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A Hybrid Routing Approach Comparison with AODV Protocol Regarding Speed for Disaster Management in MANET

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Abstract: The Mobile Ad-hoc Network (MANET) is a wireless, systematic, autonomous network that can be used in various situations without the need for central control. A disaster is a sudden event that disrupts normal activities. MANET can play an important role in a disaster situation. Situations where normal communication is already interrupted. The MANET route discovery is one of the most important aspects of data transfer in a disaster. Proactive and reactive routing protocols are used as standard in various uses of MANET due to their ease of construction and operation. Their combination makes it a way to get better route discovery and efficiency because long-term route contracts do not provide better performance on heavy traffic and load, especially in a disaster. Because the hybrid method is very useful for rapid convergence of network with low memory and power management. This study introduces a hybrid approach that combines proactive and reactive protocols for route discovery and link breakage. The simulation model was used for the proposed hybrid method. The results after the simulation show that hybrid approach offers better performance during packet delivery ratio, network load, end-to-end delay and throughput as compared to the AODV routing protocols.

Keywords: AODV, MANET, Hybrid Approach

Introduction

Mobile Ad-hoc Networks (MANET's) have no infrastructure networks. The whole node can act as a router for networks. All nodes can move easily without restriction and randomly connect. Terminals are responsible for controlling, managing and organizing the entire network itself. The whole network has a portable design and the movement of each signal is free. Figure (1) illustrates this type of network (Abdali and Muniyandi, 2017). Technology has changed dramatically over the years. This ensures current success in various fields such as information processing systems, information security and information technology and computer science. The current success of information technology, especially in wireless and ad-hoc technology is more than compared to other sectors. The wireless network's survival began in the early eighty's and became the beginning of wireless systems and then opened new doors to all aspects of human life (Shakir *et al*., 2019). Many researchers have investigated the site for further research and learning purposes (Sharmin *et al*., 2019).

A disaster is an event that disrupts normal activities. During a disaster, communication between the most affected areas was severely disrupted. Therefore, it takes an ad-hoc approach or network to deal with a global emergency: A catastrophic flood, synthetic artificial, chemical and industrial. The most common natural disaster in the world is a slide. The role of information technology is critical in disaster risk management (Alameri and Komarkova, 2020). Inclusion of information available in a disaster requires a reliable system and method of information sharing, integration, analysis and rescue work.

Route discovery is a cost-effective tracking system implementation that is a key performance indicator for MANET. Protocol routes reflect the direction of the route between locations and information is distributed on the route selection between any two-network paths (Alameri *et al*., 2021). Route implementation plays an important role in MANET guiding the availability and recommendation of multiple route protocols in MANET. A network protocol initiates the flow of data and information and makes the system efficient enough to reach your destination. Route protocols in the ad-hoc mobile network are largely divided into two main forms: Topology and position-based. These routing protocols are categorized proactive, reactive and hybrid (Alkahtani and Alturki, 2021). Proactive processes as protocols run by the protocol through table- driven information periodically. Reactive is considered as dynamic on demanding routing protocol and hybrid has both operational and linear advantages of proactive and reactive routing protocols. To achieve the goal through hybrid approach that combines the behavior of link state(reactive) and table-driven (proactive) protocols for management of route discovery and link breakage in disaster situations. Experiment performs through simulation tool NS-2, with performance metrics like end-to-end delay, packet delivery ratio, throughput and network load are employed. Due to the quick network convergence, a hybrid strategy is provided in this study due to low memory usage and enabling a direct route discovery to the disaster, end-to-end delays, increased network and mobility with a minor link breakage, with an average packet delivery rate increment. This research developed a hybrid strategy that initiates route requests RREQ and the selection of Multi Point Relay (MPR) nodes as intermediate places to find an effective path (Itaiwi *et al.*, 2011). After that, discuss the proposed design and methodology. Finally, the simulation results and discussion of the outcome in future research direction (Correia *et al*., 2020). The last portion of the study is designed to conclude and guide future research.

Routing Protocols

Route protocol is a mechanism for sending data across the networks. Now, in terms of communication between locations, power management is the order of the day. As shown in the Fig. 2 below, MANET routing protocols can be classified into three categories based on navigation principles. Figure (2 and 3) the MANET routing protocols.

Link-State Routing Protocols

link-state routing protocols also known as Reactive Routing Protocols (RRP), this routing protocol develops a route to reach a destination that is only possible when needed. The distance vector routing algorithm only manages the path to a destination station when a node needs it and requests it. Therefore, such protocols are based on demand nature, also known as the optional nature routing protocol. The main idea about these protocols is to minimize the routing overhead, which is the main challenge of proactive routing protocol (PRP), for example, Dynamic Source Routing (DSR), Ad-hoc On-demand Distance Vector (AODV), Ad-hoc On-demand Multi path Distance Vector (AOMDV). In this study discuss here AODV and AMODV. AODV is a Reactive Routing Protocol (RRP). This protocol is specially designed for mobile ad-hoc networks where the operating environment is wireless (Khalaf *et al*., 2018). The optional setup of source-to-destination routing is the main part and in both cases, it provides support for unicast routing protocols and multicast routing protocols. The AODV protocol develops routes between nodes.

For this reason, it has been called the nature-on-demand procedure (Khalaf *et al*., 2019). The link does not generate extra traffic for communication purposes. According to the resource, the requirement is to maintain the life of the routes. They create a tree-style architecture to connect groups of multicast representations. AODV uses the ordinal maintenance table for route freshness. The main advantage of AODV is that it performs all operations, such as discovering new roots and maintaining discovery of new roots and maintaining routes between two nodes only on demand. The Demerits of this protocol are quite time-consuming in route finding (latency), with the help of the intermediate node (Verma and Chauhan, 2015). The AOMDV routing protocol discovers multiple routes during the route discovery process. Multipath selection mechanism used for load sharing purposes or the backup procedure of the route in case of failure of the primary routes. AOMDV follows the concept of distance vector and hop count routing techniques. In addition, AOMDV works on a demand basis through the route-finding procedure. AOMDV works on multiple broadcast routes through a single route-finding procedure. AOMDV does not discard duplicate requests like AODV. It looks forward to an alternate route with each duplicate RREQ (Min and Zaw, 2014). Route demand propagation from the source node to the destination node establishes (develops) many reverse pathways at both the intermediate nodes and the destination node in AOMDV. With the support of source and trust intermediate nodes, multiple RREP route reply uses a loose technique to move these reverse paths back to constructing many paths towards the goal. The AOMDV protocol's fundamental technique focuses on loop-less and discrete multipath and how to efficiently offer such roads using a flood in route discovery. Loop freedom and discrete features are maintained thanks to AOMDV route updating rules implemented locally at each node (Zasad and Uddin, 2010).

Table-Driven Routing Protocols

Table-driven routing protocols also known as Proactive Routing Protocols (PRP). These routing protocols broadcast relevant information to surrounding nodes. Each node in the Proactive Routing Protocol (PRP) has a table that maintains constant change. This table contains all kinds of information about the routing of the network. The network performs route management with the help of this table. Therefore, it is also known as a table-

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based routing protocol because each node includes tables containing network topology data. Management of these tables by sending and receiving data in period form to capture the current picture of the data. Examples of Proactive Routing Protocols (PRP) are Destination Sequence Distance Vector (DSDV), Wireless Routing Protocol (WRP) and Optimized Link State Routing protocol (OLSR). Here, OLSR is a well-known, table-driven, most popular routing protocol used in MANET. OLSR has three main functions. Forwarding of packets, neighbor detection and Topology Control (TC). The first two provide the router with ' 'neighbor's information and deliver the flood message via MPR (multipoint relays) (Jyothi *et al*., 2015).

Topology control function information about the whole network topology Known as table-based protocol, it is known for its revolutionary update of routing tables. OLSR stores information about routing tables to provide the route if needed. Any ad-hoc network is suitable for the OLSR routing protocol implementation. OLSR is a proactive routing protocol due to its table-oriented nature. MPR (Multi-point relay) selectors play the main role in OLSR path selection (Kachooei *et al*., 2022). In this routing protocol, not all nodes broadcast the data packet. Only MPR nodes are responsible for the broadcast procedure. The main one is the selection criteria of Multi Point Relay (MPR).

Broadcast nodes are neighbors of the source node. Every node in the network has a list of MPR information. HELLO, packet delivery selects MPR from neighboring nodes. Routes are first stored (built) in this protocol and then the source node is sent to the destination (Kurniawan *et al*., 2020). In OLSR, every node in the network knows its routing table because for OLSR this overhead is less regarding short paths to destination than other proactive routing protocols. New routes are not needed if existing routes are used, so there is insufficient routing overhead. The result reduces in-route discovery latency. Nodes present in the network broadcast HELLO messages to their neighbors (Kurode *et al*., 2021; Jubair *et al*., 2019; Hassan and Muniyandi, 2017; Hassan *et al*., 2018; Hassan *et al*., 2019). In OLSR, the preset interval is responsible for the link state. If there is a neighborhood between node a and node b, a node broadcasts a WELCOME message to node b. If b receives this message, the connection will be asymmetrical. Now, node b broadcasts the same HELLO message to a node, also called an asymmetric link. Average two-way communication comes out between nodes and calls asymmetric communication link. All neighbor information is kept in a HELLO message (Jubair and Muniyandi, 2016; Usha *et al*., 2011; Ahmed *et al*., 2011; 2018; Nawir *et al*., 2019). This procedure allows the mobile node to keep track of all of its multi-hop ' 'neighbor's information in a table. After constructing an asymmetrical link, a node selects a minimum number of MPR nodes. Topology Control (TC) messages with connection status information will be broadcast at the predetermined TC interval. Not only do TC messages construct routing tables, but they also contain information about MPR (Mustafa *et al*., 2020; Pattnaik *et al*., 2021; Mostafa *et al*., 2018; Mostafa *et al*., 2020).

Hybrid Routing Protocol

The features of both Proactive Routing Protocol (PRP) and Reactive Routing Protocol (RRP) are combined in the Hybrid Routing Protocol (HRP). The key advantage of hybrid routing is that it preserves certain proactive routes before using reactive routing techniques like Zone-based Routing Protocol (ZRP) to service demand from non-ordinary enabled nodes. Proactive and reactive have limitations such as slow restructuring process (proactive) and high reagent latency. Therefore, below are the protocols that some proactive and reactive protocols choose to take a hybrid approach for better network convergence.

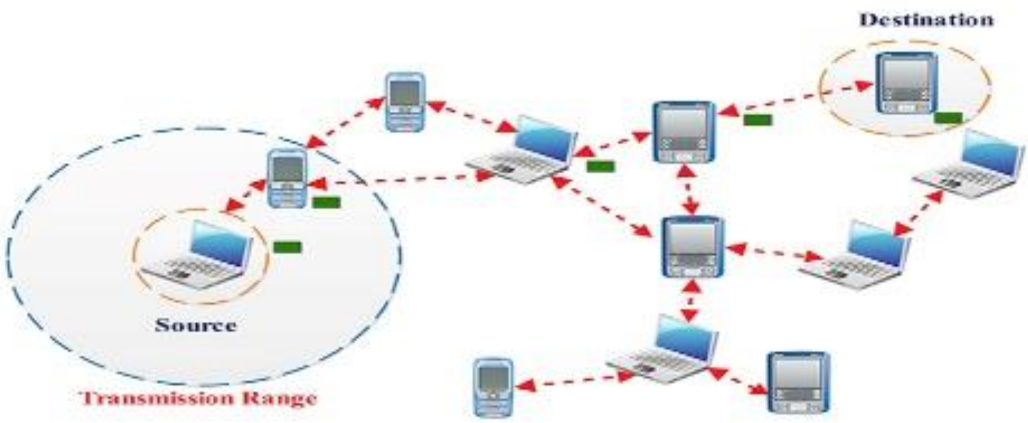

Fig. 1: Without infrastructure network

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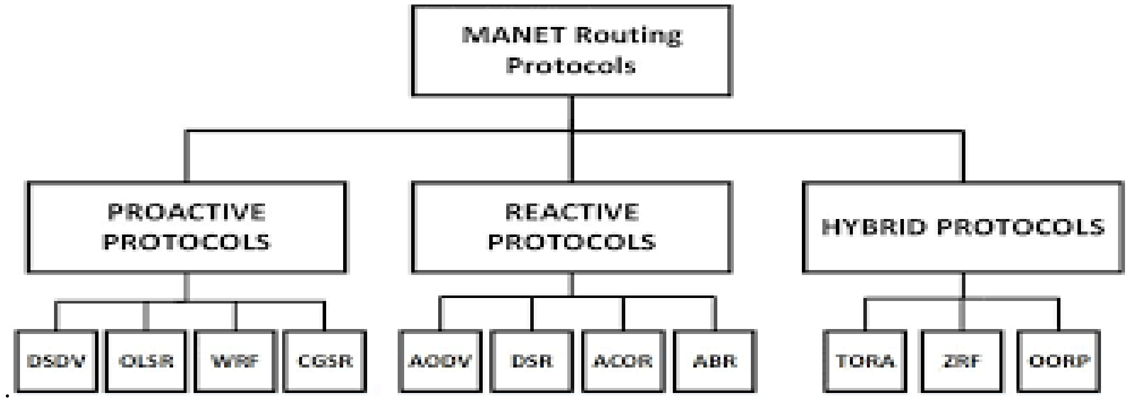

Fig. 2: Types of MANET routing protocols [9]

Table 1: Parameter for simulation

Simulation-Parameters	Speed value and description
The node's speed	5,10,15,20,25,30,35,40,45,50
Pattern of traffic	Constant- Bit- Rate (CBR)
Size of the Network	1000 X 1000
Time for simulation	100s –to-1000s
Protocol for routing	Hybrid -Approach

Research Methodology for Proposed Hybrid Approach

AODV and AOMDV reactive protocols and OLSR proactive routing protocols are hybridized to find effective route discovery and link breakage using the hybrid routing algorithm. This study selects the protocols for getting a better approach normal towards disaster situations instead of individually checking of these protocols with performance parameters as normal and disaster scenarios in performance metrics like throughput, Average packet delivery ratio, end to end delay and network overhead during the route discovery and link breakage process. The OLSR proactive protocol finds the best route through the proposed algorithm uses MPR nodes to find the best route. The algorithm and given to the AODV and AOMDV reactive routing protocols. After that, AODV and AOMDV followed route reply procedure for an efficient route discovery and continued further communication.

First, the Source node initiates broadcasts of route request RREQ to all its neighbors using the AODV routing protocol. OLSR protocol is applied within the same network to select and find the best route using MPR. Now, every node is loaded with a distance-value as hop value as 0 at the initial node and infinity for all other nodes. Each node M that has 1-hop and 2-hop neighbors is stored in the route maintenance table with a hop-count of 1 is stored on the neighbors using the OLSR routing protocol. Therefore, M indicates the number of nodes. Every added node N in the routing table with hop-count n=2 and new entries are added with a hop- count of n+1is also added from the TC set and it is stored in N. The current value is compared to the newly calculated distance of that node. Set the small one-distance or long-life value in terms of the hop count of TC set. That has TC = N. OLSR selects the best efficient route for communication and gives it to the AODV and AOMDV protocols. Next, the AODV protocol continues the further communication from source to destination. All intermediate nodes update the RREQ and Broadcasts route requests to their neighbors until they reach their destination. The destination receives the RREQ, then creates a route reply RREP packet and sends it back to Source with multipath using the AOMDV routing protocol. Otherwise, create the RERR message to all of its predecessors and end to Source then source, reinitiates the route using the New Broadcast- ID.

Algorithm: For Route Discovery in Terms of Speed:

1. IF current node is destination node then
2. Initiate route request RREQ
3. Select multi point relay MPR nodes of all feasible routes
4. Computes the distance value in terms of hops values for each feasible route
5. Select one with the smallest distance value.
6. Sends a route reply RREP packet using multipath to that selected route
7. End IF
8. Source node receives the RREP packet from destination node using Multipath
9. Source node sending data to the destination having a maximum hops count

Performance Evaluation

The performance of the proposed hybrid approach has been evaluated through simulations using the Network Simulator tool NS-2 (Bhat *et al*., 2011; Mohapatra and Kanungo, 2012; Sahel and Boudour, 2019; Rao *et al*., 2018). Simulations ranging from normal to the disaster were analyzed with the hybrid model (Zafar *et al*., 2016; Saleh *et al*., 2020; Shantaf *et al*., 2020). A hybrid approach combines the three routing protocols, two link state AODV and AOMDV routing protocols and one table-oriented OLSR form, used to evaluate the results and compare the hybrid approach result with the AODV routing protocol. In this model, each node selects path with the OLSR routing technique, where the response is given via AODV or AOMDV (Kumar *et al*., 2011). Parameter for simulation is given below in Table (1).

Results and Discussion End-to-End Delay Versus Max Speed

The average delay between sending the data packet from the source to the receiver (destination), including delays due to route buffering and processing at intermediate or trust nodes (Nawir *et al*., 2019). If the end-to-end latency value is higher, the protocol performance is not good due to network congestion.
Σ (time_arrival - time_sent)/number of consections

Figure 4 shows the total sending time for data packets. The time it took to receive the data packet is depicted in Fig. 4. End-to-end delay can be calculated by subtracting the transmitting time from the receiving time. Figure 4: Using simulation, determine the end-to-end average delay by dividing the sum of delay packets by the number of received packets. Seven times the simulation environment was created with different velocity values varying for each node and Figure summarizes the average result of the simulations. Comparing the end-to-end delay of the hybrid approach with AODV shows that hybrid approach has better delay results as compared to AODV routing protocol.

Throughput Vs. Max Speed

The ratio is determined in bits/sec and bytes/sec between the total data received and the simulation time. Mathematically, it may be written as (Pattnaik *et al*., 2021).

Number of packages delivered * Package size * 8/total simulation time = Yield (bit/s).

The throughput is the total data received at the network's destination in unit time. The entire amount of bits received at the destination is shown in Fig. 4. To evaluate throughput, divide the sum of all the bits reaching the target by the total time taken. Simulation environment performed at least seven times at each node with different velocity values and figure shows different types of results of all simulations. The entire number of bits received at the destination is shown in Fig. 5. The simulation environment's results reveal that increasing the node's speed decreases throughput in both scenarios. The figure shows the un reliability due to the rapid movement of the nodes. A hybrid approach chooses an efficient path for data transmission, so it is clear from the graph that hybrid is much better at any rate in efficiency than AODV.

Network Routing Load Vs. Max Speed

The simulation environment refers to the total number of packets sent. The byte transferred to each hop in the multi-hop route is counted as a single transmission (Mustafa *et al*., 2020). Network load represents the total number of packets needed per data packet delivery. Figure 6, a clear picture of the total number of packets received at each node in the maximum speed range of 25ms-1 is given in the simulation environment. Graph provides a clear picture of the packets at each node. Divide the total number of packets by the number of received packets to get the overall network load. Simulations were performed seven times at each node in a range of different velocity values. The figure shows all the results of the simulations.

Figure 6 shows that the network load of the hybrid approach is minimal compared to AODV. The minimum outcome of the hybrid approach is due to a reliable route from source to destination. This causes route reduction to fail and reduces maintenance and route re-discovery mechanisms as the hybrid approach has less routing overhead than AODV. The performance of the hybrid approach is much better than AODV, reducing overhead by at least 25 to 30 percent compared to AODV.

Packet Delivery Fraction Vs. Max Speed

The successful delivery of packets towards destination, dividing the total number of packets delivered by the number of packets delivered. This metric's highest value suggests that the proposed technique is performing better. A general formula for calculating packet delivery ratios as a percentage is as follows.

Σ packets received (Mostafa *et al*., 2018) Packet delivery ratio represents data packets sent by source nodes and received by destination nodes. The total packet delivery ratio can be obtained by dividing received packets and sender packets. Simulation experiments were performed for each node 6 to 7 times for a range of different speed values and Fig. 7 indicates all simulation results. Figure 7 indicates that in both cases, decrements in PDR packet delivery ratio when an increment in speed of nodes occurs, which causes more easily breakage on route due to increment in node speed. Figure 6 graph also indicates that in the hybrid approach more packet delivery than AODV. The better ness of the hybrid-approach delivery ratio is due to its criteria of root selection through which more reliable route selected due to MPR nodes. That selection of route reduces breakage of the route. Figure 6 indicates the increment in ratios of packet delivery. In comparison, AODV only selects the shortest path from source to destination. In, AODV time constraint in the selection of route is not important due to which more breakage of route and data occur during the discovery of route. From the graph, it is observed that PDR of hybrid approach increased from 2 to 3 percent at minimum speed compared to AODV routing protocol. Therefore, less breakage of route occurs at less speed, but at high speed of nodes PDR of hybrid approach increased 5 to 8% compared to AODV.

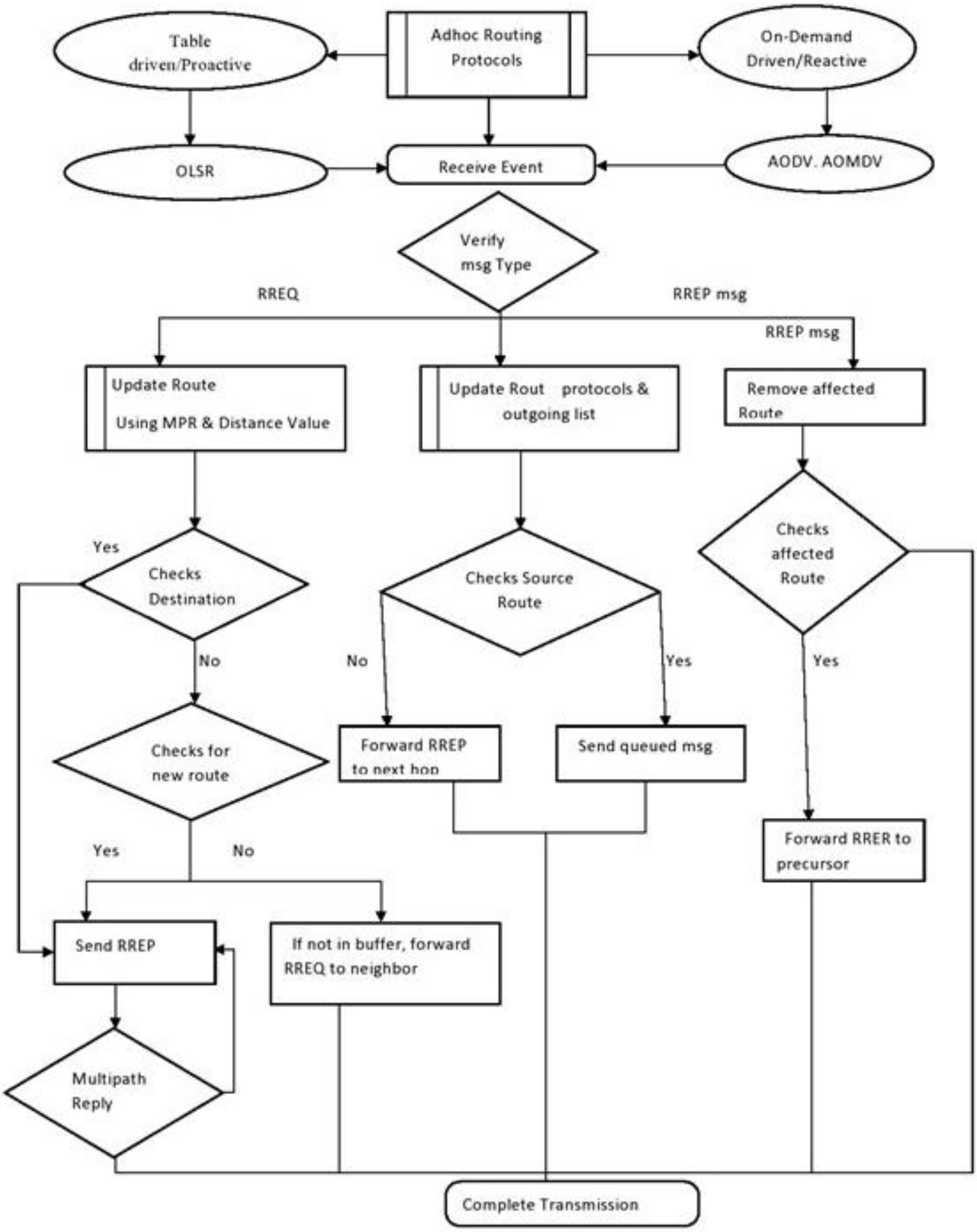

Fig. 3: Flow chart for route discovery of the hybrid approach

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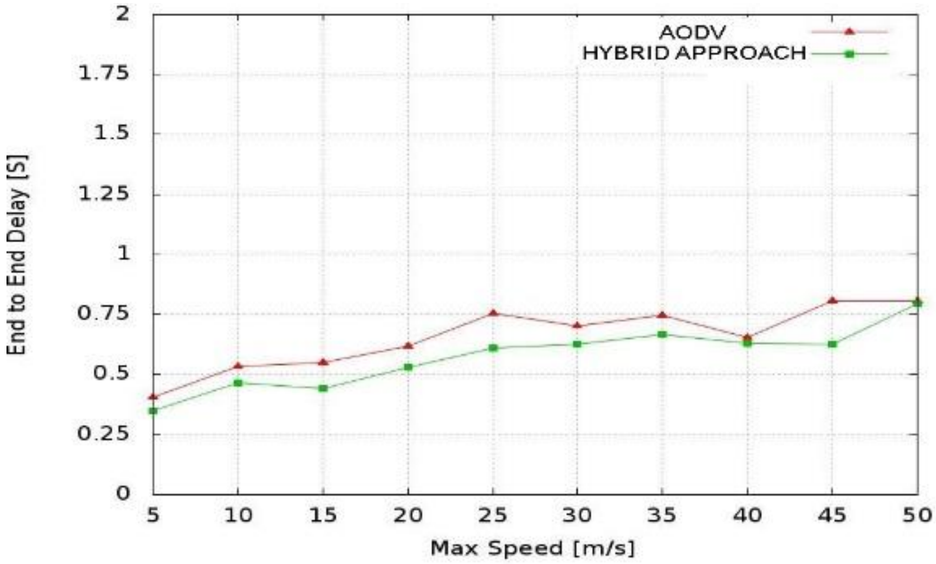

Fig. 4: End to end delay versus max speed

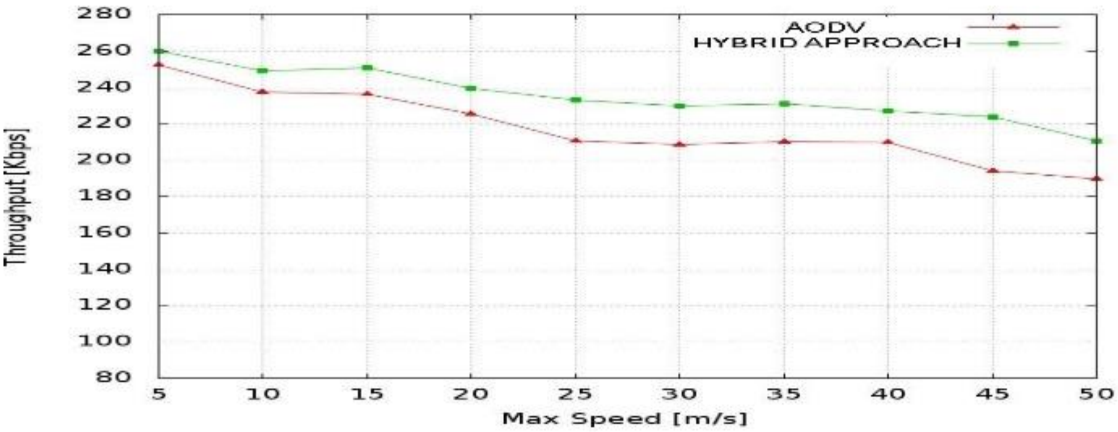

Fig. 5: Throughput verses maximum speed

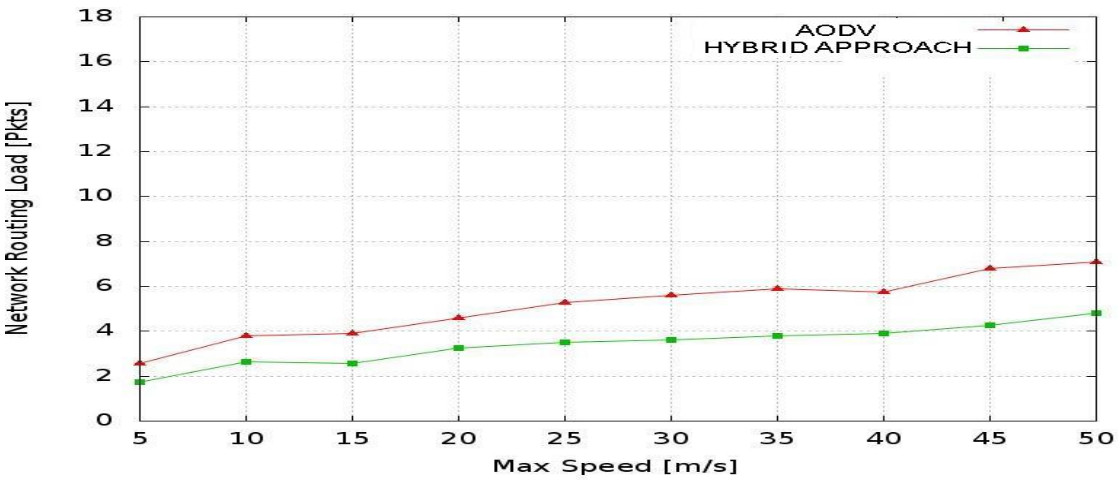

Fig. 6: Network load verses maximum speed

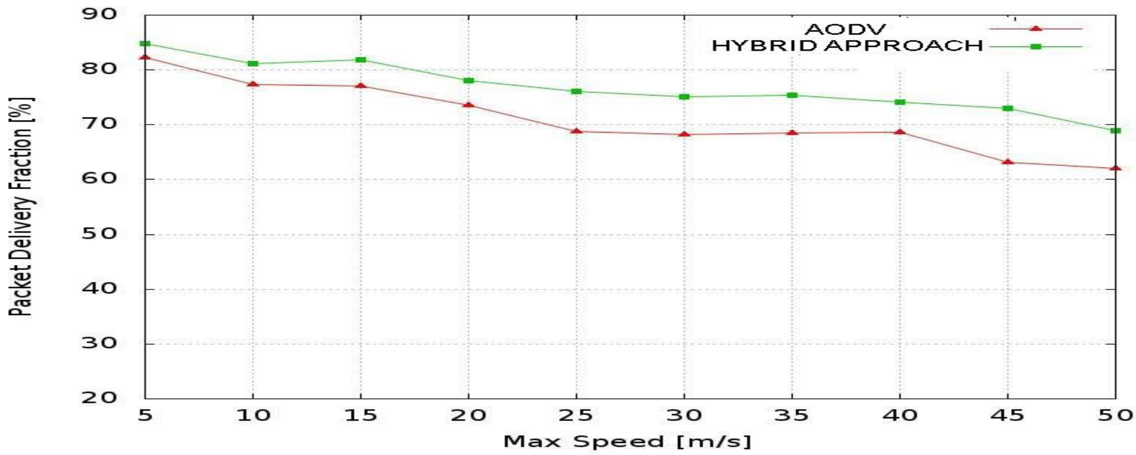

Fig. 7: Packet delivery ratio versus maximum speed

Conclusion

In the paper, a hybrid approach for route discovery mechanism and minimum link breakage has been presented, which decides the efficient route for communication in a normal-to-disaster situation in terms of variations in speed, based on the distance value of MPR nodes. In the proposed approach, distance values of MPR nodes are the main metric during the selection of routes that minimize the failure of routes and link breakage. As shown in the graph, the proposed approach results in a large reduction in route discovery requests and a significant improvement in work overhead, end-to-end delay and average packet delivery for all nodes involved in the route discovery process. As a result, the routing protocol's overall performance gets better. This study makes a significant contribution to disaster management by developing criteria for route discovery utilizing a hybrid method in terms of node speed that represent normal to disaster scenarios. Results compared the hybrid approach to the conventional AODV routing protocol regarding the speed of nodes representing normal to the disaster situation in this study. The simulated results in the graph shows that the hybrid approach outperforms AODV significantly regarding the speed of nodes. The contrasting results between the hybrid approach and existing AODV protocol indicate that the hybrid approach performs better and increases from 9 to 12%. The performance evaluation metrics are based on packet delivery ratio, end-to-end delay, routing load or overhead and throughput. The study provided in this study can be further developed in the future by merging the functionality of the proposed routing protocols through innovative strategy solves the scalability and attack on links problems that extend network lifetime. The research presented in this study can be expanded in the future by integrating the proposed route principles. The improved hybrid approach controls route discovery and link breakage that helps in improvement of overall network life as compared to existing hybrid approaches.

Author's Contributions

Abdul Majid Soomro: Considering the research framework, writing scraper bots for data collection, data cleaning, performing analysis, conducting tests, preparing final manuscript.

Mohd Farhan Bin Fudzee: Contributing to research thinking, learning related activities, which contribute to the preparation of the final manuscript.

Muzamil Hussain: Contributing to conceptualize the research, studying related works, contributing to prepare the final manuscript.

Hafiz Muhammad Saim: Advise on data collection and graphical analysis activities, proofreading and participation to complete manuscript

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved

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