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RFTMS: Robust and Flexible Trust Management Scheme for Cluster based Mobile Ad-Hoc Network

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MANET is an infrastructure-less network made up of distributed nodes. It is a self-organized, spontaneous and dynamic network. In mobile ad hoc network, due to temporary cooperation among nodes, and lack of enough knowledge between each node in advance, it is difficult to establish trust. So, in MANET nodes are divided into number of clusters for establishing temporary network in order to perform certain actions more easily. In cluster based model, each cluster consists of one special node called Cluster-Head (CH). It maintains the communication among all the other nodes of its own cluster. It also communicates with other adjacent CHs through the gateway nodes. Gateway node can connect only two adjacent cluster-heads and is responsible for the purpose of inter cluster communication. Therefore clustering approach is dynamic and efficient enough to be applicable in the ad-hoc networks. But the efficient resource utilization and flexible trust computation at intra and inter cluster level are the most challenging issues for large scale cluster based MANET. Several trust based clustering protocols have been developed for MANET, but in practice most of them are inefficient to satisfy the above mentioned requirements due to high overhead and low flexibility. In this paper, we have designed a new reliable and enhanced trust management scheme for cluster based ad-hoc network based on Beta Reputation rating technique. In our scheme, trust calculation is done in two stages, *i.e.*, for intra and inter cluster level within the ad-hoc network. In both of the cases, we compute the direct and indirect trust for the Cluster-Members (CMs) and Cluster-Heads (CHs) respectively. The recommendation (indirect) trust will be needed whenever the direct communications between member nodes are absent. In our work we have applied beta reputation rating for the calculation of indirect trust. The direct trust between two CHs at inter cluster level is calculated through the gateway node because there is no direct communication between any two CHs. The recommendation information between CMs and CHs are avoided during direct trust computation. The mathematical analysis in this work shows that, our trust management scheme is resilient against the deceptive behaviour of malicious cluster-members and cluster-heads both at the intra and inter-cluster levels. Through the effective implementation of trust value computation, we have been able to reduce the memory space requirement, which ultimately results in reduced consumption of the transmission and reception power of cluster-members and cluster-heads and better resource utilization.

Keywords : Beta Reputation Rating, Cluster, Probability Density Function, Trust Management.

1. INTRODUCTION

Ad hoc networks have been widely used [1, 2] in scientific experiments, military, engineering, traffic control *etc.*, for observing the conditions of real time changes. In an ad hoc network, mobile nodes communicate with each other using multi hop wireless links. There is no stationary infrastructure; for instance, there are no base stations. These characteristics make it vulnerable to new security attacks not present in a traditional wired network. MANET provides some fundamental functions such as routing, message sending, network management which are performed by the nodes themselves in a self-organizing manner. Each node in the network acts as a router and forwards data packets for other nodes. The routing protocols play an important role in transferring data. With respect to security, mainly two basic routing such as

CHs.

Proof:
Scenario: When ($(n > f)$ and $T^R_{g_{kj},ch_j} \geq 25$)
We need to prove $T^R_{g_{kj},ch_j} < 25$ when $(n > f)$ for the axiom 4.$T^R_{g_{kj},ch_j}$, n and f represent the gateways to CH feedback trust, negative and positive feedback respectively. According to equation (11),

$$T^R_{g_{kj},ch_j} = \frac{[Rep(f',n')] + \frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}}{2}$$

$$T^R_{g_{kj},ch_j} = \frac{50(\frac{f-n}{f+n+2}) + \frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}}{2}$$

Now we need to prove $T^R_{g_{kj},ch_j} < 25$, when the amount of negative feedback is larger than positive feedback. Therefore the expression will be,

$$T^R_{g_{kj},ch_j} = \frac{50(\frac{f-n}{f+n+2}) + \frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}}{2}$$

$$T^R_{g_{kj},ch_j} = \frac{50(\frac{f-n}{f+n+2})}{2} + \frac{\frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}}{2}$$

We have already proved that the $50(\frac{f-n}{f+n+2}) < 25$ when $(n > f)$ in axiom 3. Therefore when negative feedback exceeds the amount of positive feedback$(n > f)$ we find that $\frac{50(\frac{f-n}{f+n+2})}{2} \leq \frac{25}{2} \leq 12.5$ and $\frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}$ value also less than 25 from the axiom 2 (scenario 1). Actually $\frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}$ expression represents the mean of k^{th} number of adjacent CHs to CH j's direct trust via the respective gateways. Thus we can derive that,$\frac{50(\frac{f-n}{f+n+2})}{2} \leq \frac{25}{2} \leq 12.5$ and $\frac{50(\frac{f-n}{f+n+2})}{2} \leq 12.5$ which implies,

$$T^R_{g_{kj},ch_j} = \frac{50(\frac{f-n}{f+n+2})}{2} + \frac{\frac{\sum_{i=1}^{k} T_{i,j}^{G_{ij}}(\Delta t)}{k}}{2} \leq 25.$$

Hence axiom 4 is proved.

7. CONCLUSIONS

In our scheme, a new reliable trust mechanism scheme has been proposed for cluster based MANET. It can improve resource efficiency and reduce the effect of malicious nodes by avoiding recommendation feedback between neighbour CM's. Our enhanced and simple trust evaluation scheme between CH's via gateway node can efficiently detect and protect against non-cooperative, selfish, and faulty CH's. Mathematical explanation shows that our scheme requires less memory and communication overhead as compared with other traditional trust management schemes in the clustered ad-hoc environment. This scheme can be applicable for any type of cluster based MANET. In future, there will be a scope to implement the trust calculation at both the intra and inter cluster level by using sophisticated methods like mathematical model, soft computing, etc. to achieve more accurate and reliable result in the clustered ad-hoc network.

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