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ENERGY CONSUMPTION SOLUTION IN MOBILE AD-HOC NETWORK

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ABSTRACT

The current study was motivated because of higher energy consumption in the current mobile-ad hoc network especially the dynamic system routing. A solution was proposed consisted of nodes energy and traffic load and distance during the route discovery phase. Later, a simulation was performed to make comparison between DSR and MP-DSR. The results states that the proposed MP-DSR outperformed the DSR in all three tests including packet delivery fraction, end-to-end delay, and average energy consumption.
Keywords: MANET, Energy Consumption, DSR. MP-DSR.

INTRODUCTION

Mobile ad-hoc network is important in modern life as these network function without any centralized management and enable smart mobile nodes to communicate anywhere and at any time (Kaur, Kaur, & Kansal, 2016). Because of random nature of the network, any node can enter and leave the network thus making the network very dynamic and unpredictable. The mobile ad-hoc network function by using the intermediary nodes to function as a router between a node wish to communicate with other nodes outside its transmission ambit. Therefore, each node in mobile ad-hoc network can function as a router and host simultaneously.

Besides several benefits, the mobile ad-hoc network poses own challenges such as limited capacity of wireless channels and limited battery power due to the higher dynamic nature of the network. Generally, there are two categories of routing protocol namely proactive and reactive routing schemes (Khan, Bhutto, & Pandit, 2016). OLSR and DSDV are example of proactive

routing manner which works on the basis of interchange of directing information among nodes whether a path is required or not. The result of proactive protocol is that it become resource heavy and consumer higher bandwidth and energy. On the other hand, the reactive routing protocol such as AODV and DSR function by interchanging routing information among nodes for consistent timeframe and hence a route is only developed if it is required so. Thus, such type of reactive protocol are more economical in terms of resources consumption in the network.
In reactive routing protocol schemes, dynamic source routing algorithm is an important protocol (Zafar, Tariq, & Manzoor, 2016). The protocol is based on distributed routing mechanism. Route setup stage and route upkeep stage are two stages of DSR. Route reply (RREP) and route request (RREQ) are two control packages which are used in path unearthing phase. Route request package is released from source node for establishing the path. When destination receive the route request package, its response to the source node by sending the route reply package. If data transmission is failed, so route error package is utilized. The dynamic system routing has benefits over other protocol since it creates a route only when it is required and also nodes makes efficient use of route cache for making reduction in packet collisions and better route choice for minimal hopcounts. However, for route discovery stage, dynamic system routing fails to take consideration in to resources consumption including nodes traffic load and energy requirements. Thus, to improve the route discovery in dynamic system routing, the current study proposes a modified route discovery mechanism. In this proposed method, the transmission power of exchanged data packets will be adaptive based on nodes distance.

LITERATURE REVIEW

Dynamic Source Routing (DSR)

In main categories of routing, there are two categories namely the proactive and reactive. The dynamic source routing falls in the reactive category. The packets in the dynamic source routing is forwarded to the destination node by maintaining the tidy list of all intermediary nodes 5. Routing cache is maintained by all nodes which is in medium storage. Route creation and the route reply are two packets used in route creation and route upkeep. Route request and route reply package are used in route creation stage; while, route error packet is used in route maintenance phase.
The process start with the source node intends for connecting to the destination node by searching in routing cache. If previously, there are no route available, the route creation process begins by source node by sending a route request to neighboring nodes (Drini & Saadawi, 2008). If there is an intermediary node, it will send back the route reply package to the source node (Wu, Ni, Sheu, & Tseng, 2001). Furthermore, it may rebroadcast the route request package to neighboring nodes. The process continues until the message reaches to the destination node. The route request package may be reaching to the destination node using different paths because of rebroadcasting of transmission. Once the destination node receives the route request package, it responds back by route reply package through reward path to source node (Novatnack, Greenwald, & Arora, 2005). After the route is established, the route maintenance stage starts. At

this stage, each intermediary node for the proposed route ensures that the transmitted data has been delivered successfully to the next node in the path.

Sharifdeen and Dhavamaniprakash (2015) proposed a version of dynamic system routing referred as EEDSAR based on modification of route discovery for the purpose of minimizing energy consumption of nodes. The proposed scheme works on the reduction of repetitive route discovery mechanism by providing higher energy for minimum number of intermediate nodes. The study conducted a simulation and found that the EEDSR which was proposed and the original dynamic system routing had identical results in terms of throughput and energy consumption; however, for medium to larger networks, the EEDSR outperformed the dynamic routing system on the criteria of throughput and energy consumption.

Study by Parthiban, Sundararaj, and Maniiarasan (2018) proposed a new route discovery schema of dynamic system route. The proposed protocol was about route choice dependence on minimal hop count and the remaining energy of nodes thus magnifying network life time.

Leung, Liu, Poon, & Chan (2001) proposed a modified version of dynamic system routing with the aim to makes route stable and bring energy consumption down. The study conducted stimulations and made comparison between modified DSR, AODV, and DADV. Stimulation results highlights that the proposed DSR had better results compared to the DADV and AODV in terms of delay time, maximum throughput, and energy consumption.

Mohamed, Nouh, and Naguib (2015) also proposed a modified version of DSR and named as MP-DSR. The objective of this proposed modified version was to improve the service quality. The study conducted a stimulation and results indicate that the proposed MP-DSR had better reliability of communication among nodes compared to the other protocol compared.

LS-MDSR was proposed by (Singh & Singh, 2017). The proposed protocol was modified version of DSR. The study results show that the proposed version had better results in terms of balanced traffic load sharing and efficient routing algorithm.

EPAR-DSR was proposed by Badal & Kushwah (2015) The proposed version is modified version of DSR. The purpose of the modified version was to improve the system life and efficiency. The results based on the stimulation show that the proposed system had better results in terms of balanced distribution of traffic among nodes, better energy consumption, and improved network life time.

Another modified version of the DSR was proposed by Taha, Alsaqour, Uddin, Abdelhaq, & Saba (2017). The authors argued that the proposed system had better results in terms of route life time. The system work on the idea of advance calculations about time it takes active routes to expire.

A new schema introduced by Sarkohaki, Fotohi, & Ashrafian (2020). The proposed schema referred as MP was with the aim to reduce the flooding of RREQ packets which makes network congested and increase energy consumption. The proposed method suggests three routes metrics including the node’s speed, strength of receipted signal, and remaining energy. This way, the nodes with low energy can be avoided. The system is argued to be reducing the RREQ packets flooding because it selects nodes based on criteria of mobility, reception signal strength, and remaining energy. The study conducted stimulation and show that the proposed modified system had better results compare to the traditional DSR in terms of delay time, remaining energy of nodes, and throughput.

A modified path is proposed by Sarkar & Datta (2016). The modified path select path based on node energy consumption as metric for receiving and transmitting single packet instead of minimum hop counts. The results of the study showed that the proposed system have better performance compare to the DSR in terms of nodes energy efficiency. Based on the guidelines by previous studies and the deficiencies in the current DSR, the current study proposes a modified DSR. The details are provided in upcoming section.

MP-DSR

The shortcomings of the current dynamic system routing for the mobile ad-hoc network includes high energy consumption and shorter network life. To overcome such challenges, the study is proposing a modified DSR labelled as MP-DSR. The proposed method is to overcome energy consumption and efficiency problems by making change in the route discovery phase. It adds the awareness about nodes' energy and traffic load during this phase. It does so by replacing the transmission based on maximum power with selection of reduced power based on the nodes distance. This bring reduction in the network energy consumption and the improved network life. For implementing the proposed model, the nodes energy factor, its traffic load factor and adaptive transmission power is taken in to consideration.

In mobile ad hoc network, the energy efficiency is main problem which reduce the network efficiency and life. The proposed method first calculates the node's energy factor

In next step, the traffic load model is selected. Mostly, the route selection in the DSR is multi-hop which result in lower traffic for the intermediary nodes. It is so since nodes having higher traffic load result in higher waiting of packets in transmission buffer and thus enhance the delay time. Based on the energy factor and the traffic load factor, a new metric is created which is labelled as Node Efficiency Factor.

The study is based on the adaptive transmission power model which his different from the traditional protocol where data packets are transmitted based on fixed power and leads to the higher energy wastage and consumption. The adaptive power method on the other hand, takes in to account the nodes distance and set power accordingly. Thus, the adaptive power method brings higher efficiency in the data transmission in the DSR. Practically, it means that if there are two nodes such as X and Y where X is source and the Y is the destination node. So, if X need to send some data packet to the Y, so first it will calculate the adaptive power and send the data accordingly. Furthermore, the operational changes include route creation stage by adding present coordinates and link efficiency factor.

The process also initiates when source nodes starts searching for the routing cache to get a route to connect with the destination node. In situation, where, there is no route in cache, the source node initiates the RREQ packet which also contains the source node coordinates and link efficiency factor to the neighboring nodes. If neighboring node contains the path for the destination node in the cache, it will send RREP package using the reverse path to source node.

If no neighboring node contains the cache, it will calculate its efficiency factor and adaptive transmission power in route cache and forward to the neighboring node. At the end of the process, the source node will receive the RREP which will be stored in its reply cache. Once the source node receives the two set of RREP packets, it initiates sending data packet to the route based on highest REF and recommended transmission power to intermediate node who also follow the same procedure until the data is sent to the destination node.

Besides the route discovery, the route maintenance is responsible for managing the right operation for active route based on this proposed protocol. If there is some broken link during the transmission, the route error packet will be sent to the source node by means of hops modality. All the nodes involved in the route returning to the node will delete the route towards unreachable target. The source node will also delete the path and start the alternative route process.

Simulation Procedure

To test the performance of the proposed protocol i.e. MP-DSR, stimulation is conducted using the network's imitator NS2. The number of nodes in the simulators were 80. The time for simulation was 1000 seconds. The simulation area was 300 * 750 meter. The routing protocol is DSR and the MP-DSR. The packet size is standard 512 bytes. The channel is wireless.

RESULTS

The results based on the simulation continued for 1000 seconds is as follows.

Table 1: Simulation Results

Pause Time in Sec	DSR-Packet Delivery Fraction %	MP-DSR-Packet Delivery Fraction %
0	76	67
100	81	76
200	84	80
300	87	81
400	89	83
500	91	88
600	93	90
700	94	91
800	96	93
900	98	95
1000	99	97

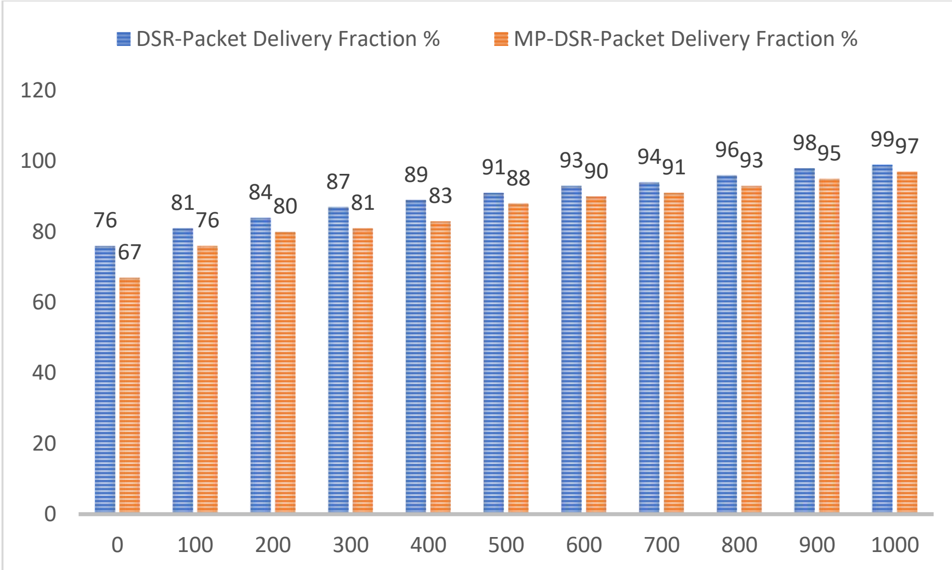

Figure 1: Packet Delivery Function Comparison

Table 2: End-to-End Delay

Pause Time in Sec	DSR-End-to-End Delay	MP-DSR-End-to-End Delay
0	4.5	3.9
100	4.3	3.6
200	4.2	3.1
300	3.6	2.8
400	2.7	2.5
500	2.4	2.1
600	2.1	1.7
700	1.7	1.6
800	1.5	1.3
900	1.4	1.2
1000	0.6	0.5

The results for the packet delivery fraction based on 1000 times seconds is provided above. At 0 pause time, DSR packet delivery fraction was 76%; and MP-DSR packet delivery fraction was 67%. At 100 pause time, DSR packet delivery fraction was 81%; and MP-DSR packet delivery fraction was 76%. At 200 pause time, DSR packet delivery fraction was 84%; and MP-DSR packet delivery fraction was 80%. For 300 pause time, DSR packet delivery fraction was 87%; and MP-DSR packet delivery fraction was 81%. At 400 pause time, DSR packet delivery fraction was 89%; and MP-DSR packet delivery fraction was 83%. For 500 pause time, DSR packet delivery fraction was 91%; and MP-DSR packet delivery fraction was 88%. At 600 pause time, DSR packet delivery fraction was 93%; and MP-DSR packet delivery fraction was 90%. At 700 pause time, DSR packet delivery fraction was 94%; and MP-DSR packet delivery fraction was 91%. At 800 pause time, DSR packet delivery fraction was 96%; and MP-DSR packet delivery fraction was 93%. At 900 pause time, DSR packet delivery fraction was 98%; and MP-DSR packet delivery fraction was 95%. At 1000 pause time, DSR packet delivery fraction was 99%; and MP-DSR packet delivery fraction was 7%. Overall, the packet delivery fraction was better in MP-DSR compared to the original DSR based on the simulation of the study.

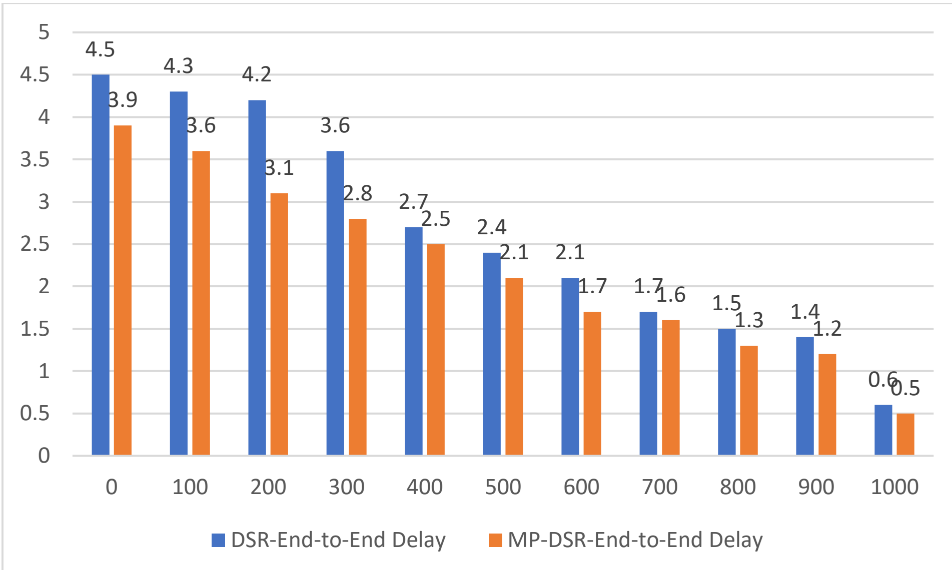

Figure 2: End-to-End Delay Comparison

The results of the end-to-end delay is provided above. At 0 pause time, DSR end-to-end delay was 4.5; and MP-DSR end-to-end delay was 3.9. For 100 pause time, DSR end-to-end delay was 4.3; and MP-DSR end-to-end delay was 3.6. At 200 pause time, DSR end-to-end delay was 4.2; and MP-DSR end-to-end delay was 3.1. At 300 pause time, DSR end-to-end delay was 3.6; and MP-DSR end-to-end delay was 2.8. For 400 pause time, DSR end-to-end delay was 2.7; and MP-DSR end-to-end delay was 2.5. At 500 pause time, DSR end-to-end delay was 2.4; and MP-DSR end-to-end delay was 2.1. At 600 pause time, DSR end-to-end delay was 2.1; and MP-DSR end-to-end delay was 1.7. At 700 pause time, DSR end-to-end delay was 1.7; and MP-DSR end-to-end delay was 1.6. At 800 pause time, DSR end-to-end delay was 1.5; and MP-DSR end-to-end delay was 1.3. At 900 pause time, DSR end-to-end delay was 1.4; and MP-DSR end-to-end delay was 1.2. At 1000 pause time, DSR end-to-end delay was 0.6; and MP-DSR end-to-end delay was 0.5. Overall, the result shows that MP-DSR end-to-end delay was better compare to the DSR.

Table 3: Average Energy Consumption Comparison

Pause Time in Sec	DSR-Average Energy Consumption	MP-DSR-Average Energy Consumption
0	13000	6000
100	12500	5500
200	12000	5200
300	11500	4600
400	11200	4200

500	10750	3900
600	9800	3700
700	9600	3500
800	9300	3300
900	9100	3100
1000	8500	2750

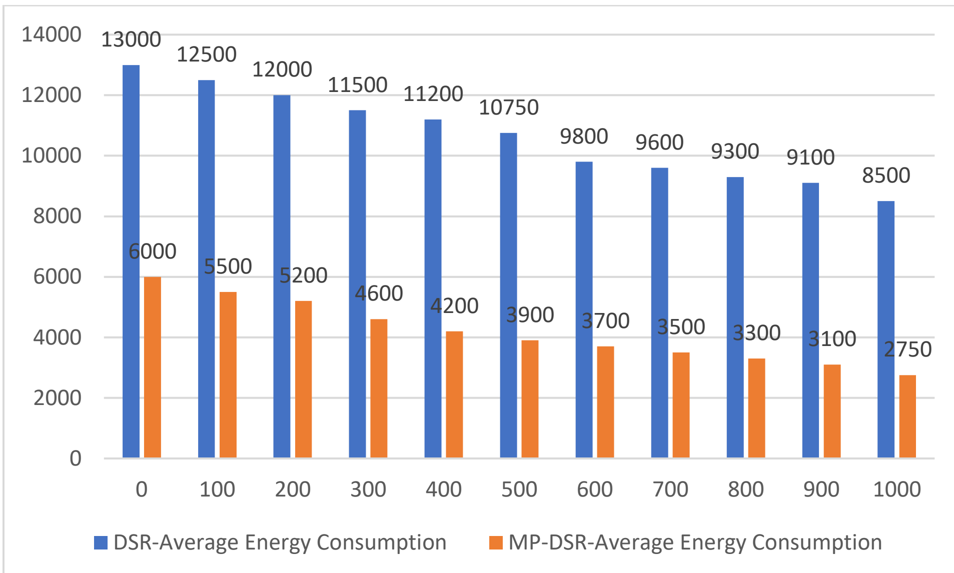

Figure 3: Average Energy Consumption Comparison

The results for the comparison of average energy consumption for both protocols are provided above. These results are important since energy consumption was the main reason of developing modification in the original DSR. For 0 pause time, DSR average energy consumption was 13000; and MP-DSR average energy consumption was 6000. For 100 pause time, DSR average energy consumption was 12500; and MP-DSR average energy consumption was 5500. For 200 pause time, DSR average energy consumption was 12000; and MP-DSR average energy consumption was 5200. For 300 pause time, DSR average energy consumption was 11500; and MP-DSR average energy consumption was 4600. For 400 pause time, DSR average energy consumption was 11200; and MP-DSR average energy consumption was 4200. At 500 pause time, DSR average energy consumption was 10750; and MP-DSR average energy consumption was 3900. For 600 pause time, DSR average energy consumption was 9800; and MP-DSR average energy consumption was 3700. For 700 pause time, DSR average energy consumption was 9600; and MP-DSR average energy consumption was 3500. For 800 pause time, DSR average energy consumption was 9300; and MP-DSR average energy consumption was 3300. For 900 pause time, DSR average energy consumption was 9100; and MP-DSR average energy consumption was 3100. For 1000 pause time, DSR average energy consumption was 8500; and MP-DSR average energy consumption was 2750. Overall, result shows that in terms of average energy consumption, the proposed MP-DSR had better performance compare to the traditional DSR.

CONCLUSION

The aim of the study was to propose a modified DSR labelled as MP-DSR based on bringing changes in the route discovery procedure for reducing the energy consumption and improving the system efficiency. A simulation was performed and the result show that the proposed MP-DSR performed better than the DSR in terms of packet delivery fraction, end-to-end delay, and average energy consumption.

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