Handling Hidden and Exposed Terminal Problems Using Agent Based Access Schema

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Abstract: **Ad hoc network is a collection of wireless nodes dynamically forming a topology without any existing infrastructure. Because of the absence of locality, it is highly open to number of hidden and exposed terminal problems. Hence it is essential to design a MAC protocol with more consideration. In this paper, a mobile agent based MAC is introduced which roaming across the network, gathering information about dynamically changing environment. The main purpose of this paper is to ease the hidden and exposed terminal problems.**

Keywords *- Ad hoc, Mobile agent, MAC, Hidden and Exposed terminals, Bandwidth efficiency.*

I. INTRODUCTION

In recent times there has been an increasing attention in the development of ad hoc networks. Studies on MANET [11] explore a lot of research topics these days. The term “ad hoc” implies that this network is established for a special purpose. The application areas of ad hoc network are battle fields, health care applications, and search and rescue applications in disaster situations, academic and industrial environments, sensor networks and so on.

Ad hoc network is a collection of portable nodes (such as PDAs, mobile phones, laptops etc) dynamically forming a transitory network without the support of pre-existing base station. Due to the lack of central access point, each node in the network acts as a router for sending packets from source to destination. The topology changes unsystematically in view of the fact that nodes are coming and moving out of the network aimlessly. The robustness of the topology is measured by taking the following parameters into consideration such as network size, number of nodes, speed of mobile nodes and the average number of links.

A. MAC Protocol Issues

Medium Access Control (MAC) protocols play an important role in the performance of the Ad hoc Networks [11]. A MAC protocol defines how each mobile unit can share the limited wireless bandwidth resource in an efficient manner. The source and destination could be far away, and each time packets need to be relayed from one node to another in multi hop fashion, a medium has to be accessed. Accessing a medium properly requires only informing the nodes within the vicinity of transmission. MAC protocols control access to the transmission medium.

Regarding the MAC protocol for a wireless ad hoc network, the performance measures such as throughput, delay, fairness, energy efficiency, multimedia support, stability, robustness against channel fading and power consumption should be considered. There are many issues that need to be addressed in order to design an efficient MAC protocol in a wireless ad hoc network environment.

Hidden and Exposed terminal problems

Bandwidth efficiency

Energy efficiency

Quality of Service (QOS)

Synchronization etc.

B. Hidden and Exposed Terminals

Hidden and exposed terminal problems are the challenging issue [1, 16] in ad hoc environment. Each and every node knows the surrounding area within their range as shown in fig 1. Node A is in the range of node B, node B is in the range of A & C, node C is in the range of B. But A & C does not know about each other’s vicinity.

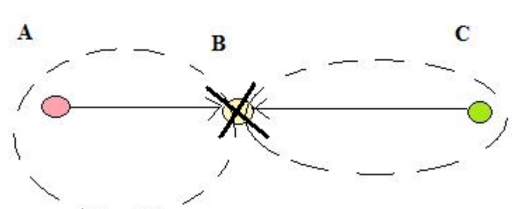

Fig.1. Hidden terminal problem

Therefore, if A & C tries to send data to B simultaneously, collision occurs at the receiver side B which

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leads to data loss. This is called hidden terminal problem.

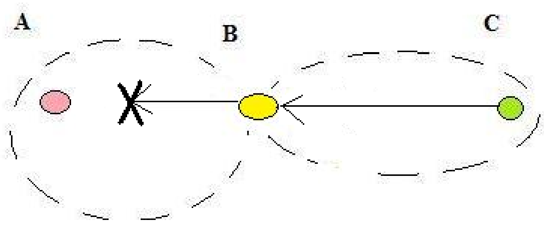

Fig.2. Exposed terminal problem

An exposed terminal problem takes place in the following situation as shown in fig 2. Node C is sending data to B and also B would like to send data to node A at the same time. But because of node C's transmission, node B mistakenly suspend its transmission to node A, although the data will reach the target node A without failure if node B transmits.

These hidden and exposed terminal problems reduce the efficient bandwidth utilization by the nodes. To handle these issues, agent based access scheme is used.

C. Mobile Agents

An agent is a piece of software that can act on behalf of the user. Mobile agents are software entities that move independently between network nodes and execute programs they carry with them wherever they are running [2]. Mobile agents are software components which migrate independently through the network [14]. Mobile agents are able to upgrade protocols in use by moving to a destination and setting up communications operating under revised policies [15]. Recently, [2] a number of mobile agent systems have been developed to address applications in areas including telecommunication services, E-commerce and personal assistance.

The rest of the paper is organized as follows. Section II provides the related works. The detailed description of agent technology is discussed in section III. Section IV presents simulation environment and expected results and finally section V gives the conclusion and future work.

II.RELATED SURVEY

The survey deals with the various MAC protocol issues and activities of mobile agents in variety of functions in ad hoc networks.

In [3], a mobile agent-based service discovery in ad hoc networks is developed. Mobile agents are traveling through the network, collecting the dynamically changing service information. The travel route and the number of travel agents are adjusted according to the information state and the change of network topology. This proposed scheme can significantly reduce the number of control packets and the overall traffic.

In [2], a new mobile agent routing protocol is presented. The agent-based algorithm implements a demand-based protocol that provides efficient routing at the application layer. The proposed algorithm provides an efficient and flexible routing using mobile agent to discover and maintain routes.

A new ad hoc routing algorithm is introduced in [4] without increasing network load. The proposed work is multiplying each entry in the routing table to store much more information from agents and evaluating them to make better use of information.

In [5], the Ant Hoc Net algorithm makes extensive use of ant-like mobile agents which sample full paths between source and destination nodes in a Monte Carlo fashion. It is a hybrid algorithm, combining reactive route setup with proactive route probing and exploration. The algorithm seems to benefit a lot from situations in which there are some regularities and correlations which can be learned and exploited for transport and path discovery. The algorithm also shows good scalability.

Mobile agent in [6] would act as a messenger that would migrate from a source and carry the message from a source to a destination. A mobile agent can migrate off a source node with a message and navigate autonomously throughout the network to find out the destination in order to deliver this message. For a large highly dynamic ad hoc network where each node has a pre-defined home location, agent based scheme for message delivery is much more efficient and effective, exploiting the basic theme of mobile agent paradigm: reduction of network traffic and ease of asynchronous interaction.

The research [7] proposes different models of the usage of static and mobile agents to determine the best route through ad hoc networks by gathering relevant information. These agents could perform important tests, which could be used to generate the best route through a network. The purpose of the paper is to improve over traditional schemes in terms of performance, scalability, end-to-end reliability and error handling. The metrics of description convergence and divergence is defined, and performed experiments which show that the obtained topology descriptions are very close to the actual topology. A technique is proposed for agent population control, and show that it is able to adjust the number of agents automatically as the size of the network changes. The techniques used for selection of agent destinations and population control depend only on information local to each node, with no additional communication between the nodes.

The proposed strategy [12] based on mobile agents and swarm intelligence for topology discovery in dynamic and decentralized networks is inspired by ant colonies, employing simple agents that disseminate information about the topology and communicate through stigmergy. It is shown that the stigmergy-based method for the selection of agent destinations produces better results than a random selection, and that the number of agents can be dynamically adjusted as the size of the network changes.

The paper [13] addresses the problem of data acquisition in ad hoc and sensor networks with mobile sinks and proposes a protocol based on swarm intelligence to route data in ad hoc and sensor network environments. The proposed protocol is based on a swarm agent that integrates the residual energy of nodes into the route selection mechanism and maximizes the network's lifetime by evenly balancing the residual energy across nodes and minimizing the protocol overhead. The protocol is robust and scales well both with the network size and in the presence of multiple sinks. The main drawback of the proposed scheme is the energy required to transmit the swarm agent packets to set up the routes, although most other protocols also incur similar overheads. Additionally, there is a small delay, in the order of few hundreds of milliseconds, associated with the setup of routes using the proposed scheme.

To address hidden and exposed terminal problems, the ready-to-send and clear-to-send (RTS/CTS) dialogue using the DBTMA protocol [9] has been proposed is based on the RTS packet and two narrow-bandwidth, out-of-band busy tones. The busy tone, which is set up by the transmitter, provides protection for the RTS packets, increasing the probability of successful RTS reception and, consequently, increasing the throughput. It is concluded that the DBTMA protocol is superior to other schemes that rely on the RTS/CTS dialogue on a single channel or to those that rely on a single busy tone. A power-save MAC layer protocol is offered in [1] by combining a busy tone, power control and power efficiency techniques with an internal matrix that keeps records of all the transactions that takes place in a station's vicinity. This feature results in a significant increase of channel utilization by avoiding hidden and exposed terminal problems.

III.PROPOSED SCHEME

A. Motivation

Many MAC protocols have been proposed for eliminating hidden and exposed terminal problems in ad hoc networks. In [1], an intelligent power efficient Ad Hoc MAC protocol with busy tone and power control to address these problems has been proposed. But because of the broadcasting nature of status message of all the nodes, it increases network traffic. If any node fails to send a status message for some period of time [1], other nodes will delete the records of the particular node from the database. In the proposed scheme, the mobile agent in one node will go to other nodes location and collects the information and returns back to the original place. Because of these agents information, each node knows the status of other nodes. So if any node is in transmission state, no other node will enter into transmission state in order to use the bandwidth efficiently and to avoid network traffic. Since there are no broadcasting messages and no network traffic, it will eliminate network overload.

B. Problem Definition

The problem is to diminish the hidden and exposed terminal problems in ad hoc networks using mobile agent technology.

C. Description

In a de-centralized network where the nodes are free to move randomly and forming a topology arbitrarily, the hidden and exposed nodes arise problems during transmission. Since it does not have the neighborhood information, it cannot take best possible decision regarding the current topology of the network and the nodes cannot share the channel resourcefully. To address these issues, mobile agents are used to deliver the necessary information about the recent location of the nodes in the network.

D. Mobile Agent Paradigm

A mobile agent is an autonomous entity that has the ability to communicate with other agents and host systems and consists of its code and state, which carries with it during the self-initiated migration [7]. Mobile agents can reduce network load and latency by running remotely and can react dynamically and autonomously to environmental changes.

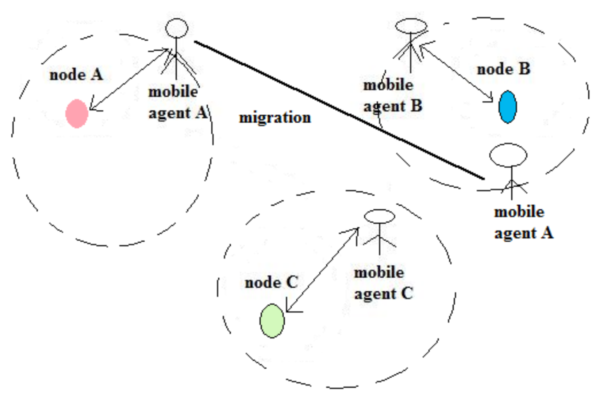

Fig 3: Mobile Agent System

The mobile agents are roaming in the network and updating their MAC table periodically as shown in fig 3. Whenever any new node enters into the network, the mobile agent of the node starts its execution automatically and collects the information regarding the network.

E. MAC Table

The MAC table contains the facts about all the nodes in the network. As shown in fig. 3, the mobile agent A migrates to node B and collects the information such as the node id (Nid) , current location of the node (LX,Y,Z), energy level of the node(En) and returns back to the original position and stores it in the node's database.

The agent also finds out the status of another node whether it is in ideal state (S0) or in transmission state (S1).

Similarly each and every node's agent migrates to other nodes in the network and periodically updates its MAC table as shown in table 1.

Table1. Sample layout of MAC table

Nodes	Nid	L(X,Y,Z)	En	State (S)
A	N1	L(1,4,9)	En>1	S1
B	N2	L(2,3,6)	En>1	S0
C	N3	L(5,7,1)	En>1	S0

The energy level of the nodes should be always greater than one. While sending data the receiver must have energy efficiency to receive the incoming data. If the energy level of the target node is zero the source node will not send the packet after checking the MAC table. Being familiar with the topology and the status, a node can take best possible decision regarding transmission.

F. Structure of a Node

Initially each node knows its id, current location and the transmission range of each other. The node itself maintains the database without using any static agents. After gathering the information about the network, the mobile agent returns back to the node and wait for some time (till timer expires) in order to copy the database from agent to node for updating the MAC table. If the agent comes with new information, the old records will be deleted by the node and the new records will be maintained. Since all the nodes are working in battery power, the energy level of the node is always medium. The transmission power of the packet is also medium since it has to aware of the power level of the nodes in the ad hoc network environment.

G. Agent Migration

The migration of mobile agent from one node to another is demonstrated in fig 4. In the beginning, the self initiated mobile agent starts its execution by updating its MAC table with the details of neighboring nodes within the range. After updating the MAC table, it checks the condition. If the condition is true the mobile agent moves to the node's location and collect the information and then it will move to the next node's location and so on until visiting the last node which is present in the MAC table. By incrementing the node id, it will check the condition whether the next entry in the MAC table contains node id or empty. After the last entry, the node id becomes null value.

Finally, if there is no entry in the MAC table, or it reaches the end of table, the node id will be indicated as NULL value. Then if any new node enters into the network, the mobile agent goes to the new node's site and gathers the information. After accumulating all the information, the agent updates the MAC table and again starts the process since the topology changes frequently.

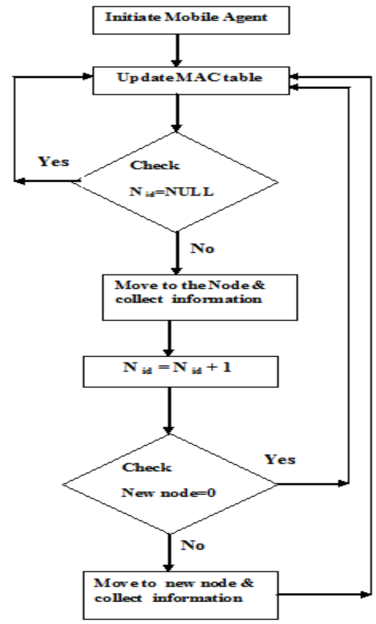

Fig 4. Flowchart for migration of an agent

H. Data Transmission

The state transition diagram of a node is illustrated in fig 5, which shows four states namely ideal, ready, transmit and wait.

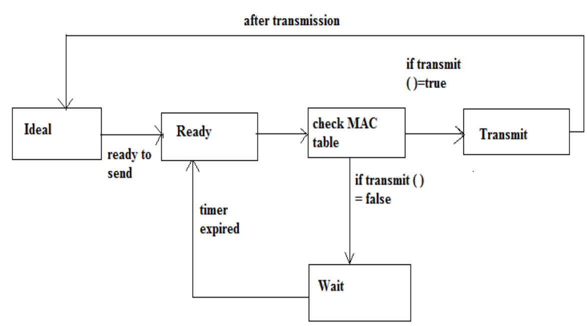

Fig.5 State Transition Diagram

Normally a node is in ideal state. If it is ready to send out a data it enters into ready state and checks the MAC table. If the status S of all nodes is zero and the energy level of the target node is greater than 1, it will move to transmit state and send the data. After transmitting the data, it returns to the ideal state.

If the status S of any node in the MAC table is one, it enters into wait state and executing the timer algorithm. If the timer expires it will move to ready state and again check the MAC table and so on. The timer is fixed to a certain threshold value up to the time it has to wait. The MAC timer value is changed according to the transmission time of a packet from source to target node. The transmission time is calculated according to the distance between the source and destination.

IV. SIMULATION ENVIRONMENT

A. Simulation Model

The agent based MAC protocol will be simulated in ns2 allinone 2.29. Basic assumptions for the proposed algorithm are as follows. The parameters considered for the Agent MAC protocol is listed in the table 2 given below.

All the nodes are having the fixed id and fixed transmission range.

The data packet for transmission of all the nodes is of same length.

MAC timers for executing the mobile agents are same.

The above assumptions are made in such a way that the nodes in the network has been assigned the id initially and if any new node comes into the network, the new id will be given to that node and the old ones will not be changed. The data packet transmitted by each node is of same size that is fixed before simulating. Because of fixed data size there is no need of calculating the packet size. The agent is given time to roam across the network to gather information. If the time is varied for every agent in the network, each node will not get the information simultaneously. So there is a minimum time set for all agents and within this time limit the agent has to collect information and returns back to the original place. These assumptions are made in order to concentrate completely in the usage of mobile agents to eliminate hidden and exposed terminal problems in ad hoc networks.

Table 2. Simulation Parameters

Parameters	Values
No. of Nodes	50
Network Size	10 * 102
Network Model	Ad hoc (IEEE 802.11)
Channel Capacity	3 Mbps
Mobile Speed	3m/s
Packet Size	512 bytes

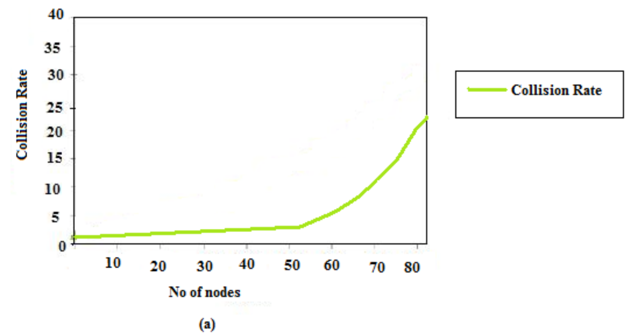

Fig. 6 (a) Collision rate vs. Number of nodes

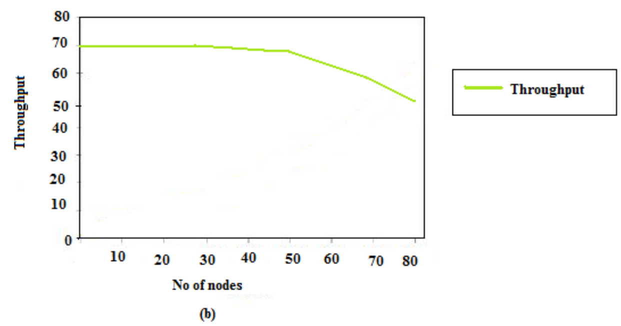

Fig. 6 (b) Throughput vs. Number of nodes

B. Results and Discussion

The expected result of the number of nodes versus collision rate is plotted in fig 6 (a). If the number of nodes increases the collision rate also increases. But collision rate remains stable for upto a small ad hoc network of 50 nodes and suddenly it will raise when the network size goes higher. So in a large ad hoc environment the number of nodes is directly proportional to the collision rate.

In fig 6 (b), the expected result of the number of nodes versus throughput is plotted and it is high for small ad hoc network and it reduces as the network size increases. Here the number of nodes is inversely proportional to throughput.

V. CONCLUSION

Several key aspects were discussed for designing such a new type of protocol, especially with an emphasis on mobile agents, which reduces the hidden and exposed terminal problems. This benefits in proper bandwidth utilization by reducing control overhead. We assumed some parameters as fixed in this algorithm. The mobile agent used in this proposed work reduces the network load and latency. We provided a state transition diagram for every node which will work according to the states it exhibits and timers for waiting state. Basic assumptions for setting the parameter values are provided for evaluating the new agent based MAC protocol.

Future work includes the evaluation of results and comparisons of the new agent MAC protocol with traditional schemes. This is well suitable for a small ad hoc network environment. For network scalability, we have to go for clustering concept in future.

REFERENCES

[1] G.Kalfas, G.I.Papadimitriou, P.Nicopo litid is, A.S.Pomportsis, “LE-WIMARK: An intelligent power efficient Ad Hoc MAC protocol with busy tone and power control”, 2008 IEEE.

[2] Lei Liang and Peter Graham, “Assessment of a Mobile Agent based Routing Protocol For Mobile Ad-hoc Networks”, 21st International Conference on Advanced Information

[3] R. Tobias Meier, Jürgen Dunkel, Yoshiaki Kakuda and Tomoyuki Ohta, “Mobile Agents for Service Discovery in Ad Hoc Networks”, 22nd International Conference on Advanced Information Networking and Applications, 2008 IEEE.

[4] Ryokichi Onishi, Saneyasu Yamaguchi, Hiroaki Morino, Hitoshi Aida, Tadao Saito, “The Multi-agent System for Dynamic Network Routing”, Proceedings of the Fifth International Symposium on Autonomous Decentralized Systems (ISADS.01), 2001 IEEE.

[5] Frederick Ducatelle_, Gianni Di Caro and Luca Maria Gambardella, “Ant Agents for Hybrid Multipath Routing in Mobile Ad Hoc Networks”, Proceedings of the Second Annual Conference on Wireless On-demand Network Systems and Services (WONS’05), IEEE.

[6] S. Bandyopadhyay, Krishna Paul, “Evaluating the Performance of Mobile Agent-Based Message Communication among Mobile Hosts in Large Ad Hoc Wireless Network”, Techna Digital Systems, Sector V, Saltlake SDF Building, Saltlake, Calcutta 700 091 INDIA Calcutta.

[7] Nikos Migas, William J.Buchanan, and Kevin A. Mcartney, “Mobile Agents for Routing, Topology Discovery, and Automatic Network Reconfiguration in Ad-Hoc Networks”, School of Computing, Napier University, EH10 5DT, Scotland, UK.

[8] D. Lange and M. Oshima: “Seven Good Reasons for Mobile Agents”, Communications of the ACM 42(3) (1999) 88–89.

[9] Zygmunt J. Haas and Jing Deng,” Dual Busy Tone Multiple Access (DBTMA)- A Multiple Access Control Scheme for Ad Hoc Networks”, IEEE transactions on communications, vol. 50, no. 6, june 2002.

[10] A. Mawlood-Yunis, A. Nayak, D. Nussbaum , N. Santoro, “Comparing Performance of Two Mobile Agent Platforms in Distributed Search”, Proceedings of the IEEE/WIC/ACM International Conference on Intelligent Agent Technology (IAT’04) 0-7695-2101-0/04 IEEE.

[11] Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks -Principles, Protocols, and Applications”, ISBN: 978 1 4200 6221 2.

[12] Bogdan T. Nassu, Takashi Nanya Elias P. Duarte, “Topology Discovery in Dynamic and Decentralized Networks with Mobile Agents and Swarm Intelligence”, 0-7695-2976-3/07 © 2007 IEEE.

[13] Hua Yang, Fengji Ye, and Biplab Sikdar,” A Swarm-Intelligence-Based Protocol for Data Acquisition in Networks with Mobile Sinks”,IEEE transactions on mobile computing, vol. 7, no. 8, August 2008.

[14] M. Wooldridge, N. R. Jennings, "Intelligent agents -theory and practice", Knowledge Engineering Review 10 (2), 1995, pp. 115-152.

[15] D. Lange and M. Oshima: “Seven Good Reasons for Mobile Agents”,Communications of the ACM 42(3) (1999) 88–89.

[16] G.Kalfas, G.I.Papadimitriou, P.Nicopolitidis, A.S.Pomportzis “WiMARK : An intelligent MAC protocol for Ad Hoc WLANs with Busy Tone and Power Control”,13TH european wireless conference , Paris 1-4 April 2007.