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Implementation and Analysis of IPS-AODV for Emergency scenario in MANET

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Abstract— **The limiting major factor in successful organization of mobile ad-hoc networks is energy conservation since mobile nodes dynamically form a temporary network without the use of pre-existing fixed infrastructure. Although MANETs are known for providing efficient routes in propagation of data but now a more challenging task is to provide energy efficient routes. The most critical issue in mobile wireless communication is conservation of energy due to power constraints on mobile units. In this paper we mainly focus in the implementation of a new strategy i.e. Intelligent Power Saver AODV (IPS-AODV) for routing in which the main criteria for routing will not be limited to only shortest path. There will be two parameters for selection of proper routing path i.e. shortest path (followed by conventional protocols) and evaluation of energy utilization of each node. It means before propagating data to the network, battery power of each node will be evaluated and then shortest path will be considered. The major criterion of proposed protocol is implemented by considering the transmission of emergency packets although the node energy is below threshold point. In this paper we will also investigate that if battery power of a node is falling down below threshold value then that node should not take part in data communication while it still transmit the control packets so that energy can be conserved.**

Keywords— **MANET, AODV, IPS-AODV, Threshold Energy.**

I. INTRODUCTION

he mobile ad-hoc network (MANET) is a distributed network where mobile nodes are connected together by wireless links without any fixed infrastructure like base stations, fixed links, routers, and centralized servers. In such a network the data can be transmitted or routed by intermediate nodes which are not in the fixed location [8]. In order to facilitate communication within the network, a routing protocol is used to discover the routes between nodes. Figure 1 shows a mobile ad hoc network. The primary goal of such an ad-hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. Route construction should be done with a minimum of overhead and bandwidth consumption [3]. The topology of mobile Ad Hoc network is not static and depends upon the mobility of the nodes so it can adjust rapidly and suddenly. Mobile Ad Hoc networks are useful in many areas such as, vehicular network, Communication in front line, Disaster recovery areas, agro sensing, Institutions and Colleges, Space and astronomy related projects, pollution monitoring and Medical Field [10]. One of the main design constraints in mobile ad-hoc network (MANETs) is that they are power constrained. Hence every effort is to be channelled towards reducing power. Power required by each mobile host can be classified into two categories namely communication –related power, non communication-related power. The communication related power can have two parts: first processing power; second transceiver power. Each mobile host spends some processing power to execute network algorithm and run applications. Transceiver power refers to the power used by the radio transceiver to communicate with the other mobile hosts [6] [7].

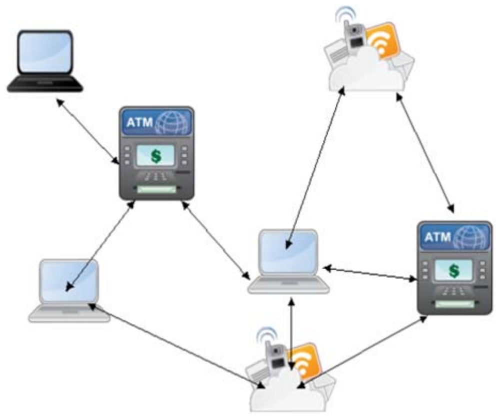

Figure 1: Mobile Ad-hoc Network

Routing is the process of path establishment and packet forwarding from source node to sink node. It carried out in two steps, first selecting the route for different pair of source-sink and delivers the data packets to the target node [8] [10]. Various protocols and data structures are available to maintain the routes and to execute this process. The limited energy capacity of mobile computing devices has brought energy conservation to the forefront of concerns for enabling mobile communications. In wireless networks, there is direct trade-off between the amount of energy consumed by sending that data. Communication in ad hoc networks necessarily drains the batteries of the participating nodes, and eventually results in the failure of nodes due to lack of energy[9]. Hence the battery power of a node is a precious resource that must be used efficiently in order to avail early termination of a node or a network. Efficient battery management, transmission power management [4] are the major means of increasing the life of a node.

1.1 Types of Energy Consumption Models in Ad-hoc Networks - The mobile nodes in wireless mobile ad hoc network are connected to other mobile nodes. These nodes are free to transmit and receive the data packet to or from other nodes and require energy to such activity [9] [11] [12]. The total energy of nodes is spent in following modes-

A. Transmission Mode- A node is said in transmission mode when it sends data packet to other nodes in network. These nodes require energy to transmit data packet, such energy is called Transmission Energy of that node. It should be noted that the energy consumed during sending a packet is the largest source of energy consumption of all modes. Transmission energy is consumed by only source node. Transmission energy is depended on size of data packet (in Bits), means when the size of a data packet is increased the required transmission energy is also increased [11]. The transmission energy can be formulated as:

$$Tx = (330*P\textit{length})/2*10^6$$

And

$$P_T = Tx / T_t$$

Where Tx is transmission Energy, P_T is Transmission Power, T_t is time taken to transmit data packet and P*length* is length of data packet in Bits.

B. Reception Mode- When a node receives a data packet from other nodes then it said to be in Reception Mode and the energy taken to receive packet is called Reception Energy (R_x). Reception energy is consumed by intermediate node and destination node. Then Reception Energy can be given as :

$$R_x = (230* P\textit{length})/2*10^6$$

And

$$P_R = R_x / T_R$$

Where R_x is a Reception Energy, P_R is a Reception Power, T_R is a time taken to receive data packet, and P*length* is length of data packet in Bits.

C. Forwarding Mode- When an intermediate node forwards data packet to other node then it is said to be in Forwarding mode and the energy taken to forward the packet is called Forwarding energy. Forwarding energy is consumed by only intermediate nodes (between source and destination) as their main task is to forward data packets.

D. Idle Mode- In this mode [11] [12] generally the node is neither transmitting nor receiving any data packets. But this mode consumes power because the nodes have to listen to the wireless medium continuously in order to detect a packet that it should receive, so that the node can then switch into receive mode from idle mode. Despite the fact that while in idle mode the node does not actually handle data communication operations, it was found that the wireless interface consumes a considerable amount of energy nevertheless. This amount approaches the amount that is consumed in the receive operation. Idle energy is a wasted energy that should be eliminated or reduced. Then power consumed in Idle Mode is:

$$P_I = P_R$$

Where P_I is power consumed in Idle Mode and P_R is power consumed in Reception Mode.

Therefore energy conservation can be achieved in one of two ways:

- Saving energy during active communication
- Saving energy during idle time in communication.

The first targets the techniques used to support conservation of battery power or energy during communication activity in ad-hoc network (Active mode). The second focuses on reducing the energy consumed when the node is idle and not participating in any communication activity in an ad-hoc network.

II. THE BASIC AODV PROTOCOL

AODV uses an on-demand based protocol to discover the desired path, while using hello packets to keep track of the current neighbors. Since it is an on demand algorithm, it builds routes between nodes only upon request by the source nodes. It maintains these routes as long as they are needed by the sources. AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination [1] [2]. AODV allows mobile nodes to obtain routes quickly for new destinations and does not require mobile nodes to maintain routes to destinations that are not in active communication. It also allows mobile nodes to respond to situations associated with broken link and changes in network topology in a timely manner. AODV uses a destination broadcast id number to ensure loop freedom at all times, since the intermediate nodes only forward the first copy of the same request packet. The sequence number is used in each node, and the destination sequence number is created by the destination for any route information it sends to requesting nodes. The route is updated if a new reply is received with the greater destination sequence or the same destination sequence number but the route has fewer hops. Therefore, this protocol will select the freshest and shortest path at any time.

Path Discovery- When a source node desires to send a message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the other node. It has two steps: the source sends out a request and the destination return a reply.

Request Phase- When a route to a new destination is needed, the node uses a broadcast a route request (RREQ) to find a route to that destination. A route can be determined when the RREQ reaches either the destination itself or an intermediate node with a fresh route to the destination. The fresh route is an unexpired route entry for the destination associated. The important step during the request phase is that a reverse path from the destination to the source can be set up. When a source node wants to find a path to a destination, it broadcasts a route request packet to its neighbors as shown in figure 2. The neighbors update their information for the source node, set up backwards pointers to the source node in their route tables, and rebroadcast the request packet [1] [3].

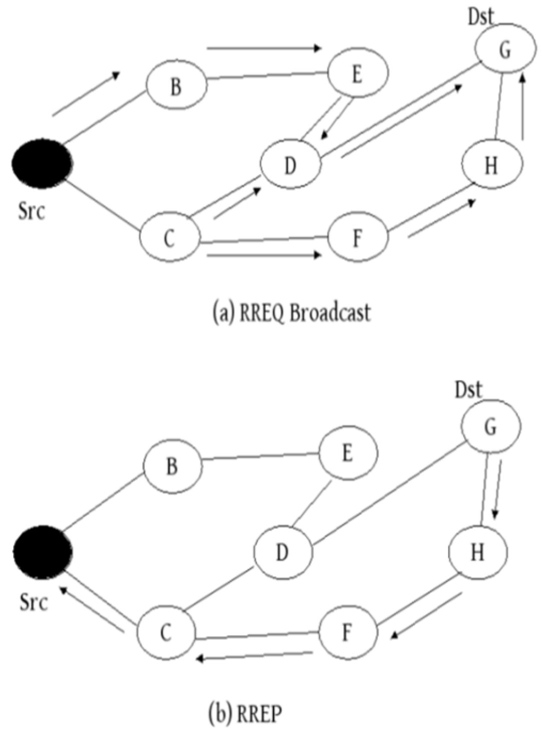

Figure 2: Request and Reply Phase in AODV

Reply phase- When the request arrives at the destination or at an intermediate node that has a path to that destination a reply packet (RREP) is returned to the source node along the path recorded as shown in figure 2. While the reply packet propagates back to the source, nodes set up forward pointers to the destination, and set up the forward path. Once the source node receives the reply packet, it may begin to forward data packets to the destination.

Data Packet Forwarding- After the reply packet returns from the destination, the source can begin sending out the packet to the destination via the new discovery path, or the node can forward any enqueued packets to a destination if a reverse path is set up and the destination of the reverse path is the destination of the path. A route is considered active as long as there are data packets periodically traveling from the source to the destination along that path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate node routing tables [1].

Dealing with the broken links- If a link breaks while the route is active, the packets that are flowing in that path can be dropped and an error message is sent to the source or a local repair routine will take over. If the node holding the packets is close to the destination, this node invokes a local repair route. It enqueued the packet and finds a new path from this node to the destination. Otherwise, the packets are dropped, and the node upstream of the break propagates a route error message to the source node to inform it of the now unreachable destination(s). After receiving the route error, if the source node still desires the route, it can re-initiate a route discovery mechanism [1].

Disadvantage of Basic AODV- The basic disadvantage of basic AODV protocol is that when source node broadcasts RREQ packet, an intermediate node receives multiple copies of the same RREQ packet from different directions or routes. Hence on receiving multiple copies of the same RREQ packet drains some amount of energy of that node. Therefore this protocol (AODV) is not an energy saver protocol as RREQ packet is delivered to too many nodes that do not need to receive them.

Another disadvantage is that it always selects the least power cost routes. As a result nodes along these routes tend to die soon because of the battery energy exhaustion.

III. INTELLIGENT POWER SAVER AODV (IPS-AODV)

In this section we discuss intelligent power saver AODV protocol which overcomes the disadvantage of basic AODV and also serves an efficient routing protocol for ad-hoc networks which may take care of battery power needs. The prime focus of this strategy is to distribute the power consumption of the individual nodes and make the nodes reachable for high priority packets. During the development and design of IPS-AODV protocol we have investigated several mechanisms. In this paper following approaches have been settle-

A. *Dropping of same RREQ packet*

In this approach when source node broadcasts RREQ packet in the network, then if an intermediate node receives same copy of RREQ again and again, it will discard the packet instead of forwarding it. Therefore some amount of energy can be conserved while discarding the replica copy of RREQ because there is no use in forwarding of multiple replicas as it will lead to more and more power consumption by nodes, bandwidth consumption, overloading of network and congestion in network.

B. *Calculation of battery power of each node*

In this approach when a route is established between source and destination, then the battery power of each node will be calculated at each and every time when that node wants to transmit the data and control packet.

C. *Comparison of battery power of node with threshold value*

In this approach calculated battery power of each node will be compared to threshold value when the data packet or control packet are transmitted to next hop or destination node. If battery power of any node is less than threshold value, it will simply drop the packet and send an error message to previous hop or source node to inform about the dropping of packet. If the data packet is of high priority or control packet then the same route will be available but if it is a normal data packet then it follows the another suitable route by adopting the route discovery procedure. By deploying this strategy any of the nodes will not die from the network and it will maximize the network lifetime. By adopting this mechanism it may be possible that algorithm does not choose shortest path but here our main effort should be to enhance the connectivity and network lifetime of mobile ad-hoc network as power failure of single node affects the overall network connectivity.

Algorithm of IPS-AODV

if packet type== AODV data packet
if source address==current node address
Drop the RTR route loop packet
else
if !emergency packet && node energy < threshold energy value
Drop RTR no route.
else

Forward the packet to next hop according to routing table

IV. Simulation Result

The simulation result obtained in this paper is achieved by using Network Simulator version 2. (NS2). The key parameters of analysis are network performance, throughput and normalized routing load in the network. We vary the density of the nodes and investigate their information based on three different scenarios which consists of 10, 20 and 30 nodes respectively. Packet size is 1024 bytes and each simulation was executed for 24000 sec. The initial battery capacity of each node is 20 units and the threshold value is set to 5 units. Figure 3 shows that the network performance of IPS- AODV is much better (97.78 %, 96.74 % and 97.23% for 10, 20 and 30 nodes respectively) than AODV (96.33%, 95.22% and 95.73% for the same scenario). Figure 4 shows that the routing load is very less in IPS-AODV when we compare it with conventional AODV. The achieved routing load is 0.151, 0.387 and 0.376 for 10, 20 and 30 nodes respectively in IPS-AODV. Whereas in AODV the achieved routing load is 0.314, 0.678 and 0.718 for the same scenario. According to the calculated result, the routing load over the network when we use IPS-AODV is very less in comparison to AODV.

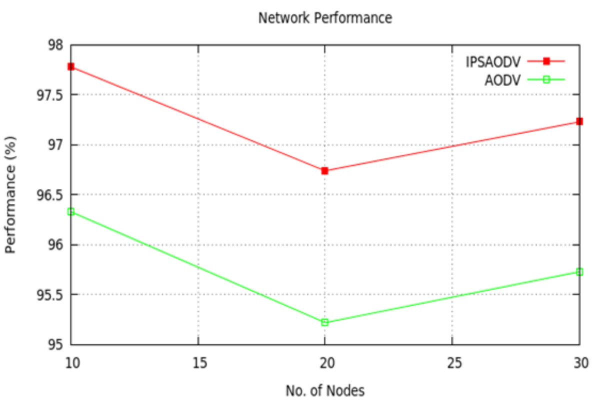

Figure 3: Network performance

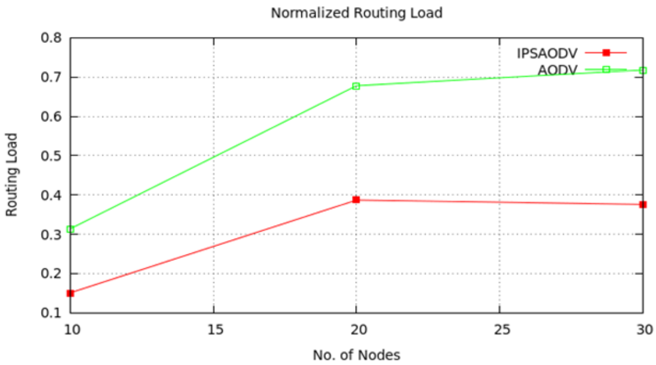

Figure 4: Normalized Routing Load

In figure 5 it is clearly visible that throughput of IPS-AODV is far better than AODV. The throughput for IPS-AODV is 64.89 unit, 64.29 unit and 63.91 for 10, 20 and 30 nodes respectively. But in case of AODV the throughput value is 45.88 unit, 40.28 unit and 40.18 unit for the same scenario.

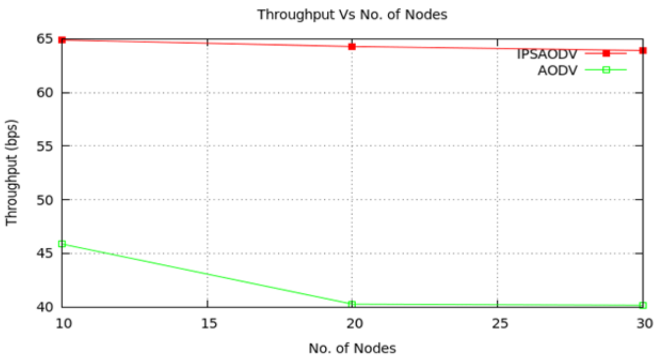

Figure 5: Throughput

V. Conclusion

In this paper we designed an energy saving and survival routing protocol, IPS- AODV to increase the existence of mobile ad hoc network. IPS- AODV is compared with conventional AODV routing protocol which proved that it gives better result in comparison to conventional AODV with respect to energy conservation. IPS- AODV can be a better alternate to balance energy of all nodes in mobile ad hoc network. The proposed routing protocol includes the features of conventional AODV protocol and incorporates the feature of comparison of batter power of each node with the threshold value. We perform test on emergency scenario and we conclude that IPS- AODV performs better than AODV to extend the lifetime of a network. Overall we found that our mechanism demonstrates significant benefits to conserve precious resource i.e. energy to maintain the connectivity in a mobile ad hoc network.

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