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Node Mobility and Encounter Rate Metrics to Enhance Stability in MANET

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***Abstract*— Mobile Ad hoc Networks (MANETs) have been broadly functional in a wide variety of scenarios, for example, in disaster recovery, health care, video conferencing, and battlefield transmissions. MANET is an independent and peer-to-peer network which builds a chain of nodes to enable data transmission from sender to receiver. Hop count is measured as the most significant metric in MANET. Though several metrics have been introduced as the replacement for the hop count metric, there is a need for outperformance in mobile scenarios. The node mobility will affect the link stability, and it creates congestion. To solve these issues, a Node Mobility and Encounter Rate metrics (NMER) to enhance the stability of the network. It selects the route based on the node mobility and Encounter Rate (ER) metrics. The congestion ingredient measures the congestion level in the MANET. The objective of this route has the least cost for forward data packets and minimizes congestion. The NMER approach simulation results demonstrate that the NMER approach minimizes the packet loss ratio and reduces the network delay.**

Keywords*— Encounter rate, Mobile ad hoc networks, Simulation results, Node mobility, Congestion, Delay minimization.

I. Introduction

A MANET is a self-enhancement of movable wireless nodes linked with one another by connections; in this network, each mobile node acts as a router [1]. Dynamic scenario, Bandwidth- restrained as well as uneven capacity links, limited energy and inadequate security are the essential characteristics and MANET significant attributes like lacking infrastructure, multi hop, distributed routing deployment of cost. The need for these gadgets to communicate seamlessly is becoming more important as they evolve and spread across every aspect of civilization. These devices must broadcast via a multi-hop method because of their limited range. MENET handles several features, for example, Self-configuration, broadcast communication, inadequate resources, mobility, Data centric routing, unreliable wireless link and route expensive. Every node must do the forwarding, acquiring, and routing tasks, but in a MANET, the routing techniques must be skilled and provide a variety of Quality of Service (QoS) criteria [2]. Throughput, routing load, delay, packet received rate, stability, energy efficiency and packet loss parameters analyzes the QoS in MANET [3]. The control of mobility is a substantial challenge for MANET. The potentially hazardous analysis of the existing ways to manage mobility administration by comparing them to a set of criteria that is, at their core, essential aspects [4]. The node reliability strategy considers and employs unimodal function is evaluated using a Markov model [5]. Figure 1 shows the MANET example.

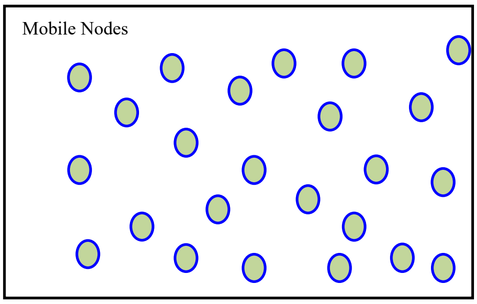

Fig. 1. MANET example

Figure 1 contains the mobile nodes, and these nodes move arbitrarily. Mobile, laptops, WiFi, and other mobile devices are used in MANET technology. Node mobility control is a big challenge. The need for resilience, capacity, and throughput has increased due to the frequent introduction of new wireless services, notably in the wireless access space [6]. In addition, various restrictions are placed on the network to ensure effective operation. These restrictions may be described in terms of power consumption at the terminals, latency, jitter, frequent network partitions, packet loss rate, and bandwidth needs. To be able to provide assurances for the limitations as mentioned earlier, it is necessary to build methods for the effective use of resources, MANETs, and the terminal. For the user to enjoy an experience that comes close to that provided by cable networks, effective utilization of these resources is necessary. The main issue in these scenarios is network congestion, which results in pointless delays and dangerous impacts.

II. Literature Review

In MANET, connected mobility captures the character of the movement procedure [7]. A multi-layer routing strategy and the recommendation of many different forms of causal scheduling rules, with the understanding that the total multicast capacity-delay tradeoff is derived via the discovery of numerous association degrees of node mobility. A bandwidth-aware routing method, also known as BARS, may avoid congestion by monitoring residual bandwidth and the amount of space now available to store information [8]. The BARS uses the feedback mechanism to communicate with the source of the traffic and tell them of the need to alter the information rate in conjunction with the availability of bandwidth and queue.

This study examines the factors that contribute to traffic congestion and mitigation strategies [9]. Because the delayed packets finally attempt to deliver within the allotted time, congestion may seem a fairly straightforward problem among the networks. Industrial applications, on the other hand, need prompt replies from the test site to prevent a complete network meltdown. There are several reasons for congestion in MANETs, including packet collision, transmission competitors, and buffer overflow [10]. The three main issues brought on by congestion are excessive bandwidth, loss of packets that sometimes include critical information, and information latency. Congestion reduces network performance by making it impossible for it to meet certain QoS standards, such as real-time, end-to-end routing, and extending network life. To enhance performance and increase the system's lifespan, congestion management measures must be implemented in response to this issue.

Transmission Control Protocol (TCP) guarantees that all sent data packets are received to achieve high dependability [11]. It is now the Internet's most widely utilized transport protocol. The majority of Internet apps support it. It was created to prevent network congestion, which is the major reason for data packet loss in wired networks. The goal of the TCP, regardless of its iteration, is to ensure fair distribution of the available bandwidth among the many active streams on the network. To do this, TCP will reduce its performance since it interprets every packet loss as a result of congestion.

A random waypoint mobility model with a closed-form logical model for the route's connection and lifespan [12]. This technique is able to determine the impacts of characteristics such as the number of mobile nodes, the number of hops, the size of the network, the transmission range, and the node speed. Efficient route discovery and link failure detection strategy to enhance routing using zone-based route discovery and a link failure forecasting approach to improve an on-demand source routing approach [13]. The objective is to evade route breakages. Energy Efficiency Optimization for MANET using branch and bound method to improve the routing efficiency [14]. The global optimum solves the computational complexity.

Improving the Network Lifetime approaches to enhance the network performance [15]. A distribute utility-based optimal transmitter node selection by position information and remaining energy [16]. To enhance multipath routing, one method is called Enhanced Node [17] selection Technique. This technique generates an optimized node that aids in route discovery and improves WSN service quality. Choose the path here based on the node received signal strength and remaining energy.

In a MANET, reverse routes use a significant number of mobile nodes, which often cause interruptions [18]. This results in frequent failures to accomplish data goals, as well as considerable expenses and delays associated with data recovery. An effective data acquisition system boosts the data collection success rates and decreases data attainment expenses. Mobility support has been attained in order to guarantee the permanence of the data's reverse route and successful response.

III. Proposed Methodology

In MANET, the mobile nodes spread randomly and move arbitrarily. In most cases, mobile nodes will choose a speed and then proceed in the chosen direction or toward a predetermined receiver. The mobile node will continue to travel at a consistent pace between transitions until it reaches the receiver that has been chosen. When the mobile node arrives at its receiver, it comes to a complete and abrupt halt. After that, it adjusts its heading, and then, all of a sudden, it adjusts its speed from the minimum to the chosen value. Finally, it begins a new transition. In some circumstances, the mobile node may change its pace or stop traveling altogether and then begin moving without first updating its path. In MANETs, node mobility is a significant parameter. The node mobility is determined by the previous node movement for the beyond time. The node mobility computation is specified in equation (1).

$$NM = \frac{1}{T}\sqrt{(x_2 - x_1)(y_2 - y_1)} \tag{1}$$

Where, NM represents the node mobility, T indicates the MOD (T_1- T_2), x1,x2 and y1,y2 are the co-ordinates of the node at time T1 and T2. To condition the nodes as, cooperative, the mobility should be zero as feasible since the nodes with greater mobility will subside the revealed route that will build the route is greatly unbalanced. The ER of a route in the MANET is defined as the sum of the average rate of encounters of entire nodes along that route, as shown in equation (2).

$$ER = \sum_{j=1}^{k} 2AER_j \tag{2}$$

Where ER represents the Encounter Rate, AER indicates the average encounter rate, k indicates the count of nodes along the route, and AER denotes the average encounter rate.

During the routing process, a Congestion Ingredient (CI) is calculated for each mobile node to determine the present congestion amount and the node's propensity for congestion in the upcoming transmissions. The inflowing and outflowing packets for each network node are used to dynamically calculate a CI as specified in equation (3).

$$CI = \frac{Outflow\ packets}{Inflow\ packets} \tag{3}$$

This CI value helps determine whether the node is experiencing congestion. During the estimating process, the busiest node has the largest CI value. As a result, these nodes are segregated from the real routes, which removes them from the routes. The other accessible nodes are included in the data transmission pathways used to send data. Figure 2 illustrates the example diagram of the CI process in MANET.

There is a single sender S that informs its neighbors of the need to transmit data through a route request message. The neighboring nodes use their own recent inflow packets and outflow packets to estimate the CI. This CI value is returned to the source S along with the response. The node with the lowest CI value determines the next hop, and data is sent to that specific node.

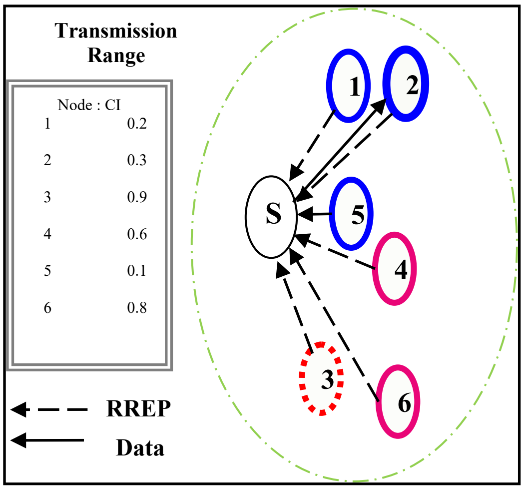

Fig. 2. Example diagram of CI process

The past several transactions are averaged to determine the current instant inflow and outflow packets unless when the node is about to cease receiving or transmitting packets, in which case the last five packets received are averaged to determine the current instant inflow and outflow packets. The available number is averaged in cases when the transaction starts or ends. Consequently, this provides a more precise outflow and inflow packet number.

The objective of this route has the least cost for forwarding data packets. Here, the cost of every route is measured as its related ER. The sender selects the route with the least ER value amongst the present routes from sender to receiver. The particular route will give the best quality for transferring the data packets. The sender picks the route R is specified in equation (4).

$$R_{picked} = \arg R_j \min(ER) \quad (4)$$

where R_j indicates the replied paths, and ER denotes the encounter rate. Figure 3 demonstrates three routing choices among sender S and receiver R.

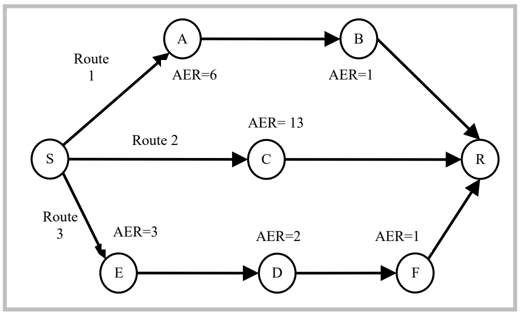

Fig. 3. AER-based route formation in MANET

From Figure 3, route 2 is presents two hops from S to R. Route 2 is the shortest route related to the other two routes. Though, it has the highest ER value. Compared to route 1 and route 3, route 3 is the highest ER value, but route 1 is the lowest ER value. Therefore, route 1 is picked for routing with the least ER value rather than other routes. The ER value of a route reveals the mobility of the route. In MANETs, the node mobility metrics are also a significant factor since the highest mobility diminishes the network performance. Finally, the route is selected by the ER, CI and NM metrics. The algorithm of the NMER strategy is given below.

Steps in the Algorithm
For {n = 0 to N} {
    Declare CI, ER, and NM = 0
}
While { S!=D} { // sender S has data to forward to the receiver R
    Evaluate the present inflow packet
    Evaluate the present outflow packet
    Compute present ER
    Compute present NM
    Compute present CI
    Select the route with the lowest NM, CI, and ER
    Data transmission
    Data reach the receiver
} end procedure

IV. Results And Discussion

In MANET, 250 mobile nodes are dispersed over the 850 x 900 m^2 simulation zone for the NMER. By using a mobility model like Random Waypoint, the mobile nodes are moved freely throughout the simulation area. MANET uses a traffic paradigm called Variable Bit Rate (VBR). Transmission Control Protocol transmits the data from the sender to the receiver. Throughput, routing load, delay, and packet loss parameters measure the effectiveness of the NMER strategy. Table 1 indicates the simulation criterion for the NMER strategy.

TABLE I. Criterion for the NMER mechanism for simulation

Criterion	values
Type of Simulator	NS-2.34
Mobile node	250
Period for simulation	500 seconds
Range of transmission	180 meter
Simulation region	$850 \times 900 \ m^2$
Sizing of the packet	1024 bytes
Traffic Example	VBR
Type of Queue	First in First out
Initial Energy	1 Joule

The proposed strategy NMER and the existing strategy BARS of throughput efficiency is shown in Figure 4.

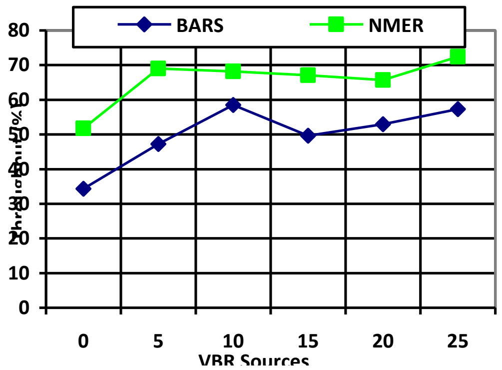

Fig. 4 . Throughput based on VBR Sources

When compared to the BARS technique, the NMR approach offers the greatest throughput value. Because, ER, NM, and CI metrics chosen the most efficient path to deliver the data. However BARS increases the network congestion in MANET. The delay values for the BARS and NMER strategies are demonstrated in Figure 5.

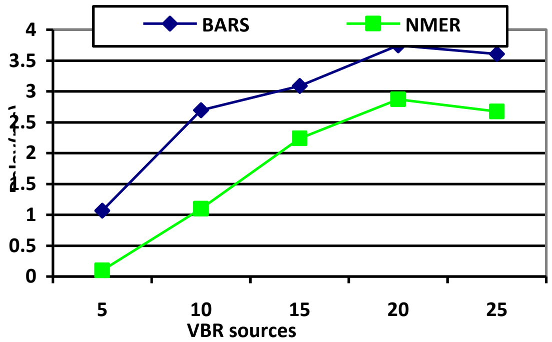

Fig. 5. Delay based on VBR Sources

When raises the VBR sources, the BARS and NMER mechanism's delay value is also raised. The NMER strategy compared to the BARS strategy, the NMER strategy has a relatively high delay. However, the delay value is minimized since the NMER strategy chooses the route using ER, CI with NM metrics. The packet lost of the BARS and NMER strategy is demonstrated in Figure 6.

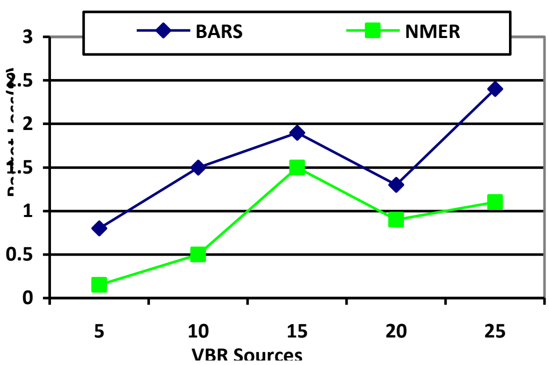

Fig. 6. Packet Loss based on VBR Sources

According to this data, BARS loses more packets than the NMER method. Due to the BARS approach, 's can't measure the routing congestion level. But, the NMER strategy measures the level of congestion, node mobility, and encounter rate; as a result, it minimizes the loss ratio.The routing load of BARS and NMER strategies based on VBR sources is illustrated in Figure 7.

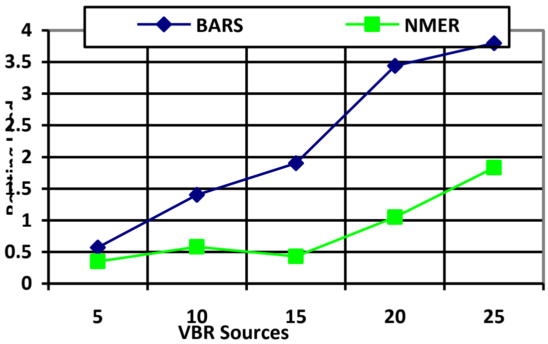

Fig.7. Routing Load based on VBR Sources

Figure 7 increases the VBR sources, and the routing load of BARS and NMER strategies increases. However, the proposed NMER strategy is slightly rising due to the NM, ER, and CI metrics to minimize the routing load in the MANET.

V. Conclusion

A MANET is an independent mobile device that transmits with one another across several hops in a disseminated way. This work presents Node Mobility and Encounter Rate metrics to enhance Stability in MANET that has the capability to handle the changes in mobility conditions. The node mobility will affect the link stability, and it creates congestion. Node Mobility and Encounter Rate metrics to enhance Stability mechanism utilizes the Congestion Ingredient to evaluate the congestion level and minimizes packet losses. The NM, the node ER and the CI metrics improve the route stability. The retransmission packets are minimized since data transmission is via stable routes. The network simulator NS-2.35 tool is used for measuring the network performance. The simulation results demonstrated improved routing performance in VBR sources. NMER approach improved the throughput, thus minimizing the loss ratio and routing load in the network.

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