Performance Analysis of WSN Routing Protocols with Effective Buffer Management Technique

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Abstract. Routing in WSN has dependably been a serious issue of concern mainly because of a few case studies which extend from unfriendly deployment conditions, network topology that change over and over, network failures, resource constraints at each sensor hub to issues in designing of routing protocols. Accordingly, the implementation of routing protocol is influenced by a few fundamental elements which must be thought of before any attempt at designed routing are implemented. Two major protocols used in WSN are Dynamic-Source Routing (DSR) and Destination Sequenced Distance Vector Routing (DSDV). DSR protocol is mainly source based routing protocol and implemented to limit the bandwidth utilized by packets in WSN by avoiding the regular messages transmitted to update table in table-driven approach. The proposed system is Multilayer Buffer Management DSR (MBMDSR) where multilayer buffer management mechanism is implemented in existing DSR protocol and a considerable increase in performance was noted.

Keywords: DSR · WSN · Multilayer buffer management · DSDV

1 Introduction

Wireless network is a gathering of wireless sensor hubs with no fixed structure and communicates with each other through remote connections. Applications for wireless sensor networks include different domains, such as medical monitoring [1–3], environmental monitoring, home surveillance, military operations, and machine monitoring in the industries. For recent many years analysts have concentrated on major routing protocols such as, DSDV and DSR and their working mechanisms. DSR protocol is based on source, utilizing intermediate nodes for information exchange from source hub to destination hub. In DSR protocol problem arises due to fast movement of nodes which causes collision between the nodes which in turn causes flooding in the network. Efficient buffer management policy aims at maximizing the overall throughput by reducing the number of packets that are retransmitted due to packet loss. Network Simulator-2 (NS2) is used for the simulation of the scenario in the network. The comparative analysis is carried out between the existing DSR and DSDV. A Multilayer Buffer Management policy is introduced to DSR and compared with DSR.

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The results show that the loss of relevant packets is less in MBMDSR when compared to the existing DSR protocol.

2 Literature Survey

Akyildiz et al. [4] stated that the characteristics of sensor networks such as fault tolerance, flexibility, high sensing fidelity, rapid deployment and low cost creates new application areas for remote sensing. However, sensor networks needs to fulfill the constraints presented by components, for example, adaptation to internal failure, adaptability, cost, hardware, topology change, environment and power utilization.

V. Jacobson [5] presented that computer systems have encountered an unstable development in the course of recent years and with that development have come extreme congestion issues. For instance, it is presently consistent to see web gateways drop 10% of the incoming packets on account of local buffer overflows. Examination of some of these issues has demonstrated that a significant part of the cause lays in transport protocol executions. The "self-evident" approaches to actualize a window-based transport protocol can bring about precisely the wrong behavior because of network congestion.

J. Postel [6] depicted that currently available buffer management mechanisms are divided into two categories mainly congestion avoidance and congestion control. Congestion avoidance mechanism first identifies the congestion in the network or avoids it from happening whereas congestion control mechanism focuses on recovery of a packet loss in the network. The main disadvantage of congestion avoidance mechanism is that it does not fit to the type of arrangement where several hubs sends their reading to a particular node.

Zafar Mahmood, Muhammad Awais Nawaz [8] and other authors studied and compared the behavior of AODV, DSR, and DSDV routing protocols. Analysis was carried out using NS2 as a computer simulator tool and results of analysis were depicted in graphical format. The graph is represented with respect to the pause time which depicts DSR protocol is improved than other two protocols, it is mainly because the system was fewer intense and fewer stressful DSR was better in packet delivery ratio with respect to packet sent when compared to the AODV and DSDV with minimum routing load, but DSDV have highest value for the performance metrics like average end to end delay.

Review of above literature survey indicates that most of the authors worked on routing protocols in WSN, studied their behavior, compared many routing protocols with each other and determined which routing protocol is better in terms of performance metrics by using the NS2 simulation tool. Also work has been carried out on buffer management policies as the WSN has limited memory and power. To overcome this limitation of WSN, authors have carried out survey on buffer management policies. This survey clearly indicates that if multilayer buffer management policy is implemented in routing protocol the loss of relevant packets was decreased and the throughput was gradually increased. The main objective of this work was to study and compare the DSDV and DSR routing protocol and to check which protocol is better in terms and performance metrics. Further, implement the routing protocol MBMDSR in order to increase the throughput and decrease the loss of relevant packets.

3 Existing System (Existing DSR)

The Route Maintenance protocols do not fix a broken connection. The broken connection is just conveyed to source. The DSR protocol is just productive in Mobile System with less than 200 hubs. Problem occurs due to rapid movement of nodes in a network. Flooding packets in the network may lead to collision among the packets. Additionally there is a little time delay at the start of another association with a new node on basis that the initiator should first discover the route to the objective.

4 Proposed System–MBMDSR

Multilayer buffer management technique is implemented to the existing DSR protocol (MBMDSR). The process includes four modules: DSR route discovery, packet classification, buffer partitioning and a discard policy.

It finds the multiple reliable paths from source to destination so that if one link fails the information is sent through other alternate paths. The MBMDSR protocol is efficient for large number of nodes up to 500. There is less chance for flooding the network which reduces the collisions between the packets. As the main buffer is divided into multiple buffers the relevant data can be saved and successfully transferred to the destination and drop of packets is less at destination side when compared to the existing DSR.

4.1 DSR Route Discovery

Source node Send request (RREQ) to intermediate nodes if respond (RREP) from the true destination is received by the source, it begins to transfer data packet. Otherwise exceeded dynamic hop discovery again source node send RREQ and the process repeats. Data packets are transmitted to destination through shortest path.

When path is set up and if target finds that packet delivery ratio drastically falls to the threshold, the detection scheme is activated to recognize the constant maintenance and real time reaction efficiency. The threshold is a differing value in the range [85%, 95%] that can be balanced by current system efficiency. The initial threshold value is set to 90%. This can be done by utilizing a dynamic threshold calculation that control the time when packet delivery ratio falls under the same threshold.

4.2 Packet Classification

Every node divides the arriving packets into three distinctive types and subsequently every packet is said to be of type i, $1 \leq i \leq 3$. First type of packets is relevant packets that include relevant and important data. Second type of packet is irrelevant packets that include diverse type of information that is not related to the receiver information.

Last type of packets is normal packets that incorporate hello packets and regular packets those created at consistent time interval. Regardless, it ensures that there is no loss of important packets and disregard the loss of other types of packets.

4.3 Buffer Partitioning

Buffer partitioning indicates measure of storage space accessible to specified queue and characterizes how memory is shared between distinctive queues. In network situation, every hub comprises of a total buffer size B, shared by T diverse kind of queue. Entire buffer is divided into T queues as per expected incoming packet type. Main buffer is divided in three queues (relevant, irrelevant and normal) and every queue accepts packets with corresponding type only. The memory space of relevant, irrelevant and normal type of queues is L, M and N respectively. Consequently, total capacity of three queues should not exceed total limit of main buffer, $L + M + N \leq B$. Every hub can recognize the kind of received packets by the data represented in packet header.

4.4 Discard Policy

Discard Policy primarily manages the policy that incorporates tolerating or dismissing of arriving packets and moreover pushing out a previously stored packets to make space for an incoming packets. The judgment is made in perspective of the type of incoming packets. Arrived packets are explicitly divided in three types as described previously. When the main buffer is full, discard policy is implemented and it executes as below.

If incoming packet is of normal type and if there are a couple of packets in normal queue, then it replaces the oldest packet in normal queue with the newly arrived packet. If the length of normal queue is zero, i.e. there are no current normal packets to be dropped or evacuated, it drops the incoming packet. If the incoming packet is important, it drops oldest packet either from normal or relevant queue to make a space for new incoming relevant packet. If the incoming packet is irrelevant, it drops the irrelevant packets.

Comprehensive analysis and comparison is carried out between existing DSR and MBMDSR.

5 Experimental Analysis and Results

Simulation (By default the X-axis is always taken as simulation time period) has been conducted to compare DSDV with DSR and it was noted that DSR performed well as compared to DSDV in terms of Packets dropped, Packet delivery ratio and Throughput as depicted in the Table 1.

Table 1. Comparative results of DSDV with DSR

Simulation time (milliseconds)	Parameter	DSDV	DSR
0–17	Packets dropped	65	15
6–18	Packet delivery ratio	0.95	1.000
15	Throughput	85	90

With respect to the above results, since DSR performed well compared to DSDV, the proposed buffer management technique was introduced to obtain the results as shown in Table 2.

Table 2. Comparative results of DSR with MBMDSR (considering no. of nodes)

Number of nodes	Parameter	DSR	MBMDSR
500	Packets dropped	8	3
300	Packets dropped	6	2
100	Packets dropped	3	0

It is observed that the packets dropped gradually decreased with increase in number of nodes.

Simulation results were also tabulated for Packet Rate Vs. Packet Dropped as shown in Table 3.

Table 3. Comparative results of DSR with MBMDSR (considering packet rate)

Packet rate	Parameter	DSR	MBMDSR
5500	Packets dropped	3	0
3500	Packets dropped	1.8	0
1500	Packets dropped	0	0

It is observed that as the Packet rate increases the Drop of packets were NIL in MBMDSR.

The result of simulation is depicted in the graphical format. Simulation of DSR protocol and Multilayer Buffer Management DSR (MBMDSR) is performed for 100–500 nodes and the result is depicted in graphical format shown.

Figure 1 shows the Loss of relevant packets vs the Buffer size for three layer WSN. Packet loss is gradually decreasing for three layer WSN, which means as the buffer size increased its capacity to accommodate the packets is also increased. Hence the maximum packets can be accommodated in buffer. As the buffer size increases the number of packets accommodating is more, as a result the loss of relevant packets is less.

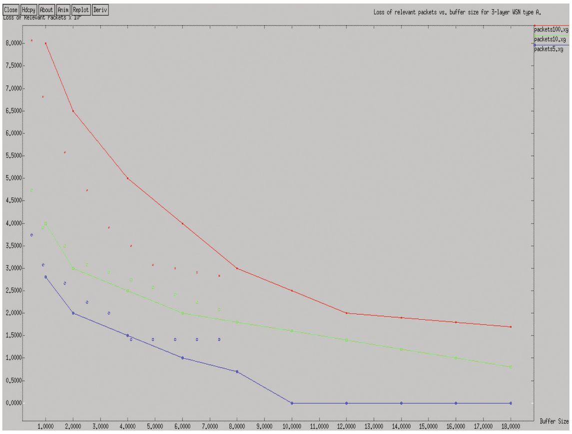

Fig. 1. Loss of relevant packets vs Buffer size

Figure 2 shows the loss of relevant packets vs number of nodes for three layer WSN. Loss of relevant packets is less in MBMDSR when compared to DSR. The graph depicts that loss of relevant packets is gradually decreasing with respect to increase in number of nodes in case of MBMDSR.

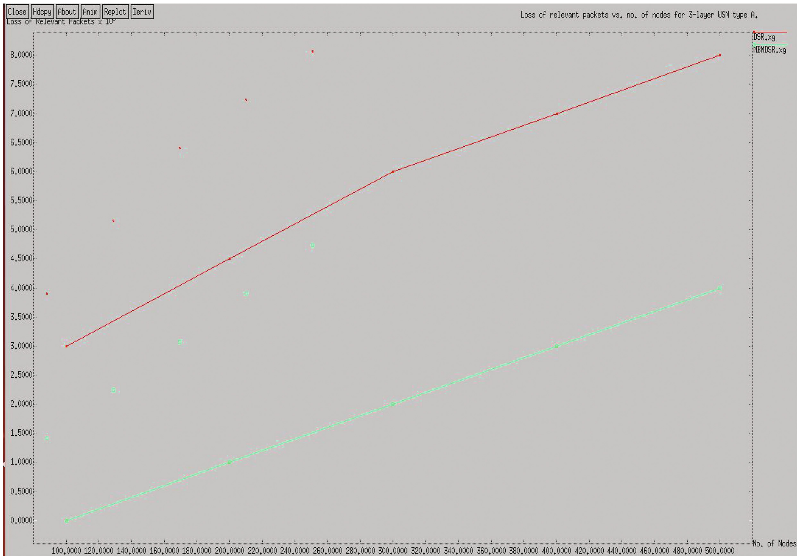

Fig. 2. Loss of relevant packets vs number of nodes

Figure 3 shows the loss of relevant packets vs packet rate for three layer WSN. Loss of packets is more in case of DSR when compared to MBMDSR. The graph depicts that the loss of relevant packet is more in DSR protocol because when the packet moves faster in a network, there is collision of packets which results in loss of packets. But when MBMDSR is considered, it overcomes with that problem as it is efficient during the fast movement of nodes.

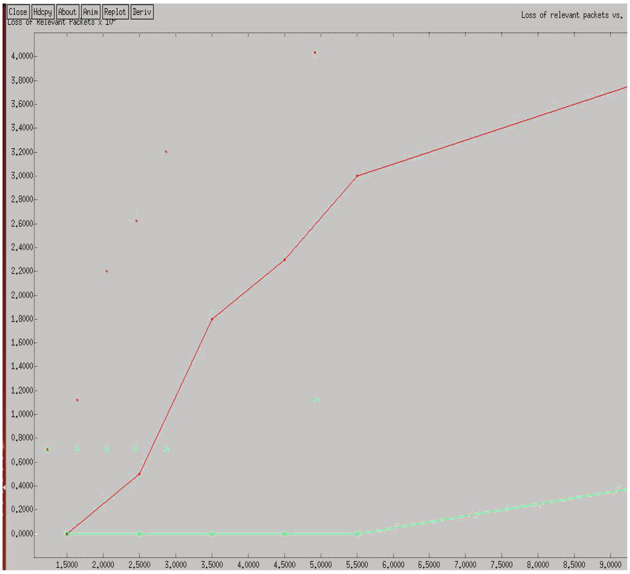

Fig. 3. Loss of relevant packets vs packet rate

To conclude, MBMDSR is better than DSR protocol in terms of packet rate, loss of relevant packet and buffer size. MBMDSR overcomes the major limitation of DSR which is Loss of relevant packets and hence it can be used in network were there are more number of nodes. It can also be used when the nodes are moving fast as it avoids the collision between the packets. It also helps in accommodating more number of packets and also useful and relevant packets. MBMDSR avoids loss of useful packets to a great extent. As WSN has major applications in critical domains such as healthcare, the loss of important packets should be considered as a major issue. The unwanted information can be dropped and useful information can be stored and utilized.

6 Conclusion

A. The main focus of the work is on routing protocols with respect to their performance in the wireless sensor network. And implementing the multilayer buffer management technique to one of the routing protocol is a step towards achieving a network with better Quality of Service.

B. MBMDSR protocol is efficient for large number of nodes.
C. There is less chance for flooding the network which reduces the collusions between the packets.
D. As the main buffer is divided into multiple buffers relevant data can be saved and successfully transferred to the destination. For MBMDSR drop of packets is less at destination side when compared to the existing DSR.
E. By implementing the buffer management technique in DSR protocol it is possible to reduce the loss of relevant packets in WSN.

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