An Energy Efficient Technique in MANETs modified Trust based Route selection Algorithm

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ABSTRACT:
In real world energy consumption is a very big issue in Ad-hoc network. Mobile Ad-hoc network (MANET) interface has four types of potential energy consumption states that are transmitting and receiving state for transmitting and receiving data packets. But there is one default state for MANET that is idle or the sleep state, when nodes do not have enough power for itself, it could not transmit the data packet. When node has less energy, it is more challenging and difficult to search multi-hop path between transmitting node to receiving node. This paper proposes an energy efficient technique using trust based route selection algorithm.

Key Words:- Energy efficient routing, Mobile Ad-hoc Network, Route select algorithm.

I. INTRODUCTION
Mobile ad-hoc network (MANET), is a wireless mobile self-organizing network which is also a temporary multi-hop autonomous system composed of a set of mobile nodes with radio transmitters and receivers. Because of the limitation of a nodes radio range, any two mobile nodes which can’t make communicate directly, could forward data packet with the help of the other nodes and so implement data interaction between each other [33]. Compared with other networks, MANET doesn’t need any structure to work and has so many characteristics, such as network self-organizing, dynamic network topology, unidirectional wireless links. MANET is mainly used in military operations, emergency communications, co-operating with mobile communication, wireless access and sensor networks. In MANET, each node is both end system and router, and so for efficient communication, appropriate routes must be constructed between nodes.

A MANET node can perform smoothly and behave co-operatively as the conventional routing protocols were build up with the assumption of cooperative and trusted environment among the nodes. Attackers can easily attack by compromising some valid internal nodes in the physically hostile environment [25]. These malicious nodes may make up routing information before launching variety of attacks (such as a black hole or grey hole attack) in order to interrupt the flow of information during data transmission by dropping some number of packets. One of the main principal is network layer attacks and prevention of routing malfunctioning during data transmission is secure routing.

In MANET energy plays a main role during the broadcasting of data packets [3]. Every node has its own energy level. It reduces partially when the data packet is transmitted and received but when nodes do not have sufficient energy for broadcasting data packets, nodes drop data packets. The major issues regarding security are due to the lack of an infrastructure and the use of the wireless medium, therefore the communication could be easily disturbed or eavesdropped, the nodes could be corrupted by Malicious agent and the measures needed to detect the intrusion have to be executed by each node with a distributed approach [1]. The limited power source available to the nodes puts a severe constraint to the operations that a node can execute and this implies that the intrusion detection system should be energy-efficient, so the node lifetime will not be affected excessively.
II. RELATED WORKS

Juan-Carlos Can and Pietro hlanzoni have evaluated the Energy-Consumption Reduction in a MANET by Dynamically Switching-off network interfaces and compared AODV, DSDV, DSR, TORA protocols [14]. The AODV protocol is a combination of DSR and DSDV protocols using the on-demand mechanism of route discovery and route maintains from DSR, hop-to-hop routing and sequence number from DSDV. It calculates the power saving range between 25 percent and 60 per cent of the total energy.

Andrea Lupia and Floriano De Rango have discussed a probabilistic energy-efficient approach for monitoring and detecting malicious/selfish nodes in mobile ad-hoc networks. The main concept is detecting a misbehaviour node in less time and EEMF concerns the energy saving. This method detects a misbehaviour node in very efficient manner because it also monitors the energy efficiency in a positive manner and it requires the network security level.

Jinhua Zhu and Xin Wang have designed and implemented energy-efficient routing protocols for mobile ad hoc networks. A peer protocol reduces the energy consumption especially by path discovery with low overhead and an efficient path maintenance scheme in mobile environment. It is a comparatively better protocol to a normal energy efficient protocol in mobile scenario and static scenario. It is used under all circumstances in terms of node mobility, network density, and load.

Florian De Rango, Francesca Guerriero and Peppino Fazio [10] have evaluated a novel routing protocol called Link-Stability and Energy aware Routing protocol (LAER) [10]. This protocol is a power efficient reliable routing protocol for mobile ad-hoc networks and applies the following three metrics for path selection: first to estimate the total energy required to transmit and process a data packet, second to calculate each node’s residual energy and finally find the path stability.

Prof. S. P. Pingat and Ms. A. K. Gaikwad have studied fundamental interconnecting structure homogenous network model that has a fish shaped topology and proposed a bypass flow splitting and forwarding algorithm to forward packets in a network[23]. Reset time is constant in BFF algorithm and there is no establishment for optimization of energy while selecting a path, which affects the capability of BFF algorithm to make proper utilization of channel which increases packet loss ratio and controls the transmission energy consumed for a packet to reach destination.

Anshu Guru and Dr. Siddaraju [24] have discussed a TPGF in which multimedia streaming data is transmitted over node-disjoint path. Every paths transmission capacity is increased by choosing node-disjoint path and does not allow sharing the capacity of the currently used path thereby reducing the delay of data transmission. The TPGF routing protocol is enhanced with energy feature of the node by selecting the router which has sufficient residual energy.

Vipin Kumar and Sushil Kumar have implemented the energy of the sensors to maximize the network lifetime [30]. Using a new position based routing algorithm to fairly utilize the forwarding search space (FSS) is to control unnecessary transmissions. A next forwarder selection function is designed based on the residual energy, node degree, distance, and angle. Each time, this function selects different set of sensors for packet transmission, which fairly balances the energy consumption among the sensors.

Prasenjit Chanak, Indrajit Banerjee, and R.Simon Sherratt have evaluated a novel clustering algorithm for WSNs, termed distributed energy efficient heterogeneous clustering (DEEHC). This method selects the cluster head based on the residual energy of the deployed sensor nodes with the assistance of a secondary Timer. [22] During the clustering phase every node finds k-vertex disjoint paths to cluster heads depending on the energy level of its neighbour sensor nodes. They present k-vertex disjoint path routing (k-VDPR) algorithm where each cluster head finds k-vertex disjoint paths to the base station and relays their collective data to the station. A novel routing maintenance mechanism (RMM) can repair k-vertex disjoint paths throughout the monitoring session. The resulting WSNs become tolerant to k-1 failures in worst case.

Adnan K.Kiani, Umair Rashid and Omer Waqar discussed a new energy and mobility aware routing protocol referred to as mobility and energy aware AODV (MEAODV) protocol [29]. A new link stability algorithm for MANETs has been presented that is based on relative mobility and residual energy of nodes. These are the two most prominent causes of link failures in MANETs.

After completion of extensive literature survey on algorithms for link stability based MANETs, it is found that the techniques presented thus far do not deal simultaneously with mobility of nodes and their residual energies, MEAODV algorithm, to fill this technological gap. It is show that when residual energy and mobility are simultaneously considered during route formation, a great deal of improvement is witnessed compared with MAODV-X and RAODV especially in highly mobile scenarios.

Xiaozong Yang, Renfa Li, Kenli Li and Yanyan Liu implemented that Mobile Ad-Hoc network (MANET) is a dynamic and unstructured network composed of wireless mobile hosts or nodes [33]. It is significantly run on an on-demand routing protocol with bandwidth assurance in MANET. A new on-demand routing algorithm LABGR (Location – aided bandwidth guaranteed routing), is based on the node’s geographical locations. The algorithm unites route stability and controlled energy levels, and using forced diffusing routing and utilizing various mechanisms to avoid flooding in whole network, it also limits the number of nodes affected during routing request. Hence, the algorithm efficiently increases the efficiency of routing request and guarantees the bandwidth of links.
The algorithm attempts to extend the network’s lifecycle in routing and maintain the integrity of network, in order to protect the network from being divided since some nodes use up their energy too fast. Next goal is to improve LABGR and research the support for unidirectional way routing, multicasting and how to get the neighbour node’s information.

Yanhg Qin and Chia Yui Lee analyse PRS – Probability Random Routing Scheme, where a route discovery feature is when a source node needs to forward a routing path to a destination node and it does not overflow the network with the packets, which is an approach widely used in most of the ad hoc routing algorithms. In its place the source randomly selects one of its neighbours to send a route request packet. The main drawback is that this algorithm is designed to work for a small number of control packets. The data packets and control packets are forwarded using a source routing. That is, the header of each packet covers a path to be navigated by the packet. The packet is forwarded at each node it reaches according to the order of the nodes that appear in the packet header.

Khusnheet Kaur Batth and Rajeshwar Singh have evaluated the performance of Ant Colony Optimization based On-Demand Routing algorithm ACODeRA with traditional routing protocol AODV for Mobile Ad Hoc Networks[17]. The ACODeRA reduces the average end-to-end delay and the time of congestion happening effectively by on demand creating the multiple routes of link disjoint paths. This algorithm uses local and global updating rule to update the probability route table.

Filomena de Santis[11] has discussed the ideas inspired from natural systems and provided a sufficient motivation for designing and developing algorithms for not only scheduling and routing problems, but also for auto configuration. According to them, a reengineering approach has been followed that allowed to map concepts from a bee colony to an IP address auto- configuration algorithm.

Navid Nikaein, Houda Labiod and Christian Bonnet implemented an alternative routing algorithm for mobile ad hoc network, called DDR. It is based on forest construction of mobile nodes [19]. To design a new routing algorithm for MANET, some important factors are necessary to take into account like bandwidth, energy constraints and node mobility. The DDR combines two main notions first one is zone which is used to reduce the delay due to routing process and reach high scalability, second one is forest which gives an appropriate structure to the mobile ad hoc network that allows better radio resource utilization. But the non-overlapped zones are dynamically constructed in relation with the forest.

K.Sumathi and A. Priyadharshini have evaluated an Ant Routing Protocol used to find the optimal path. Efficient Energy Aware Routing Protocol (EEARP) can increase the network lifetime of MANET [16]. It is also using a minimum and maximum formulation and, EEARP selects the path that has the smallest residual packet transmission capacity and the largest packet capacity. But the proposed scheme may reduce the energy consumption to some extent and decrease the mean delay, while achieving a good packet delivery ratio.

III. DESIGN AND IMPLEMENTATION

The trust communication route is basically where the information flows form one node to another [15]. For instance if node A trusts node B, now a route is created form node A to node B in which information can flow from A to B. In this communication sometimes source node may need to discover multi-hop communication routes with destination node in which destination lacks trust information about source. Conventionally, destination node develops this trust based on recommendations from the intermediate nodes of multi-hop route. This trust management is called neighbour-based routing where opinions/recommendations come from. Hence, integrity and validity of the recommendation is critically important since malicious nodes may be present in a multi-hop route and any misguided recommendation from them may be the result of insecure information flow. A node may also get Contradictory recommendation from different routing for a single node. A trust management system should have a proper mechanism to recognize the valid and correct node by sharing the information.

In this proposed model, Trust based route selection algorithm finds out the shortest and trusted neighbours. It helps to save the energy level in each node and also increases the network lifetime.

The proposed Trust based Route selection algorithm is given in figure 1:-

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Source node is ready to broadcast data packet and establish the route.</td>
</tr>
<tr>
<td>2</td>
<td>Destination node received the request from source node.</td>
</tr>
<tr>
<td>3</td>
<td>Calculate transmitting and receiving energy of each node from request.</td>
</tr>
<tr>
<td>4</td>
<td>Wait for route reply from destination node.</td>
</tr>
<tr>
<td>5</td>
<td>Calculate power loss for path searching and fix the threshold value.</td>
</tr>
<tr>
<td>6</td>
<td>Destination node creates the route table based on the threshold value.</td>
</tr>
<tr>
<td>7</td>
<td>Destination node builds a route and then replies to source node.</td>
</tr>
<tr>
<td>8</td>
<td>Broadcast data packet to destination node.</td>
</tr>
<tr>
<td>9</td>
<td>Resend response to source node for receiving data packets.</td>
</tr>
<tr>
<td>10</td>
<td>Continue data transmission.</td>
</tr>
<tr>
<td>11</td>
<td>Check if data packet dropped or node moved from route.</td>
</tr>
<tr>
<td>12</td>
<td>Compute energy level on nearest neighbour nodes.</td>
</tr>
<tr>
<td>13</td>
<td>Find if neighbour node is trustworthy or not.</td>
</tr>
<tr>
<td>14</td>
<td>Rebuild and broadcast data packet to new route.</td>
</tr>
<tr>
<td>15</td>
<td>Broadcast acknowledge node ID to all neighbour nodes.</td>
</tr>
<tr>
<td>16</td>
<td>Update route list.</td>
</tr>
</tbody>
</table>

Fig. 1: Trust based Route selection algorithm.
In this algorithm the main focus is on energy efficiency and finding the trusted neighbour. First normally fix the threshold value. If the node is above threshold value give more importance to the node. Second find out the trust relationships of one node to their neighbour nodes. Every node has a progress table If a node has higher probability value it is a trustworthy node otherwise it is not a trustworthy node.

IV. PERFORMANCE EVALUATION

The implementation of node Trust based route selection algorithm is carried out on ns-2.34 simulator, for evaluation effect of our algorithm. In this simulator varying number of nodes, speed and traffic patterns are considered and the performance analysis is done. Here 20 nodes are used for simulations such as End-to-End Delay, Energy Consumed, Network Throughput, Routing overhead and Packet Delivery ratio. Existing work is defined as an EET_DM (Energy Efficient Techniques in Distributed Monitoring), and proposed work is defined as EET_TRSA (Energy Efficient Techniques using trust based route selection algorithm).

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>1000 X 1000 m</td>
</tr>
<tr>
<td>Channel Frequency</td>
<td>2.4GHZ</td>
</tr>
<tr>
<td>Data Rate</td>
<td>2 MBPS</td>
</tr>
<tr>
<td>Routing Protocol</td>
<td>AODV</td>
</tr>
<tr>
<td>Nodes</td>
<td>50</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>1200 m/s</td>
</tr>
<tr>
<td>MAC Protocol</td>
<td>IEEE 802.11</td>
</tr>
<tr>
<td>Packet Size</td>
<td>512 bytes</td>
</tr>
<tr>
<td>Propagation</td>
<td>Two Ray Model</td>
</tr>
<tr>
<td>Antenna Model</td>
<td>Omni-Directional</td>
</tr>
<tr>
<td>Interface Queue Type</td>
<td>Pri-Queue</td>
</tr>
<tr>
<td>Node Energy</td>
<td>500 Joule</td>
</tr>
</tbody>
</table>

Table 1: Simulation scenario

Network Throughput is calculated by the number of bytes or kbps/sec received at the destination. Throughput can be defined as the ratio of, total data packets from the source to destination. It calculates the time it takes for the last packet to reach.

\[
\text{Throughput} = \frac{\text{Total no of successful packets delivered}}{\text{Total Time Taken}}
\]

End-to-End Delay is used to compute how much time is being taken for a packet to broadcast across the network from transmission node to receive node. End-to-end delay for packet p which was sent by node n, as a source and received successfully at destination node is given by:

\[
\text{End-to-End Delay}_n = \text{Start Time}_n - \text{End Time}_n
\]

In figure 2 it is shown that our proposed algorithm gives higher performance with respect to throughput. If the number of nodes is increased then there is a huge variation in throughput because of nodes mobility and their movements in network. At this time selecting right node for transmission is a difficult work. By using this algorithm we discarded all those nodes that do not have sufficient energy for transmission and receiving of packets.

Fig. 2: Network Throughput Vs No. of Nodes

Fig. 3: End-to-End Delay Vs No. of Nodes

The end-to-end delay over various node scenarios is shown in fig.3. This shows that our proposed algorithm has less delay in comparison to existing EET_DM (Energy Efficient Techniques for MANET Distributed Monitoring). It is because, while transmitting data packets there is minimum possibility of data dropped and especially when node have sufficient power for
transmitting packets. But in case of EET_DM there is a higher probability of a link failure to take place in the rebuilding of route due to less energy for nodes, because nodes are not dependent over energy.

**Packet delivery ratio** or packet delivery fraction is used to calculate how many packets are received on destination node which are sent by source node.

\[
\text{Packet Delivery Ratio} = \frac{\text{Total no. of successful packets received}}{\text{Total no. of packets sent}}
\]

**Figure 4**: Packet delivery ratio Vs No. of Nodes

Figure 4 shows that EET_TRSA performs better in terms of packet delivery ratio as compared to EET_DM. Demonstrated route nodes are persistently awake for longer time in comparison of existing EET_DM and spent more time in network. Therefore, in EET_DM the nodes packet delivery ratio is lesser than EET_TRSA, because of insufficiency of power in between node during establishment of the route between source node and destination node. On the other hand in EET_DM packets may get dropped because of route failures, thus frequent establishment of route can take place due to deficiency of power in nodes.

**Energy Consumed** per packet: the average energy consumption is the most significant parameter for calculating network performance. The average energy consumption is the total reduces energy in network for broadcasting data from sender node to receiver node. The calculation of energy consumption as overall expenditure of energy is divided by the total number of data packets arrived.

In the fig.5 shows the average energy consumption for exchanging data packets in network transmission. The figure it is clearly shows that the proposed algorithm performed well and uses less energy. It shows that the proposed algorithm is more efficient. It also increases network life time and overall performance.

**Routing overhead** In the context of computers, communication overhead is those bits of data that must be sent to convey information about transmission for example, where the information originated and where it is being sent to, how it is to be routed, timestamps, or any other information that is not actually the "payload" representing the actual content to be communicated.

**Figure 6**: Routing overhead Vs No. of Nodes

Figure 6 shows number of nodes Vs processing routing overhead with respect to EET_DM and EET_TRSA. It is also increasing a little bit routing overhead, to find the trusted route and to be update the route table. so it has small routing overhead compared to an existing system.
The series of simulation results were carried out to evaluate the efficiency of the proposed model for the energy efficient trust based route selection algorithm to present the results obtained from actual simulation runs.

V. CONCLUSION

This paper, Proposes energy efficient trust based route selection algorithm in mobile ad-hoc network, by using AODV routing protocols. This algorithm finds the best and trustworthy routes and also reduces the energy consumption of nodes when nodes are in sleep mode. It increases the network performance and shows a comparative evaluation over parameters, average throughput, packet delivery ratio, and packet drop at the end to end delay with different mobile scenario. This algorithm gives better performance of network and increases nodes life time in network, less link failures, higher throughput, higher data delivery rate and less delay time for sending data packets.

References


Volume 57 – No.17, November 2012.


