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Performance Evaluation of Secure Power Aware Routing Protocols for MANET

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***Abstract*—** Now a days, a most powerful routing protocols are being used between mobile nodes in the mobile ad hoc network (MANET). MANET is used because it is has the characteristics of decentralization, dynamic topology and neighbor based routing. This MANET can be established without any centralized authority. In this paper we propose an efficient secure power aware routing algorithm which maximizes the network lifetime and minimizes the power consumption during the data transformation by the usage of efficient algorithm we can improve the packet delay of ad-hoc network routing protocols. In this paper the modified secure power aware routing protocol is compared with distance vector routing protocol (DSR). The protocols are compared based on the quality of service such as packet delay, throughput, packet loss. The two types of data traffic used in modified secure power aware routing is constant bit rate (CBR) and transmission control protocol (TCP).And the results is simulated using Ns2.

***Keywords*—** dynamic topology, no centralized network, robustness.

I. Introduction

A Mobile Ad-hoc network is a network without any base stations "infrastructure-less" or multihop which is also a collection of two or more devices equipped with wireless communications and networking capability. The Mobile ad-hoc network which supports the mobility of any time and any where computing the mobile ad-hoc network having a two different types of topologies one is heterogeneous which topology is having the differences in capabilities and another one is homogeneous which is also known as fully symmetric. In this homogeneous topology all the nodes have identical capabilities and responsibilities. This mobile ad-hoc network commonly known as autonomous system and mobile ad-hoc network is a dynamic distributed system of wireless mobile nodes in which the nodes can move in any direction independent of each other it is used in the wide range of applications such as battle fields and rescue operations. Normally, MANETs have a several operating constraints such as limited battery charge per node, limited transmission range per node and limited bandwidth. A node consumes its battery power of each transmission and reception of data packet as more as it will transmit or receive data packet, power consumption will also be increased therefore it is very difficult to find and maintain an optimal power aware route. The main target is of proposed routing is to increase the lifetime of the overall network. Our goal is to minimize energy consumption of a mobile nodes at runtime. A Threshold value is set based on the normal behavior of the network. The path from source to destination is then rated and the most secured ones are selected for further communication. And also analyze the security framework that was used for route discovery. During the problem of finding routes when nodes are moving in ad-hoc network which results in consuming lot of system bandwidth and battery power to overcome this we proposed a new algorithm for energy consumption model using CBR Traffic and TCP Traffic.

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II. Related Work

Many research studies have been devoted for developing secured routing protocols. Different approaches can be applied to achieve the target. The target is to minimize the energy consumption of individual nodes. There are many routing path that can be discovered between the source node and the destination node. So in order to find the correct routing path threshold value is used. The threshold value can be described as a value which is constant to each node and every node having separate threshold value. All the nodes don't have the same threshold value. Every node has its own energy level. Threshold value is set based on the normal behavior of the network. Transmission power control and load distribution are the two approaches to minimize the active communication energy during inactivity. In transmission power control approach stronger transmission power increases the transmission range and reduces the hop count to the destination, while weaker transmission power makes the topology sparse , which may result in network partition and high end-to-end delay due to a larger hop count[8]. the OMM (Online Max Min) which achieves the same goal without knowing the data generation rate in advance [5].MER (Minimum Energy Routing) which addresses the issues like obtaining accurate power information [7].PLR (Power Aware Localized Routing) is a localized, fully distributed energy aware routing algorithm but it assumes that a source node has the local information of the neighbors and the destination [6]. LEAR (Localized Energy Aware Routing) protocol is based on the DSR but modifies the route discovery procedure for balanced energy consumption. Route maintenance has greatly enhanced the performance of the protocol in terms of the network lifetime and the packet delivery ratio. While discovering the path, destination waits for threshold time after receiving RREQ packets. During this time destination calculate link status ratio for every route from which it receives RREQ packet. Destination stores all possible route request for certain time [7][8]. The paths from source to destination are then rated and the most trusted ones are selected for further communication. We also analyze the security framework that was used for route discovery [10]. Quality of Service (QoS) refers to a set of mechanisms able to share fairly various resources offered by the network to each application as needed, to provide, if possible, to every application the desired quality (the network's ability to provide a service) [6]. The QoS is characterized by a certain number of parameters (throughput, latency, jitter and loss, etc.) and it can be defined as the degree of user satisfaction. The QoS support must take in consideration a number of Ad-hoc networks constraints (mobility, energy, scale, etc.). QoS can be introduced into different layers network if there is need (channel access functions at MAC layer, routing protocols at network layer, etc.).[8].

III. DYNAMIC SOURCE ROUTING PROTOCOL

In DSR, when a mobile (source) needs a route to another mobile (destination), it initiates a route discovery process which is based on flooding. The source originates a RREQ packet that is flooded over the network. The RREQ packet contains a list of hops which is collected by the route request packet as it is propagated through the network. Once the RREQ reaches either the destination or a node that knows a route to the destination, it responds with a RREP along the reverse of the route collected by the RREQ. This means that the source may receive several RREP messages corresponding, in general, to different routes to the destination. DSR selects one of these routes (for example the shortest), and it maintains the other routes in a cache.

IV. SPAR – SECURE POWER AWARE ROUTING

The algorithm increases the lifetime of the network and minimizes the power expenditure during the source to destination route establishment using a secure cryptographic method. This algorithm takes special care to transfer both CBR and TCP traffic by providing energy efficient and less congested path between a source and destination pair.

A. Methodologies of Power Aware Routing Protocol

Current research works mainly focus only on the selection of the path that is based on sum of energy of all the nodes in that path. But while calculating this, the energy level of the node less than the threshold value then the node is considered as dead node. The path should be selected only if all of the nodes have energy level greater than or equal to some threshold value. Also as volume of data is known, energy level of each node after transmitting the data can be estimated. The path will be selected only if the entire node survives after transmitting the data.

Route Selection Parameters

Step 1**:** Sum of the energy of path.

$$Eij = \sum_{i=1}^{j-1} Ei \quad (1)$$

Where Eij is the remaining energy of an intermediate node I, and Ei is the accumulated energy of path form i to node j.

Step 2: Battery Status (B_S)

Step 3**:** Type of Data transfer

a. Constant Bit Rate(CBR)

b. Transmission Control Protocol (TCP)

The destination has to wait for threshold time while selecting the route after route request (RREQ) packet is arrived. During this time destination decides link status ratio by using equation (1) for every arrived RREQ packet and stores all route request for certain period of time.

A1. Explanation of Power Aware Routing

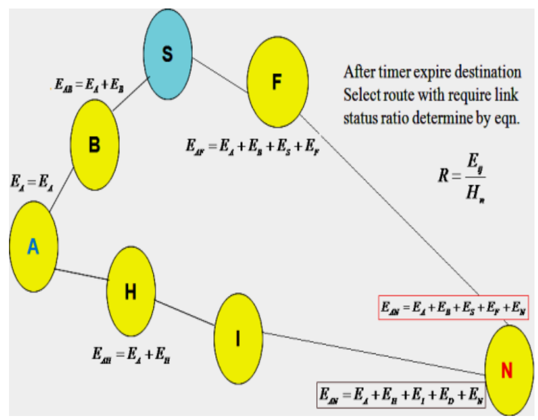


Figure 1.1: Design methodology of PAR

The destination node selects the route along with the link status ratio and sends reply to select path. While selecting the path the node should have the energy level greater than the threshold energy.

In figure 1.1 node A has energy greater than the threshold energy but node S has the energy less than the threshold energy hence node S is considered as the dead node. Hence the link is omitted and another path is selected.

B. Methodologies of SPAR

Step 1**:** The energy level of the node reduces after transmitting every packet.

Step 2**:** Source will send the total volume of data along with route request.

Step 3: After transmitting the complete data node will estimate its battery status.

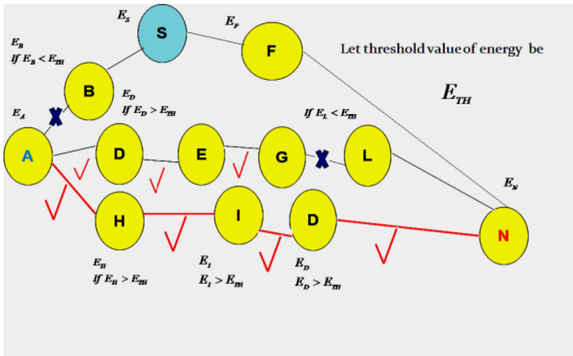
Step 4: If the energy level is below the minimum required level, then the path will be discarded by blocking the RREQ.

Algorithm

If

EXM>=EM

Then proceed



B1. Explanation of Design methodology SPAR

Step 1: The battery status can be estimated from the details sent by the node.

Step 2: The header file of the route request packet has the following information header file information.

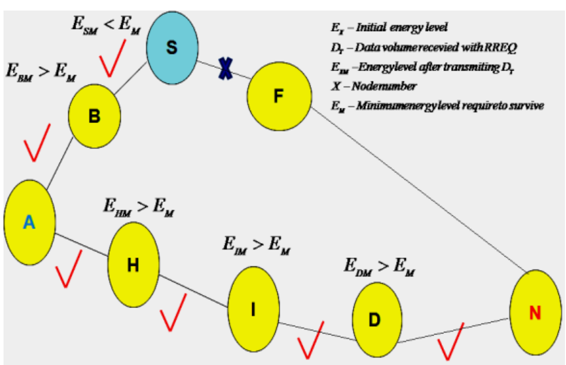
Step 3: Source id, Destination id, Type of Data to be transfer, Total Battery Status, Total Traffic level and Node id.

Step 4**:** By using the packets buffered in the interface queue of the node the total traffic level is calculated.

Step 5: After transmitting the volume of the data the battery status of node is estimated.

Step 6: Let's assume to forward one packet 1Joule is required.

Step7: While transmitting data from source, total packet to be transmitted will be send along with request node will calculate the remaining energy required.



4.1 Parameters on Each Node

Each node has 3 variables:

Node ID, Battery Status (BS)

and Traffic Level (TL)

1.Node ID : Used for node identification. Each node is identified by unique ID.

2. Battery Status (BS): Total energy at node.

3. Traffic Level (TL): Number of packets stored in the interface queue of the node.

Battery status is further divided into 3 categories:

1) If (Battery Status < 40%)

Then Set BS = 1.

2) If (20% □ Battery Status <80%)

Then Set BS = 2.

3) If (Battery Status =80%)

Then Set BS = 3.

4.2 Parameters to Concern during Route Search

At the time of route discovery phase, a route request (RREQ) packet send or broad casted by the source to all its neighbor nodes for getting information about the destination. The header of the RREQ packet includes Source id, Destination id, T_D_T (type of data to be transfer), T_B_S (Total Battery Status), T_T_L (Total Traffic Level), and Node IDs.

4.3 Calculation of Total Battery Status (TBS)

Initially TBS = 0 at source node.

When RREQ packet propagates along the path then TBS is updated at each intermediate node i as follows:

If (BS == 3)

Then TBS = TBS + 5

Else-if (BS == 2)

Then TBS = TBS + 3

Else-if (BS == 1)

No updating is performed.

4.4 Calculation of Total Traffic level (T_T_L)

1) Initially T_T_L = 0 at the source node.

2) Traffic status of each intermediate node is added at the time of route discovery.

Traffic level(T_L) is the number of packets stored in the interface queue of the node.

4.5 Route Selection Criteria at Destination Side

After a RREQ packet arrives the destination waits for the threshold time (Tth). During that time the destination determines the link status ratio (LSR) of the route for every arrived RREQ packet. Destination stores all possible route request for a certain amount of time (Threshold time). After expiry of timer, the destination node selects the route with the required LSR and replies for a path accordingly with secured node. Here link status ratio of a path is calculated using equation

R=Eij/Hn (2)

4.6 Energy Consumption Model

Energy consumption is calculated using equation (3)

Ec(t)=NT*A+NR*B (3)

Where Ec(t) , energy consumed by a node after time t.

NT-no of packets transmitted by the node after time t.

NT- no. of packet received by the node after time t.

A and B are constant factors having a value between 0 and 1.

If E is the initial energy of a node and Er(t)is the remaining energy of a node at time t, is calculated using equation (4):

Er(t)=E-Ec(t) (4)

4.7 Proposed algorithm and flowchart describe this decision

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CBR traffic implies that the packets are send at the constant bit rate and with constant interval between the packets.TCP is a connection oriented protocol and it is mainly based on three way handshake and flow control and congestion control.

CBR TRAFFIC

S and T from received packet R

Step 1: If(S==R)

Send positive acknowledgement

Step 1.1: Else

Send negative acknowledgement

Step 2: If(T==ST)

Send positive acknowledgement for data correctly received

Step 2.2: Else

Send negative acknowledgement for data dropped

TCP TRAFFIC

S sending & R receiving data

Step 1: If(S=R)

Send positive acknowledgement for data correctly received

Step 1.1: Else

Send negative acknowledgement

I input &O output queue

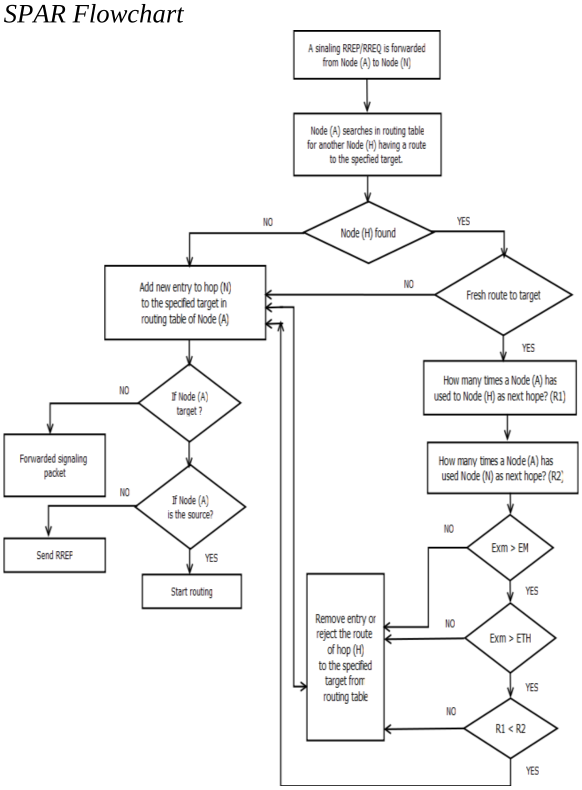
Step 2: If(I=R)

Send positive acknowledgement for data correctly received.

Step 2.2 Else

Send negative acknowledgement for data dropped.

SPAR Flowchart



V. SIMULATION

The proposed scheme is simulated using the network simulator NS-2 with the latest version NS-2.34 and the performance is compared with well known on demand protocol SPAR and DSR scenarios have been setup for 10,30,50 and 100 nodes in an area of 1000m*1000m.in the different scenarios from the small network to large networks value for packet delivery ratio has been observed by varying pause times from 0 to 500 and the speed has been changed from 1 meter per second to 25 meters per second mobile or wireless network which have been used following values for different parameters.

PARAMETER	VALUE
Simulator	NS-2 version 2.34
Simulation time	100s
Number of nodes	10,30,50,100
Routing protocol	SPAR,DSR
Traffic Model	CBR
Pause time	0 to 500s
Mobility	1 m/s to 5 m/s
Terrain	1000m*800m
Transmission range	250m

VI. RESULT ANALYSIS

Initially scenario has been setup for a 20 nodes network as shown .speed is constant and pause time is varied. In the beginning of the simulation, performance of DSR dips slightly; the reason can be delay in route reply messages due to high mobility of nodes and then once DSR Stabilizes it is delivering more packets. PAR scheme performs better as number of nodes increases. There is a slight delay in the start as it takes time to calculate the values for different parameters like power status, Traffic level, number of hops etc. DSR shows the similar results as compared to PAR. As shown in figure 1(b) the performance of proposed algorithm 'DSR' is best for 50 nodes proving the point that it was better to take care of factors like energy status and traffic level. DSR is delivering more number of packets for all speeds from 0 m/sec to 20 m/sec. DSR uses IP level HELLO messaging to detect link breakages. Request retransmits are done with three seconds intervals. Again, a node can send one route reply at each second. Energy status is attached with each HELLO packet; it is decremented by factor 0.025 each time a HELLO is echoed. Power status is attached with each HELLO packet; it is decremented by factor 0.025 each time a HELLO is echoed. Power status has been set at a scale of 7-10 at start for all nodes to be in active state. the average End-to-End delay of SPAR & DSR continuously increased in different number of nodes as compare to DSR. The performance of DSR & PAR when the pause time is varies and the node speed is constant. In figure` 3(b) show that throughput of DSR is better than the throughput of SPAR & DSR. Performance comparison of SPAR and DSR in all above discussed .Results show that the proposed scheme outperforms as the network grows and become larger and more dynamic. Network lifetime has been considered as the time in which a percentage of nodes are completely exhausted and the network is considered as a dead network.

VII. CONCLUSION

Energy efficiency is one of the main problems in a mobile ad hoc network, especially designing a routing protocol. The proposed work aims at discovering an efficient power aware routing scheme in MANETs and analyzing the derived algorithm with the help of NS-2. Simulation result shows that the proposed scheme modified SPAR as well as DSR is delivering more packets in different network scenarios as well as network life time of the modified SPAR is better even in high mobility scenarios.

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