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Impact of Mobility on the Routine of Enhanced - DSDV Protocol in Mobile Ad-hoc Networks

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Abstract

Mobile Ad-hoc Network (MANET) is a collection of mobile devices which are connected by wireless links without the use of any fixed infrastructures or centralized access points. Mobile Ad-hoc Networks have been highly vulnerable to attacks due to the dynamic nature of its network infrastructure. Among these attacks, routing attacks have received considerable attention since it could cause the most devastating damage to MANET. This article presents a routing strategy for MANET called Altitudinal Destination Sequenced Distance Vector which is an improved version of Destination Sequence Distance Vector (DSDV) routing protocol. The proposed routing protocol is to reduce the power consumption of the embedded node by reducing the computational overhead and data routing through less energy consuming routes through sensor nodes of interest using Enhanced-DSDV (E-DSDV). The proposed routing algorithm is composed of three stages i.e. identification of the activity area, identification of representative node and route discovery process. The proposed routing protocol has been simulated and compared with the existing routing protocols with Network Simulator NS2. Based on the experimental results, our proposed method produced better results compared to other leading protocols.

Keywords: Wireless Sensor Network, Energy Efficient, NS2, Routing Protocol

INTRODUCTION

A Mobile Ad-hoc Network (MANET) is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. MANET has dynamic topology and each mobile node has limited resources such as battery, processing power and on-board memory. This kind of infrastructure-less network is very useful in situation in which ordinary wired networks are not feasible like battlefields, natural disasters etc. The nodes which are in the transmission range of each other communicate directly otherwise communication is done through intermediate nodes which are willing to forward packet hence these networks are also called as multi-hop networks. MANETs are utilized to set up wireless communication in improvised environments without a predefined infrastructure or centralized administration. Therefore, MANET has been normally deployed in adverse and hostile environments where the central authority point is not necessary [1].

MANET is a decentralized group of mobile nodes which exchange information temporarily by means of wireless transmission. The network topology is unstructured and nodes may enter or leave in their will. A node can communicate with other nodes, which are within its transmission range. However, to communicate with nodes out of its range, a node uses the help from other nodes, which play a ‘‘bridge” role to receive and forward messages. Therefore, a node in a MANET acts as both a terminal and a router. There are many applications for MANET. For example, in a military field, search and rescue operations, or any remote geographical area where is no base station for communication. Routing in MANET [2,3] is extremely challenging because of MANET’s dynamic features, its limited bandwidth and powerful energy. Routing is the process of information exchange from one host to the other host in a network. Routing is the mechanism of forwarding packet towards its destination using most efficient path [4]. The efficiency of the path measures in various metrics like number of hops, traffic, security, etc. In ad-hoc network, each host node acts as a specialized router itself. Routing protocol for ad-hoc networking [5] can be categorized into three different types as shown in fig.1.

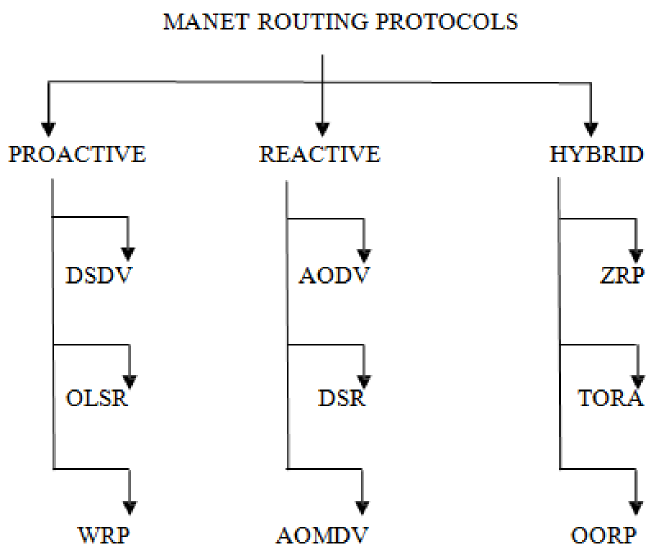

Figure 1. Types of Routing Protocol

The performance of ad-hoc networks depends on cooperation and trust among distributed nodes. To enhance security in ad-hoc networks, it is important to evaluate trustworthiness of other nodes without centralized authorities. Security is an essential requirement in mobile ad-hoc network [6]. A sensor node is an embedded system device which is capable of performing some processing, congregating sensory information and communicating with other connected nodes in the network. The energy of the sensor nodes is crucial area of concern since WSN deployed inaccessible environments. Routing in MANETs has been an active area of research and in recent years numerous protocols have been introduced for addressing the problems of routing, reviewed in later sections. These protocols are divided into two broad classes – Reactive and Proactive [7]. In Reactive or on-demand RPs, the routes are created only when they are needed. The application of this protocol can be seen in the Dynamic Source Routing Protocol (DSR) and the Ad-hoc On-demand Distance Vector Routing Protocol (AODV). Wherein Proactive or Table-driven RPs, the nodes keep updating their routing tables by periodical messages. This can be seen in Optimized Link State Routing Protocol (OLSR) and Destination Sequenced Distance Vector Protocol (DSDV). All these protocols are quite insecure because attackers can easily obtain information about the network topology.

The Routing Protocols for ad-hoc wireless networks can be divided into three categories based on the routing information update mechanism. They could be Reactive (On-demand), Proactive (Table-driven) or Hybrid. The table-driven ad-hoc routing approach is similar to the connectionless approach of forwarding packets, with no regard to when and how frequently such routes are desired. This is not the case, however, for on-demand routing protocols. When a node using an on-demand protocol desires a route to a new destination, it will have to wait until such a route can be discovered. On the other hand, because routing information is constantly propagated and maintained in table-driven routing protocols, a route to every other node in the ad-hoc network is always available, regardless of whether or not it is needed [8,9]. In this paper, a new protocol is proposed that consumes less energy of mobile nodes in the MANET and also extends the lifetime of the network. The proposed routing protocol, data can be transmitted as a secure manner and consuming lesser energy. This concept provides secure data communication and increases the lifetime of the sensor network as a whole. The proposed method performance is compared the other routing protocols for different network parameters and studied the efficient protocol under a particular scenario on the basis of the following metrics such as Average Delivery Ratio, Average Delay and Average Energy Consumption.

LITERATURE SURVEY

Hua Wang, Zao Shi, Anfeng Ge, Chaoying Yu (2008) [10] proposed a modified Ant Colony algorithm for the ad-hoc network by adding the gradual changing orientation factor and applying it to solve multi-constraint routing problems. The directionality of the gradual changing orientation factor enables the ant to consider direction in the search of paths, moves quickly to the target node, thus improving the convergence speed by overcoming the setback of slow convergence. The author says an ant in the modified algorithm not only makes use of the previous search findings, but also reduces the misguiding effect of pheromones on the irrelevant paths, thus overcoming the problem of slow convergence. The experiment results indicate that the ant colony algorithm with gradual changing orientation factor is better than the conventional ant colony algorithm in convergence time, and meanwhile avoids the liability of the local best solution.

Quality-of-Service-enabled Ant colony-based Multipath Routing [QAMR] [11] is a nature inspired algorithm for mobile ad-hoc network. QAMR is based on foraging behavior of ant colonies for selecting paths and transmitting data which uses bandwidth, hop count, and delay for calculating multipath disjoint between source and destination. The author (P. Venkata Krishna et al.) (2012) simulated QAMR in network simulator 2 and compared with existing routing algorithm. M. Mohanpriya et al. (2013) [12] presented a novel routing technique to detect black hole attack in MANET called Modified DSR [MDSR] protocol for detection and removal of selective black hole attack, which is modified and improved version of DSR routing protocol. The MDSR protocol detects the malicious nodes and prevent from black hole attack. The MDSR algorithm is an Intrusion Detection System [IDS] to detect the abnormal difference in the number data packet being forwarded by a node. The MDSR routing protocol is implemented and simulated in GIOMOSIM, compared with DSR routing protocol and shows that percentage of data packet loss in MDSR is better than DSR protocol in presence of multiple gray hole nodes.

Shipra Gautam, Rakesh Kumara [13], have proposed a technique for minimizing energy conservation within the routing protocols of the ad-hoc network. A Modified Energy Saving Dynamic Source Routing in MANETs (MESDSR) had been proposed. MANETs were infrastructure-less and can be set up anytime anywhere. One of the main design constraints in MANETs was that they are power constrained. Hence, every effort was to be channeled towards reducing power. More precisely, network lifetime was a key design metric in MANETs. In this kind of network, the mobility rate of nodes was high, so excessive use of energy and also switching off of nodes will cut links between nodes. In order to maximize the lifetime of ad-hoc networks, traffic should be sent via a route that can avoid nodes with low energy while minimizing the total transmission power.

In a MANET, the energy depletion of a node did not affect the node itself but only but the overall network lifetime. Pariza Kamboj et al. [14] have proposed an energy efficient multicast routing protocol for MANET with minimum control overhead. The protocol created shared multicast tree using the physical location of the nodes for the multicast sessions. Protocol employed a distributed location service to obtain the physical location information of the nodes, which effectively reduced the overheads for route searching and shared multicast tree maintenance. The algorithm used the concept of small overlapped zones around each node for proactive topology maintenance within the zone. To search for an existing multicast tree outside the zone, constrained directional forwarding was used which guarantees a good reduction in overhead in comparison to network wide flooding for the search process.

PROPOSED ROUTING PROTOCOL

We are proposing a new Routing Protocol based on DSDV, which is more energy efficient and routing data in an efficient path. The improved protocol is designed and added to existing modules using C++ and OTcl languages in NS2. The proposed routing E-DSDV algorithm is implemented and compared with the existing DSDV routing protocols. In the proposed routing protocol, data can be transmitted in a secure manner and consuming lesser energy. This concept provides secure data communication and increases the lifetime of the sensor network as a whole. The proposed method of performance is compared with other routing protocols for different network parameters and studied the efficient protocol under a particular scenario on the basis of the following metrics such as Average Delivery Ratio, Average Delay and Average Energy Consumption.

The enhanced DSDV protocol, is an active routing protocol designed for wireless sensor networks. Improved DSDV is capable of unicast and extendable to multicast routing. Improved DSDV protocol builds routes between nodes only as desired by sink nodes. It maintains these routes as long as they are needed by the sources. In this chapter, the strategies used to accomplish the objectives are described to begin with overall working of routing protocol neighbors discovery phase, primary path discovery phase, path establishment and operation. We then attempt to analyze and interpret the data gathered during simulation and present the results. By assuming certain initial condition about the WSN, we are proposing the above said protocol. The assumptions were considered that M-identical wireless sensor nodes are distributed randomly in a field. All nodes have the same transmission range, and have enough battery power to carry their sensing, computing, and communication activities.

The network is fully connected and densed (i.e. data can be sent from one node to another in a multihop bases). Each node in the network is assigned a unique ID and all nodes are willing to participate in the communication process by forwarding data. Additionally, at any time, a sensor node 'm' is able to acquire the residual energy level, residual energy of its battery and the X-Y co-ordinates of the node position. The proposed E-DSDV is composed of petal algorithm [15] and Destination Sequenced Distance Vector (DSDV) routing algorithm [16]. The E-DSDV identifies and broadcast route update packet to only selected area. Since the route update packet propagates only in limited and selected areas, the end-to-end delay for a packet is minimum and increases the reliability by eliminating number of redundant intermediate nodes in the network, by sending the number of packet across the network, by receiving number of packets in the network and reduces the routing overhead when compare to a DSDV routing algorithm.

The E-DSDV routing algorithm combines the advantages of petal routing and the DSDV routing algorithm. The S-DSDV routing first identify the activity area, representative node and then routing process is carried out. The E-DSDV routing algorithm for mobile ad-hoc network identifies an activity area as follows:

Step-1 Calculate the distance (D) between source and destination using Eqn. (1)

$$D = \sqrt{(X1 - Y1)^2 + (X2 - Y2)^2} \quad \text{------------------------ (1)}$$

Step-2 Calculate Midpoint (Ms,Md) between source and destination using Eqn. (2)

$$Ms = (X1 + X2)/2 \quad , \quad Md = (Y1 + Y2)/2 \quad \text{--------- (2)}$$

Step-3 Identify activity area by using the Eqn. (3) as shown in Fig. 2

$$Area = \wedge AB$$

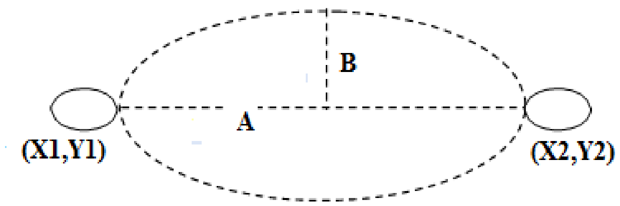

Figure 2. Finding of Activity area

Step-4 Identification of Representative Node (if nodes do not lie inside the activity area, then node is called a non representative node).

Routing is a process of finding a better path in the network. In E-DSDV, each representative node of a Mobile Ad-hoc Network maintains a routing table, sequence number generated by the destination as in DSDV routing. Whenever source needs to communicate destination, E-DSDV identifies all the representative nodes among the network, and broadcast route update packet in the active area. After flooding route update packet in the active area, the representative nodes update their routing table with incrementing the metric by one and retransmit the route update packet to corresponding neighboring representative node and repeats until the entire representative node receives the route update packet along with a corresponding metric. Using such information available in the routing table, the packets are transmitted between source and destination through representative nodes.

RESULT ANALYSIS

We study the performance of E-AODV routing algorithm through extensive simulation. E-AODV routing algorithm is evaluated for number of simulation scenarios. Our proposed routing algorithm is implemented in NS2.35, with the use of various performance metrics and analyzing the trace files generated by the scripts run for different routing protocols. Graphs have been plotted to strengthen the analysis with trace file information. The observation and conclusion can be made from the graphs plotted using the analyzed data and compared with other routing protocols present in the network simulator NS2. The following sections contain detailed analysis and descriptions for each of the performance metrics considered. The simulation set up is as follows:

Table 1. Simulation Parameters

Network field	1000m X 500m
Number of Sensor	10 to 50
Number of Sinks/Number of Sources	1/10 to 50
Transmission Range	240 m(Default range in Ns2)
Packet Size (Data + Over head)	Up to 1024bytes
Transmit Power	15 Units
Receive Power	13 Units
Idle Power	12 Units
Sleep mode Power	0.015 Unit
Initial Battery Power	1000 Units
MAC layer	IEEE 802.11
Simulation time	10 seconds

The performance of the proposed method is evaluated using the evaluation metrics such as average End-to-End Delay, Average Delivery Ratio and Average Energy Consumption. Average End-to-End Delay is calculated by subtracting “time at which first packet was transmitted by source” from “time at which first data packet arrived to destination”. This includes all possible delays caused by buffering during route discovery latency, queueing at the interface queue, re-transmission delays at the MAC, propagation and transfer times. This metric is significant in understanding the delay introduced by path discovery. From the trace file, we can get the sequence number of the data packet sent by the source and received at the sink end by taking the difference we get the delay of transmission. The lower the transmission delay, the performance of the protocol is better. The values are tabulated in Table 2 and the corresponding bar graph is shown in Fig. 3. We can observe that the proposed E-DSDV has lower delay comparatively.

Table 2. Experimental Results of End-to-End Delay

ROUTING PROTOCOL	20 Nodes	40 Nodes	60 Nodes	80 Nodes	100 Nodes
AODV	0.0568	0.0739	0.0632	0.0290	0.0755
E-DSDV	0.0223	0.0522	0.0201	0.0212	0.0204
DSR	0.0282	0.0702	0.0318	0.0258	0.0238
DSDV	0.0323	0.0722	0.0401	0.0412	0.0404

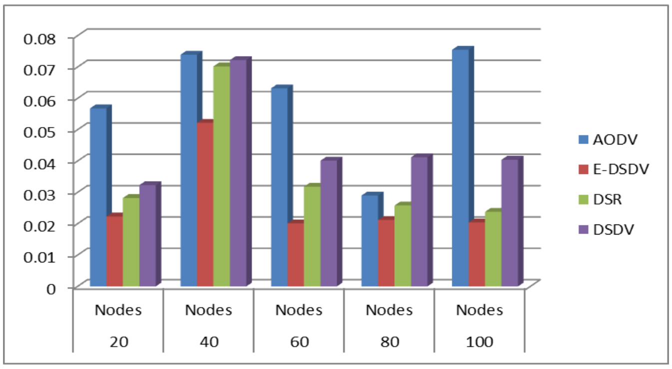

Figure 3. Average End-to-End Delay Values of Existing and Proposed Method

The packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source. It specifies the packet loss rate, which limits the maximum throughput of the network. The better the delivery ratio, the most complete and correct is the routing protocol. Average number of packets delivered, considering the total number of packets sent as one unit. It can be observed from the graph that E-DSDV performs better than the other two since the route is ready before the sensor starts sensing the data. The average delivery ratio values of existing and proposed method is given in Table 3 and graphical representation is shown in Fig. 4.

Table 3. Experimental Results of Average Delivery Ratio

ROUTING PROTOCOL	20 Nodes	40 Nodes	60 Nodes	80 Nodes	100 Nodes
AODV	0.5012	0.4361	0.4973	0.3853	0.3312
E-DSDV	0.6323	0.4923	0.6333	0.5027	0.6312
DSR	0.5912	0.4211	0.5187	0.4813	0.6292
DSDV	0.5333	0.4947	0.6333	0.4027	0.5933

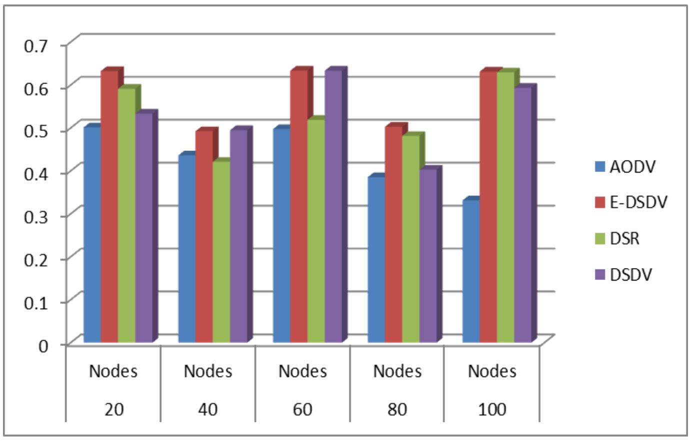

Figure 4. Average Delivery Ratio of Existing and Proposed Method

The average energy consumption is the average of the energy consumed by the nodes participating in message transfer from source node to the sink node. From the simulation that AODV and DSR use more number of routing nodes for transmission of data resulted in increased average energy consumption compared to E-DSDV. The values are tabulated in Table 4 and graph is plotted in Fig. 5 which shows the number of nodes versus number units of energy consumed. Based on the experimental results, the proposed method produced better results compared to other leading routing protocols.

Table 4. Experimental Results of Average Energy Consumption

ROUTING PROTOCOL	20 Nodes	40 Nodes	60 Nodes	80 Nodes	100 Nodes
AODV	95.69	102.98	93.34	82.13	90.21
E-DSDV	89.40	92.622	88.43	87.49	88.46
DSR	89.10	101.11	90.25	89.82	95.22
DSDV	88.40	96.62	90.43	90.19	90.26

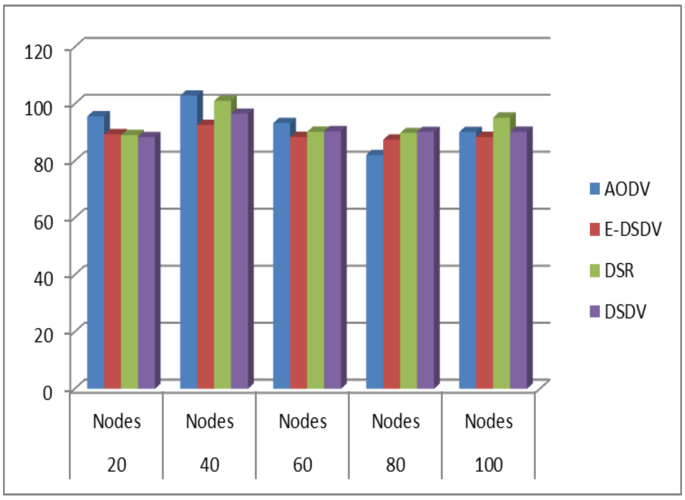

Figure 5. Average Energy Consumption of Existing and Proposed Method

CONCLUSION

The proposed algorithm, the E-DSDV routing technique identifies the activity area, optimize the nodes participate in the route discovery process and provides better performance by increasing throughput, packet delivery fraction, number of packets sent and received across the network. The results of simulation of E-DSDV and DSDV routing algorithm show that end-to-end delay and routing overhead are consequently reduced when compared to DSDV routing protocol. Performance of each routing protocol has been analyzed and evaluated accordingly based on a different number of nodes, pause time over same area size. In the simulation result, proposed routing protocol performs well compared to other leading protocols. Hopefully, the result of this study can be used as reference for the future work.

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