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An Adaptive Energy-Efficient with Location Detection in AODV-ACO Optimized Routing for Disaster Resilient in MANET

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Abstract- The ACO approach uses the concept of pheromones, and the presence of the high pheromone means the optimal route for communication. As a result of finding numerous routes to a destination, the ACO protocol picks a single path with a high pheromone value for data delivery. It uses low pheromones routes as an alternate choice to routes with an equal or larger hop count. The location information of nodes is very important for further communication. The routes for data delivery serve as backup routes in the event of a failure of an established link. Increasing the effective usage of the network is the goal of transferring load to a more efficient route. It is proposed in this research that a location detection algorithm be used in Adaptive Energy efficient with Location Detection in AODV-ACO (AELD-ACO) Optimized Routing for Disaster Resistant in MANET to regulate the balance of incoming and outgoing packets in a dynamic network. This approach eliminates the risk of congestion and balances the load on a particular link with queue management. If the rate at which packets are being sent exceeds a certain threshold, other routes are used to offer less energy consumption of nodes. The nodes' broadcast route request packets are not sent out regularly to prevent network congestion. The AELD-ACO technique reduces the latency and control rate, the primary causes of performance degradation, improving network performance by limiting the delay and control rate. The performance of AELD-ACO is compared with the existing MCER-ACO approach. The proposed approach provides better performance than others. The AELD-ACO approach outperforms the latter in routing performance by decreasing latency and controlling overhead.

Keywords: AELD, ACO, MANET, MCER, MANET, Location Detection.

I. INTRODUCTION

A mobile ad hoc network (MANET) is a decentralised network of mobile nodes that temporarily exchange information through wireless transmission [2]. Because the nodes are movable, the network architecture may change quickly and without warning. The network topology is ad hoc, and nodes may come and go as they choose. Within its transmission range, a node may connect with other nodes. Compared to networks with infrastructures, this network offers many cost and flexibility benefits. MANETs are ideal for various applications, including data gathering, seismic activity, and medicinal applications. Unfortunately, MANET nodes are restricted in terms of energy and bandwidth. These resource limitations create a slew of non-trivial issues, particularly routing and flow management. Routing is required in communication networks because nodes are seldom linked directly. Any routing protocol's primary task is to route traffic from sources to destinations, but since contemporary networks are becoming more complicated, routing algorithms face significant difficulties [3-4]. Because the network topology is continuously changing and network resources are restricted, the routing function in these networks is especially difficult. It is especially true in wireless ad hoc networks, where node mobility and connection failures cause the network architecture to change frequently. Network performance is hampered by the routing algorithm's inability to react to rapid topological changes, limited resources, and energy availability.

II. RELATED WORK

The recent work is finished in CSMA, and multipath routing is mentioned in this section. These works are effectively done some new reduces stinginess and downside of congestion in DTN.

Christy Jeba Malar· M. Kowsigan, et al. [1] "Multi constraints applied energy-efficient routing technique based on ant colony optimisation used for disaster resilient location detection in mobile ad-hoc network" they propose a new ant colony inspired technique for energy-efficient routing in MANET. The proposed technique is a multi-objective constraint applied energy-efficient routing technique based on ant colony optimisation in mobile ad-hoc networks (MCER-ACO). The proposed MCER-ACO technique selects the next-hop node centred on the constraints, residual energy of mobile node, no of packets in the path and dynamic movement of topology. By applying the ant colony technique on objectives and constraints, the probability of choosing the next-hop node as a forwarding node is determined. In mobile ad-hoc networks, the suggested method is a multi-objective constraint applied energy-efficient routing strategy based on ant colony optimisation (MCER-ACO).

Milan Kumar Dholey et al. [5] "ACOLBR: ACO Based Load Balancing Routing In MANET" In this title, ACOLBR (ACO-based load balancing routing) is a new routing protocol that is designed to manage congestion and balance load across various routes between source and destination. Because the Ant Colony and MANET environments are so similar to others, the authors decided to use the ACO (Ant colony optimisation) method during MANET routing to manage congestion and balance load. Two colonies of ants (red/blue) transport packets depending on the network state in our proposal. A decision variable is used to choose between red and blue ants for packet transmission depending on network characteristics, including bandwidth, energy, mobility, and distance.

Bright Selorm Kodzo Anibrika et al. [6] "A Survey of Modern Ant Colony Optimization Algorithms for MANET" is a survey of modern ant colony optimisation algorithms for MANET. This book looks at Ant Colony Optimization techniques and how their framework may be used to route Mobile Ad-hoc Networks. The work in the field was then examined, including the features, capabilities, and applications and the architecture, topology, and routing anatomy of MANET. Finally, it went through the Ant Colony Optimization methods in more detail, including their design, algorithm architecture, and routing mechanisms. MANETs are networks that are built without the use of any pre-configured or pre-existing network infrastructure. MANET nodes operate as both a node and a router in a client-server architecture, providing comparable tasks.

Jubin Sebastian E [7] "Performance Comparison of ACO Algorithms for MANETs" compares the performance of several ACO algorithms. A Mobile Ad Hoc Network (MANET) is a dynamic multichip wireless network formed by a group of mobile nodes sharing a shared wireless channel. Because of the mobility of the nodes, one of the main problems with MANET is routing. Due to MANET nodes' changing topology and dynamic behaviour, routing transfers data from a source to a destination through a network. Ant Colony Optimization (ACO) has been discovered to be a unique optimisation method with a characterisation of Swarm Intelligence (SI) that is well suited to discovering adaptive routing for such a volatile network. ACO algorithms are based on the foraging behaviour of a swarm of ants that can figure out the best way to link their nest to a food supply.

R.Geetha, G.Umarani Srikanth [8] "Ant Colony optimisation based Routing in various Networking Domains – A Survey" examines ACO-based routing across various networking domains, such as Wireless Sensor Networks and Mobile Ad Hoc Networks. One of the main problems in the computer network literature is routing, which transfers information through Internetwork from a source to a destination. Nature-inspired algorithms have recently been investigated as a possible answer to this routing issue. Ant colony optimisation (ACO) is a probabilistic method for resolving complicated computing problems, such as determining the best path across a network. In the natural world, ants roam about aimlessly, returning to their colony after finding food and leaving pheromone trails. If other ants discover such a route, they are more likely to follow it rather than wandering, returning and strengthening it if they finally locate food. Because these pheromones are appealing, neighbouring ants enticed to follow the trail more or less directly. When they return to the colony, these ants reinforce the path. Suppose there are two routes to the same food source, the shorter path taken by more ants in a given period than the longer route. The short path improved as time went on, making it more appealing.

Dweepna Garg and Parth Gohil [9] "Ant Colony Optimized Routing for Mobile Ad-hoc Networks (MANET)" in this titled, the protocol's primary aim in terms of design is to minimise routing overhead. A Mobile Ad-Hoc Network (MANET) is a temporary network of wireless mobile nodes that operate without centralised access points, infrastructure, or management. Routing is transferring data from a source to a destination through Internetwork. The most challenging task in this network is determining a route between communication endpoints, which is made more difficult by node mobility. This article proposes a novel routing method for mobile, multi-hop ad-hoc networks. Swarm intelligence is at the heart of the protocol. Ant colony algorithms are a branch of swarm intelligence that looks at how tiny ants can work together to solve complicated issues. The routing protocol that has been developed is adaptable, efficient, and scalable.

Aws Kanan et al. [10] used the Ant Colony evolutionary optimisation method to solve the routing issue, implying more of the desired characteristics in the guided probabilistic route selection. Simulations of routing based on the biological system known as Ant Colony Optimization (ACO) were carried out, with various variables taken into consideration to examine its adaptable nature. The algorithm's average end-to-end latency and success rate performance was not affected in scenarios with significant degrees of node mobility.

Ma Lin et al. [11] proposed an efficient congestion elusion method for mobile ad hoc networks in 2011, based explicitly on an ant colony algorithm, which quickly explored the best path between two nodes while forecasting the link's congestion condition. As a result, a new route was quickly identified to disperse the flow around and alleviate the bottleneck. The method significantly decreased the packet loss ratio and average end-to-end latency compared to OLSR, which efficiently utilises networking resources.

Vahid Rajabi Zanjan et al. [12] introduced AAODV, an Ant Colony Optimisation-inspired algorithm for mobile ad hoc networks. It was suggested using Ant Colony Optimization to preserve the essence of Ad hoc On-Demand Distance Vector (AODV) routing. It kept the on-demand aspect of AODV while also working adaptively. It did not transmit any of the AODV's Route Request packets. Instead, it determined its routes based on input from previously travelled packets, then modified and maintained them. It was a probabilistic and adaptive technology that, by learning the environment, could alter its path in response to changes in network architecture. Simulations indicate that the AAODV method outperformed the AODV algorithm regarding average latency, bandwidth overhead, throughput, and packet loss.

Mohammad Golshahi et al. [13] for Mobile Ad-hoc networks introduces a multipath hybrid routing method. This method is inspired by swarm intelligence techniques, namely Ant Colony Optimization (ACO). These approaches seek to solve issues by mapping mathematics and engineering problems onto biological societies. The number of neighbours of a node was utilised to choose the next-hop in the proposed method.

III. PROPOSED RESEARCH

Mobile ad hoc network is adopted in various applications such as disaster management, military surveillance, remote access. Due to their variety of applications, we focus on their existing problem utilised for real-time implementation. As on problem definition, develop an adaptive energy-efficient algorithm with location detection AODV-ACO optimised protocol name as (AELD-ACO). The proposed protocol implemented in network simulator -2 is helpful to increase network lifetime and provide predictive location information of the node. In the proposed energy management technique, node energy is stored in the vector data structure fields are (node id, tx_time, rx_time, tx_energy, rx_energy), which helps to calculate the energy discharge rate of node, another parameter for the route decision is real-time location detection of the node which contain the field of (node_id, x_axis, y_axis, speed) it is utilised to calculate the predicted location information. During the route discovery process, the AODV routing protocol takes the route decision based on how much time nodes are alive and the expected location of the node. In this mechanism, select the node for route established process to increase the network lifetime and reliability of the node for the communication. AELD-ACO protocol jointly works, which provide exponential node reliability (increase/decrease) to adopt the route for data communication. Ant colony Optimisation is an approach to provide an optimised route for the betterment of route decisions, and it's a computational model of swarm knowledge which gives a fruitful route for optimisation related issues. Various ants created by a node travel the system in ACO steering computations to seek paths between two nodes. If the ant discovers a method, it should record pheromone during the operating process. The characteristics of the path, such as the number of bounces, delay, location and energy of nodes along the route, are used to calculate pheromone. An information packet is sent via a link, the likelihood of which is determined by the pheromone measurement. In this proposed AELD-ACO, calculate the ant scans for a goal G and update the information about nodes goes with the pheromone table, which depends on the number of parameters. The intermediate hop node is picked based on the following dependencies: location, speed, node's energy, delay, traffic rate, and channel rate. To achieve the QoS, the objectives considered are the node's stability and reducing the energy consumption for transmission, which increases the network lifetime and minimises routing overhead. Measure the effectiveness of node in route is required by every node is how many packets effectively forward the k^{th} data packet to next neighbour node is calculate by eq. 1.

I(Fwrd) = I(receive – drop) (1)

If drop =0 then I(Fwrd) = I(receive)

The effectiveness of any node depends on how many packets forward out of receiving from the predecessor node. How many intermediate nodes packets forward calculated by equation 2, which is used to calculate the achievement rate for moving the k^{th} data from X to Y node.

$$AR = \sum_{p=1}^{n} \frac{I(Fwrd)}{p_n} \quad (2)$$

Where P_n indicate the total no of the actual packet transmitted, while the achievement rate is high, it means data drop is low, and the node is more reliable.

Node stability is calculated by eq. 3, let assume node X stability

$$Avg(s) = \frac{\sum_{l=1}^{n} l(speed)}{n} \quad (3)$$

Where Avg(s) is the average node speed in the network, n is several nodes in range.

If X(s) < $Avg(s)$ it means X node is more stable concerning predecessor node next parameter is the energy discharging parameter which is denoted by e_d and calculate energy discharging rate by eq. 4 & 5

$$e_d = (T_{time} * T_{pow}) \quad (4)$$

$$Avg(e_d) = \frac{\sum_{i=1}^{n} I(e_d)}{n} \quad (5)$$

Similarly, here T_{time} is transmission time, T_{pow} transmission power, e_d energy discharge of node, n is number of node and $Avg(e_d)$ average discharging rate.

Let assume $x(e_d)$ is node x discharging rate, then select the node for the route while

$$x(e_d) < Avg(e_d) \quad (6)$$

The proposed AELD-ACO route selection is efficient and effectively performs for mobile ad hoc networks. The proposed technique is implemented by network simulator-2 and analyse the network performance in terms of percentage of data received throughput, overhead, network active lifetime and end to end delay.

IV. PROPOSED ALGORITHM

This section describes a formal way of the algorithm named as AELD-ACO algorithm, and the algorithm describes how the implementation is done to achieve pheromone table, which contains the energy of node, the power requirement per packet, location, speed and their reliability. The proposed AELD-ACO algorithm provides stable and reliable communication for the MANET application.

Algorithm: AELD-ACO
Input: Mobile Node ∀N,
Source S
Destination D
Pheromone Table T
Intermediate Node I
Radio Range Ψ ($550m^2$)
Energy discharge (e_d)
T_{time}: transmission Time
T_{pow}: Transmission Power
I_{speed}: I node speed/seconds
ACO: Optimize routing
AODV: routing protocol
R_p: routing packet
Output: Pheromone table T, PDR, Throughput, network active time, Overhead
Procedure:
∀N in Ψ
S initiate R_p (S,D, R_p)
For all I node in Ψ
$\forall I(e_d) = T_{time} * T_{pow}$
$\forall I(_{speed})$ = distance * time;
Store $I(e_d)$, $I(_{speed})$, I(fwrd)
Select ∀I in route

$$Avg(s) = \frac{\sum_{i=1}^{n} I(speed)}{n}$$

$$Avg(e_d) = \frac{\sum_{i=1}^{n} I(e_d)}{n}$$

If $I(e_d) < Avg(e_d)$ or lower ($e_)$, $I(_{speed}) < Avg(S)$ or lower(S)
I in route S to D

$$AR = \sum_{p=1}^{n} \frac{I(Fwrd)}{p_n}$$

NI= ∀I based on AR value
Else
Path not found S to D
Call R_p for retransmission
End if
Destination D receive R_p & initiate R_p(ant) R_p(ant) Communicate

$$NH = \sqrt[\alpha]{\sum_{p=1}^{n} \forall I \in NI, I(e_d), I(speed), I(fwrd), \emptyset IG = 0}$$

Select Node ∀I based on NH value
ACO execute
Pheromone table T Update
Destination Node D Found
Call Data Send (S, D, Data)
End
Data Send (S, D, Data)
S Call Data (cbr/ftp)
For ∀I in path ∈ NH
S Send (cbr/ftp)
Update $\forall I\ I(e_d), I(speed), I(fwrd)$
Receive Data (cbr/ftp) in D
Update Pheromone table T Update
If (NH low)
Call AODV for new route search
Else
Next data send by same route
End if
End

V. SIMULATION PARAMETERS

To replicate ad-hoc routing protocols, we utilised the Network Simulator (version ns-2.31) from the University of California, Berkeley. The CMU Monarch project at Carnegie Mellon University has developed a mobility extension to the ns programming language that we have utilised to mimic the mobile wireless radio environment. The experiment is carried out based on the following simulation settings, and the results are displayed as matrices.

A. Packet Delivery Ratio

Multipath routing increases the routing performance while also providing the option of a backup route in the event of a failure of the current route. In this graph, the Packet Delivery Ratio (PDR) performance of normal MCER-ACO and AELD-ACO is evaluated, and the proposed scheme provides better performance than others.

Table 1 Simulation Parameters

Parameter	Value
No. of Nodes	50,100,150
Area Size	1000*1000m^2
Routing Protocol	AODV-ACO
MAC	IEEE 802.11
Traffic Source	FTP, CBR
Transmission Range	550M
Packet Size	1024, 512Kb
Initial Energy	15J
Transmission Power	0.33w
Receiving Power	0.12w
Idle Power	0.0.5w
Simulation Time	100S
Mobility Model	Random

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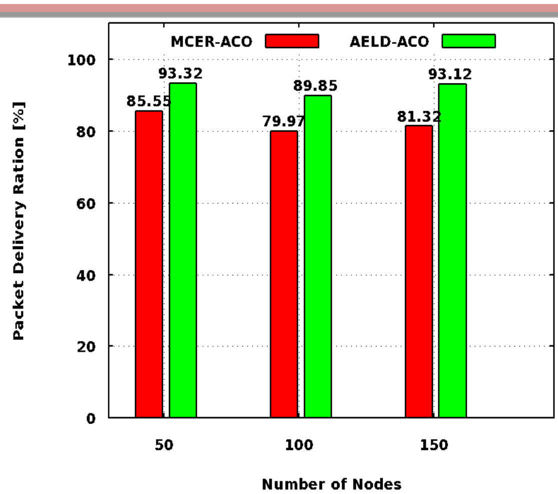

Figure1: PDR Analysis

The proper node's location identification approach improves accuracy. The proposed scheme's PDF performance does not vary w.r.t time and provides about 93% successful delivery. The performance of normal MCER-ACO does not reach more than 85%. Now, the PDF performance is only dependent on the factor of packet reception about the sender and the number of real packets sent in the network, as shown in Table 2 of the overall summary.

B. Routing Load Analysis

This graph depicts the routing load analysis in the case of the existing scheme and the new scheme, respectively. The presence of additional routing overhead indicates that the sender is not transmitting data in the network since it has taken more time for connection formation, resulting in a decrease in network performance. In this graph, the routing overhead of AELD-ACO is less than the routing overhead of the existing MCER-ACO approach. It shows that just multipath protocol does not minimise routing overhead; however, the multipath protocol can provide greater performance than conventional routing approach if we make some modifications to the routing strategy.

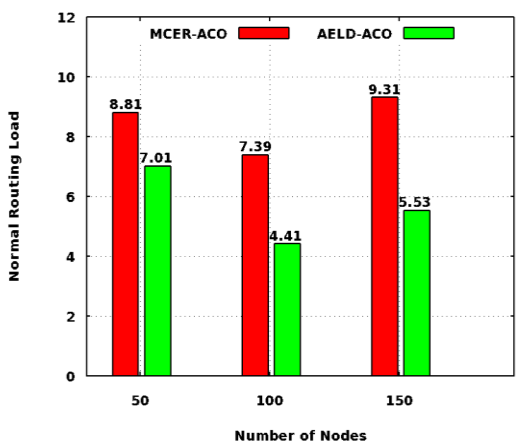

Figure 2: Overhead Analysis

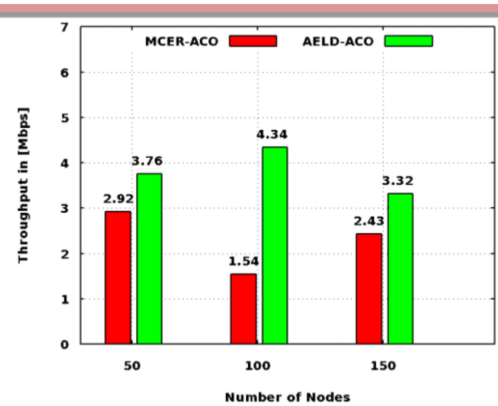

Figure 3: Throughput Analysis

C. Throughput Analysis

The improved network throughput is an indicator of improved data delivery in the dynamic decentralised network. Throughput, also known as network data delivery per unit of time, is the number of packets transmitted in a network. It is measured in bits per second (bps). In this case, we observe that in the MCER-ACO routing, only approximately 2.92Mbps maximum is received in the network, but in the proposed scheme, more than 4Mbps maximum are received in the network. The only protocol that can enhance network performance is the ACO approach in routing, which indicates that the proposed protocol is better than previous. The new method enhances network performance by managing location information and distributing the load more evenly.

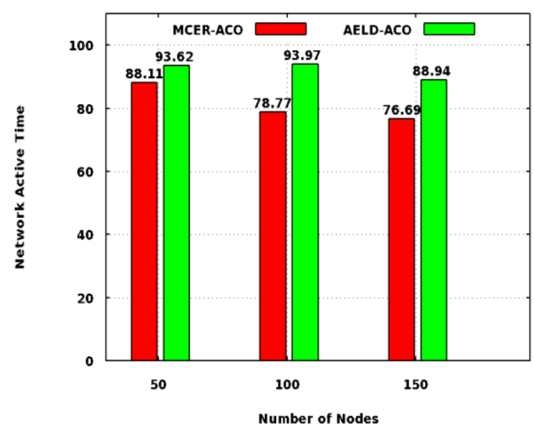

Figure 4: Active Time Analysis

D. Network Active Time

The network active time is directly related to the remaining energy of nodes in the network. A few pathways with a higher hop count value were retained and utilised as backup routes in the event of a connection breakdown, according to the proposed AELD-ACO protocol. Energy depletion and location of nodes are the most severe problem associated with node failure. The proposed modification reduces the energy loss by utilising light load routes to deliver RREQ and data packets and shifting the load to other channels with more outstanding hop dependencies if the nodes or route become congested, unlike the current configuration.

E. Average End to End delay [ms]

The ACO-based multipath routing protocol aims to balance the load on a network by using pheromone-based multipath. The delay in the network is exacerbated due to connection failures and congestion in the network infrastructure. There is a loss of data packets in both situations, resulting in increased network latency resulting from retransmission of lost data packets. The end-to-end delay analysis of the proposed AELD scheme and the performance of previous MCER-ACO schemes comparison mentioned in this graph Determine that the delay in the network in the proposed AELD-ACO is minor compared to MCER-ACO, it means better routing performance.

F. Overall Analysis Table

The precise simulation performance of the network is shown in Table 2 of this document. The performance metrics of all MCER-ACO and AELD-ACO protocols are compared in this table 2, and each performance meter of the AELD-ACO produces a superior result than the MCER-ACO. Within a 100-second simulation time frame, the performances of protocols are evaluated in three different node density scenarios.

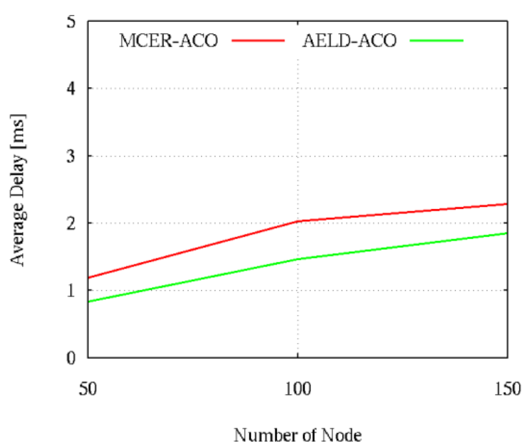

Figure 5: Delay Performance Analysis

Table 2 Complete Performance Analysis

Parameters	50		100		150	
	MCER-ACO	AELD-ACO	MCER-ACO	AELD-ACO	MCER-ACO	AELD-ACO
PDR	85.55	93.32	79.97	89.85	81.32	93.12
NRL	8.81	7.01	7.39	4.41	9.31	5.53
Throughput	2.92	3.76	1.54	4.34	2.43	3.32
NAT	88.11	93.62	78.77	93.97	76.69	88.94
Delay[ms]	1.19	0.84	2.03	1.47	2.29	1.85
Avg [hop]	3.82	4.32	1.44	4.27	1.77	2.50
Eng[depl]	5.11	3.74	4.32	2.55	1.96	1.38

VI. CONCLUSION AND FUTURE WORK

Mobile Ad hoc Networks are defined as networks in which the nodes create dynamic linkages and are mobile. They believe that MANET is a wireless network and that it uses a wireless medium to create connections between the transmitter and the receiver to function. Congestion occurs when there are too many assets in a small network space. The proposed AELD-ACO using the ACO protocol, more than one route to a destination is discovered based on pheromones value. A single route with a high pheromones value is selected for data delivery, and this route is used as an alternate option if routes with an equal or larger hop count are discovered.

In the event of a failure of an established link, the existing routes would be used for information delivery as backup routes. If a current path fails, it is necessary to shift the load to another way to ensure optimally. The publication of route request packets is discouraged to reduce congestion inside the community. The location-based routing also improves energy utilisation because the flow of control packets is reduced, and delay is also reduced in the network. In this research, the performance of AELD-ACO compared with MCER-ACO and the performance of the proposed scheme is better. The estimation of bandwidth is done by using the acknowledgement extend difference. In order to avoid energy loss, the sender chooses the path having high pheromones value. Location information minimises extra network cost and multiple path balances loads by employing more than one sending channel, which helps to reduce latency. This process enhances the outcome of the previous procedure while also clearing the network of congested areas. In the future, we will implement the proposed scheme with any load prediction approach for analysing the impact of the control packets and data receiving. Furthermore, we will also implement the proposed scheme with WIMAX technology to determine the most appropriate outcome power consumption on it in the future.

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