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Performance analysis of multicast routing using multi agent zone based mechanism in MANET

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Abstract

MANET is a structure less and emerging technology in recent years. Generally, this structure forms a network with nodes with inherent characteristics, including resource heterogeneity, node reliability, etc. In this manuscript, we proposed a Multi-Agent-Based Zone Routing (MAZR) protocol for enhancing the performance of MANET. Our proposed MAZR is works based on the principle of packet forwarding through intermediate and zone leaders. It consists of multiple agents, which include static and dynamic mobile agents. The proposed implementation is done as follows: Initially discovering the zone leaders .The discovered zone leaders are connected to the communication nodes . The communication nodes and zone leaders are associated for building the network backbones for achieving multicast routing .To the multicast, zone members are connected .The zone managements, backbone and highly mobile nodes are initiated. The proposed MAZR protocol comprises five types of agents: Path agent, Network control agent, Multicast control agent, Network launch agent, and Multicast control agents. The Path agent, Network control agent, and Multicast control agent are static, and Network launch agents and Multicast control agents are mobile. The future protocol's

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performance is determined using the experimental work based on the evaluation metrics like delay, power consumption, and network lifetime. The obtained results prove the future MAZR is far improved than the Zone-based Hierarchical Link Protocol and Zone Routing Protocol in all aspects and ensures flexibility with versatile multicast service.

Keywords: Mobile Ad hoc Network (MANET), Multicast routing, Zone protocols, Backbones, Multi-Agent-Based Multi-Hop Routing (MAMR) protocol

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1. Introduction

Mobile ad hoc networks (MANETs) is dynamic autonomous network connected with mobiles nodes through the wireless link [12]. The MANET nodes do not require any centralized base station for communicating with each other in the network. MANET has rapid growth in recent days due to reasons like Auto configuration, inexpensive deployment, no need for inexpensive deployment, self-maintenance, etc. [11]. However, MANET's popular design of dynamic routing protocols is considering a complex and most challenging task. The routing protocol for MANET should have the ability to identify efficient routes, be mobility aware, and have maximum successful communication with minimum less overhead [2, 4, 9]. In MANET, various protocols are discovered by the researchers, in which the protocols are classified into proactive, reactive, and hybrid routing mechanisms [1, 13, 3, 7, 6]. A proactive protocol is a table-driven protocol that calculates the reachable nodes and maintains up-to-date routing information using the periodic route update process. The optimized link-state routing protocol (OLSR) and destination-sequenced distance-vector routing (DSDV) are the popularly known proactive protocols. A reactive protocol is an on-demand routing protocol that discovers the on-demand route for establishing network connections. The AODV and dynamic source routing (DSR) are popularly known as reactive protocols. The third type is the hybrid routing protocol, which inherits proactive and reactive routing protocols. The best example of a hybrid protocol is a zone routing protocol.

We proposed MAZR protocol is a hybrid type routing protocol that addresses and overcomes the drawbacks of the existing multicasting protocols effectively. This paper is organized as follows: Section 1 describes the introduction, section 2 describes the related works, section 3 described the proposed, section 4 describes the result and discussion, and, finally, section 5 describes the conclusion.

2. Materials and methods

2.1. Related Works

Shanthy et al. [14] proposed a zone routing protocol incorporated with sleep scheduling for MANETs. This model is proposed for achieving energy-efficient and load-balanced. In this approach, Zone Leader (ZL) plays an essential role in choosing multiple paths using an adaptive sleep duty cycling mechanism. Farrukh Aslam Khan et al. [8] proposed a hierarchical routing protocol for mobile ad hoc networks (MANETs) called Location Aware Grid-based Hierarchical Routing (LGHR). In this system, the network is constructed with non-overlapping zones and then split into smaller grids. The LGHR routing system is similar to link-state routing. Chalew et al. [15] proposed Mobility-Aware Routing Algorithm for MANET. The proposed system facilities rebroadcast or discard received broadcasted messages. The decision parameter used for performing route requests and route replies is node speed, the distance between nodes, and residual energy of nodes. This approach is very effective against link breakage and broadcast storm problems. Neeraj Chugh et al. [5] proposed Anomaly Behavior Detection Scheme for MANET. The author proposed a novel hybrid routing protocol known as e data-driven zone-based routing protocol (DD-ZRP). By implementing this DD-ZRP, a dynamic threshold is used for identifying the anomalies in MANETs. Qasim et al. [10] proposed reactive protocols for detecting anomalous activities and managing routing traffic in MANET. The author describes that reactive protocols are very effective in path allocation and avoiding faults.

2.2. Proposed Technique

In this paper, MAZR is developed for MANET. The proposed model is comprising of static and dynamic mobile nodes. In this section, the proposed model working principle and network arrangement is described in detail.

3. Network Arrangement

MANET is a wireless network consists of numerous mobile nodes connected randomly over a network range. In this proposed model, zone leaders play a vital role, and along with the communication node, its executes network communication. Each zone leader is associate with zone member, and communication nodes are works as forwarders. The zone leader operates multicast operations with communication nodes for transferring the packets forward. For zone leaders, zone members are like child nodes. The communication nodes and zone members are independent to move anywhere within the mobility range. There is a pairing between the zone leaders and communication nodes. This pairing varies and frequently construct with multicast paths during high mobility. All nodes taking part in network communication will be established in the mobile agent platform to support the entire network features.

3.1. Node Definitions

In the proposed protocol, nodes are categorized into three kinds such as communication nodes, zone members, and zone leaders.

3.2. Zone members

The proposed network is categorized into multiple zones and zone membership. This categorization is based on the geographical location where nodes are formed as a zone. Each zone is provided with a zone leader with zone members and communication nodes. At the end of any two zone coverage's, the communication node is positioned. The intra communication is processed by the communication node, which forwards the packet known as zone top zone communication. The zone members in the network are also referred to as child nodes of zone leaders.

3.3. Zone leader

The zone leader is like a parent to its zone member in the network. In a network, reliability factors determine the zone leaders. If a node fulfills all the highest reliability factors and that node is elected as the zone leader. The zone leader's responsibilities are zone monitoring, zone processing, and connection providence to its zone members. A node that needs to join in the zone means that node needs to be authorized; the reliable bode of that zone does this node authorization. The zone leader is also responsible for a reliable network throughout the communication; if any link failure occurs zone leader will provide an alternate link.

3.4. Communication node

In the network, all the mobiles are considered nodes. The zone leader connection will terminate when it moves out of zone coverage. In this situation, to enable interconnections, the communication nodes are introduced. The communication establishes the new connection for the connection lost zone leaders. Additionally, the communication nodes are responsible for connection management and packet forwarding. The communication node establishes reconnection through the information on the connection table; it will show if any connection is lost for the zone leader.

3.5. Agent Definition

The proposed technique consists of five agent nodes, and in the network, a common cognition base is provided for managing the five agent's information. The workflow of five agents is described in this section. This cognition base enables agent interaction between the network and shares the network information like list of connection nodes, zone ID, zone member status node type, forwarding and responsibility tables, and connectivity status.

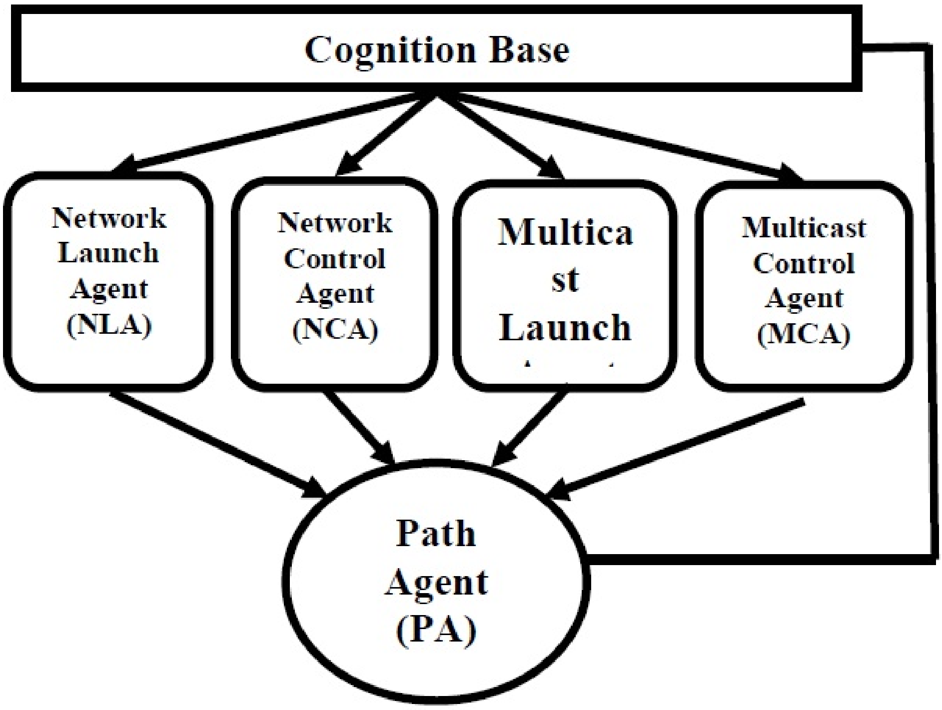

Figure 1: Routing Model Using Agents.

3.6. Path Agent (PA)

Path Agent (PA) is the important node in the network, which are static nodes and plays a prominent role. PA involves the creation of four other agents. PA is responsible for agent node actions and cognition base synchronization. PA computes the reliability factor of all nodes and broadcasts to its neighbor or nearby nodes in a regular manner. Path agents choose their child nodes for enabling communication with other agents in the network. The communication details are updated in the responsibility table located in the cognition base.

4. Network Launch Agent (NLA)

Network Launch Agents (NLA) are the mobiles nodes that are responsible for packet collections and neighbor nodes reliability advertisements. NLA examines these reliability advertisements and the nodes that contain the highest reliability factor among others announced as zone leaders. Based on the node mobility period, the Path agent creates a network launch agent periodically.

4.1. Network Control Agent (NCA)

Network Control Agents responsible for connection management of the network. NCA is a static node that controls the connection management for eluding mobility issues.

4.2. Multicast Launch Agent (MLA)

Multicast Launch Agents (MLA) are mobile nodes that create multicast network zones. The MLA makes and distributes the multicast key to each zone member. Initially, MLA verifies its membership by sending an invite message to the zone leader. It conducts the zone members required information for earning zonal memberships. Then MLA associates zone leaders, zone members, and communication nodes through a multicast tree. The multicast member who is participating in the tree is provided with a zone ID.

4.3. Multicast Control Agent (MCA)

Multicast Control Agent (MCA) is responsible for controlling and maintaining the multicast tree. MCA is a static node present in multicast zones for reconstructing the link breakage or failures. MCA constructs the broken links between the zone leader and zone member. MCA generates tokens in the multicast zone which periodically transmits within the zone. In the data packets, the zone member receives the tokens and it. The child nodes assure the network connection, and connectivity is established by the received token periodically. If MCA does not receive the token means child nodes recover the tokens. The connection for the token recovery process is made by MCA with zone leaders using the help of cry calls.

4.4. Algorithm for Proposed Model

1. Nodes are created and deployed randomly.
2. Four-zone agents are created, such as ZA1+ZA2+ZA3+ZA4
3. Next, the zone member is spitted into four regions such as Zm1+Zm2+Zm3+Zm4
4. The threshold values are established (T=30MBbs)
5. The threshold value is the measure, and based on the result, zone leader election (Zm¿T) act as Zone leader otherwise act as Zm.
6. END

5. Operation Principle

In this section, the proposed MAZR protocols operation principle is described. Initially, for all the members in the zone reliability factor is computed through packets advertises. PA executes the packets advertises to the neighbors or nearby members. In this model, nodes are randomly spread all over the network. The neighbors who are received the packets advertise among them the reliability factor is analyzed and compared. Based on the comparison, the neighbor node which achieves a high-reliability factor is selected as zone leader, and it is informed to its PA. Next in the zone, all the reliability node is identified, and the connection is established with the zone leader. In the network, NLA creates the clones and is flooded into three hops. The three hops restrict the agent's movements.

The NLA clone using the three hops through flood declares the zone leader with a route. The discovered route information is traced and transmitted to the parent NLA. The clone NLA fails to create a route that destroys itself and the information is transmitted to the parent NLA. On the multiple routes created by the clone NLA, the parent NLA chooses the perfect route which contains minimum hops and higher reliability. The communication nodes stored the connection information as a connection list. Using the chosen best route, NLA transmits the collected information between any two zone leaders. NLA maintains the generate packet forwarding table, the reliable and communication nodes in the zone generates and packet forwarding. In each zone, PA declares a zone member to each zone leader, and the zone member is considering as the child node used for constructing the responsibility table. This ensures a backbone setup is done for the communication. The multicast zone creating node facilitates MLA to travel and invite each zone leader to join the zone. MLA provides each packet forwarding node in the zone with a zone ID and key for multicasting.

6. Results and discussion

The experimental work is conducted in Network Simulator-2 (NS-2) with various network scenarios. This section describes the simulation network arrangement, simulation parameters, and obtained result discussions in a detailed manner. The experimental setup for the proposed model is constructed with 50 mobiles nodes. Each node in the setup is deployed randomly and spread all over the network. The mobile nodes deployed are independent to move anywhere within the network range. The speed of mobile nodes is differing from node A to node B, which is calculated as meters per second. The network environment, it's split into four zones based on the network geographical area. The zone area in the network is described as square meters. Each zone is provided with a zone leader and zone members. The location of the communication node is placed at the end of any two zones. The network parameters are described in the below Table 1;

Table 1: Network parameters and their values

Network Parameters	Values
Total number of nodes	50
Network Area	1000×1000 meter^2
Zone Area	250×250 meter^2
Node Speed	0 to 30 meters/second

The performance of the proposed model is compared with the existing ZHLS and ZRP protocols. The evaluation metrics taken for consideration are delay, energy consumption, and network lifetime of the total number of nodes that took part in the execution. Figure 2 demonstrates the comparison work conducted between the proposed MAZR with ZHLS and ZRP protocols in the aspect of delay. The x-axis determines the total number of nodes, and the y-axis determines the total delay obtained. At each stage number of nodes is increased in the count of 20 gradually. Based on the observation, plots are made and represented graphically. Figure 2 clearly shows all the stages; the proposed MAZR shows a minimum delay than the ZHLS and ZRP protocols.

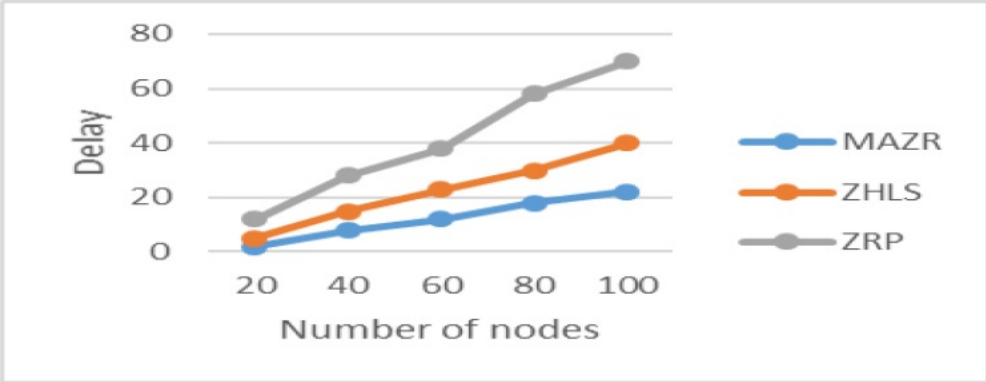

Figure 2: Delay vs. Number nodes.

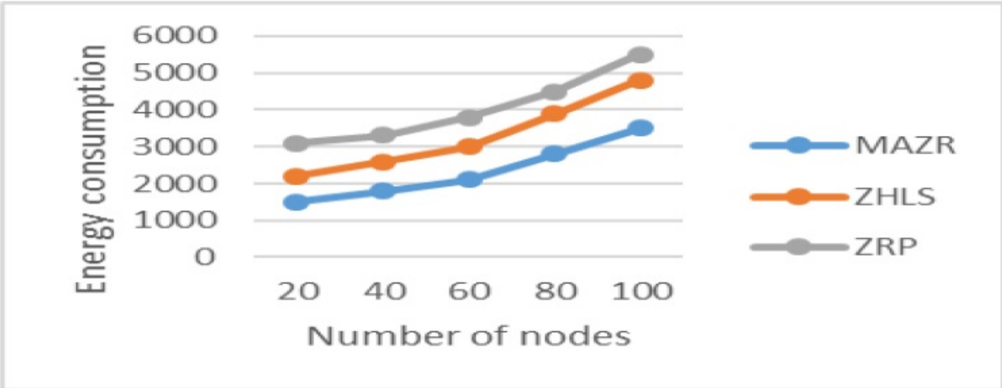

Figure 3: Energy Consumptions vs. Number nodes.

Figure 3 demonstrates the comparison work conducted between the proposed MAZR with ZHLS and ZRP protocols in the aspect of energy consumptions. The x-axis determines the number of nodes, and the y-axis determines the total energy consumed. At each stage number of nodes is increased in the count of 20 gradually. Based on the observation, plots are made and represented graphically. Figure 3 illustrates the proposed MAZR consumes minimum energy on all the stages of the proposed MAZR, which is far better than the ZHLS and ZRP protocols.

Figure 4 demonstrates the comparison work conducted between the proposed MAZR with ZHLS and ZRP protocols in the aspect of network lifetime. The x-axis determines the number of nodes, and the y-axis determines the total network lifetime achieved. At each stage number of nodes is increased in the count of 20 gradually. Based on the observation, plots are made and represented graphically. Figure 4 illustrates the proposed MAZR obtained a higher network lifetime, which shows the proposed protocol's communication success rate and efficiency than the ZHLS and ZRP protocols.

7. Conclusion

In this paper, the authors proposed (MAZR) protocol for MANET's. The main objective of this work enhances the overall network performance with a high network lifetime with minimum delay and energy consumptions. The proposed MAZR is works based on the principle of packet forwarding through intermediate and zone leaders. Under the supervision of the zone leader, data packets are routed effectively and transmitted through the zone members and communication nodes.

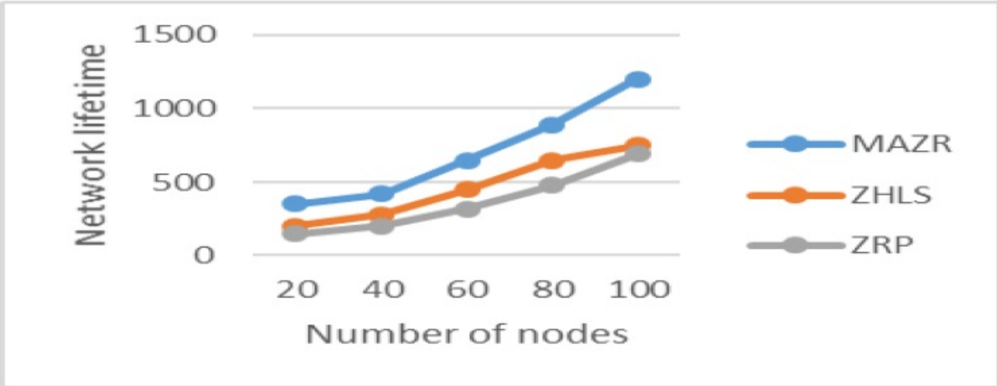

Figure 4: Network lifetime vs. Number nodes.

The proposed model obtained results are compared with ZHLS and ZRP in network lifetime with minimum delay and energy consumptions. The reconstruction of routes generated by the agents is considered the backbone of the proposed model, which earns better flexibility. As a result, the proposed MAZR achieves a higher network lifetime with minimum delay and energy consumptions than the existing ZHLS and ZRP. This proves that our proposed MAZR protocol is very efficient in node mobility than the existing protocols.

8. Future Scope and Research

Multicasting is used when the same message or the same stream of data must be forwarded to multiple destinations. Multicasting is an efficient data transmission method to support group-oriented communications in one-to-many or many-to-many applications such as audio/video conferencing, collaborative works, and so on. In MANETs, the most challenging issue in multicast routing is to effectively handle the frequent and unpredictable topology changes caused by host mobility, link breakage and host failure. Multicast based group communication demands dynamic construction of efficient and reliable route for multimedia data communication during high node mobility, contention, routing and channel overhead. This paper gives an insight into the merits and demerits of the currently known research techniques and provides a better environment to make reliable.

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