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Techniques for Diversified Optimization of Routing Algorithms in Mobile Ad-Hoc Wireless Connections

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Abstract:

MANETs, for example, are a type of network that lacks a well-established infrastructure. Creating ad-hoc networks is difficult because of a lack of infrastructure. Choosing a routing protocol in an ad-hoc network may be difficult due to the network's volatility. To obtain the optimum performance, Zone Routing Protocol (ZRP) is a hybrid routing protocol that combines the best aspects of proactive (Optimized Link State Routing) and reactive (Ad hoc On-Demand Distance Vector) routing approaches. MANET performance can be improved using a Genetic Algorithm and Ant Colony Optimization.

Keywords:-Distance vector ad-hoc (AODV), zone routing protocol (ZRP), ant colony optimization technique, proactive routing, reactive routing, hybrid (ACO) route.

1. Introduction:

A router is used to connect two separate wireless networks. The demand for a local network was driven by connecting two or more computers to share files. Routers were created so that two or more networks may communicate without sharing all of their data.

1.1 MANET:

In mobile ad hoc networks, nodes can be moved at any time. Multihop wireless links can connect a large number of nodes in a network. There are no routers between nodes. The primary goal of routing is to move data from one location to another. With mobile nodes and inefficient routes, this is a challenge for MANETs. A few of MANET's attributes include its adaptability, portability, and wireless connectivity [2]. Since their introduction, ad hoc networks have become increasingly popular because of their diverse applications. A lack of transmission power may have caused the topology to alter. The high operating frequencies in an urban area interfere with and fade out the linkages, making them inoperable. Ad-hoc networks are becoming increasingly popular because of this. Using high-frequency lines in a city puts them at risk of interference and signal degradation due to the high frequencies utilized. Networks of mobile nodes with dynamic topologies, such as MANETs, do not have a stable infrastructure. Ad-hoc networks' dynamic topology and lack of infrastructure necessitate flexible routing algebraic techniques.

1.2 Genetic Algorithm:

Darwin's natural selection (GAs) idea is a genetic algorithm's base. This is an excellent solution if you're concerned about enormous computation costs. Natural selection has been replaced by a computer fitness function in the modern world, where bits have taken the role of genetic material.

Genetic algorithms can solve problems where the intended function is nondifferentiable, stochastic, or excessively nonlinear. The evolutionary approach can address mixed integer programming problems in which some components can only have integer values.

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1.3 Ant Colony Algorithm:

As part of the umbrella term "swarm intelligence," the Ant Colony Optimization (ACO) subfield examines the collective problem-solving abilities of ants in a group. The fascinating thing about this is that the ants communicate indirectly rather than directly to solve problems. Different optimization issues have been solved using methods based on ant colony problems.

According to this study, ad hoc routing protocols can be improved using evolutionary algorithms and ant colonies. The proactive routing protocol OLSR, the reactive routing protocol AODV, and the hybrid routing protocol ZRP all use this optimization technique. The packet delivery rate and the throughput and end-to-end delay are measured (PDR).

2. Mobile Ad-Hoc Routing Networks (MARNs):

Ad-hoc wireless network routing techniques can be divided into three types based on the method used to update routing information. Thus, they can be either proactive or reactive or a combination of the two (both proactive and reactive). Figure 1 shows a breakdown of MANET routing protocols.

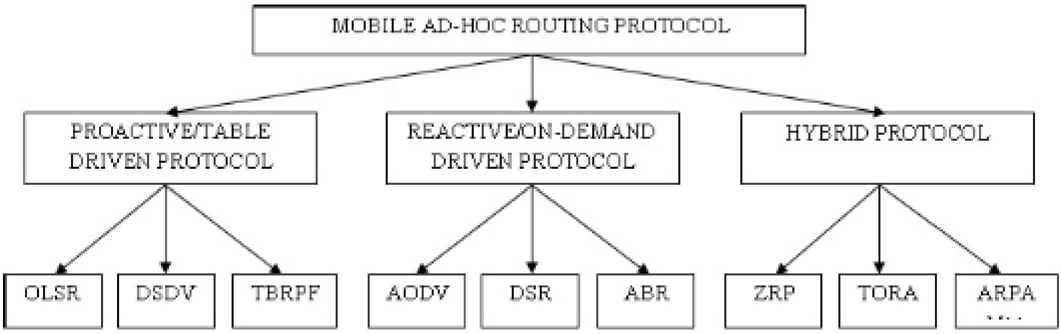

Figure-1. MANET routing protocols.

2.1 proactive Router protocol:

Routing in Advance Maintaining nodes where no packets are exchanged is a task that requires protocols. These strategies are put into operation if the topological changes have no impact on traffic. "Table-driven techniques" is another name for these methods. Hosts can quickly get route information and establish a session by utilizing this class of protocols. Even if no data is being exchanged, the network continues to function normally by sending out control messages. An evaluation of proactive routing is carried out using the OLSR protocol.

2.2 Routing protocol that responds in real-time:

When the data transfer is required, Reactive Routing Protocols are used. As long as they are explicitly needed, routes are created. "On-demand" methods may be referred to as "reactive" strategies. When there is little traffic, and the topology is stable, there is no need to discover and maintain routes with no traffic; routing overhead is decreased dramatically. Establish the routes for forwarding data, it will take longer, and the control messages will be overloaded, resulting in network congestion during the process. The data in this inquiry is examined using AODV, an Ad-hoc On-Demand Distance Vector from a reactive methodology.

2.3 Hybrid routing protocol:

Proactive and reactive routing strategies are combined in hybrid routing protocols. It uses less bandwidth and is faster than reactive routing systems while using less bandwidth and slower than proactive routing technologies. An analysis of Zone Routing Protocol (ZRP) is conducted in this study.

3. RELATED WORK:

Ant Colony Optimization (ACO) and Cuckoo Search (CS) are discussed in [1] as an optimization strategy for higher overall performance.

With and without black hole assaults, numerous measures such as Packet Delivery Ratio (PDR), Average Jitter, and End-to-End Delay are compared in this study [2].

Ad hoc networks are better served by [3]. End-to-end delay and control overhead were decreased by as much as 80% due to these changes in the simulation environment.

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Ad hoc and wireless routing algorithms are compared based on routing overhead, route optimization, and energy consumption. Mobile ad hoc and sensor networks' swarm intelligence algorithms focus on this study [4].

ACO-based ad-hoc routing protocols and well-known ad-hoc routing algorithms are examined in [5]. Performance metrics such as packet delivery fraction, average delay, normalized routing load, throughput, and jitter were used by Dilpreet Kaur and Naresh Kumar in their presentation to describe the characteristics of ad-hoc routing protocols in networks with low mobility and low traffic as well as those with high mobility and high traffic. [6].

4. Suggested Methodology:

MANET performance was measured using several protocols, including the OLSR protocol for proactive routing and the AODV and ZRP hybrid routing protocols. Next, hop neighbors are selected using a genetic algorithm and an ant colony optimization approach.

4.1 AODV: Ad-hoc On-demand Distance Vector:

In mobile ad-hoc networks, AODV stands for Ad-hoc On-Demand Distance Vector Protocol. When a user requests a source-to-destination path, it is created. Tracking routes is accomplished by using routing databases and a route-finding algorithm. This protocol is agile enough to respond to shifting link circumstances and failures. Link failure flags a route as invalid. When using AODV, destination sequence numbers assure the absence of loop restrictions. Use the most recent path to your final destination to use these features. The routing table contains information on both the final destination and the next hop, which calculates the number of hops necessary to get there. In addition, the table keeps track of a destination sequence number, which is tied to both the final destination and the overall lifespan of the route. The routing table record will be wiped off if a route is never used.

There are three forms of communications defined by AODV: a Routing Request, a Response, and an Error.

4.2 Optimization of Link-State Routing (OLSR):

The OLSR protocol uses the most direct route available to reach all feasible network destinations. First, it's a good idea to examine the quality of the links. The strength of the signal received can be used to assess the quality of a link. You may be able to get this information from a wireless network card. To determine the quality of a connection without this information, the OLSR protocol uses the number of missed controls. After a certain number of retries, the link layer can notify higher layers of a failure with a neighbor node using either the timer expiry or the link layer itself.

4.3 ZRP: Protocol for Zone-Based Routing:

Zone Routing Protocol allows routers to be both proactive and reactive simultaneously. The rooting zone is a small network area that each node actively maintains routes inside when using this protocol. The query-response approach is commonly used by programmers when creating routes. As the network's transmission range expands, so does the number of neighbors. ZRP provides a query control tool that redirects inquiries away from the cover routing zones to reduce the amount of traffic on the route. One of the nodes in the vicinity of the node's routing zone requested a route. Before moving on to the next phase, queries are checked to see if they originate from a neighbor. If it can identify other nodes in the same zone, it is covered. As a result, the question is passed around until it is answered. The route is formed when the final destination replies in the opposite direction.

4.4 Genetic algorithm:

Genetic algorithms are more likely to pass on chromosomes with higher fitness scores. It's done by sorting the chromosomes into ascending or decreasing order of fitness. When two sets of chromosomes are separated into upper and lower classes, there are two chromosomes.

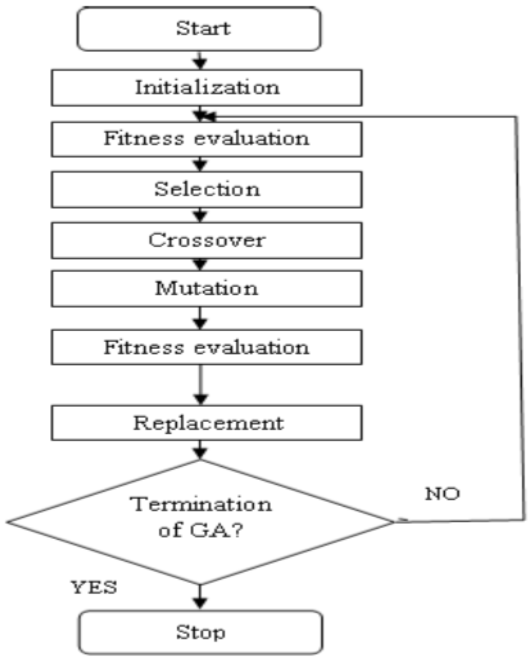

Figure 2 Flowchart for optimizing Genetic Algorithms (GAs)

Crossover occurs when two chromosomes of different classes are combined to create a new chromosome. Node attributes are analyzed using a Genetic Algorithm, which subsequently provides information on assaults. The Genetic Algorithm incorporates the Request Forwarding Rate, Reply Rate, and Receive Rate of OLSR, AODV, and ZRP. To better understand how Genetic Algorithm optimization works, consider the flowchart shown in Figure 2.

4.5 Optimization of ant species:

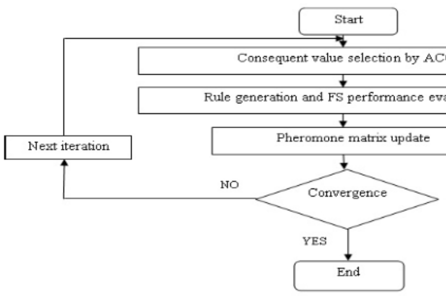

Figure 3 Ant Colony Optimization Flowchart (ACO)

Ant Colony Optimization revolves around finding the quickest route between the colony and a food supply. There doesn't appear to be a central or active coordination mechanism in an ancient colony to select the best method of obtaining nourishment. For the best possible travel, the Ant uses its high pheromone concentration. Simply put, a computer program is an artificial ant. Probabilistic path selection led to the creation of an artificial Ant. If a multi-path section is required, ACO-based metaheuristic techniques are the best option. The use of ACO-based algorithms eliminates the requirement for nearby networks to receive routing tables or other network information. The current node's pheromone value is used to make the selection. It gives you a wide range of options for your journey. Techniques for solving stochastic optimization problems, NP-hard industrial difficulties, and emotional problems in communication networks are among the many applications of meta-heuristic algorithmic techniques. Ant Colony Optimization's flowchart is shown in Figure-3.

5. SIMULATION:

The NS2 simulator is used to implement the proposed idea. A grid with a dimension of 1000 meters by 1000 meters is used to measure the performance of 100 nodes. The number of data packets sent and received and the total number delivered are metrics used to evaluate network performance. This method's success is evaluated using a variety of parameters, including packet delivery and throughput as well as latency, packet loss ratio, and power usage. Measure. Table-1 lists the parameters that were used in the experiment.

Table-1. Simulation parameters.

Parameter	Value
Surface of the network	$1000m^2$
Number of nodes	100
Size of data packet	500 Byte
E_{el}	50nJ/bit
RTS, CTS, ACK size	30 Bytes
Traffic type	Constant Bit Rate (CBR)
Routing protocol	AODV, OLSR, ZRP
Antenna type	Omni-Antenna
Channel bandwidth	20kpbs
Initial energy	2J
Transmission range	250m

5.1 Metrics of performance:

5.1.1 Ratio of Packet Delivery (PDR):

To determine the PDR, divide the total number of packets sent from one location to another. D/S = Delivery per second.

Notation is used to indicate how many packets the destination has received. Internet slang refers to D. S packets as "source-generated packets.

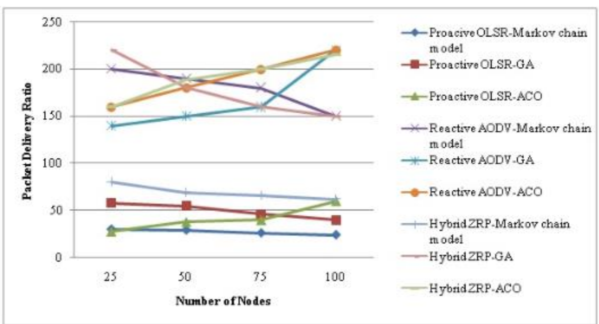

Figure-4. Packet delivery ratio vs. No. of nodes.

Table-2. Packet delivery ratio with 100 nodes.

	Various protocols	Packet delivery ratio		
		Markov chain	Genetic Algorithm (GA)	Ant Colony Optimization (ACO)
Number of nodes is 100	Proactive OLSR	24	40	60
	Reactive AODV	150	220	220
	Hybrid ZRP	62	150	215

Figure-4 and Table-2 illustrate the packet delivery ratios for 100 nodes, as well as the number of nodes.

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The PDR for anti-proactive OLSR is the lowest, but the PDR for reactive AODV and hybrid ZRP is the greatest because of their ant colony optimization. A better packet delivery ratio is required to increase performance. It has been found that Ant colony-optimized reactive AODV and hybrid ZRP are best in delivering packets in this study.

5.1.2 Delay from start to finish on an average basis:

The amount of time it takes for a data packet to travel over the network is measured in milliseconds. To arrive at the final result, the time at which the source's first data packet arrived at the destination is subtracted from the time at which it was transmitted. For better performance, there needs to be a short end-to-end delay. Latency is a function of S/N.

When a packet reaches its final destination, the time it takes for the delivery process is known as "S."

Each destination node has received a certain amount of data, which we will call N.

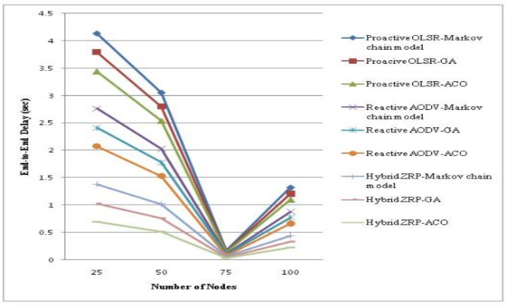

Figure-5. End-to-End delay vs. No. of nodes.

Table-3. End-to-End delay with 100 nodes.

	Various Protocol	Average End-to-End delay (sec)		
		Markov chain	Genetic Algorithm (GA)	Ant Colony Optimization (ACO)
No.of node 100	Proactive OLSR	1.32	1.21	1.1
	Reactive AODV	0.88	0.77	0.66
	Hybrid ZRP	0.44	0.33	0.22

Table-3 compares the End-to-End delay for 100 nodes for various protocols and displays the End-to-End latency as a function of node count in Figure-5 (see fig. 5).

Ant colony optimized hybrid ZRP has a smaller End-to-End delay than ant colony optimized proactive OLSR. Propagation, transmission, queue, and processing time are all causes of end-to-end delays. The time to market hybrid ZRP based on ant colony optimization is shorter.

5.1.3 Throughput:

It is calculated by taking the time to receive one shipment from the sender and dividing it by that number. Throughput is commonly measured in bits per second (bps) or bytes per second (bps). According to Little's Law, R/T is equal to R/T throughput.

The amount of data received by the receiver is denoted by R, while the delivery time is indicated by T.

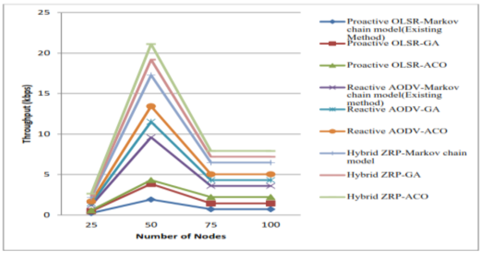

Figure-6. Throughput vs. No. of nodes.

Table-4. Throughput for 100 nodes.

	Various protocols	Throughput (kbps)		
		Markov chain	Genetic Algorithm (GA)	Ant Colony Optimization (ACO)
No.of node 100	Proactive OLSR	7.2	14.4	22.2
	Reactive AODV	36	43.2	50.4
	Hybrid ZRP	64.8	72.0	79.2

As depicted in Figure-6 and Table-4, the Throughput Vs. Node Count is shown in the figures. Enhancing system throughput is critical for ad-hoc wireless networks. Hybrid ZRP has the highest throughput of our proposed ways, while ant colony optimized proactive OLSR has the lowest throughput of any of our approaches. Ant colony optimized hybrid ZRP routing protocol has the most significant possible data transfer rate out of the three.

5.1.4 Ratio of Dropped Packets (PLR):

If there is a high percentage of packets lost in transit, this is called a high packet loss ratio (HPLR).

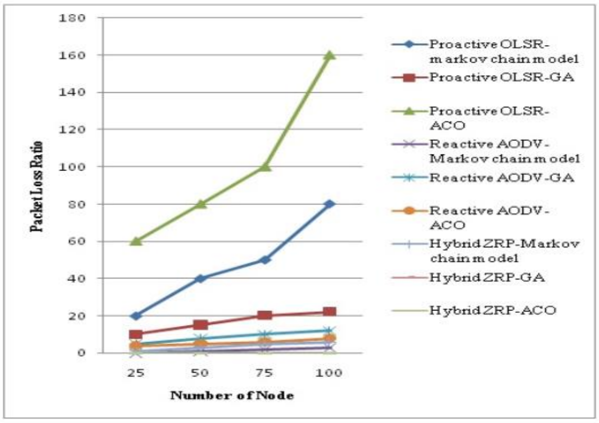

Figure-7. Packet loss ratio vs. No. of nodes.

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Table-5. Packet Loss Ratio with 100 nodes.

No.of node 100	Various Protocol	Packet loss ratio (Dropped packets)		
		Markov chain	Genetic Algorithm (GA)	Ant Colony Optimization (ACO)
	Proactive OLSR	80	22	160
	Reactive AODV	3	12	8
	Hybrid ZRP	6	5	4

A packet loss ratio for various protocols and the number of nodes is shown in Figure-7 and Table-5, respectively.

As a rule, the system's packet loss ratio should not exceed a certain threshold. Hybrid ZRP has a lower packet loss ratio than Ant colony-optimized proactive OLSR. Thus, the ant colony optimized hybrid ZRP packet loss ratio is superior to all three routing protocols evaluated.

5.1.5 Consumption of Electricity:

The International Energy Agency defines the total quantity of energy consumed by a process or system.

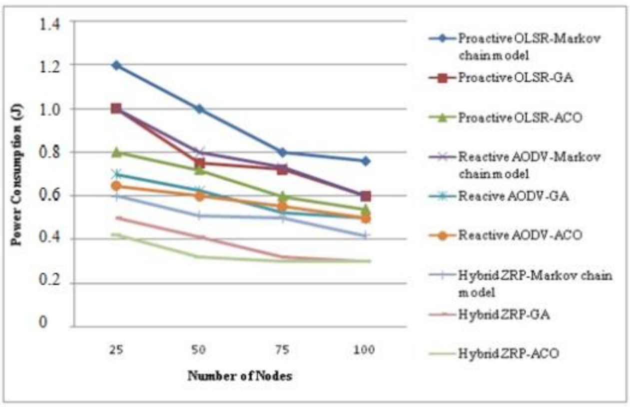

Figure-8. Power consumption vs. No. of nodes.

Table-6. Power consumption with 100 nodes.

No.of node 100	Various Protocol	Power consumption		
		Markov chain	Genetic Algorithm (GA)	Ant Colony Optimization (ACO)
	Proactive OLSR	0.76	0.6	0.54
	Reactive AODV	0.60	0.5	0.5
	Hybrid ZRP	0.42	0.3	0.3

Node count can be seen in Figure-8, while Table-6 indicates how much power each protocol requires to run a 100-node network.

However, the Ant colony-optimized proactive ZRP consumes more power than hybrid ZRP. The hybrid ZRP protocol outperforms the other two protocols examined regarding energy consumption.

6. CONCLUSION:

This study used a combination of the Genetic Approach and the Ant Colony Optimization method to improve ad hoc networks. Proactive (OLSR), reactive (AODV), and hybrid strategies were all considered in this study. Comparisons with results from the Genetic Algorithm and the Markov chain model show the proposed Ant Colony Optimization approach to be effective. Throughput and end-to-end delay were among the performance metrics that might be predicted using the NS-2 simulator. This comprised the use of power, the delivery ratio, and the loss ratio of the packets sent and received. Ant colony-enhanced ZRP performs better in a simulated environment.

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