Design of a Reputation System for M-Commerce by Ad Hoc Networking

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Abstract – Trust development among traders in an ad hoc m-commerce trading system is needed to mitigate uncertainty and risks involved in transactions. It helps traders decide whether to trade with potential trading partners as well as to gauge the degree of confidence that they should give to these parties. One way to facilitate such trust is through use of a reputation system. However, the potential for ill-intentioned traders to subvert the reputation system makes the task challenging. This paper discusses key issues in designing a reputation system that can effectively facilitate trust development in such a community. It proposes a fully distributed approach that employs a sanction-backed mechanism to encourage traders to be truthful in providing reputation reports. It advocates letting traders maintain their own reputation information as well as share knowledge about other traders’ trading behavior in a peer-to-peer (P2P) manner without relying on network services that are always available.

Index Terms – casual local trading, ad hoc community, infrastructure-less service, peer-to-peer service

I. INTRODUCTION

Ad hoc m-commerce [1] offers interesting opportunities for more convenient and cost effective m-commerce transactions. It enables traders that are equipped with mobile devices, suitable networking capability and appropriate software applications to spontaneously organize themselves into a trading forum [2] and then engage in online trading when the need arises regardless of time or location. However, online commerce in such a casual local trading community is vulnerable to security attacks such as identity spoofing and man-in-the-middle attacks, as well as fraud and deception by trading counterparties [3].

To be a viable means to conduct online trading, ad hoc m-commerce must mitigate uncertainty and risks in its transactions by providing a means to foster trust among traders. A reputation system can be an effective means to do this. It provides a collaborative method for traders to assess the trustworthiness as well as predict the future behavior of other traders based on sharing past trading history and testimonials of tradeworthiness. It helps traders choose reputable parties to trade with and avoid dealing with dubious ones. However, designing a reliable reputation system for ad hoc m-commerce trading systems is challenging as traders cannot be expected to spend lengthy periods of time to obtain their potential trading counterparties’ reputation reports. Casual online trading is likely to take place over fairly short periods and not on an extended basis due to unpredictable network connectivity and irregular participation by its members. Another important issue is that ill-intentioned traders might try to subvert the reputation system by compromising the reliability of its reputation reports. Thus, to be effective in assisting traders make fast and reliable trust decisions, a reputation system for ad hoc m-commerce trading systems must provide high availability and efficient retrieval of relevant reputation information as well as be robust against attacks that could compromise the reliability of this information.

This paper presents the design of a distributed reputation system that lets traders maintain their own reputation information locally and share their knowledge about other traders’ trading behavior in a totally P2P manner without having to rely on network services that are always available. It advocates reinforcing this with a sanction-backed mechanism that lets traders collaborate to exclude any member that has misbehaved or has a poor trading history from a trading forum’s membership [2].

The rest of this paper is organized as follows. Section II defines the concept of trust in the context of online trading and describes how reputation information helps establish trust among traders. Section III discusses three key issues in designing an effective reputation system for ad hoc m-commerce trading systems. Section IV gives a brief review of some related work. Section V presents our approach and Section VI concludes the paper.

II. TRUST AND REPUTATION

This section characterizes the concept of trust from the perspective of online trading and discusses how reputation information helps facilitate trust development among traders.

A. Trust

Various views on trust [4] have been offered. We take trust to be evidently founded belief that one party has about
another with respect to its reliability and honesty in carrying out cooperative actions where there are significant risks of loss to the first party. This definition emphasizes three aspects of trust in the context of a transaction namely belief, evidence and associated risks.

A trust relationship is established between two traders when both parties have a belief supported by appropriate evidence that the other party is a reliable and honest party to trade with. Such trust enables the parties to view the downside risks in transactions such as being cheated through non-payment, the traded items not being as described and so on, as acceptable. The supporting evidence could include testimonials of a trader’s trustworthiness, history of evaluated trades, digital certificates and so on. A transaction is risky if engaging in it makes traders vulnerable to significant loss in terms of:

1) The item being traded
   Loss can be incurred if a trader does not get what he has paid for or has received items or money in exchange for goods that are less than promised in the trade agreement.

2) Trading opportunities
   A trader may lose opportunities to trade with other traders on better terms if his trading counterpart withdraws from their deal or forces inferior terms on the deal under the threat of withdrawal.

3) Reputation risks
   Engaging in a transaction with an ill-intentioned trader who then provides an unfair negative evaluation after the transaction can damage a trader’s good reputation.

4) Time and effort
   Loss can also be incurred in terms of the time and effort to get to the exchange place if one party does not turn up after making an agreement to do so.

A transaction that is potentially risky becomes acceptable if supporting evidence is sufficient for a trader to believe that his trading counterpart is a reliable and honest trader and the likelihood and impact of downside losses are low enough for that trader to expose himself to those risks.

B. Reputation

Exploiting reputation is an effective way to encourage cooperation and honesty in transactions by using past trading history to predict the future behavior of a trader. Studies [5]-[6] show that a reputation system helps to reduce transaction risks by providing a means for traders to develop trust relationships among themselves based upon their past trading history. This motivates traders to act honestly in each of their transactions to maintain a sufficient reputation to remain active in that marketplace.

Reputation systems have already proven useful in many commercial online applications. In eBay’s reputation system [5] a buyer can rate a seller by giving a positive, negative or neutral rating and also a short comment after the completion of each transaction. An overall score is computed based on the percentage of the total number of positive and negative ratings that a seller has received for the past 12 months. A buyer can also provide more detailed information about a seller by giving a 5-star rating on the aspects of item description, communication, delivery time and postage and packaging charges. An average rating for each aspect is published. A study by [6] shows that eBay ratings encourage users to engage in transactions offered by highly rated sellers and sometimes allows them to charge higher prices. However, unlike with our work, such online applications are able to use network services that are always available and can rely on a trusted centralized component to collect, manage and publish the reputation information.

III. DESIGN CONSIDERATIONS

A fully distributed reputation system for ad hoc m-commerce with high availability, efficient retrieval and reliable reputation information raises the following issues:

A. Relevant Reputation Information

Reputation reports to some degree reflect the trustworthiness of a trader. They can be a useful reference in assisting traders making trust decisions. In many existing reputation systems, traders build their reputation by a means of a deal evaluation which is provided after the completion of each transaction that they participated in. Positive evaluations can be used as proof that a trader has engaged in transactions before in a proper manner whereas negative evaluations are evidence that a trader has misbehaved or at least failed to satisfy in his previous transaction agreements.

However, the use of deal evaluations as the only relevant reputation information to evaluate a trader’s trustworthiness will make it difficult for new members in a trading forum to begin participating in transactions. They will struggle to get started as they can only build a reputation after they have participated in several transactions. A testimonial recommending that a trader is worth dealing with from a respected member of the forum could help them get started. Testimonials from well known reputable traders would also help established traders be accepted as reputable in addition to favorable evaluations of their past deals. Testimonials have value as well in helping traders who have been unsatisfactorily evaluated in a few deals to have these evaluations put in a wider perspective of relevant evidence.

B. Reputation Information Storage

Because an ad hoc m-commerce trading system lacks a network service infrastructure, is self-organized and has no centralized authority to manage each trader’s reputation reports, its reputation system has to be fully distributed. One of the challenges of a distributed reputation system is to decide where to store reputation reports. One approach is to store a trader’s reputation reports with his trading counterparties who have evaluated their trades with him or created testimonials recommending him. However, this approach requires a trader who is considering transacting with another trader to send reputation requests to as many potential recommenders as possible to elicit such reputation reports. This might generate unacceptable communication delays and could overburden other traders. Those third parties may also
be unreachable or no longer active in the trading forum at the time the reputation reports is required.

A second approach would be to store all reputation information in a trusted shared store that is always accessible and access it on demand. However, this approach is infeasible in ad hoc networked communities. These communities have no computing components that are omnipresent to host such a store. Nor can such a store be established in some distributed way across whatever nodes of the community happen to be connected by ad hoc networking.

A third approach is called a self-maintaining approach where traders store their own reputation reports locally. This approach minimizes communication overhead and delay as it does not require any reputation request to be sent to any other third parties and the requested party does not need to wait for recommendations from others. It will also make the retrieval of reputation information more efficient as it is stored locally and can be provided anytime by its owner when requested by others. However, if traders store their own reputation reports, two issues need to be addressed. The first issue is the integrity of the reputation reports as a trader may try to change them to increase his reputation dishonestly. The other issue is that a trader may refuse to supply or fail even to store negative information about himself.

C. Reliability of Reputation Information

The usefulness of a reputation system depends critically on the reliability of its reputation information. Unreliable reputation information will expose traders to the risk of significant loss if it incorrectly supports a good reputation for a dishonest trader. An ill-intentioned trader might try to compromise the reliability of reputation information by:

1) Providing unfair deal evaluations

Unfair deal evaluations can be categorized into at least two categories: overstating (unfair positive) and slandering (unfair negative). Overstating is where a trader inaccurately evaluates a bad or mediocre transaction as good. This may be poor judgment or done to boost the reputation of an associate. Slanderering is where a trader inaccurately gives a negative evaluation to a good transaction. Again this may be poor judgment or done to lower the reputation of a reputable trader.

2) Colluding with accomplices

There are at least two types of collusions; hyping and bad mouthing. In hyping, a trader colludes with associates to give him good evaluations or testimonials to increase his own reputation. He can then try to use his bogus good reputation for fraudulent purposes. Bad mouthing is where a group of traders conspire to harm the good reputation of a trader by each giving unfair negative evaluations to that trader.

Another way a trader can try to manipulate reputation information is by creating multiple identities (Sybil Attack) to create many bogus deal evaluations. For example, a trader creates multiple trading pseudonyms and corresponding certificates to enable him to create bogus transactions with those identities. He then uses those identities to provide good evaluations for each of the transactions that he has created, so that his own reputation will apparently be increased.

IV. RELATED WORK

The emergence of online trading communities has changed many aspects of conducting business and demands corresponding means for trust development among traders in such a community to minimize transaction risks. A considerable amount of research has been conducted into this issue and several solutions have been proposed [8]-[17]. Xiong and Liu in [14] have proposed a dynamic trust model for P2P e-commerce communities using a transaction-based feedback system where a trader’s trustworthiness is measured based on five factors, namely satisfaction, number of transactions, credibility of feedback, transaction context and community context. It is a fully decentralized system that uses an overlay for supporting trust propagation and a public key infrastructure for securing remote trust scores. This proposal is among the most credible yet for supporting decentralized support for P2P online transactions that require trust judgments. However, the assumption made in the proposal that network connectivity is always available for traders to obtain reputation information seems to be unlikely to be fulfilled in ad hoc m-commerce trading systems. This proposal also assumes that a reputable party will provide accurate deal appraisals, which may not always happen.

Jurca and Faltings in [16] have proposed an incentive-compatible mechanism using a side-payment scheme to encourage agents to report reputation information accurately. The side-payment scheme is organized through a set of agents that act as brokers to buy and sell reputation information. These broker agents are called R-agents. Agents can buy another agent’s reputation information from an R-agent at a certain cost F and then sell reputation information to the same R-agent at another cost F’. The integrity of reputation information and its binding to its owner is protected using a cryptography mechanism. However, this approach is vulnerable to collusions even when only two agents are involved. Any agent can collude with an R-agent to provide fake reputation information to other agents. Furthermore, it is not useful for trading parties in ad hoc m-commerce trading systems to store their reputation information with a third party as the availability of such reputation information cannot be guaranteed every time it is required. The party who stores the reputation information may not be online during the transaction period or may no longer be an active participant. It will take unpredictable periods of time for the requestor of the reputation information to get in contact with that party.

Another approach by Aberer and Despotovic [12] is based on a binary valued concept of trust, where an agent can only be trustworthy or not. In their approach, only information on dishonest transactions is used to evaluate the trustworthiness of each agent. If an agent discovers that its counterpart is dishonest in their transaction, that agent can forward a complaint about its counterpart’s misbehavior to other agents. To store the complaints in a P2P network, a decentralized storage method, called P-Grid is used. To evaluate the trustworthiness of a particular agent, an agent will search the leaf level of the P-Grid for complaints on that agent. The main interest in this approach is that it does not require any
centralized infrastructure for agents to assess the trustworthiness of other agents as well as to store complaints on each agent’s misconduct. However, the use of complaints as the only relevant data to assess trustworthiness is not an adequate way of evaluating an agent’s reputation. The absence of complaints is not positive evidence of an established reputation. Only a reasonable number of recently conducted mutually satisfactory trades is evidence of that. In addition to that, in Aberer and Despotovic’s approach, there is no consideration made of the possibility of an agent making an inaccurate complaint. It is important to consider this issue to ensure that there is little likelihood of a malicious agent undermining the purpose of the reputation system by compromising the reliability of a complaint.

V. OUR APPROACH

In this section, we propose a fully distributed reputation system that aims at providing an effective way to facilitate trust development among traders in ad hoc m-commerce trading systems. Our approach addresses the three key design issues discussed in Section III. The distribution of reputation information among traders will be done in a truly P2P manner. We assume that:

a) Traders trade through trading forums that operate a trading model such as for swapping digital resources or arranging to buy second hand goods for money and have policies governing forum membership and sanctions [2].

b) Each trader possesses their own private and public key pair supported by a PGP certificate that identifies a trader by a trading pseudonym and a photo along the lines of our identity support scheme [3].

c) Traders multicast a request for negative evaluations of traders in a trading forum every time they join a new trading forum and store such negative reputation reports whenever they receive them in their local repository.

d) Traders store reputation reports and certificates of other traders that they have dealt with before in their local repository.

A. Modeling the Trading Process

To participate in ad hoc m-commerce transactions, traders must first join a trading forum that offers services that they are interested in such as to buy and sell second hand goods. Under our approach, we expect that after a party advertises items to be traded and potential trading parties express their interest, traders will perform transactions according to at least the following four main steps, as shown in Fig. 1.

Fig. 1: Four main steps involve in an ad hoc m-commerce transaction

1) Exchanging trading standing

In this step, both traders will exchange their digitally signed trading standings which consist of a set of recent deal evaluations and any testimonials that they have as well as their membership voucher and PGP certificate. Each will check the PGP certificate [3] and membership voucher [2] offered as satisfactory. After evaluating each others’ reputation and checking their local repository to see if any negative reputation report or forum exclusion proposal has been made against the other party as well as considering the potential risk involved in the transaction, both traders will decide whether or not to enter into a transaction. A trader may receive responses from more than one potential trading partner. In this case, a trader needs to decide with whom to trade with after assessing the potential trading counterparties’ trustworthiness and considering the potential transaction risks.

2) Agree a deal

The traders will negotiate a deal based on the advertised trade. It will specify the terms including what is to be exchanged for what and how this will be affected. If both of the traders decide to proceed with the transaction, the process will continue with both parties digitally signing a transaction contract which is produced by instantiating it from a standard pattern approved by the forum.

3) Direct interaction to complete transaction

At this stage, if no party repudiates the contract, the transaction will take place where both traders will interact directly to try to complete the transaction. This will involve a step of verification during which each party will assess whether the offered resource or item is as described or whether the money or swap offered is as agreed. The identities of the parties will also be further verified by checking that the photograph on the other trader’s PGP certificate resembles his current appearance [3].

4) Exchange deal evaluations

After the completion of each transaction, traders are expected to generate a deal evaluation about the trade, digitally sign it and then send it to their trading counterpart. The deal evaluation will also contain the transaction contract that is digitally signed by both parties involved in the transaction [3]. Poor evaluations can be circulated more widely in the trading forum at either trader’s choice.

There are many ways in which traders can evaluate their trading counterpart’s behavior in satisfying their trade. The simplest one is to use a one dimensional evaluation parameter where 1 is used to indicate a good transaction and -1 to indicate a bad transaction.

A second approach which we intend to use employs a more differentiated scheme with the following parameters:

- Honesty in describing what is traded
  This expresses a trader’s satisfaction as to the quality of the traded items being as described.
- Conformity to agreement
  This expresses a trader’s satisfaction with how well the other party has fulfilled the transaction agreement, e. g. made payment or delivered the traded items as agreed.
- Manner of dealing
This expresses a trader’s satisfaction with how well the other party behaved in doing the deal. Did they act in good faith or did they try to take unfair advantage or cheat.

Traders can also qualify their satisfaction by leaving textual comments. To express the amount of satisfaction for each parameter, we will use a 4-category grading scheme as shown in Table I to signify fully satisfied, satisfied, unsatisfied or wholly unsatisfied.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Honesty</th>
<th>Contractual Compliance</th>
<th>Manner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Satisfied</td>
<td>Traded items exactly as described</td>
<td>Fulfilled their end exactly</td>
<td>Behaved well</td>
</tr>
<tr>
<td>Satisfied</td>
<td>Traded items roughly as described</td>
<td>A bit late or not quite as agreed</td>
<td>Grudgingly but roughly acceptable</td>
</tr>
<tr>
<td>Unsatisfied</td>
<td>Traded items not at all as described</td>
<td>Late payment or non-delivery</td>
<td>Tried to take unfair advantage or failed to deal fairly</td>
</tr>
<tr>
<td>Wholly Unsatisfied</td>
<td>Traded items not at all as described</td>
<td>Non-payment or non-delivery</td>
<td>Cheated or tried to cheat</td>
</tr>
</tbody>
</table>

Consider for example, a scenario where trader A has bought a second hand bike from trader B in a selling or buying items trading forum. Trader B described the bike as new and never been used but when trader A went to collect the bike and pay for it, it is not exactly as described but is still in an acceptable condition. After the trade is completed, trader A might give the following evaluation to trader B, as shown in Table II. This scheme enables the evaluation given by different parties to be comparable as it involves only four categories of degree as well as being simple for traders to understand. To aggregate such evaluations data, a simple summation scheme might be used by trader A to total up the number of reliable ratings received by trader B for each parameter. For example, trader B with 10 recent transactions in the past 6 months with parties known to A might have the following deal evaluations summary as depicted in Table III. In the honesty column, it shows that 5 out of the 10 known trading counter-parties are fully satisfied with that trader’s honesty, 3 are satisfied, 2 unsatisfied and none wholly unsatisfied.

### TABLE II: EXAMPLE OF A POSITIVE DEAL EVALUATION

<table>
<thead>
<tr>
<th>Honesty</th>
<th>Contractual Compliance</th>
<th>Manner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfied</td>
<td>Fully Satisfied</td>
<td>Fully Satisfied</td>
</tr>
</tbody>
</table>

### TABLE III: EXAMPLE OF A DEAL EVALUATIONS SUMMARY

<table>
<thead>
<tr>
<th>Deal Evaluations Summary: last 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Transactions : 10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Honesty</th>
<th>Contractual Compliance</th>
<th>Manner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Satisfied</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Satisfied</td>
<td>3</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Unsatisfied</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Wholly Unsatisfied</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

A third approach adopted by some reputation systems evaluates trades by means of a rating using a single numerical value. For example, trader A gives a value 0.9 to trader B for satisfying their transaction agreement on a scale of 0 (bad) to 1 (good). However, single numerical measures like this misleadingly suggest that one dimension of valuation sum up all the key qualities at stake to quite a fine degree of precision.

We suggest it is more intuitive to differentiate out different quality aspects and grade them among a few categories of degree as well as allow short free text comments. However, our approach to a reputation system does not mandate use of any particular scheme of evaluation. We only require that whatever scheme is used clearly distinguishes good from bad evaluations to suitable degrees so that software can summarize such data.

By allowing traders to store their own deal evaluations locally, the retrieval of reputation information will be more efficient as it can be accessed immediately by its owner when requested by others without having to rely on any other third party to supply it. This reduces communication overheads among traders. It also addresses the availability issue for much of the reputation information as well as simplifies the storage issue in ad hoc m-commerce trading systems. The evaluator’s private key that is used to digitally sign the deal evaluation will guarantee its authenticity and integrity. It will also ensure that the evaluator cannot credibly deny having made that deal evaluation.

To guard against traders discarding or withholding poor evaluations of their trades, we propose that traders multicast markedly poor evaluations of trades within the trading forum. Recipients would be expected to store such data but could condense or expire it as it ages or threatened to exceed allocated storage space. We also recommend that trading software implementing our approach provide no convenient means for users to discard or filter out unwanted recent evaluations when sharing evaluation data. For testimonials we intend to use the template as shown in Fig. 2 to capture tradeworthiness recommendations. Its structure helps elicit key aspects and makes comparisons easier to make. An alternative would be to use unstructured text of a certain maximum size. Either can be employed.

How long known: ___________months / years
Known in what capacity: < short free text >
Honesty: < short free text >
Good Faith: <short free text >
Keens Their Word: < short free text >

Fig. 2: Testimonial Template

### B. Mitigating Poor Trading Behavior

We recommend using exclusion from membership of a trading forum to sanction traders that misbehave or have a series of poor deal evaluations [2]. This mechanism enables any trader who has evidence about a particular trader’s misbehavior to multicast a proposal to exclude that trader from a trading forum’s membership to other traders in the trading forum. The exclusion proposal will consist of the target party’s trading pseudonym, brief reasons for the exclusion and also the digital signature of the party who makes the proposal [2]. To reduce the risk of traders being unfairly excluded from a particular trading forum’s membership, traders are expected to check the credibility of the sender of the exclusion proposal, whether poor evaluation
reports have been broadcast about him or whether he himself is the subject of an exclusion proposal. As the decision for the exclusion will be based on collective decision making by any sufficiently large number of current forum members, depending on each trading forum’s exclusion policy [2], traders with views on the proposal will have the opportunity to give their vote. If they do not regard the sender of the exclusion proposal as a credible party, they can vote their disapproval. Having a stringent exclusion policy helps diminish the possibility of unfair exclusions due to collusion among ill-intentioned traders as they need to have a large number of associates in order to obtain a quorate decision for the exclusion. The sender’s digital signature on the exclusion proposal will ensure that he is accountable for any exclusion proposal that he has made.

Thus, a trader who makes a habit of providing unfair negative evaluations or colluding with accomplices to harm other traders’ reputations or unfairly try to exclude them, will also be open to the risk of being excluded from membership of a trading forum if other traders receive poor reputation reports and an exclusion proposal from one of his unsatisfied trading counterparties. As mentioned in Section III (A) above, testimonials from respected reputable traders in the trading forum can be valuable evidence to rebut a trader’s poor evaluation report if they can be obtained. The exclusion mechanism will be a significant incentive for traders to desist from behavior that creates negative evidence that other traders can use as a basis for excluding them from a trading forum’s membership. Our proposed identity support scheme [3] will also make it difficult for them to reenter with a whitewashed new identity once they are excluded.

C. Mitigating Overstating and Hyping

The issue of overstating and hyping is challenging to tackle. It requires a mechanism that provides significant incentives for traders to remain honest under any circumstances. Our approach proposes using negative evaluations to defeat overstating and hyping as they have greater import than positive evaluations. Trading counterparties will be able to multicast negative evaluations about their subject’s trading within the trading forum, which could influence other traders not to trade with them or only do so on disadvantageous terms or even cause them to be excluded from a trading forum’s membership if they are seen to have received too many poor evaluations.

D. Mitigating Sybil Collusions

Sybil collusions can be prevented if trading systems can provide the means to constrain a trader from exploiting multiple identities. The use of a photograph in a trader’s PGP certificate as proposed in our identity support scheme [3] will make it difficult for traders to operate with multiple identities without this becoming apparent.

VI. CONCLUSION

In this paper, we have discussed three key design considerations in implementing a fully distributed reputation system for ad hoc m-commerce trading systems, namely relevant reputation information, its storage and reliability. Our aim is to design a reputation system with high availability and efficient retrieval of reputation information as well as reasonably reliable deal evaluations and testimonials in order to provide effective ways to facilitate trust development among traders in ad hoc m-commerce trading systems. We have presented our approach to address those issues. We have also proposed using a collaborative exclusion mechanism to encourage traders to provide truthful reputation reports and a self-maintaining mechanism to enable efficient retrieval as well as high availability of reputation information to assist traders in making faster and more reliable trust decisions.

With support from our proposed group membership service [2] and identity support scheme [3], the aim is that this type of reputation system will make ad hoc m-commerce a viable means to conduct online trading via ad hoc networking.

REFERENCES


