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Dynamic Link Aware Routing for MANET's to Achieve QOS Requirements

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***Abstract*—Advancement in mobile ad hoc networks (MANET's), have offered solutions for various real time applications fields including health care, unmanned aerial vehicles (UAV), vehicular ad hoc network (VANETS) and emergency response. Channel fading, error rates, attacks, traffic obstructions, frequent link failures, and topology changes are among the distinctive characteristics of MANETs that could have an impact on the network's performance parameters. One of the main causes of the quality of service (QoS) degradation in present MANETs is link failures imposed on high mobility nodes, low energy, and frequent topology changes. Packet loss can be avoided if the link failure time is predicted on the established path, such that delay can be minimised as possible if alternate paths are found quickly enough. In this paper, we propose a dynamic link aware routing (DLAR) for MANET's through estimating link stability, which adapts topology changes, estimate link quality and improve overall network lifetime to support QoS.**

***Index Terms*— Mobile nodes, link quality, topology, QoS and energy.**

I. INTRODUCTION

Due to advances in technology and wireless competencies, the use of wireless communication and networks has dramatically increased over the recent years. Infrastructure networks and non-infrastructure networks are the two categories under which wireless networks operate. Fixed base stations (BS) or sink nodes form an infrastructure network. They cooperate with other nodes within the communication range and share wireless channels [1-5]. Nodes cooperate with one another and serve as hosts and routers in non-infrastructure networks. Mobile ad hoc network (MANET) is a type of self-regulating network that is built up of mobile nodes that can change their configuration on its own and execute wireless forwarding across the network [6-11]. Nodes transmit packets using multiple hops while employing routing functions. Because nodes are dynamic, frequent link interruptions between them cause the link quality to decline and cause packet loss. Finding nodes with stable links, high residual energy nodes, signal strength, and mobility patterns leads to the discovery of efficient and stable routes [12-13]. In this paper, we propose a dynamic link aware routing (DLAR) for MANET's through estimating link stability, which adapts topology changes, estimate link quality and improve overall network lifetime to support QoS. High-quality signal strength is assured by the link quality indicator (LQI). Energy awareness guarantees that a link's bandwidth is accessible for high-quality communication at a stipulated moment and including high residual energy extends the life of the network and improves data transmission efficiency.
The rest of this paper is structured as follows. In Section I describes introduction, In Section II problem statement and motivation is presented. Section III presents related works done. In section IV proposed DLAR is

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described. In the last section V the performance analysis and relative experiments and simulation are conducted. Finally, we draw the conclusion on the proposed scheme in section VI.

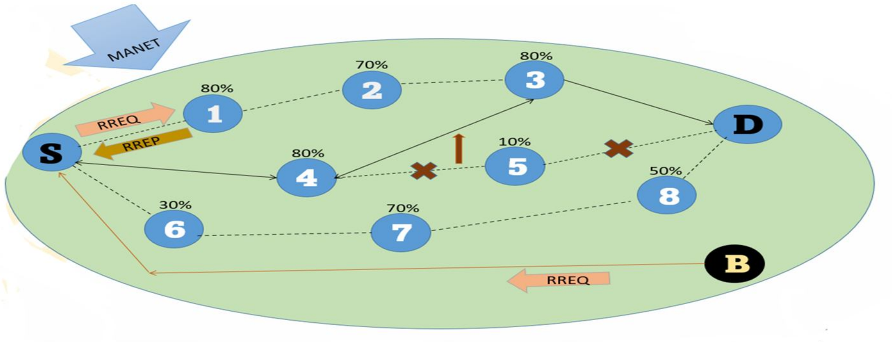

Figure 1 Functionality of a Manet using DLAR

II. LITERATURE SURVEY

In [14] author proposed QoS routing in order to create a selection criterion for high-quality routes, this protocol collects cross-layer data on residual energy and queue length. Due to node mobility in MANET, QoS-AOMDV effectiveness would degrade. Fast modifications in network structure will often result in path interruptions, forcing QoS-AOMDV to switch paths frequently, and will ultimately result in a decline in QoS. As a result, path stability is taken into account while selecting other paths. For example, some methods base their calculation of the stability probability of the relevant path on the distance between nodes or the strength of the received signal. In [15] author proposed topological change Adaptive Ad hoc On-demand Multipath Distance Vector (TA-AOMDV) routing technology, capable of reconfiguring to support QoS during high-speed node mobility. The route identification factors for this protocol's reliable path selection method include link stability probability across nodes in addition to node resources (residual energy, available bandwidth, and queue length). Link interruption detection method, which updates the routing technique according to regular probabilistic estimations of link stability and also built to adapt changes in network. In [16] author proposed fault tolerance routing scheme for MANETs based on the characteristics to determine robust path for reliable data transfer. In this scheme the data packets are routed in two of the discovered paths to maximize fault tolerance. This routing scheme employs the routing metrics such as nodes movement, signal strength and energy in path discovery process for reliable transmissions. Simulation results show better performance in terms of packet delivery ratio, throughput and energy. In order to reduce the prevalent end-to-end delay and improve network lifetime, the author suggested the dynamic energy efficient adhoc on demand distance vector protocol (DE-AODV) in [17]. This protocol chooses nodes with reliable and energy-efficient nodes and supplies dynamic external energy via battery. Every time a link fails, energy from an external battery is dynamically supplied, lowering node energy usage, and extending network lifetime.

III. METHODOLOGY

Periodic path failures in unpredictable MANET behaviour have an impact on factors including bandwidth, energy resource, mobility, and channel fading. For constant communication, it is necessary to keep the link between the two nodes stable. The reliability, asymmetry, and error tendency of tiny nodes with low power wireless communications have been investigated for decades. These links are affected by hardware and ambient factors. The dynamic variation in topology makes it difficult to sustain stable link quality.
The path robustness is predicted by the link quality prediction function, which is a crucial need to maximise routing efficiency and extend network lifetime. Determining the stable path by estimating link quality is necessary for reliable data transmission and to achieve QoS. This motivates us to propose a link quality estimation function to be aware of the link quality before data transmission and avoid packet loss. The below block diagram represents the methodology of the DLAR method.

A. Network Model

Network composed of n mobile nodes, deployed randomly in a sensing area which can be represented as graph $G(n, l)$ where n is number of nodes and l is the communication link. Nodes are free to move in and around the network with different speed and directions, random way point (RWP) model is employed to know the direction

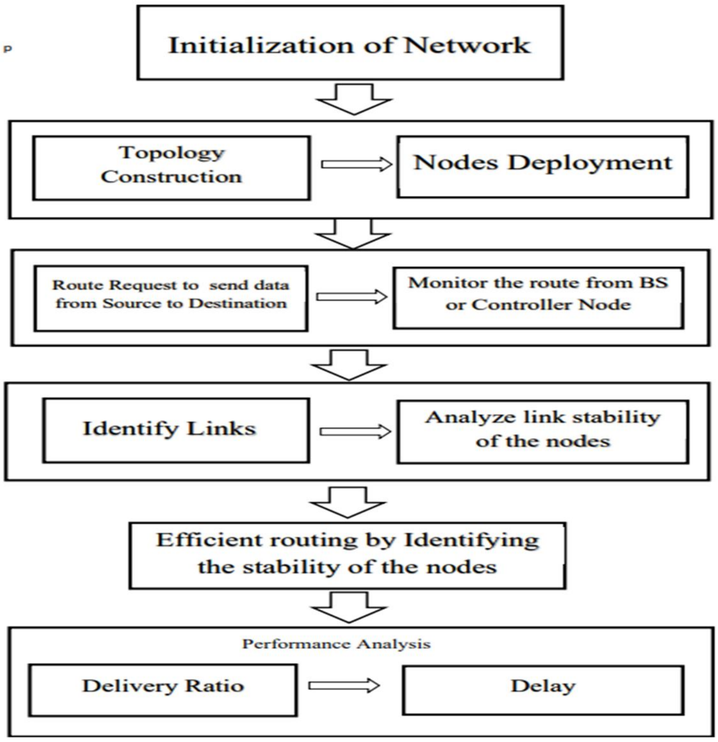

Figure 2 : Block diagram of the Functionality

and velocity of the mobile nodes. Nodes are assigned with same amount of initial energy. Nodes transfer data through single or multi hop transmissions. The distance between nodes is computed using distance equation and is expressed as:

$$D_n = \sqrt{(y_i - y_j)^2 + (x_i - x_j)^2} \quad (1)$$

B. Energy Model

In order to guarantee consistent link lifetime and consistent data transfer, the routing protocol should select energy efficient nodes. Total energy $E_{Total}(n_i)$ represent energy consumption on the selected i path, total energy consume is given as

$$E_{Total}(n_i) = \sum_{j=0}^{j=n_i-1} cost_{j,j+1} \quad (2)$$

The energy consumed to transmit and receive data at time instant T is given as:

$$E_{trans}(T + \Delta) = D_{pkt(tx)} \times P_{tx}(T + \Delta) \quad (3)$$

where $P_{tx}(T + \Delta)$is power consumed during data packet transmission of $D_{pkt(tx)}$ with intermediate node at time Δ measured in Watts per second and energy consumed for receiving packets is given as :

$$E_{receive}(T + \Delta) = D_{pkt(rx)} \times P_{rx}(T + \Delta) \quad (5)$$

The residual energy is calculated as:

$$E_{Residual}\ (T + \Delta) = E_{initial}(T) - E_{cons}(T + \Delta)$$

$$E_{cons} = E_{trans}(T + \Delta) + E_{receive}(T + \Delta) \quad (6)$$

C. Link quality Indicator (LQI)

Link quality metrics are used to calculate how long a link has been active among two nodes. We can predict packet losses caused by the link failure using the link quality indicator. Due to the highly dynamic environment, it is difficult to foresee robust wireless links in MANETs. Robust link between two nodes can be estimated based on transmission range and velocity. Stable link between two nodes n_i and n_j with their coordinate locations (X_i, Y_i) and (X_j, Y_j) and the distance between node is expressed as :

$$D_n = \sqrt{(Y_i - Y_j)^2 + (X_i - X_j)^2} \tag{7}$$

Let R be transmission range and $\varphi V = Vn_i - Vn_j$ be velocity and the stable link quality is indicated as:

$$LQI = \frac{(R-D)}{\varphi V} \tag{8}$$

D. Algorithm

1. Initialize network which consists of a Source node and a destination node in the Manet.
2. Deploy nodes randomly in area.
3. Assign nodes mobility speed.
4. Assign nodes initial energy.
5. Use procedure LQI.
6. Initiate route discovery process.
7. Compute distance between nodes using D_n
8. Send RREQ packets.
9. Estimate link quality using LQI
10. Receive RREP packets.
11. Check for residual energy using $E_{Residual}\ (T + \Delta)$
12. Choose high residual energy nodes for data transmission.
13. End procedure
14. End

IV. Performance Evaluation

Simulation of proposed DLAR scheme is simulated using NS2 tool and performance analysis is compared to existing TA-AOMDV scheme. The simulation parameter used is given in Table No I.

TABLE I: SIMULATION PARAMETERS

Parameters	Value
Nodes in the network	80
Area of the network	800X800
Simulation time	100 Sec
Mobility mode	RWP
MAC	802.11
Energy	50J
Mobility Speed	10,20,30 and 40 m/s
Packet type	CBR

A. Throughput

Figure 3 shows the throughput graph of proposed DLAR compared to existing TA-AOMDV scheme.

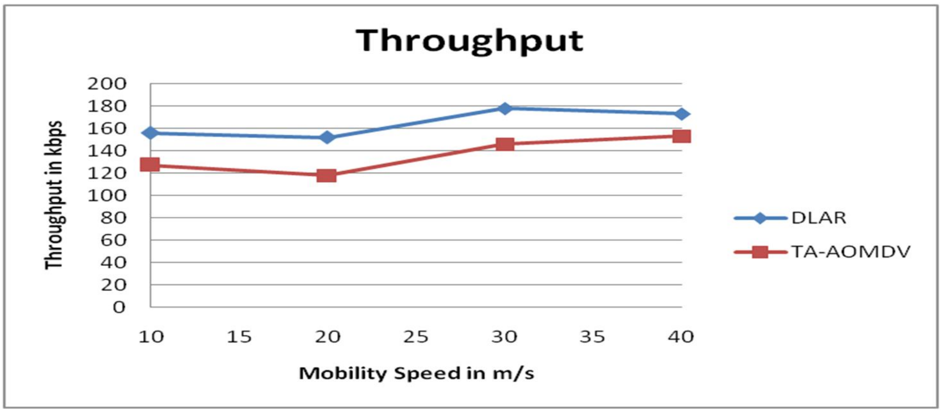

Figure 3: Throughput vs Mobility Speed

It is seen from the graph, as the mobility speed of the node increases the variation in throughput is seen due to link failure and re-establishing routes to destination. When nodes are moving at higher speed, proposed DLAR has throughput of 173 kbps compared to TA-AOMDV of 152 kbps. DLAR computes stable routes to destination by considering higher link quality and more residual energy.

B. Average end-to-end delay

Figure 4 shows the average end-to-end delay graph of proposed DLAR compared with TA-AOMDV. It is observed from the graph that the delay of proposed DLAR is lower compared to TA-AOMDV. DLAR estimates link quality before establishing path and also considers high residual nodes for reliable data transmission. However, TA-AOMDV has more data retransmissions due to link interruption and does not predict the link failure in advance. It is seen from the graph, DLAR has delay of 0.143 ms when nodes moving at 30m/s compared to TA-AOMDV of 0.201 ms.

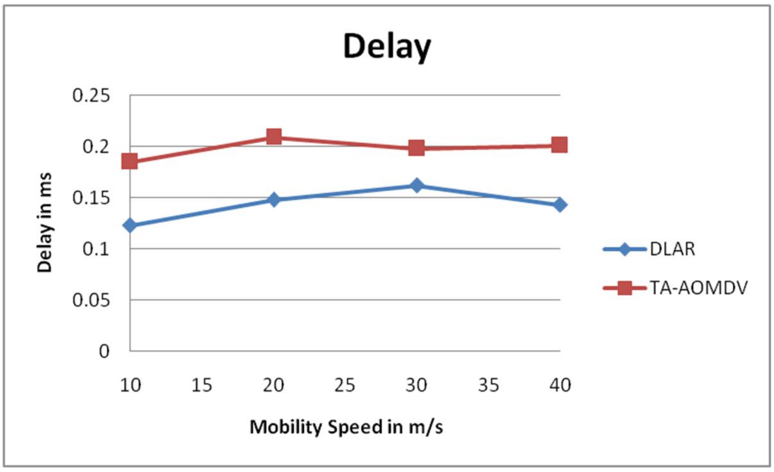

Figure 4: Delay vs Mobility Speed

C. Packet Deliver Ratio (PDR)

Figure 5 shows the PDR graph of proposed DLAR compared with existing TA-AOMDV. It is observed from the graph, DLAR has PDR of 98% compared TA-AOMDV of 79%. The route computation in DLAR is based on available bandwidth, stable link quality and high residual energy nodes. The discovered routes are reliable enough to deliver packets with loss and the LQI estimates the strength of the link and updates about its failure in advance, such that alternate routes are established.

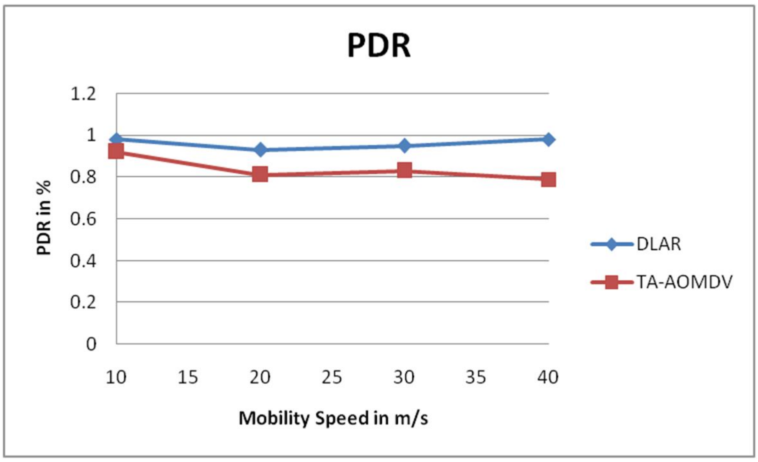

Figure 5: PDR vs Mobility Speed

D. Energy Consumption

Figure 6 shows the energy consumption graph of proposed DLAR compared with existing TA-AOMDV. The network energy is balanced through selecting node with high residual energy during route discovery process.

During data transfer the energy cost is computed such that energy consumption is minimal. It is observed from the graph, as the mobility speed increases the energy consumption of both the scheme increases. However, DLAR scheme has energy consumption of 21.3 Joules compared to 28.4Joules of TA-AOMDV.

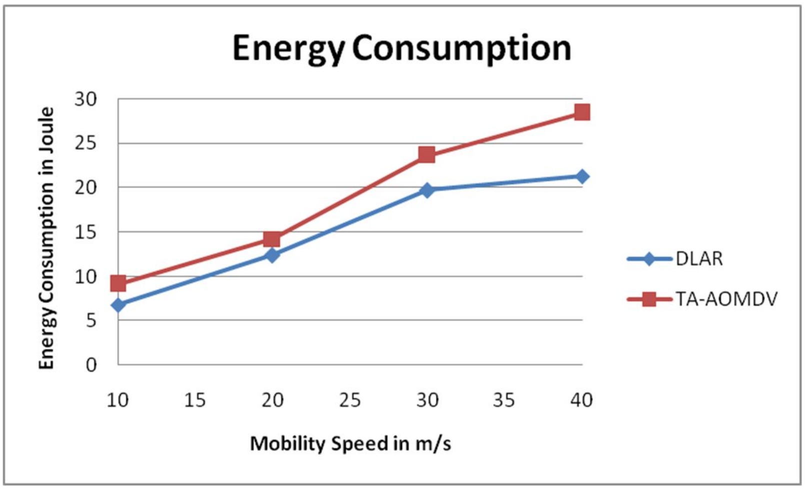

Figure 6: Energy vs Mobility Speed

V. CONCLUSION

The distinctive feature of MANET makes it challenging to anticipate node mobility and dynamic topology variations. Because of their mobility, the nodes frequently experience link failures, causing unstable paths between the source and destination nodes. we propose a dynamic link aware routing (DLAR) for MANET's through estimating link stability, which adapts topology changes, estimate link quality and improve overall network lifetime to support QoS. High-quality signal strength is assured by the link quality indicator (LQI). Energy awareness guarantees that a link's bandwidth is accessible for high-quality communication at a stipulated moment, and including high residual energy extends the life of the network and improves data transmission efficiency. Simulation results show, proposed DLAR scheme outperforms in terms of throughput, delay, PDR and energy compared to TA-AOMDV. In future, congestion control mechanism can be modelled to reduce packet drop caused by congestion at node level.

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