An Enhanced Energy Efficient Routing Protocol for MANETs

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Abstract:
Micro sensor networks are widely deployed in sensor networks typical geographical areas where human interaction is almost impossible. A WSN is a collection of several small energy limited sensors. These devices perform the job data collection and forwarding to central node called sink. Ad hoc networks are network which operates without the need of an infrastructure. Low control over head and power cost are two key issues in wireless sensor networks to improve the protocol efficiency. Aodv is predefined routing protocol in wireless sensor networks. The routing overhead of Aodv is drawback is power-constrained environment. In this paper we present an Enhance routing algorithm E-AODV which reduces the routing overhead and improve the efficiency. In standard AODV, hello packet broadcast mechanism is enhance to save time- and- gain discarding and rediscovering the routes.Ns2 simulator used for performance evaluation. The results show that the proposed algorithm is efficient with reduced control overhead and end-to-end delay.

Keywords: wireless sensor networks, Mobile Ad hoc Networks, AODV, power-constrained environment, protocol efficiency, routing overhead and end-to-end delay.

1. Introduction:

The history of wireless networks started from the 1970s and the interest has been growing ever since. At present, in this sharing of information is difficult task. As a result user needs to perform some administrative tasks to set up static and bi-directional links between the computers. This motivates the construction of temporary networks with no wires and no communication infrastructure and no intervention is required. Such a interaction between mobile computers are called Ad hoc Network. An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self configuring multi-hop wireless networks where, the structure of network changes dynamically. In Latin, ad hoc literally means “for this,” further meaning “for this purpose only” and thus usually temporary. An ad-hoc network has certain characteristics, which imposes new demands on the routing protocol. The most important characteristic is the dynamic topology [8], which is a consequence of node mobility. The nodes in ad-hoc network consists of laptops and personal digital assistants often very limited in resources such as CPU capacity, storage capacity, battery power and bandwidth. This means routing protocols should try to minimize control traffic, such periodic update messages. Broadcasting is a fundamental and effective data dissemination mechanism for route discovery, address resolution and many other network services in ad-hoc networks. In MANET, each node acts as both as router and as a host & even the topology of network may also change rapidly. Some of the challenges in MANET include: 1) Unicast routing2) Multicast routing 3) Dynamic network topology 4) Speed 5) Frequency of updates or Network overhead 6) Scalability 7) Mobile agent based routing 8) Quality of Service 9) Energy efficient/power aware routing 10) Secure routing.

MANETs have several salient characteristics:

1) Dynamic topology
2) Bandwidth constrained , variable capacity links
3) Energy constrained operation
4) Limited physical security.

Because of the routing protocols used in ordinary wired networks are not proper suited for this kind of dynamic environment. The topology of the ad-hoc network depends on the transmission power of the nodes and the location of the mobile nodes, which may change from time to time. One of the main problems in ad-hoc networking is the efficient delivery of data packets to the mobile nodes where the topology changes dynamically. Therefore, due to the frequently changing topology, a routing protocol is needed whenever a packet needs to be transmitted to destination via number of nodes in ad-hoc networks. These protocols find a route for packet delivery and delivery the packet to the correct destination. Basically, routing protocols for MANETs can classify two categories:

A) Proactive or table-driven protocols.
B) Reactive or on-demand routing protocols

A. Proactive or table driven protocol:

In proactive protocols, nodes maintain one or more routing tables about nodes in the network. These routing protocols update the routing table information either periodically to change in the network topology. One of the advantages of this protocol is that a source node does not need to route discovery procedure to find a route to destination node. Drawback of these protocols is that maintaining consistent and up-to-date routing table requires substantial messaging overhead, which consumes bandwidth and power, and decreases throughput, in case of large number of high node mobility. Some of the existing proactive or table driven protocols are: Destination Sequenced Distance Vector routing (DSDV)[6],[19] , Wireless Routing Protocol(WRP) [23],Fish eye State routing Protocol (FSR), Optimized Link State Routing Protocol (OLSR),Cluster Gateway Switch Routing Protocol (CGSR), Topology Destination Based on Reverse Path forwarding (TBRPF) [3],[1].

B. Reactive or on demand routing protocols:

Reactive routing also known as on-demand routing protocol these protocols have no routing information at the network nodes if there is no communication. In these protocols route are crated as and when they required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved. Some of the existing on demand routing protocols are: Dynamic Source Routing (DSR) [8], [4] Ad hoc On Demand distance vector Routing (AODV) [[4], [5], TORA [26], [27]. Many routing protocols [11], [12] need to flood a route request to seek out multi hop route to the destination.

Ii. Related Work:

The problem of routing in MANETs has received attention among researchers, and many routing protocols have been proposed. Some of protocols are, The DSDV protocol requires that each mobile station in the network must constantly advertise to each its neighbors. One of the limitations of this protocol there is wastage of bandwidth due to unnecessary advertising of routing information and it doesn't support multi path routing and difficult to determine a time delay [6].

The Ad-hoc On-demand Distance Vector (AODV) protocol is an enhancement of DSDV. The AODV protocol is a reactive routing protocol that utilizes an on-demand technique to establish routes [3].

The Dynamic Source Routing (DSR) [11], protocol is a reactive or on demand routing protocol, it works only in moderate nodes speed and every node has enough energy. In this routes are discovered only as they needed. One of the limitations of these protocols is lack of energy savings.

The Temporally Ordered Routing Algorithm (TORA) is reactive or on demand routing protocol. This protocol comes under "Link Reversal Algorithms". TORA algorithm maintains the "direction of the next destination" to forward the packets. Thus a source node maintains one or more downstream paths to destination node through multiple intermediate neighboring nodes. One of the advantage of these protocol is reduces the control messages in the network by having the nodes to query for a path only when it needs to send a packet to a destination.

The Two Stage Source Routing (TSSR) is a routing protocol for many-to-one communication in sensor networks that is designed for route construction from many-source to one-sink in sensor networks. It uses the shortest route construction even in heterogeneous node environment and smaller number of control packets leads to low power consumption [4].

Iii. Description of Selected Protocols:

In this section our discussion is limited to only selected on-demand routing protocols that is AODV and E-ADOV.

a. AODV

The Ad-hoc On Demand Distance vector routing protocol is routing protocol designed for ad hoc mobile networks under reactive protocols type. AODV is capable of both unicast and multicast routing. It is an on demand algorithm, means it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources. The operation of these protocol is divided into two functions are route discovery and route maintenance. In ad-hoc routing, when a route is needed to some destination, the protocol starts route discovery procedure. Then the source node sends route request message to all neighbor nodes. And if those nodes do not have any information about the destination node, they will send the message to all its neighbors and so on. If any neighbor node has the information about the destination node, the node sends rote reply message to the route request initiator. In this process a path is recorded in the intermediate nodes. This path identifies the route because this is called reverse path. Since each node forwards route request message to all its neighbors, a unique id is assigned, when a route request message is created. When a node received, it will check this id and the address of the initiator and discarded the message if it had already processed that request. Node that has information about the neighbor from the destination sends route reply message to the neighbor from which it has received route request message. This neighbor does the same process. Due to the reverse path it can be possible. Then the route reply message travels back using reverse path. When a route is ready and the initiator can start sending data packets. Once the initiator stops sending data packets, the link will time out and eventually be deleted from the intermediate node routing tables. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it of the now unreachable destination.

In MANETs, some of the characteristics of AODV protocol:

- It supports Unicast, broadcast, and multicast communication among the nodes.
- On-demand route establishment with small delay.
- Link breakages in active routes efficiently repaired.
- It uses of sequence numbers to track accuracy of information.
- It keeps track of next hop for a route instead of the entire route.
- It uses period HELLO messages to track neighbors [21].

Advantages and disadvantages of AODV protocol

The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. In this protocol connection setup delay is less. The HELLO messages uses routes maintenance and this range is limit. So they do not cause unnecessary overhead in the network.

On other hand disadvantages of these protocols is that intermediate nodes lead to inconsistent routes if the source sequence number is old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also multiple route reply packets in response to a single rout request packet can lead to heavy control overhead [21]. Periodic beaconing is another disadvantage which leads to unnecessary bandwidth consumption.

b. ENHANCED AODV(E_AODV)

AODV is well suited for wireless sensor networks over DSDV [6]. One of the main disadvantages of AODV protocol has high delay from source to destination routing and the valid route expiry. In this paper we propose a protocol called e-AODV based on the model for reducing delay by using hello packets to exchange to local route using local discovery algorithm.

Design of the proposed algorithm:

- Discover the neighbor node by sending hello packets along with route information.
- If no route is available, send the hello packet alone.
- When route request is received from source, check the local route table to know whether any neighbor with route to destination exists
- If so, send RREP. If not, broadcast RREQ.

In the figure 1, Node E acts as an intermediate node which has route to the destination. It sends and receives hello packets to their nearby nodes. After node E sends the hello packet to node B, node B updates the information to the source through the return of RREP. If route information is not available, the control packets are exchanged as AODV fashion. RREQ message is initially sent from source node S to node A, and then to B, since node B has already got hello message from D by fig1. RREQ is only sent up to B. node B simply sends the RREP message to node A. finally, the node A sends the RREP message to source node S.

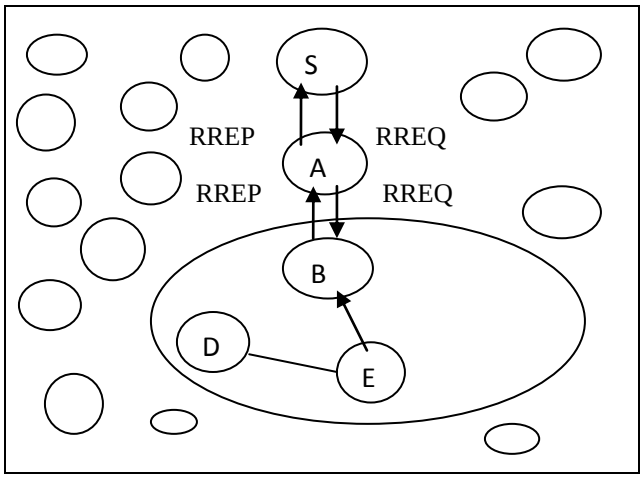

Figure 1. Exchange of hello packets, RREQ and RREP messages with help from intermediate node.

IV. Simulation Based Analysis Using Network Simulator (Ns-2)

Here the tools and methodology used for analysis of ad hoc routing protocol performance about simulation tool and simulation setup (traffic scenario).

Simulation tool
The simulations were performed using network simulator2 (NS-2), is particularly popular in the ad hoc network community. NS is a separate event simulator targeted at networking research. NS provides significant support for simulation of TCP, routing, and multicasting protocols over wired and wireless networks [14]. NS2 is an object oriented simulator, written in c++, with an OTcl interpreter as a front end. This means that most of the simulation scripts are created in Tcl (Tool Command Language). If the components have to be developed for ns2, then both Tcl and c++ have to be used.

Performance Evaluation
There are number of qualitative and quantitative metrics that can be used to compare in these protocol. These are comparing with use of NS-2 simulator.

Routing overhead:
This metric describes how many routing packets for route discovery and route maintenance need to be sent so to as propagate the data packet.

End-to-End delay:
It is the ration of time difference between every continuous bit rate (CBR) packet sent and received to the total time difference over the total number of CBR packets received.

A local route model for AODV is designed where the hello packet is modified to exchange route information with the local neighbors. The route information reaches the large number of nodes. There are

S.N0	Time (milliseconds)	Total number of nodes in reached AODV	Total number of nodes reached in e-AODV
1	0.30	2	3
2	0.50	4	5
3	0.71	6	7
4	1.02	8	10
5	1.33	11	12
6	1.52	13	15
7	1.74	16	18
8	2.38	20	23

Table1.comparision of number of nodes reached in AODV and e-AODV.

Using NS-2 simulator, the performance of packet transmission from source to destination is done. In this model first, the hello packets broadcast to the neighboring nodes. After finding out the neighbors, the information also broadcasts by means of hello packets. Here large number of nodes receives the routing information. From table 1, observed that the routing overhead is reduced 25% less compared to AODV. In these observations more number of nodes is reached in the same time for e-AODV, thus reducing the routing overhead.

S.NO	End-to-End delay for ADOV (in milliseconds)	End-to-End delay for e-AODV (in milliseconds)
1	0.40	0.30
2	0.62	0.50
3	0.81	0.71
4	1.12	1.02
5	1.42	1.33
6	1.73	1.52
7	1.91	1.74
8	2.56	2.38

Table2. End- to -End delay comparisons.

By using these observations the percentage of delay is reduced 11% in e-AODV.

V. Conclusion:

Proposed protocol is enhancement of AODV protocol, thus the new protocol is called e-AODV (Enhanced AODV). The routing overhead and end-to-end delay are taken as metrics. Ns2 simulator is used for performance evaluation. The routing overhead and end-to-end delay in e-AODV is 25% and 11% against ADOV.

VI. Future Scope:

It has been future concluded that due to the dynamically changing topology and infrastructure less, decentralized characteristics, power awareness is hard to achieve in mobile ad hoc networks. The focus of the study on these issues in our future research work and effort will be made to propose a solution for routing in ad hoc networks by tackling these core issues power aware/energy efficient routing.

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