A Survey on Reliable Path Discovery in MANET

BHAVANA VERMA, SHIVANK KUMAR SONI, CHETAN AGRAWAL

Abstract— MANET (Mobile Ad-hoc Network) is a self-configuring, infrastructure-less, distributed and wirelessly connected network of mobile devices that can arbitrarily change their geographic locations such that these networks have dynamic topologies, which are composed of bandwidth, constrained wireless links. One of the major challenges in MANET is link failure during communication due to a mobility of nodes, residual energy of nodes, and lifetime of the link. This paper gives a general survey of different existing techniques to address this challenge and contribution to solving this problem. In this paper, we present a technique of Link stability by discovering the most reliable path for communication in MANET. For Stable Path Selection, our technique uses a combination of AODV (Reactive routing protocol for Local Link Repair) with Coordinate-based routing protocol and Received signal strength of node. In this survey, we present a comparison of various existing mechanisms and provide the best way to improve the link stability lifetime, delivery ratio, efficiency, and diminish end-to-end delay in high mobility cases.

Keywords—AODV, Link Break, Local Repair, Link Stability, RSS, Routing Protocol, MANET

I. INTRODUCTION

MANET- a Mobile Ad Hoc Network, Here "Ad Hoc" is actually a Latin phrase that means "for this purpose". An Ad Hoc network refers to a network connection built up for a single session and doesn't require a router or a wireless base station. MANET is the new developing innovation, which enables users to communicate with no physical framework regardless of their geographical area, that is the reason at some point it referred to as an "infrastructure less" system.. MANETs has become one of the most powerful research areas in the recent years because of the challenges it posed to the related protocols.

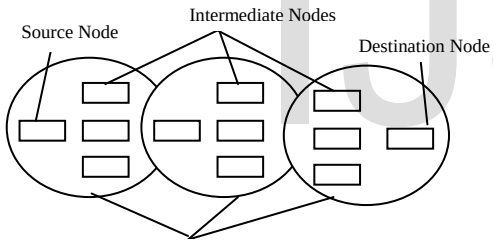

FIG: 1 MOBILE AD-HOC NETWORKS

In the above figure, the numbers of nodes are in the network, in which, one is a sender node and another one is the receiving node. A sender wishes to send a data packet to his subsequent receiving node. For initiating the communication, the sender can send these data packets with the help of intermediate nodes, which are in the range of communication to the sender node. By following this strategy, the sender sends all data packets to the respective receiver node.

Mobile ad hoc network (MANET) [1] is one of the challenging areas of wireless networks. MANET is an ad hoc network and comprised of a mobile node that communicates using the wireless link. In MANET, each mobile node is equipped with wireless transmitters and receivers.

In MANET, as nodes are free to move, nodes may not remain in the coverage area of each other. For the nodes, which are not in the transmission range, communication is done by using multi-hop mechanism. Nodes in MANET have characteristic like dynamic topology, bandwidth, and energy constraint, limited transmission ranges, and limited physical security. Due to these differences, routing in MANET is more difficult than the wired networks. In MANET, an active route can have a link break due to the mobility of nodes or empty battery of node as in that case a node cannot perform its intended function of forwarding packets. Therefore, it is very difficult to maintain the link stability during communication. Many other researchers have already worked in the direction of link stability, link repair based, and Coordinate based routing protocol. For Link stability, this paper presents the reliable path discovery mechanism using AODV protocol.

II. LITERATURE SURVEY

Researchers have investigated various areas of link breakage prediction and local link repair scheme with routing protocol for a reliable path in mobile ad-hoc networking. Here we present some of them-

In 2016 by Gaurav Singal, Vijay Laxmi, M. S. Gaur, and Vijay Rao introduced "MOraLISM: mobility prediction with link stability based multicast routing protocol in MANETs" technique. In this paper, node mobility is considered to map better their movement using "mobility prediction" in the network [2]. In mobility prediction, they predict the node movement according to their last estimated positions and concerned only with node's maximum active time in another node's transmission range. Therefore, the links with long active duration time can be distinguished as a stable link for route construction. Variation in signal strength is used to identify whether the direction of the node is towards or away from estimating node. They consider signal strength as QoS metric to calculate link stability for route construction. Efforts are made to identify the link with highly probable longer lifetime as the best suitable link between two consecutive nodes. We predict the movement time of nodes that define the route path to the node destination. Exata/cyber simulator is used for network simulation.

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In 2015 by Pravin Ranjan and R. Leela Velusamy proposed "Optimized Local Route Repair and Congestion Control in Mobile Ad hoc Network". In this paper, a new routing algorithm Improved Optimum Angle Selection AODV (IOASAODV) proposed [3]. This algorithm avoids the congestion and repairs the broken link by choosing a set of limited nodes for an alternate route based on the quadrant position, battery status, queue length, and forwarding region. This algorithm tested using NS-2 simulator and simulation result reveals that performance of IOAS-AODV improves the routing performance such as throughput, end-to-end delay, routing overhead, and packet delivery ratio.

In 2015 by Mohammed M. Kadhum introduced "Innovative Route Maintenance Based on Link Failure Prediction for Mobile Ad Hoc Networks". This paper presents a mechanism that targets the node mobility in a near future scenario and takes action to maintain the active route by utilizing an effective link prediction method between sources and destination prior to the route breakage [4]. It utilizes the information provided by neighbor nodes, who are overhearing the packet transmission communication over an active route, to build alternative links. When a link on an active route is about to be broken soon, the proposed mechanism uses the alternative ones, that are contiguous to the active route, to forward the data. The performance evaluation shows that the proposed mechanism performs well in the medium-sized highly dynamic environment and outperforms the common on-demand routing protocols in terms of packet delivery rate and control packet overhead.

In 2014 by Sujata Mallapur and Siddarama R. Patil introduced "Route Stability Based on Demand Multipath Routing Protocol for Mobile Ad Hoc Networks". In this paper, they have constructed a route stability based on demand multipath routing protocol for MANETs named, Stable Backbone based Multipath Routing Protocol (SBMRP) to improve link quality and to select a stable path between the nodes [5]. Proposed scheme includes a selection of candidate nodes (i.e. nodes with high residual bandwidth, residual power, link quality and low mobility) and construction of routing backbone (i.e. multiple paths are established between each source and destination through candidate nodes) to select the stable paths between the source to the destination node. If any candidate node in the path tends to fail because of the absence of bandwidth, residual energy or link quality, an alternative path through another candidate node can be built up. By simulation using Network Simulator 2 (NS-2), results conclude that the SBMRP outperforms the existing routing protocols by increasing packet delivery ratio and the lifetime of nodes.

In 2013 by Rajan Pravinchandra Modi and Dr. K. Thirunadana Sikamani proposed "Minimization of Link Failure in Mobile Ad Hoc Network by Using RSS Based AODV Routing Protocol" In this paper, a route break avoidance mechanism based on RSS value is proposed [6]. The proposed scheme predicts the route failure in the MANET by evaluating the RSS value periodically. If the RSS value is less than the threshold, the value in the sense the link failure is expected in between the nodes. Then the responsible intermediate node locally repairs the route to reach the destination. The node density is also considered to reduce the transmission delay in the network. The maximum number of neighbor nodes indicates the high transmission delay in the network because of the collision occur for the channel access. In this scheme, if the node density of the intermediate node is greater than the threshold value the route is reconstructed to reach the destination. So, the transmission delay is low for the proposed scheme. From the analysis, it is to be found that the proposed scheme outperforms than standard AODV in terms of transmission delay and communication overhead.

In 2013 by R. Senthil Kumar, Dr. P. Kamalakkannan introduced "A Review and Design Study of Cross Layer Scheme Based Algorithm to Reduce the Link Break in MANETs". In this paper, a new cross-layer scheme has introduced for wireless mobile devices to increase the performance and capacity of network based on the prediction of RSS value [7]. simulation is carried out to evaluate network performance using network simulator NS-2 based on the basic parameters like Throughput, packet delivery ratio (PDR) in term of the number of nodes when various pause times.

In 2013 by R.Kiruthika, Dr. R.Uma Rani proposed "A Reliable Path Selection Mechanism to Enhance QoS in MANET Routing Protocols" This title proposed Reliability Measurement is associated with Service Curve Measurement (RSCPS) to enhance the QoS through node stability, amount of data to be transmitted and bandwidth required to send the data [8]. In this node stability is used to select the reliable path followed service curve estimation which decreases path failure and increases packet delivery ratio.

In 2012 by Peyman Arebi introduced "A New Method for Restoration Broken Links in Wireless Ad-hoc Networks by Estimation Energy Consumption". This title proposed novel method based on energy estimation to restore broken links and reconstruct the paths of them [9]. One of the major issues in wireless ad-hoc Network is the broken links due to the lack of energy. So investigate Effect of broken links on topology control and routing process in Ad Hoc network. It indicated that these effects were harmful in the mentioned couple of network portions. In this paper, they used Hardware Method to estimation energy in ad-hoc node.

In 2012 by Qingyang Song, Zhaolong Ning, Shiqiang Wang, Abbas Jamalipour introduced "Link stability estimation based on link connectivity changes in mobile ad-hoc networks" In this paper, they proposed an arrangement to estimate the link stability based on an availability of link changes, which can be performed on the network layer, with no need of peripheral. They adopted a variable sized sampling window and proposed a strategy to evaluate the link transition rates. The estimation scheme is not limited to particular network topologies or mobility models. After that, they proposed a routing method, which adjusts its operating mode based on the estimated link stability. Simulation results determine that the proposed stability estimation scheme is able to evaluate the link stability in both stationary and non-

stationary scenarios and the proposed routing method enhances packet delivery rate effectively in ad-hoc networks.

In 2012 by Abolfazl Akbari, Mehdi soruri and Ali Khosrozadeh proposed, "A New AODV Routing Protocol in Mobile Ad hoc Networks". In this paper, they give a route maintenance algorithm to avoid route breaks [11]. Each intermediate node on an active route detects a danger of a link break due to the distance between nodes being farther than the communication range based on the received radio power. When it detects the danger of the link break, it notifies the danger to the upstream node. Proposed AODV-BA routing protocol, which avoids route break by reestablishing a new route and decreases end-to-end delay.

In 2012 by Floriano De Rango, Francesca Guerriero and Peppino Fazio presented, "Link-Stability and Energy Aware Routing Protocol in Distributed Wireless Networks", In this paper, they explored a Link-stAbility and Energy-aware Routing protocol (LAER) to make a correct balance between link stability and energy efficient [12]. Each node broadcasts HELLO packets to all its neighbors that are in its communication range and each node in LAER maintains the table of its direct neighbors. When a node receives the HELLO packet, it updates the information of the neighbor, if neighbor ID is already present in the table or adds neighbor information, if it is a new neighbor. They have not considered on path, neighbor node stability.

In 2012 by P. Priya Naidu and Meenu Chawla proposed, "Extended Ad Hoc on Demand Distance Vector Local Repair Trial for MANET". In this title, the current Local Repair Trial technique in AODV extended to achieve broadcasting and minimizing the flooding [13]. First, broadcasting, it should be possible by using the perimeter routing. Secondly, flooding is minimized by using local repair method and lastly, the number of intermediate nodes from a particular source to destination has been increased. Extended AODV-Local Repair Trial (EAODVLRT) protocol implemented on NS2 network simulator. Simulations are performed to analyze and compare the behavior of EAODVLRT for different parameters such as the size of the network, node load etc.

In 2012 by Geetha Nair and Dr.N.J.R.Muniraj introduced "Prediction based Link Stability Scheme for Mobile Ad Hoc Networks". In this paper, they proposed Prediction based Link Stability Scheme (PLSS) to create a right balance between stability of path, link, neighbor node and total mobile nodes to extend the network lifetime [14]. In the first phase of the scheme, stability of neighbor nodes is achieved using mobility and stability of paths. In the second phase, the stability of path is achieved. In the third phase, the stability of total mobile nodes is reached using the threshold signal strength value. In the fourth phase, we predicted the network lifetime of the whole network.

In 2011 by K.Vanaja, Dr. R. Umarani investigated "An Analysis of Single Path AODV Vs Multipath AOMDV on Link Break Using ns-2". The main objective of this title is to investigate the environmental-based protocol under mobility induced link breaks [15]. The Single Path Reactive Routing Protocol AODV and Multipath reactive routing protocol AODV considered analyzing the performance. The decision made by taking the quantitative performance measurements of packet delivery ratio, average end-to-end delay, and throughput utilizing Network Simulator NS-2.

In 2011 by Ming Yu, Wei Liu, and Tian Xing introduced "Link Availability Modeling for Routing Algorithms to Reduce the Link Break Time in MANETs". In this paper, they propose a new routing protocol, called link effective available time (LEAT) routing that can significantly increase link connectivity while maintaining other network performances [16]. For solving the problem of "Route the information reliably and efficiently" New routing protocol LEAT First, present a method to find the link available time during a particular period in history by measuring the distance between the two mobile nodes of a link, instead of using complete localization information. Second, In order to reduce the link break time in MANETs, they propose a new link cost for routing, i.e., the product of the link available time and link availability. Based on the new cost, the routing is formulated as an optimal routing problem, for which a heuristic algorithm is developed. Simulation results have demonstrated that LEAT routing protocol significantly reduces the number of link breakages by about 15%, and slightly increases the delivery ratio.

In 2011 by Akbari Torkestani, Meybodi M R introduced "A Link Stability-based Multicast Routing Protocol for Wireless Mobile Ad hoc Networks". In this paper, they proposed algorithm called weighted multicast routing algorithm for MANET in which the mobility parameters should be a random variable with unknown distribution [17]. In this method, the multicast routing problem first transformed into an equivalent stochastic Steiner tree problem in which the random weight associated with a communication link is its expected duration time. The aim of the proposed algorithm is to find the most stable multicast route (with the maximum duration) against the host mobility. At each iteration of the proposed algorithm, a multicast route is built by finding a random arrangement of the stochastic Steiner tree issue in the network topology graph. The constructed multicast route rewarded if its expected duration time is longer than those of the previous iterations are and it is penalized otherwise. The choice probability of the most stable multicast route converges to one as the proposed algorithm proceeds.

In 2008 by Li Q, Liu C, and Jiang HH proposed "The routing protocol AODV based on link failure prediction". In this paper, they have studied the link failure prediction into AODV routing protocol in data transmission process called AODV_LFF [18]. In large-scale Ad Hoc networks, the frequent interrupting of networks can produce high transmission delay, and also can reduce the packet delivery rate, in view of such disadvantages this paper introduces a mechanism of link failure prediction i.e. AODV_LFP (link failure prediction). This improved AODV routing protocol AODV_LFP can reduce network transmission delay effectively, and can boost packet delivery rate.

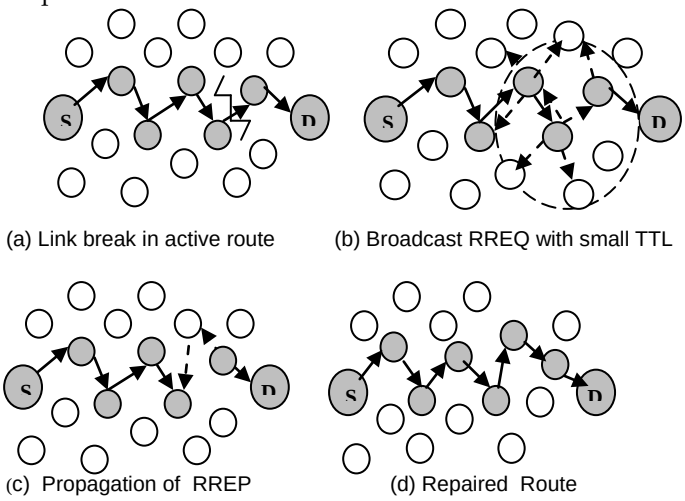
III. AODV LOCAL ROUTE REPAIR

Ad-hoc On-Demand Distance Vector (AODV) is a reactive routing protocol based on the distance vector algorithm where path between two nodes is calculated when needed [19]. If a source wants to send data packets, it checks the route table. If there is a route to the destination, the data packets will be transmitted to the next node, following the route in the route table. Else, if the route is not present in the route table, source node starts the route discovery process. The source node broadcasts a route request [RREQ] message. An RREQ message contains following important fields:

- Source address
- Source sequence number
- Broadcast ID
- Destination address
- Destination sequence number
- Hop counter

The source address and broadcast ID uniquely identifies an RREQ packet. When an intermediate node gets an RREQ message, it first checks that the RREQ has been received already according to the source address and broadcast ID. If this RREQ message has been already received, discards the RREQ message. Else it records the data in RREQ, increases the hop counter, and broadcast the RREQ to its neighbors. This process continues until the RREQ message reaches the destination or the value of Time to Live (TTL) exceeds the maximum allowed. When an intermediate node from a node receives an RREQ message, a reverse link is formed between these nodes. When the destination node gets the RREQ, a reply message RREP will be transmitted back to the original source along the established reverse route path and after receiving the reply message, the source node gets a path from source to destination and source is ready to send the data packets. AODV broadcasts a HELLO message with regular intervals to check the connectivity of the active route. When neighboring nodes receives HELLO message, they update corresponding routes. If HELLO message is not received in the definite time interval, the link is considered to be a break. When a link is broken, a route error message RERR is transmitted to inform the source node that a link has been broken. Then the route discovery process restarts. AODV performs well in high mobility and high loads.

In Local Route Repair Instead of sending an error message to the source node, the upstream node attempts to repair the broken link itself, fewer data packets may be lost and the link can be repaired without the source node (and other upstream nodes) being disturbed [20]. For short routes, local repair may not have any significant performance advantages. A node upstream of a link break that attempts to repair the route does so by broadcasting an RREQ with a TTL set to the last known distance to the destination, plus an increment value. This TTL value is used so that only the most recent location of the destination will be searched, which avoids flooding the whole network. The upstream node places the sequence number of the destination, incremented by one, into the RREQ. This prevents nodes further upstream on the route from replying to the RREQ, which would form a loop.



(a) Link break in active route (b) Broadcast RREQ with small TTL

(c) Propagation of RREP (d) Repaired Route

Fig.: Example of local repair

IV. RECEIVED SIGNAL STRENGTH (RSS)

RSS at a given area is normal of the signal received through various ways (multipath effects) [21]. Therefore, it becomes crucial to decide the variables that influence RSS. The RSS (Received Signal Strength) sometimes referred, as RSSI (Received signal strength indicator) is a measurement of the power present in a received radio signal. The nodes utilized by the Accurate Wi-Fi Location Monitor and Bluetooth Beacon Tracker are prepared for estimating the RSS of close-by Wi-Fi and BLE gadgets.

The RSS values are estimated in dBm and have typical negative values running between 0 dBm(excellent signal) and -110 dBm(extremely poor signal). Please keep always in mind some empirical tests can be done to determine how the RSS varies with the distance from the nodes in a specific environment but it must be remembered that the issue of figuring the distance based on RSS is a noisy procedure by default. Over that, the mistake tends to increment with the separation. So it can be relatively easy to determine when a device transmitting is very close to a node (<1m), but as distance increases the estimates become more and more erratic.

V. COORDINATE BASED ROUTING

In Coordinate Based Routing protocol to forward packets, a node only requires its own position, that of the destination (obviously), and those of its adjacent (one-hop) neighbors [22]. The control packets are forwarded in different coordinated with respect to single node in network. A transmitting node uses a location service to determine the location of the destination, and includes this location information as part of the destination address in its messages. Routes do not need to be established or maintained explicitly; thus, there is no need to store routing tables at the nodes and no need for routing table updates. Adjacent nodes are typically identified by broadcasting limited range beaconing

messages and various time-stamping mechanisms. The beaconing message includes distance limits; a receiving node discards the message if its location lies beyond the distance limit. Availability of accurate location information at each node is essential for location-based routing to work. This, in turn, requires timely and reliable location updates as nodes change their locations. One or more nodes, designated to act as location servers, coordinate these location service functions, which are necessarily decentralized because of the mobility of the nodes. A large part of the ongoing research, as the references cited above show, is focused on designing efficient location services.

VI. PERFORMANCE COMPARISON OF EXISTING METHOD / APPROACHES IN MANET

S.No.	Method/ Name of Approach	Main Work or Functions	Advantages	Disadvantages
1.	A New Cross-layer scheme Modified AODV (MAODV) routing protocol based on	A Modified AODV routing protocol is a Cross-layer designed by modification in the existing AODV protocol [7]. A new cross-layer scheme is designed by combining the physical, MAC and network layer. A new cross-layer scheme reduces the link break in mobile ad hoc networks.	Minimize packet loss. Improve Throughput.	Implementation based on the prediction of RSS value.
2.	AODV with break avoidance (AODV-BA)	This is route maintenance algorithm based on AODV to avoid route breaks [11]. In this algorithm, each intermediate node on an active route detects the danger of the link break to the upstream node and route breaks are avoided by reestablishing a new route before route breaks.	The number of route breaks decreases. The packet arrival ratio rises. The end-to-end delay decreases.	The routing overhead increases.
3.	Link-stAbility and Energy-aware Routing protocol (LAER)	The LAER algorithm requires every node to advertise its area, rate of energy consumption, and link stability index for each connection active by node [12]. We will insert the information mentioned above in LAER HELLO packet. This novel routing scheme has been compared with other three protocols: PERRA, GPSR, and E-GPSR.	It improves the performance in terms of node selection with higher link duration. LAER can increase the average link duration. It reduces the energy consumption.	It considers Average link stability rather than path due to the absence of a path Establishment phase.
4.	EAODVLRT	In this method, the existing Local Repair Trial method in AODV is extended to achieve broadcasting and minimizing the flooding [13]. The Enhanced protocol first creates the group of mobile nodes then broadcasting can be done and if the link breaks then local repair technique can be applied.	It has Lower Routing Overhead. It gives Higher Throughput. It achieves Higher Packet Delivery Ratio.	The effect of the modifications in EAODVLRT does not appear in small sized networks.
5.	Prediction based Link Stability Scheme (PLSS)	This proposed strategy comprises of four stages like the determination of stability of neighbor node, link (path), total mobile nodes and prediction of total network lifetime [14]. Neighbor Stability gives a thought of the neighbor's consistency in the network while Path stability gives a thought of the path's consistency from a source node to the destination.	It achieves Good packet delivery ratio. It gives more network lifetime. It uses Minimum energy consumption	In PLSS lifetime of a path is bounded by the lifetime of all the nodes along the path. It means PLSS Predict Lifetime for a Particular Path.
6.	Multipath AOMDV	It is a multi-path routing protocol and extension to AODV [15]. It provides two main services i.e. route discovery and maintenance. In AOMDV, if there is a link break in any case then an alternative path of the destination has chosen and through that path, data packets are forwarded.	It provides Highest Throughput for small and medium networks. It provides Highest Throughput at lower pause time. It provides Routing overhead	Throughput degrades for a large network. Throughput degrades as pause time increases. Network performance is Not for Static

			good for all type of network.	distributed network.

Description of comparison-

In the above performance comparison table, each proposed method/approach is better than the other or existing method in some cases presented in a research paper and has certain drawbacks. The performance of MAODV is a Cross-layer designed to reduce the link break uses the prediction value of RSS. The AODV-BA provides the information of danger link that has many possibilities of link breakage and here a possibility of overhead is more. LAER based on the joint metric of link stability and energy drain rate and this convention acquires the adaptability of GPSR and E-GPSR. EAODVLRT is enhanced AODV by local route repair that also consumes some time but reduces overhead. Prediction based Link Stability Scheme (PLSS) has a slightly lower delay than LAER scheme because of stable routing, energy consumed by PLSS is less compared to LAER and overhead of PLSS has low overhead than LAER scheme. The Multipath AOMDV provides better performance for small and medium networks and it does not work for Static distributed network.

VII. CONCLUSION

This paper presents the various mechanisms for reliable path discovery to stable the link connection during communication. Researchers have studied different techniques to provide a reliable path for the communication and improve the performance of the network. Some methods improve the throughput and packet delivery ratio but some methods decrease delay and minimize flooding. In some approaches, either two or more mechanisms combined to give a better performance or some methods inherit the property of previous methods. Therefore, our objective is to discover a reliable path to improve the stability of link and reduce the link break, in real time environment using AODV reactive routing protocol with a combination of RSS, Coordinate Based Routing for Static, and Mobile distributed network.

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