve trust information of different sellers and also to update newly calculated trust based on mathematical model in ITA and CTA on behalf of customer.

3.1 TRUST MANAGEMENT IN ITA

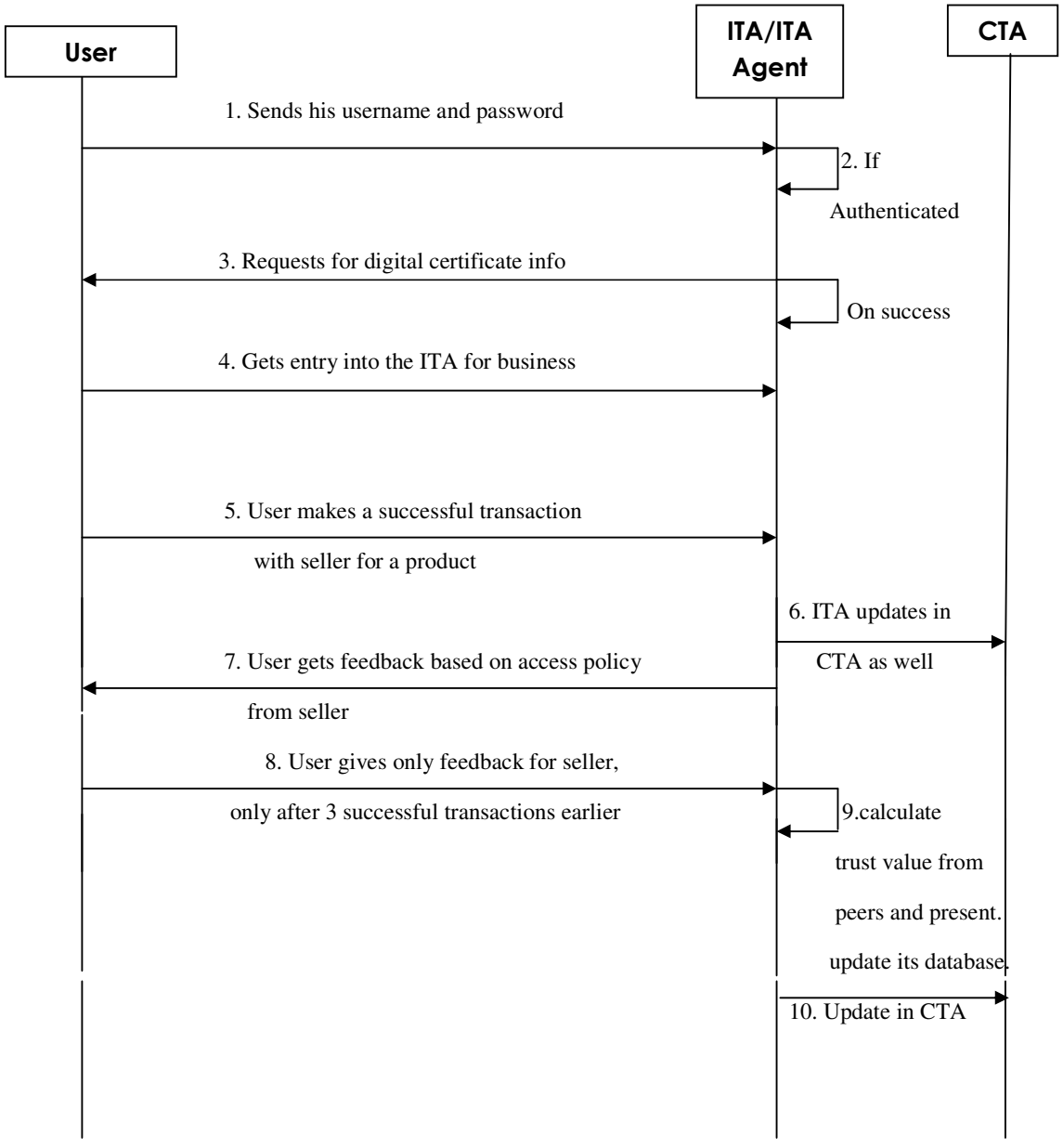

Figure 3: Sequence diagram for ITA with and with out agents

The trust management system in ITA is described in this section. This architecture is based on the distributed objects model. Various objects are used in distributed manner to update and maintain trust information of customers as shown below. Trust management system is responsible to capture and update trust information from the transaction. The main object provides an interface to the administrator of the system to manage the transactions, to create and initialize transaction objects whenever a client initiates a transaction. For each transaction, one transaction object is created; these objects are distributed in nature, collaborating with each other and also with the trust management system. Users can participate in more than one transaction at a time

The feedback details are maintained in the database. When the buyers evolve as sellers after a specified number of transactions with the specified transactions can give feedback for the customers also. By regularly updating the feedback information, the trust level information is maintained up to date. If any entity misbehaves, then its trust level is reduced by negative feedback and it can improve its trust level afterwards by its improved behavior. Also, information is outdated after some threshold period of time or after some transactions to reflect the current behavior of a customer.

4. SYSTEM IMPLEMENTATION: TRUST MANAGEMENT

The system implementation requires the development of three modules i.e. Intermediate Trust Authority (ITA), Central Trust Authority (CTA) and Certificate Authority (CA) and more importantly in this model, the trustworthiness is calculated based on customer's direct experience and feedback from other peers.

4.1 Feedback mechanism design:

The feedback value ranges between 0 to 1, Where 0 is not a trusted person and 1 is the most trusted person. Initially if a new customer logs into the site for the first time, his trust value will be set to 0 and subsequently for each and every set of transactions that he makes, the trust value will change dynamically.

4.2 Estimate Trust level based on direct experience:

The estimation of direct feedback is done by considering various factors such as transaction satisfaction, No of transactions, delivery time and transaction time etc..,

For each Transaction,

$$If\ (CurrentTransaction < N) \quad then \quad TL_d = \partial * TL_p$$
$$else \qquad TL_d = (1-\partial) * TL_p$$

Where, TL_d represents Trust based on direct experience, ∂ represents the relative significance where the value ranges between 0 to 0.1, N denotes the number of transactions and TL_p denotes the trust based on past experience.

Hence, $TL_d = S_d + \partial * TL_p + (1-\partial) * TL_p$

4.3 Estimate Trust level based on peer feedback:

In calculating trust from peers, ITA's will provide trust regarding each and every entity which is stored in its local database.

Feedback from peers $TL_f = \frac{\sum_{i=1} Ag_i TL_i}{\sum_{i=1} Ag_i}$, where, Ag_i denotes aggregate value of TL_i and TL_i denotes trust level estimation by the peer i.

4.4 Determine the Final Trust level:

The customer has to aggregate the results of the above two steps: trust level based on direct experience and the trust level based on feedback from peers. TL denotes the final trust level that is calculated as shown below.

$TL = TL_i + (1-\rho) * TL_p$ Where, ρ is the weights of direct and feedback estimation and the value ranges from 0.1 to 1.

5. EXPERIMENTAL RESULTS

The simulation environment has been developed in JAVA JDK5.0, using the Java Agent Development (JADE). JADE simplifies the implementation of multi-agent systems through a predefined middleware concept. It provides a common agent base class for creating user-defined agents, by extending the standard functionality of JADE and by implementing custom behavior (Bellifemine, G. Caire, T. Trucco, and G. Rimassa, 2005). JADE also provides features for interacting with the standard platform such as white book and yellow book services. For each

agent, custom behaviors can be defined and triggered by internal or external events. All users share the same ontology to be able to interpret messages from other agents. The messaging

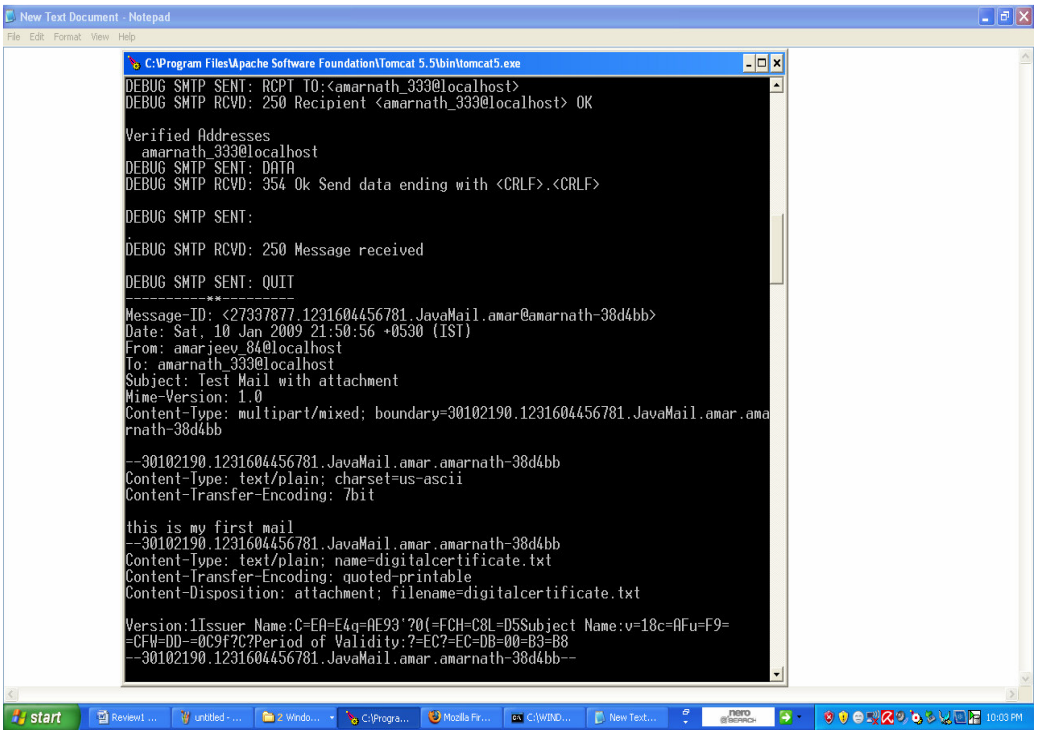

Figure 4: Snapshot of Apache server showing delivery of mail (without agent)

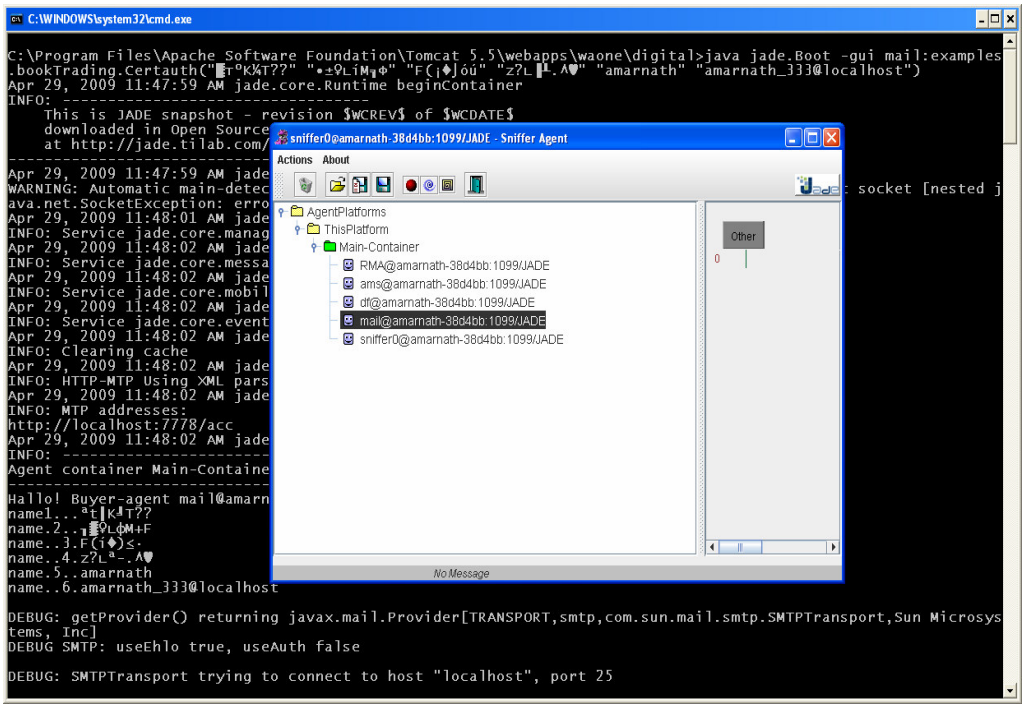

Figure 5: Snapshot of JADE Agent showing delivery of mail.

format in JADE complies with the FIPA specifications, which delivers a well-formed basis for a structured communication process. One further advantage of JADE is the support for distributed processing of agents in a network, which allows for scaling of the simulation environment. Also, since fully based on JAVA, agent objects are portable to other environments such as JAVA-enabled mobile devices.

Figure 5 shows the snapshot of apache server delivering the certificate to the registered client. Here the process involves the overhead of manually creating the certificate and sending it to the concerned client. In our paper we have tried to automate this process by using JADE agent in order to eliminate this overhead. The role of agent is to generate the certificate from details provided while registering for certificate. The agent creates the certificate and also mails it to the corresponding client. This small experiment has yielded us very good results. Figure 5 shows the JADE agent delivering the certificate through mail. The ITA agent will be there which will hold the previous trust values in her local database and compute the current trust value based on direct experience. When indirect trust value is calculated ITA agent does the process of retrieving the trust value of peers from the other ITA by making a request. The final trust value will also be calculated by ITA Agent which then stores a copy of the trust value in its local database and sends the value to CTA agent. The , CTA agent will update the new trust value in the centralized database.

We have developed an online shopping application using the frame work mentioned in this paper. This application is developed both with and with out agents. Table 1 shows the values of trust obtained during the transactions. We have considered around 2500 transactions. All the values could not be shown in the due to space constraints. Figures 7, 8, 9 shows the variation of trust values obtained from direct experience, peer feedback and final trust respectively against transactions. The graphs show that final trust value for a seller can be considered while buying a product.

Transactions	Direct Feedback	Peer Feedback	Final Trust
10	2	3	5
11	2	7	9
12	2	5	7
13	2	4	6
14	2	6	8
15	2	2	4
16	2	4	6
17	2	5	7
18	2	6	8
19	2	4	6
20	1	7	8
21	1	4	5
22	1	4	5
23	2	6	8
24	1	4	5
25	2	7	9
26	2	7	9
27	2	3	5
28	2	3	5
29	2	7	9
30	2	2	4
31	2	5	7
32	3	7	10
33	3	8	10
…..	…..	….	…..

Table 1: Trust values obtained from direct experience, peer feedback and final trust

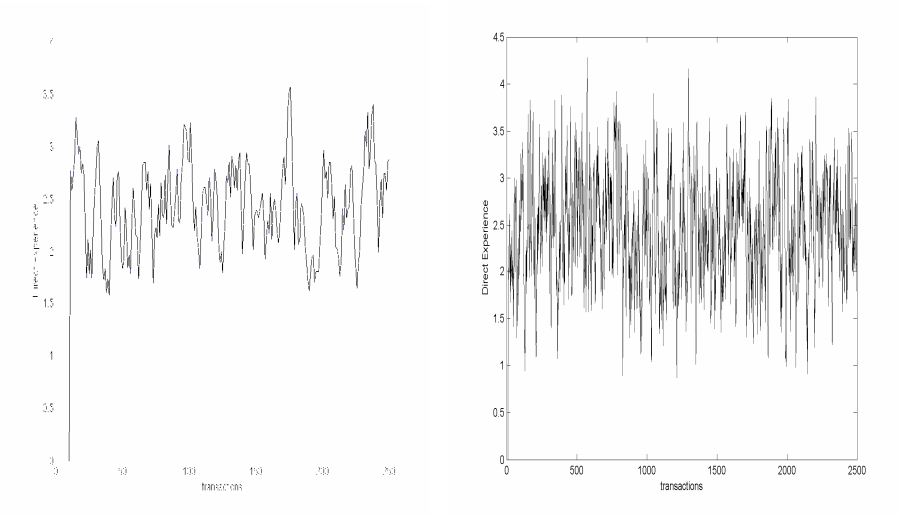

Figure 6: Variation of trust values obtained from direct experience with transactions

Figure 6 shows the variation of trust values that have been obtained from direct experience with atransaction. The First graph in the figure has been plotted by considering only 250 transactions, where as the next one is obtained by considering 2500 transactions. Minimum transactions considered for calculating trust value are 10. Figures 7, 8 also consist of two graphs obtained by considering 250 and 2500 transactions.

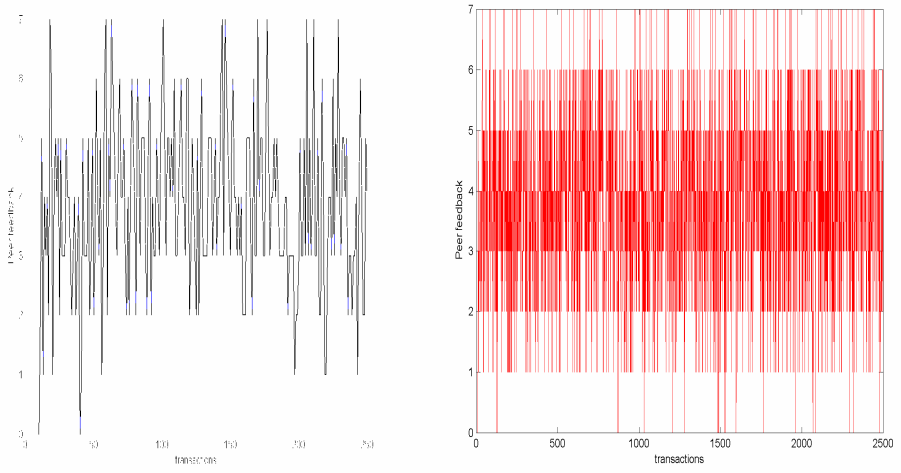

Figure 7: Variation of trust values obtained from Peer Feedback with transactions

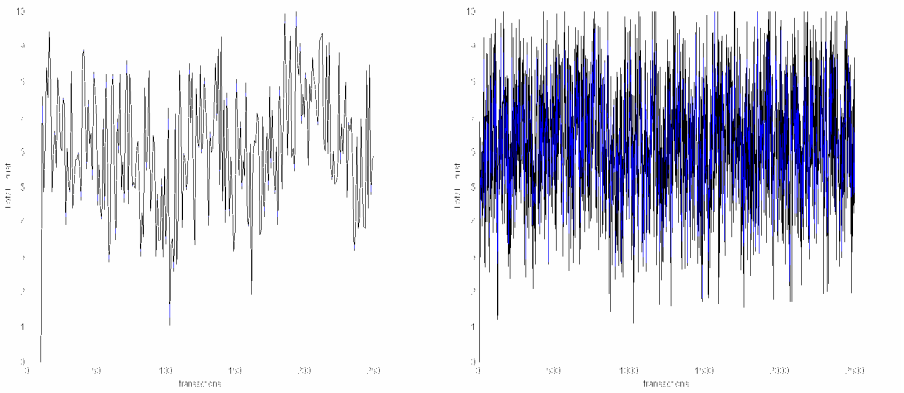

Figure 8: Variation of trust values obtained from Final Trust with transactions

The below figure 9 (a) & 9 (b) shows the variation of trust and time factor compared with Agents and without using the concept of agents. In trust calculation it shows a significance amount of variation whereas time factor is considered huge variation between agent and non agent environment.

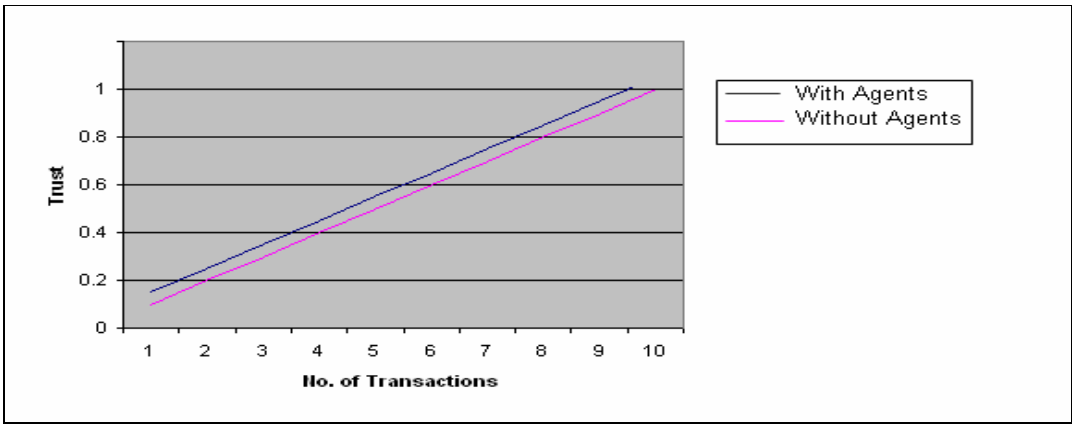

Fig.9 (a). Transaction vs Trust calculation with and without Agents

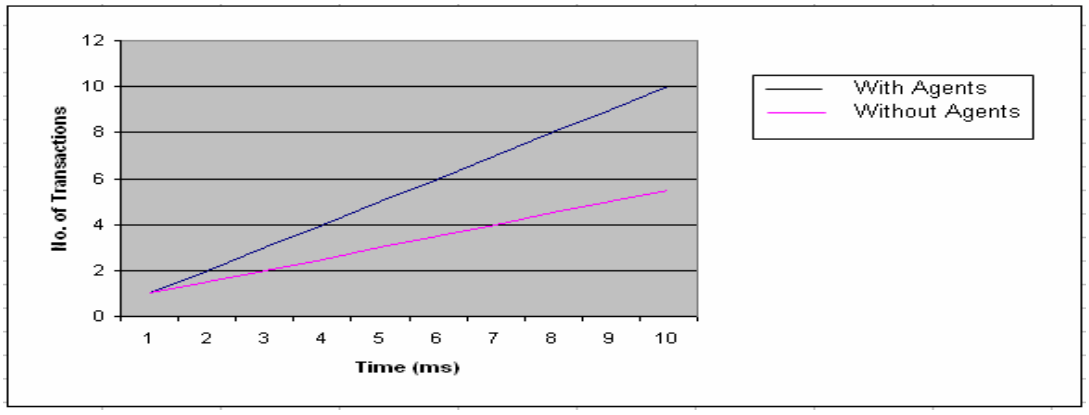

Fig.9 (b). Transaction vs Time factor with and without Agents

6. CONCLUSION

A framework which has been developed using Agents is found to be more efficient with respect to time and trust calculation when compared to the model which works under non-agent environment. In non-agent environment process such as certificate verification using policy based, Trust value updation and calculation using repudiation have to be done as a sequence of operations whereas in agent model architecture, separate dedicated agents have been developed for doing certificate verification and trust calculation which ultimately decreases time factor. The trust model that has been designed focuses on the behavior of the trustee to provide more accurate trust value. In repudiation based trust model, not only individual trust will be taken apart from the trust weight from peers but also give a more accurate trust value.

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