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Location Aware Directional Flooding Algorithm for improving Energy Efficiency in MANET

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Abstract*: MANET networks often form with mobile devices to enable communication and connectivity in time-critical applications. The routing protocol employ in the network often defines the energy efficiency and network performance in ad hoc networks. In this paper, we propose a directional flooding-based routing approach to improve data reliability and improve packet delivery ratio in MANET network. The proposed routing protocol simulate in the NS2 environment to evaluate network performance of flood-based routing algorithm.

Index Terms*: MANET, Energy Efficiency, Ad hoc Network, Routing and Data Reliability.

I. INTRODUCTION

MANET's are autonomous, ubiquitous wireless devices that communicate with each other using multi-hop channels without any need of infrastructure. MANETS employ in different applications such as military and disaster management. The MANETS has distinct features such as multi-hop communication, dynamic network topology, limited energy source and limited bandwidth. The limited resources hinder the quality of service, and several challenges arise in design to enable seamless communication between nodes in the network. The packet size and data Transmit interval further reduces the performance and improves congestion resulting in reduced quality of service. The wired network, on the other hand, handles large data packets and provides increased flow control and congestion control in the network. The packet loss ratio, throughput in network and data reliability improves with acknowledging signals. For every packet transmitted by the transmitter, the receiver on receiving the data packet replies with an acknowledgement signal. Congestion control mechanism such as additive increase/multiplicative decrease employs in the network to reduce data congestion. Furthermore, the complexity in routing protocol constitutes for seamless operation of MANET because the nodes communicate between each other directly since the coverage region is small. Conventional routing protocol designed for MANETS often employ deterministic routing where the data packets forward by the predefined set of nodes in the network. Deterministic routing works better when the routing has minimal link loss, and the network is free from congestion.

The links in wireless networks are dynamic and ever-changing due to nature of the nodes. The MANET suffers from diminished link quality, availability of short interval routes, and increased distance between nodes. The lifetime of the routes in MANET network is usually limited due to nature of mobile nodes. If a route in the node becomes invalid, then link failure algorithms apply to recover dead links between nodes. The dynamic routes in the network update at regular intervals. If the level of route change is frequent then the MANET network has increased control overhead. The routing protocols enable reliable data communication and data packet delivery in the network. Routing protocols such as opportunistic routing protocol, deterministic routing protocol, gradient forwarding, table driven routing, destination sequenced distance vector employ for data routing in MANET networks. In the above routing protocols, a routing table is maintained for data transmission between nodes in the network. Furthermore, the data packets have headers which let the other nodes know the destination of particular data in the network. Sensitive routing protocols such as AODV and DSR have reduced performance due to channel environments.

In gradient based routing protocol, the nodes do not forward data from one node to the other rather the signal to noise ratio between the nodes measure over a period and the errors solve by opportunistic routing spatial diversity.

II. LITERATURE SURVEY

Peer to peer mobile ad-hoc communication protocols implement which employs flooding routing protocol between two nodes in. The data in MAPCP (MANET anonymous peer to peer communication protocol) does not require any encryption or decryption which reduces power consumption and computational complexity. THE MAPCP route data across different paths with the query and no new routes are discovered which makes MAPCP best suit for P2P communications [1].Local link connectivity is an important parameter to establish the route and maintain the route. The Hello messages are transmitted at regular time intervals to query about link connectivity. The unwanted hello messages suppress by applying adaptive Hello messages without causing any broken links [2]. Mobile ad-hoc network gain increased popularity due to diversity, low cost and simplicity. These devices form reliable communication links between devices. The nodes in the network are mobile unlike in wired networks. Algorithms such as ad-hoc on demand distance vector, apply route request messaging scheme to determine routing path between source and destination.

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The connectivity factor routing protocol provides a means to detect underlying nodes without the use of the central controller in the network while reducing requesting signals [3].

Mobile nodes in MANETs are battery powered. AOMDV Fitness functions apply in MANET network to reduce the energy consumption of nodes. The fitness model finds the minimal path between source and destination. The AOMDV fitness function protocol performs well compared to AOMDV and AOMR-LM protocols regarding energy efficiency [4].

The mobility and performance of the reactive routing mobile ad-hoc network depend on the time taken to determine the path, hop count, relative speed and radio range. With minimal speed, the traffic pattern reduces with multimodal distributions. The high and moderate level of exponential distribution helps parameterise and provide the nominal approximation to determine path duration for different mobile network models [5].

The links between wirelesses are lossy because of channel interference. The reliability of data packets increases by transmitting duplicate data across nodes. The multicast routing protocol forms various multicast trees which satisfy bandwidth requirement in lossy MANETs. The approach minimises bandwidth consumption while making bandwidth available for data flow. Further, the redundant data in the network minimises by employing scheduling algorithms to transmit data across different routing paths [6].

The MANET wireless links are in constant risk of link failures. The routing algorithm in the network determines link failures and improves connectivity to provide seamless data transmission while maintaining the quality of service. The AODV apply in MANET for routing decisions due to its appreciable network performance regarding packet delivery ratio, throughput and hop count [7]. The location prediction based routing protocol reduces hop count between nodes and route discoveries between source and destination. Conventional routing based techniques gather information such as mobility information, location and route search process. If the hop count determination fails, the route discovery fails. The nodes in the network try to predict location and mobility information between nodes in the network during route discovery. The Dijkstra algorithm runs on local topology to predict minimum hop count and send data packets from source to destination [8].An optimised multicast routing protocol employ in MANETs. The polymorphic protocol takes advantage of proactive behaviour, network overhead, mobility and neighbour nodes in the network. The OPHMR protocol use adaptability and operations of multi behavioural models. The behaviour changes alter accordingly to improve parameters such as deliverability, improving node lifetime, and improves communication delay. The control overhead in network minimises by controlling the number of control packets propagated by nodes [9]. The tree-based routing protocol applies in MANET to improve mobile internet protocol. The internet gateway comprises 2 heterogeneous networks. pMANETs are small tress which makes from anchor nodes for direct internet gateway communication. The newly formed node communicates between the home agent and foreign agent [10].

In mobile ad-hoc networks, energy consumption affects the operation and efficiency of the network. Hence, Modified DSR routing protocol employs to reduce the energy consumption of nodes in MANET network. The modified DSR selects routing paths which consume less energy for data transmission. The modified DSR suffers from selfish nodes which often drop packets from other nodes. The selfish node problem eliminates with Efficient DSR routing protocols [11].

The MANET routing is dynamic hence new nodes join and old nodes relieve from the network. Hence, the nodes need to make fast decisions to provide reliable communication between nodes in the network. The nodes learn each node operating characteristics and choose routing decisions accordingly. The QoS routing protocol and look ahead routing protocol help evaluate link failures and provide alternate paths for data routing. The above routing protocols enable better routing decisions than conventional routing protocols [12].The multiple routing mechanisms in MANETs solve with swarm intelligence routing algorithms. The algorithm is low cost, robust and flexible. The algorithm provides a centralised heuristic approach where the routing related information is balanced by centralised control entity. Furthermore, Ant colony optimisation solves routing and data reliability problems in dynamic MANET network [13].

Reference point group mobility (RPGM) model performance monitor for proactive and reactive routing protocols. RPGM apply in the dynamic network where nodes are mobile. The mobility poses a significant threat in determining routing paths and data routing between nodes in the network. The RPGM performs well compared to DSR routing protocol [14].Intelligent transportation systems (ITS) apply for safe and secure transportation of systems. The ITS employ in vehicular transportation infrastructure communication systems. The manet routing algorithm relevance and persistence evaluate in the mobile ad-hoc network for data sharing in VANETs [15].

III. METHODOLOGY

In MANETS the nodes in the network are mobile. Hence, there is no definite single route for source packet to reach the destination node. Hence, routing algorithms employed to route data packets in a dynamic network. Directional flood based routing algorithms apply to improve data reliability in MANET network. The nodes in the network communicate with each other to know the location of other nodes in the network. When a node needs to transmit a particular data packet to a destination node, the receiving node floods the data to other nodes in the network.

Assuming that the total number of nodes in the network is finite, the nodes in the network represent as

$WN=\{x1, x2, x3, ... x_n\}$

The node lifetime, latency and bandwidth in the network represent as α, β and δ.Where, α- represents the node will remain active β- represents time taken for the data to be received by the destination node.

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δ – is the bandwidth required over which the data is transmitted.

The data latency between nodes in the network calculate with

β - Initial packet sent || initial packet received / time taken.

$$\delta = \sum_{n=1}^{l} \frac{(x)}{Latency}$$

The tonal nodes x in network WN determine by

$$N = \sum_{n=1}^{l} WN \log 2 \frac{Bandwidth \mid lifetime}{Latency}$$

Where,

N is the size of the network.

After successful determination of network size and the total number of nodes in the network, the data packet flooding is stated.

The flooded packet represent as

$WN = \{x_{1f}, x_{2f}, \ldots\ldots.. x_{3f}, x_{nf}\}$

The figure 1 below shows the Directional flooding mechanism for data to be transmitted from source to destination.

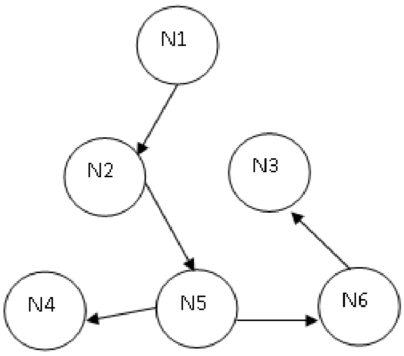

Figure 1: Data flooding in MANET

Each node in the network sends the route request to all nodes in the network. The nodes employ sender based and receiver based reply to determine node discontinuity among the routing path. Once all the nodes in the network receive route request, the data are flooded so that the same node does not receive the data twice. The routes between the nodes in the network determine with

$$\text{Node route} = \frac{\text{Number of connections between a nodes}}{Currentnumberofnodesinthenetwork}$$

The proposed routing mechanism implement in the NS2 environment to evaluate proposed system effectiveness. The network parameters and simulation models are tabulated in table 1.

Table 1: Network parameters

Mac type	802.11
Queue type	Drop tail/Priqueue
Queue length	500 bytes
No. Of nodes	50
Coverage region	1000mx1000m
Routing protocol	Directional Flooding
Simulated time	25s
Initial energy	1000j
Tx power	0.15ms
Rx power	0.15ms

Algorithm:

1. Nodes in network explore location and routes.
2. The routes are updated to explore dead end nodes.
3. Each node in the network transmits the data packet to next immediate node.
4. If the current node is a transmitter node or the node is position is outside the bounded directional space, then the data are not flooded to corresponding nodes.
5. Forward data packets to non-transmitter nodes.

IV. RESULTS AND DISCUSSIONS

The Directional Flood routing mechanism and conventional routing mechanism implement in the network to evaluate Directional flood routing mechanism effectiveness. The throughput of the network is increased since all nodes in the network try to flood data to other nodes in the network. This mechanism, in turn, increases network throughput. The conventional algorithm only relies on predefined information for data delivery hence the throughput of the network is low as shown in figure 2.From figure 2 the flood mechanism routing outperforms LOMAN routing algorithm by more than 60%

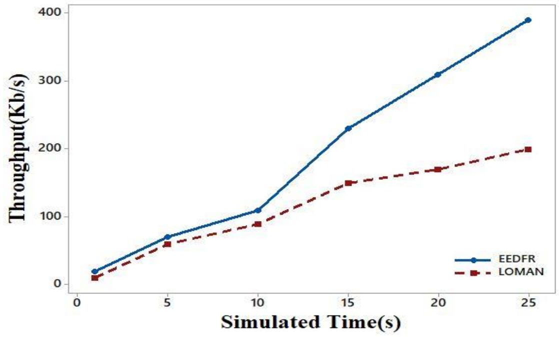

Figure 2: Network Throughput

The Directional flood mechanism consumes the energy of all nodes in network uniformly. The uniform energy consumption eliminates the use of particular nodes for data transmission. In conventional algorithm such as shortest path routing algorithm, the data are transmitted on a predefined path resulting in more energy consumption only at those nodes leaving the rest of the nodes energy level intact. This results in the reduced energy level of nodes as shown in figure3.

Compared to conventional routing algorithm Directional flooding mechanisms provide increased residual energy across nodes in the network.

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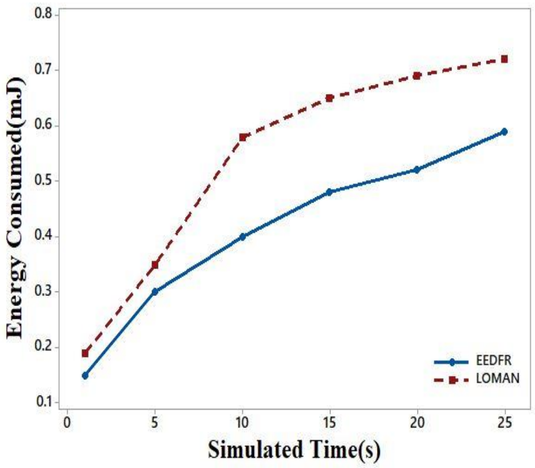

Figure 3: Residual energy

The packets once transmitted from a node falls through all the other nodes in the network. The packets are dropped when the packet reaches a dead end node. Since flooding mechanism forwards data to all other nodes the number of routes over which the data are transmitted increases resulting in low number of packet losses in the network. The directional flood routing mechanism packet loss is less compared to conventional routing algorithm as shown in figure4. In conventional routing algorithm, the nodes data forwarding path are limited resulting in more packet losses in network as shown in figure.

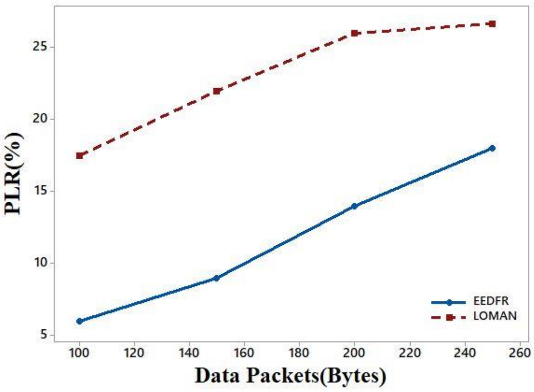

Figure 4: Packet Loss ratio

The packet delivery ratio refers to the number of packets transmitted to the number of packets received at the receiver. The packet delivery ratio is high since the number of data paths taken by the routing path is considerably high. This mechanism ensures data reliability and data to be successfully received at the receiver. Furthermore, the time and energy consumed to transmit a data are less compared to that of conventional routing algorithms. In figure5 the data delivery ratio is high for directional flooding algorithm and for conventional algorithm the data delivery ratio is low.

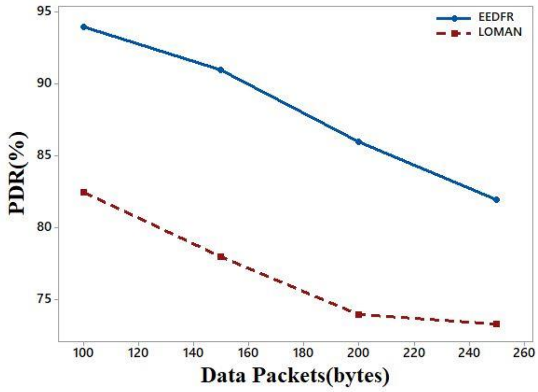

Figure 5: Packet delivery ratio

The end to end delay between nodes refers to the time taken for a particular data to be successfully handed off between two nodes. The end to end delay for directional flood routing algorithm is low as shown in figure6 since the nodes donot waste any time to decida e passing the data packet to next node. However, in conventional routing algorithm, the data forwarding is governed by a centralised controller to forward data packets. This decision making improves end to end delay between nodes in the network. The delay [16] at each node multiplies with hop count between nodes resulting in increased lag time in processing data across nodes. The processing time results in reduced quality of service. Furthermore, since all the nodes in the network are processing the data, no new process can be initiated by other nodes for any operation.

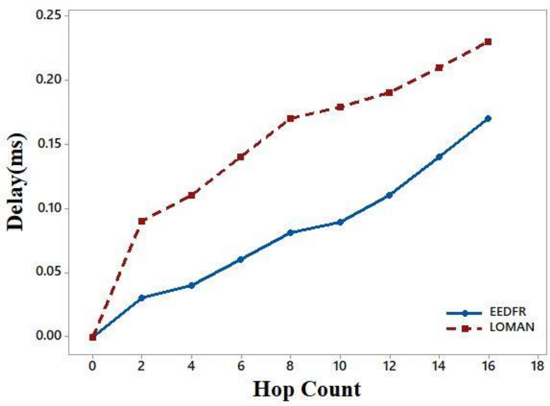

Figure 6: End to end delay

V. CONCLUSION

The directional flood routing protocol in improving data reliability and network parameters validate by NS2 simulations. The LOMAN routing algorithm first implement and its performance evaluate. The conventional routing protocol suffers from data loss and latency due to decision based routing and dead-end nodes. The latency and data reliability improves with flooding mechanism which requires less decision making. Comparative simulation analysis shows, the flood routing mechanism performs better 35% better compared to conventional routing mechanism.

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