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Performance Evaluation of Routing for Wireless Sensor Network

Saranya. N[1*] and Manimekalai. K[2]

[1] Department of Computer Science, Sri GVG Visalakshi for women, Udumalpet|
[2]Department of Computer Application, Sri GVG Visalakshi for women, Udumalpet

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Abstract- Wireless Sensor Network (WSN) is consisting of independent and distributed sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. Routing protocols represent an essential aspect of the performance of mobile wireless networks. This paper presents a comparative analysis between several routing algorithms and their impact on the performance of WSN. In this paper, we used NS-2 to simulate and implemented routing protocols like Destination-Sequenced Distance-Vector Routing (DSDV) protocol, Ad hoc On-Demand Distance Vector (AODV) protocol, Optimized Link State Routing Protocol (OLSR) protocol and Dynamic Source Routing (DSR) protocol for many numbers of nodes. We compared network parameters, analyzed and evaluated the performance with comparing the end to- end delay, packet delivery fraction (PDF), throughput and packet loss rate. As the number of nodes increases and the network expands, the performance of the AODV protocol obtains better results than the other protocols.

Keywords— AODV, DSDV, DSR, OLSR, WSN

I. INTRODUCTION

Recent advances in wireless and micro electronic communications have enabled the development of a new type of wireless network called Wireless Sensor Network (WSN). WSNs have a wide range of potential applications, including security and surveillance, control, actuation and maintenance of complex systems and fine-grain monitoring of indoor and outdoor environments [1]. Routing in WSNs is one of the most challenging tasks due to the inherent characteristics that distinguish these networks from other wireless networks. The routing algorithm is to provide a strategy to ensure at any moment, the connection between any pair of nodes belonging to the network. In general, routing protocols in WSNs can be classified, according to structure of the network, into flat routing; hierarchical routing and location based routing [2, 3]. The objective of this research is to carry out a performance study of three routing protocols, namely AODV, DSDV, DSR and OLSR Protocol.

Several routing protocols have been created to adapt the limits of the equipment of the wireless sensor network. Some were derived from mobile ad hoc routing protocols and others were newly created. The purpose of the implementation of a routing protocol is to determine the optimal path through the packet network based on a certain criterion of performance. The problem lies in the context of wireless sensor networks is the adaptation of the routing method used with the large number of existing units in an environment characterized by modest computing capabilities and rapidly changing topologies. Routing protocols for WSN can be classified into three broad categories [4,5]:

- Flat routing protocols: Each node typically plays the same role and sensor nodes collaborate to perform the sensing task. Flat protocols are classified into two types: proactive and reactive [6]. Proactive protocols maintain routes to destinations even if they are not needed, and they are not suitable for larger networks. Reactive protocols maintain routes to destinations only when they are needed. Limits of these routing protocols is energy consumption and data redundancy [7].
- Hierarchical routing protocols: Divide the network into groups that communicate through their clusters Head (CH). Each cluster can only have one CH. All non-CH nodes send the data to the CH nodes of the clusters, which they are considered.
- Location-based protocols make use of position information to relay data to the desired regions instead of the entire network. Before a packet can be sent, the position of the destination must first be determined. Classification of various protocols as shown in Figure 1.

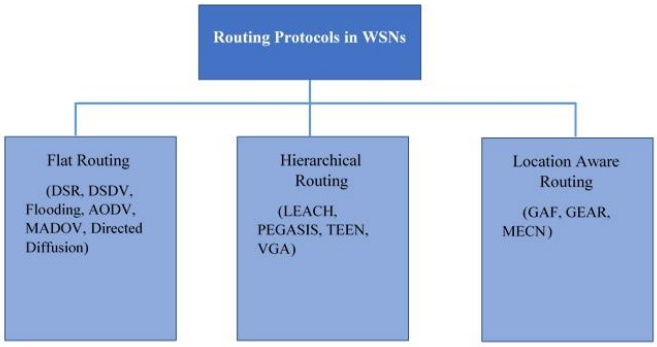

Fig. 1. WSN Routing Protocols Classification

AODV (Ad hoc On-Demand Distance Vector Routing) Protocol

AODV protocol is a reactive routing protocol. When a wireless node wants to send packets to the destination node, it checks its routing table. If there is no route entry that can reach the destination node, the node will broadcast the route requests (RREQs) packet to find a new path. The node receiving the RREQ checks first whether the destination address of the packet is for itself, if not, then checks if the intermediate point has an available path to the destination node. If so, the routing table is modified according to the information in the packet, and then it is broadcast. When the relay point receives RREQ information, and the destination address recorded in RREQ is itself, then the routing table will be changed according to the routing information recorded in RREQ. Each RREQ has an identification (ID). When a node receives a RREQ, it confirms first whether it has been received before. If it is received, the packet is discarded to ensure that the path of all nodes is Loop-free [6].

DSDV (Destination-Sequenced Distance-Vector) Protocol)

A proactive type protocol DSDV is a routing protocol based on the improved routing algorithm. In this routing mechanism, each wireless node must store and continue to update a routing table in which the destination address, the next hop, hop count, the sequence number, and the first time to connect are recorded. The sequence numbers are contained in each record in the routing table, which can be used to determine whether some paths are old, to avoid the generation of loop routing. Each node transmits its routing table to the neighbor periodically to maintain a complete path for all nodes. When the network topology changes so greatly that the routing table has a great change, the node will also transmit the new routing table to the neighbors actively, so the update of the routing table has the characteristics by time-driven and by event-driven. The update of the routing table has two kinds of full dump and incremental update. If the routing table changes most, the node transmits full dump to neighbors. If not incremental update [7].

DSR (Dynamic Source Routing) Protocol

DSR protocol is a reactive routing protocol too. In this routing mechanism, each wireless node has route buffer. Route information is directly recorded in the header of each packet. DSR protocol also uses route discovery process to find routes dynamically when a route is needed. The routing discovery process in DSR protocol is similar to the AODV protocol. When a node wants to transmit a packet to destination node, it checks its routing table first. If it cannot find the route entry to the destination node, the source node send route request (RREQ) to each node by broadcast. The node receiving the RREQ will reply route reply (RREP) to the intermediate point or original source, in order to generate the route. Unlike AODV protocol, when the route record goes through a hop, the hop ID is recorded in the route record of RREQ. In this way, when route is recorded to the destination node, there will be information on Hop-By-Hop Route. The destination node selects an optimal route in a number of RREQs, and sends a RREP to the source node based on the route record. The source node store the route records in the RREP in the route table. Therefore, the source node knows Hop-By-Hop Route to the destination node [8].

OLSR (Optimized Link State Routing) Protocol

OLSR is a Proactive link state routing protocol. In a link state, every node in the network transmits few message i.e. “HELLO” message or some sort of information to their neighbouring nodes, this process is called flooding. After sometime, each node constructs a topology of the network in the foam of a graph. In link state routing every router communication with other routers and exchanging their link state information for either building a topology or the entire network. However, the main problem with this flooding mechanism is that flooding causes encountering multiple copies of the same link-state information. The main limitation in link-state routing is wastage of network bandwidth as flooding causes high battery consumption so to overcome this problem (MPRS) Multipoint Relays is designed. MPRs are those elected nodes that are leading to broadcast messages during its flooding process. This technique essentially scales down the message overhead as compared to a classical method. This protocol is particularly suitable for large and dense networks. MPRs act as intermediate routers in route discovery procedures. Disadvantage of OLSR routing protocol need more time for re-discovering a broken links. OLSR has three functions: packet forwarding, neighbor sensing and topology discovery.

The paper is organized as follows. Section II describes literature review. Section III details the simulation scenario and the evaluation parameters. Section IV shows and analyzes the simulation results for four routing protocols. The conclusions of this paper are finally presented in section V.

II. LITERATURE REVIEW

The authors simulate and compare the performance of AODV, DSDV, and DSR in network size, packet delivery ratio, average delay and average throughput. The conclusion is that AODV is best in the average throughput and improved in case of average packet deliver ratio. DSR performs with the least delay in the network [4].

The authors compare the performance of AODV and DSDV using the NS-2 simulator. The result shows that AODV achieves higher efficiency and performance under high mobility scenario than DSDV [5]. The authors simulate the protocols of DSR, DSDV and AODV using dissimilar setting in terms of nodes density variation and nodes speed along with various traffic types. They evaluate the performance parameters, which are energy usage, throughput, small packet delivery ratio and total packets dropped. Simulation results show that DSR behaves to be more consistent for throughput and PDF for different approaches. DSDV outperform the other two protocols in term of energy utilization when using constant rate. The behaviour of AODV seemed to vary according to the traffic type used but on average it shows a high throughput regardless of the scenario examined [6].

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The authors stated that the Wireless sensor network is an important communication tool used in many applications. There are various routing protocols, which can provide significant benefits to wireless sensor networks in terms of both performance and reliability. Many routing protocols have been designed for wireless sensor networks. However, the popular ones are DSR, DSDV, AODV.NS-2(Simulator) has used for comparing the performance of these 3 protocols and the simulation results are analyzed for the parameters Throughput, End to End Delay, Packet delivery Ratio [8].

The author said the field of wireless sensor networks (WSN) engages many associates in the research community as an interdisciplinary field of interest. This type of network is inexpensive, multifunctional attributable to advances in microelectromechanical systems and conjointly the explosion and expansion of wireless communications. A mobile ad hoc network is a wireless network without fastened infrastructure or federal management. Due to the infrastructure-less mode of operation, mobile ad-hoc networks are gaining quality. During this work, we have performed an efficient performance study of the two major routing protocols: Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) protocols. We have used an accurate simulation model supported NS2 for this purpose. Our simulation results showed that AODV mitigates the drawbacks of the DSDV and provides better performance as compared to DSDV [9].

The authors' stats Wireless Sensor Networks (WSNs) comprises of small nodes with sensing, computation and communications. These sensor networks interconnect a numerous other nodes when set up in massive and this opens up several technical challenges and significant application opportunities. In WSN, data accumulating from the surroundings and sending that records to be processed and evaluated is the most crucial troubles. Hence overall performance evaluation and evaluation among routing protocols is required due to the fact performance of any routing protocol may be modified or very with diverse parameters which include speed, seed time, pause time, wide variety of node, and traffic situation. In this paper routing protocol AODV, AOMDV, DSR and DSDV has been analyzed by comparing the two performance matrices as packet delivery ratio (PDR), loss packet ratio (LPR) with varying pause time and number of node under TCP & CBR connection via network simulator NS for wireless sensor network [10].

III. SIMULATION SCENARIO AND EVALUATION PARAMETERS

Simulator NS2 in the WSN provides us with the idea of its output performance in real time situations. The two different scenarios are evaluated where the number of nodes are varies. Four routing protocols like AODV, DSDV, OLSR and DSR are compared in First scenario with diverse numbers of nodes from 10 to 500. However, the DSDV protocol lose efficacy when the number of nodes is more than 300. In second scenario, we evaluate network expansion with DSDV protocol. The number of nodes reaches to 345 at most, then DSDV protocol lose efficacy. The descriptions for the other parameters taken in simulation are shown in the table 1 as follows:

We have performed our simulations on ns-2 tool. Network Simulator (Version 2), widely known as NS2, is simply an event driven simulation tool that has proved useful in studying the dynamic nature of communication networks. Simulation of wired as well as wireless network functions and protocols can be done using NS2. In general, NS2 provides users with a way of specifying such network protocols and simulating their corresponding behaviours. NS2 consists of two key languages: C++ and Object-

oriented Tool Command Language (OTcl). While the C++ defines the internal mechanism (i.e., a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events (i.e., a frontend). The C++ and the OTcl are linked together using TclCL. Mapped to a C++ object, variables in the OTcl domains are sometimes referred to as handles. Figure 2 details the NS2 architecture.

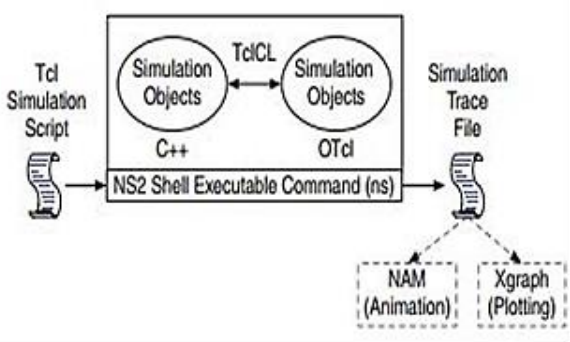

Fig. 2. NS2 Architecture [10]

For evaluating the performance, we have analyzed the following metrics:

Average End-to-End Delay

End-to-end delay is the delay occurred during packet transmission from the source node to the destination node in application layer. However, the delay from each source node to correspondent destination node is not equal. Therefore, we evaluated the average end-to-end delay. The lower the average end-to-end delay is, the better the protocol performance will be. Based on the results in Fig.3, it can be concluded that the AODV protocol has the higher average end-to-end delay than DSDV, OLSR and DSR when the number of nodes is less than 200.

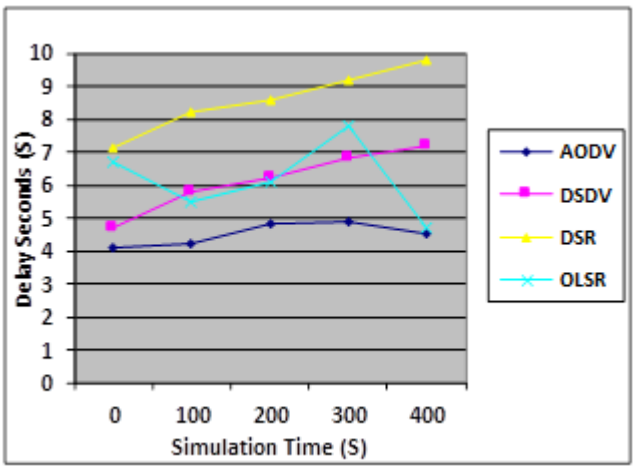

Figure 3. Average End-to-End Delay

Packet Delivery Ratio (PDR)

Number of packets the destination nodes receive by number of packets the source nodes send to destination calculates the Packet Delivery Fraction (PDF). The higher the PDF's value is, the better the protocol performance will be. Based on Fig.4, the simulated results show that DSR overcome AODV and DSDV has the highest packet delivery fraction. The higher packet delivery fraction was achieved using AODV protocol when the number of nodes is no more than 300. DSDV does not store full route. If the incumbent link is failure, DSDV will need establish link again. Therefore, the packet delivery fraction for DSDV is fluctuant and a downtrend.

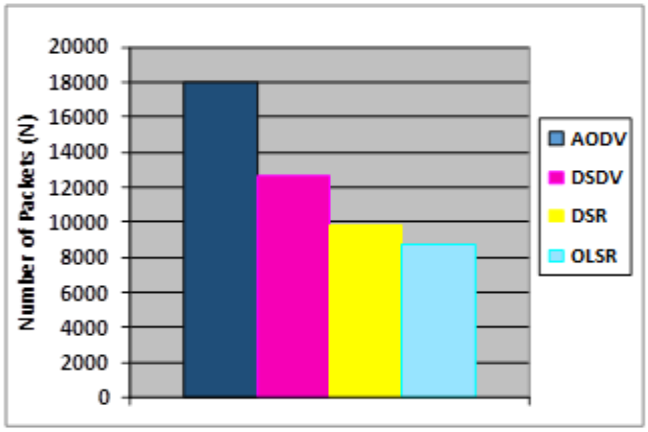

Figure 4. Packet Delivery Ratio

Loss Packet Rate

The loss packet rate is calculated by dividing the total lost packet for routing by total packet sent. The lower the loss packet rate is, the better the performance will be. Based on Fig.5, the simulated results show that DSR has the lowest loss packet rate. Loss packet rate is lower for DSDV as compared to AODV when the number of nodes is less than 300. The loss packet rate for AODV is fluctuant and a uptrend. AODV attains better result than the other routing protocols in terms of other simulation parameters.

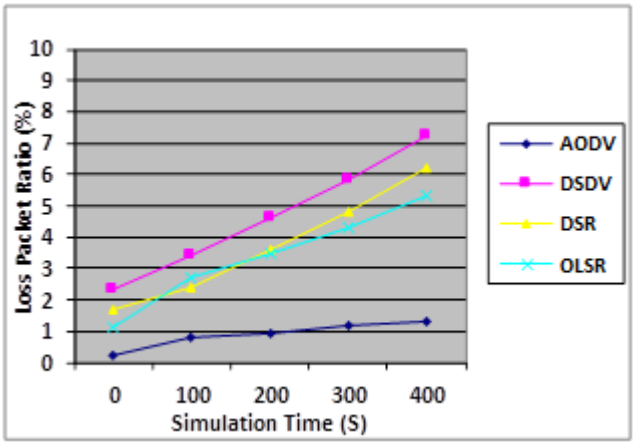

Figure 5. Loss Packet Ratio

IV. CONCLUSION

1. In this paper, we evaluate the performance of three routing protocols like DSDV, AODV, OLSR and DSR by simulation in WSN. We analyze them over four metrics named the average end-to-end delay, PDR and loss packet rate. We get the conclusions as follows. First, AODV has the best performance over three metrics in four routing protocols. The performance of AODV protocol is relatively stable though the number of nodes increases constantly. The performance of DSDV protocol is close to DSR when the number of nodes is less. Second, when the network expand, the performance of DSDV protocol will decline and lose efficacy in the end. Therefore, AODV is suitable for small networks.

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Biographies and Photographs

Saranya N is doing her PG degree in Sri GVG Vishalakshi College for women, Udumalpet. She is completed her UG degree Computer Technology in the Hindusthan Institutions. She is interested in Networking.

Manimekalai K has completed her MCA., M.Phil in Computer Science. She has published 12 International Journals. She has 15 years of teaching experience and qualified State Level Eligibility Test (SLET). At present she is working as a Head & Assistant Professor in Sri GVG Visalakshi College for Women, Udumalpet. Her area of interest is Data Mining.

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