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Secure Routing Protocol to Mitigate Attack by Optimized Public Key Selective Encryption on AOMDV Algorithm in MANET

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Abstract

A Mobile ad-hoc network (MANET) is highly efficient to provide network services. Due to the dynamic behavior of the network, routing protocols have some design issues that affect network performance. The proposed work is based on optimal route finding and detects a link failure to maintain the route between a source and destination node for media file transmission. Ant Colony Optimization (ACO) with Ad-hoc On-demand Multipath Distance Vector protocol (AOMDV) detects a link failure and gives improvised quality of service (QoS) with local convergence while multimedia file transmitted in MANET. To provide global convergence in network swarm intelligence based GWO algorithm is used. During video files transmission Op-PKSEA algorithm shows increased through put up to 30%, packet delivery ratio up to 15% and minimize the channel load to 18% and end to end delay is minimize up to 20ms. Op-PKSEA algorithm concerning the parameters as mobility, number of nodes and packet size. The Op-PKSEA algorithm protocol maintain loop-free routing, mini mum control overhead, QoS provisioning for minimum latency, end-to-end delay, maximize packet delivery ratio and throughput.

1.0 INTRODUCTION

MANETs have exploded in popularity in recent years, due to this rapid advancement of wireless and mobile communications. However, due to the constant change in network topologies, designing ad-hoc networks is a big challenge. A major issue in this environment is the efficient routing of packets to their destinations. The restricted energy and the unpredictable movement of mobile nodes are the two key aspects of a MANET that should be considered when selecting the optimized route in this study. Without QoS, network data or traffic can become scattered, overloaded networks, leading to poor performance or a completely halted network. Providing QoS in a secured environment is a difficult task in the dynamic topological network along with those existing resources are limited, the network is self-configured, and infrastructure-less, and no centralized controlled equipment or devices. MANET is a combination of multiple movable nodes which are moving freely without fixed topology and boundaries leads to form a temporary network. MANET provides good benefits and performance during search and rescue operations in any kind of climatic condition. The important thing is no fixed infrastructure is required so all nodes act as a router or connecting device. Another consideration is that ad-hoc networks may be intrinsically faulted resilient because they do not operate within the constraints of a fixed topology. Nodes are added and deleted solely through interactions with other nodes. Such a network is used among military, security services, and rescue operations. There are some factors such as security, mobility of node, packet size, etc. which affect the planning, configuration, deployment, and performance of MANET. This work mainly focuses on QoS provisioning, routing protocols, and finding

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research challenges to improve MANET's performance. This work considered the following research challenges to compare the performance of routing protocol and try to improve network performance.

2.0 LITERATURE SURVEY

Sheikh et al. [1] designed a QoS framework for multimedia data transmission in a wireless mobile ad-hoc network. This framework comprises a QoS routing component that creates numerous virtual channels between a multimedia database server and a mobile user that meet the QoS requirements that the user specifies for a specific session. Because these virtual channels' end-to-end delays and available bandwidth differ, heterogeneity may be present in them. The suggested solution solves the challenge of preserving QoS guarantees between the source and destination nodes over the route's lifetime. K-Means aims to find the best optimal centroid value that will be used as the PDR threshold.

Hyun-Jong Cha et al. [2] also work on multimedia data transmission based on node mobility. It has a quick response time and a high transmission success rate in an extensive network. The proposed protocol makes the transmission pathways more reliable, allowing for a more natural or adaptable response to changes in the network topology. It is useful for multimedia streaming services that can be offered more steadily.

P. Rani [3] analyzed and proposed artificial neural network (ANN) techniques to analyze the dynamic nature of a decentralized system and its vulnerabilities to a variety of attacks, including black-hole, gray-hole, and sink-hole attacks. The defense against double attacks for black holes and gray holes is described in this research by combining the notion of an ANN as a deep learning method with the swarm-based Artificial Bee Colony optimization technique. The outcome shows that by choosing appropriate and ideal nodes for data packet transmission, the system's performance has improved.

Pandey P. et al. [4] worked on a routing protocol with QoS support acquired by modifying AODV during route discovery. Changes have been made to the route request phase, the route reply phase, and the greeting message exchange. The PDR of QoSRP is determined to be higher as compared to the conventional AODV protocol. Other QoS parameters such as throughput, PDR, and end-to-end delay show improvement. The results are tested for an increasing number of nodes in the network.

Sedrati M. et al. [5] proposed a technique to support the transmission of numerous video streams with sufficient QoS over mobile ad hoc networks: the combination of video coding techniques with multiple routing paths. To enhance QoS for real-time multimedia applications, two multi-path routing protocols—M-AODV and MDSDV—have been assessed in this article. M-AODV performs well in high-mobility nodes, whereas MDSDV performs well in large-scale networks. Furthermore, regardless of the number of nodes with medium mobility, these protocols offer between acceptable and good quality with little jitter.

Yashima T. et al. [6] examine a novel route availability scheme to measure route non-uniformity in a MANET. It assesses how well it captures network QoS, or the quality of the video streaming experience (QoE). To develop a way of evaluating route availability schemes. The AODV and OLSR created an environment that simulates a MANET capable of streaming video. Throughput and packet loss rates are analyzed. A route availability scheme has also been diagnosed, utilizing a test for subjective quality evaluation.

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Clovis Ronaldo et.al. [7] Designed the HyphaNet system to integrate the dynamics optimization technique of fungi with a routing algorithm in order to achieve optimal route discovery in a MANET. The route discovery process in HyphaNet resembles the growth of fungal mycelium. Multiple paths are initially established, but only the hyphae of the most optimal routes receive resources for strengthening and thickening their walls over time. As a result, the best routes are preserved and exhibit higher flow attractiveness. The routing mechanism relies on the attraction principle, which posits that data flows tend to follow paths with a greater concentration of stationary biomass, indicating lower costs and improved resource availability. By route heuristic value, the best optimal route will be considered.

Kodavayur Sanka et al. [8] presented an energy-efficient routing protocol using cross-layer routing. The proposed cross-layer routing protocol, utilizing the Particle Swarm Optimization (PSO) algorithm, aims to establish energy-efficient routes and ensure network stability. The system measures the packet delivery rate, mobility of nodes, and available energy level at the network layer. The network contention is evaluated at the MAC layer. The contention window (CW) is adjusted according to the level of network contention and the available energy level on each node. This system demonstrated significant enhancements in packet delivery ratio and energy efficiency, surpassing the performance of existing systems.

Shahram Jamali et al. [9] utilized a binary particle swarm optimization algorithm (BPSO) to enhance the energy efficiency of nodes in the TORA protocol. The algorithm's proposed composition involves evaluating the best path by considering both the cost of the path and the energy required for the route. The optimization of the TORA protocol enhances the network's lifespan and reduces the total packet delivery time.

Mingchuan Zhang et al. [10] built on a previous study that used ant colony optimization (ACO) and physarum autonomic optimization (PAO) to create a bio-inspired hybrid trusted routing protocol. The MANET system is divided into zones, with each zone being responsible for maintaining routes between nodes. The ACO algorithm is employed to assess the most efficient route, while the physarum autonomic optimization (PAO) technique is utilized to optimize the path in a multi-path domain. The performance of B-iHTRP is better than that of AODV, AntHocNet, and HOPNET in terms of minimizing delay, controlling overhead, and increasing the number of packets delivered.

Ala Sabree et al. [11] also address energy-aware routing and propose the LOA maximization technique to determine the optimal path. This technique considers three key metrics: energy conservation, throughput, and packet delivery ratio. Furthermore, we employ the LOA minimization technique to select the most advantageous route based on the delay and short-path metrics.

2.1 Proposed system

AODV is a loop-free routing protocol for ad-hoc networks. AODV protocol resists a wide range of network behaviors, including node mobility, connection failures, and packet losses. The proposed system mainly focuses on control overhead and optimal route discovery for multimedia file transmission

3.0 ROUTE FINDING IN AOMDV

To design QoS enabled AODV some extensions are required in routing table which will help to detect multiple path. In conventional AODV, the routing table consist of destination sequence number, interface, hop count, next hop. In addition to these, maximum delay,

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minimum available bandwidth, list of sources requesting delay guarantees, and list of sources requesting bandwidth guarantees are required for path finding and that are added into AOMDV routing table. As per the study, AOMDV has extended features of AODV. AOMDV provides multiple routes at each route discovery phase. In AOMDV, RREQ propagation from the source towards the destination establishes multiple reverse paths. Multiple RREPs traverse these reverse paths back to the destination from the source and intermediate nodes. The AOMDV protocol ensures the discovered multiple paths are loop-free and disjoint. AOMDV updates the routing table at each node to the maintain route. As per comparison with AODV, AOMDV generates extra RREPs and RERRs packets for multi-path discovery along with a few extra fields in the routing table which constitute the only additional overhead in AOMDV relative to AODV. The workflow of the AOMDV protocol is represented in Figure 1.

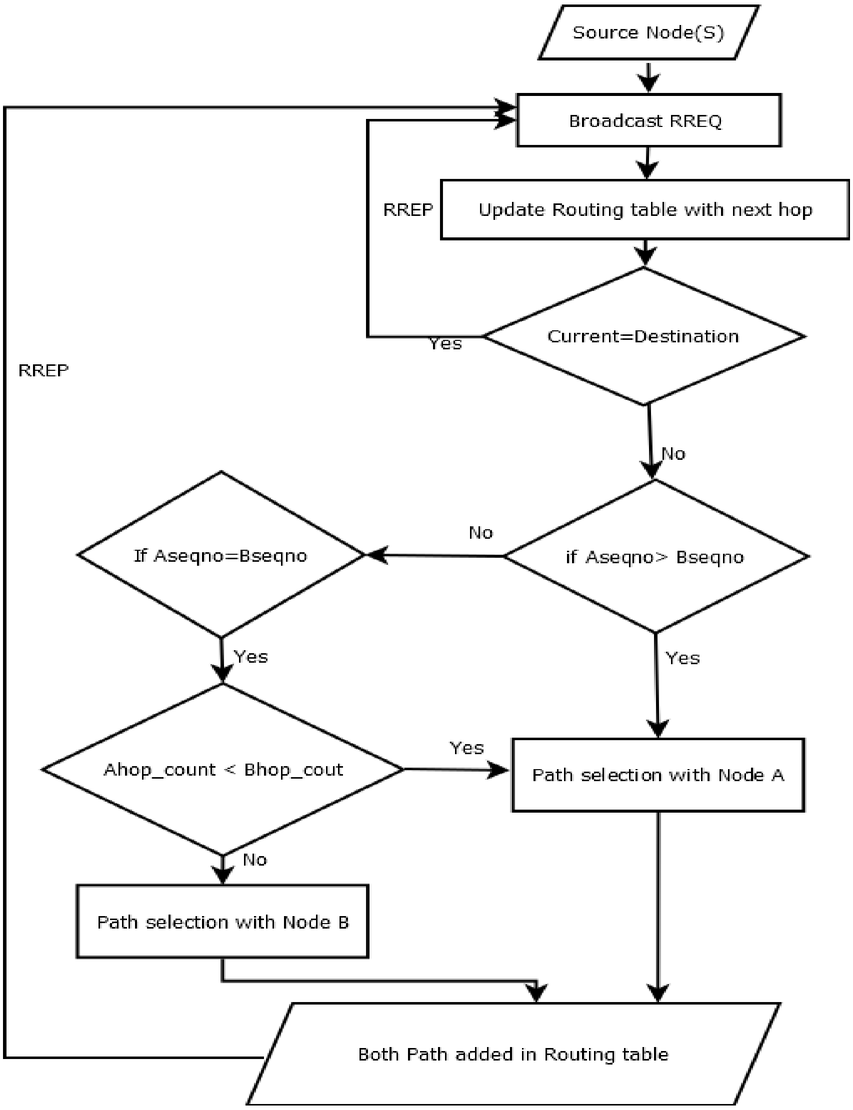

Figure 1: Workflow of AOMDV protocol for multiple route discovery finding

According to comparative analysis and design issues of MANET, there is scope for research work to define efficient methodology to achieve QoS. Analyze the routing algorithm (AOMDV, AODV, DSR, DSDV) to verify the QoS parameter which is shown in table 1 for packet delivery ratio, throughput, routing overhead.

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Table 1: Parameter for Routing Protocol Comparison

Parameter Title	Details
Number of nodes	50
No of sinks	10
Mobility Model	True
Propagation Model	Constant Speed Propagation Delay
Propagation Loss Model	Friis
Position Allocator	Random Rectangular Position Allocator
Mac Adhoc	Wifi
MAC Mac Standard	802.11B
Bps	2Kbps
Total Simulation Time	200 seconds
Node speed	20m/s
Node pause time	0
Protocol	AOMDV, AODV, DSR, DSDV

3.1 Comparative Analysis with other routing Protocols

Analysis results shows AOMDV is comparative performed well when link failure happens during multimedia data transmission. But needs to minimize the control overhead when packet size is increases. Packet drop ratio and end to end delay is minimizes. Following parameter considered to analyses performance:

- Throughput: The successful delivery of packets.
- End to End delay: Difference between the packet received time and packet sent time.
- Packets drop: The number of packets lost in network.
- Overhead: The total traffic (bps) received by the network layer.

The results shows, performance of AOMDV, AODV, DSR, DSDV concern with packet delivery ratio in figure 2 ,throughput performance shows in figure 3 and routing load in figure 4.

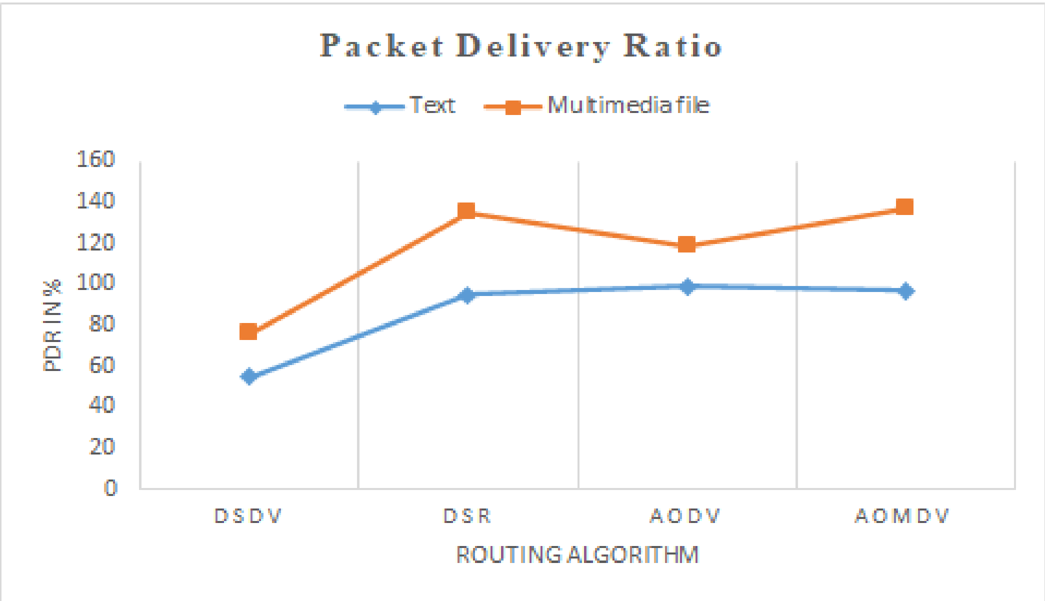

Figure 2: Comparison between routing protocol (Packet Delivery Ratio)

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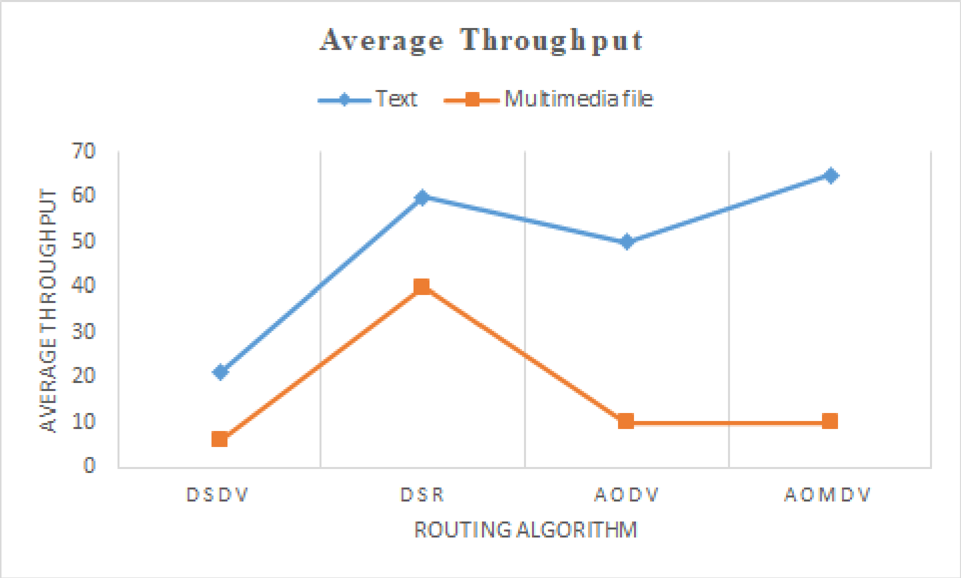

Figure 3: Comparison between routing protocol (Average Throughput)

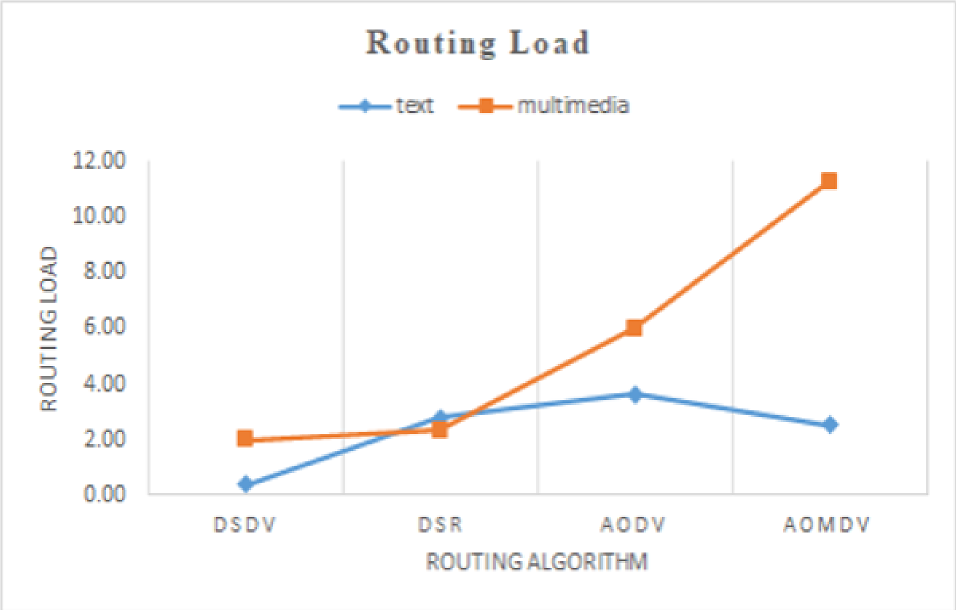

Figure 4: Comparison between routing protocol (Routing Load)

3.2 Performance Analysis of AOMDV as per packet size

In case of multimedia file transmission, throughput and end to end delay is affected in MANET and also overhead is increases. This analysis shows in figure 5 for text data transmission and figure 6 for multimedia transmission. AOMDV protocol defines the possible route from source to destination but that is not always optimal. Optimal path finding is necessary to minimize the overhead and improve network performance. Optimization techniques are apply on routing protocol for enhance their features as shown in figure 7. The features of AOMDV protocol and swarm intelligence algorithm used together to provide optimal route for multimedia data transmission. Fitness value of route is calculated based on available route details and choose the best path amongst them.

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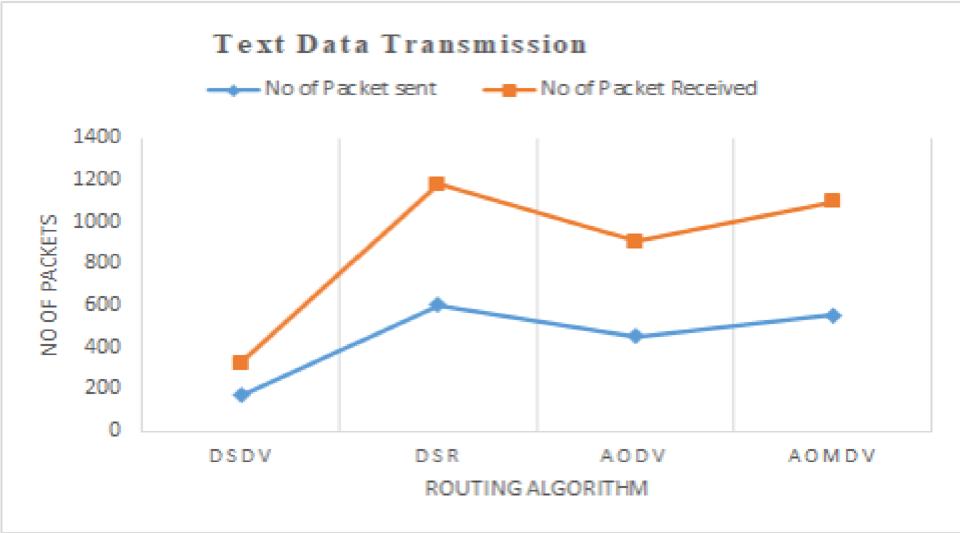

Figure 5: Performance of AOMDV with multimedia file transmission

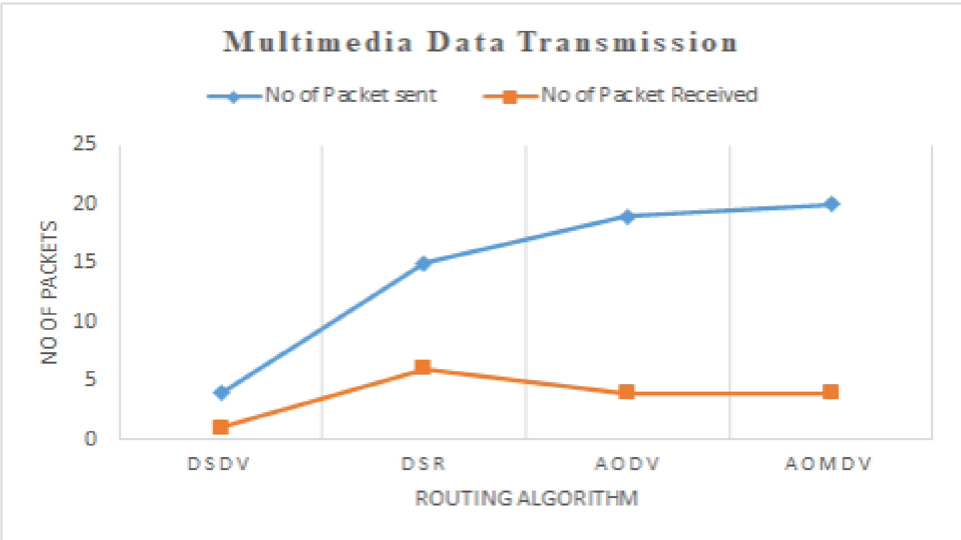

Figure 6: Performance of AOMDV with multimedia file transmission

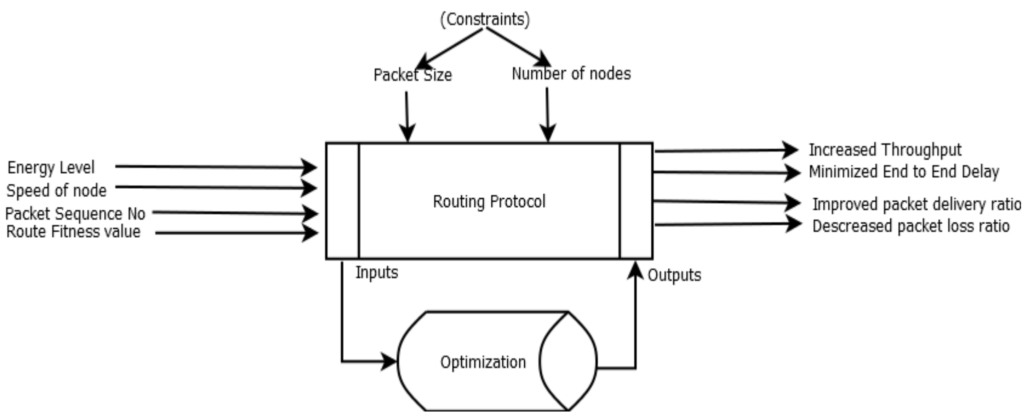

Figure 7: Optimization on Routing Protocol for QoS Enhancement

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3.3 The detection of link failure using ACO

As per result analysis in section 5, performance of AOMDV is affected when number of nodes and packet size are increased. To overcome this issue, ACO algorithm is used to solve combinatorial optimization problems in MANET. According to literature analysis of swarm intelligence algorithm, ACO was effectively apply on MANET for minimize QoS related challenges. ACO is stochastic and population based optimization technique. In case of link failure, proposed ACO-AOMDV algorithm is used to perform quick rediscovery with optimal solution. Routing tables at every node is collected additional information about the next nodes, which can be updated by receiving RREP packets.

ACO-AOMD increases throughput, minimizes end to end delay and routing overhead. In ACO-AOMDV, RRREQ packets are minimized so corresponding overhead is decreased. ACO-AOMDV algorithm detects the link failure and search a new route without affecting network performance. Working procedure of ACO-AOMDV are as follows: Route Finding Ant (RFA) deposit pheromone on path using following equation (1) and other ant follow that path to find the route:

$$Ph_{i\,j} = Ph_{i\,j} + \Delta Ph_{i\,j} \quad (1)$$

Where Phi j is pheromone value from node i to node j and ΔPhi j is the function used to determine total pheromone value. An evaporation rate of every pheromone has, define with following equation (2):

$$Ph_{i\,j} = (1 - \rho) * Ph_{i\,j} \quad (2)$$

Where ρ is the evaporation rate. $\Delta Ph_{i\,j}$ is evaluated based on, nodes energy level, the distance between nodes, and speed of nodes and active time between nodes. Speed of nodes is calculated as equation (3):

$$Vi\,j = \Delta Di\,j/T \quad (3)$$

+Vi,j means nodes are moving away from each other

-Vi,j means nodes closer to each other Where Vi,j velocity between node i and j , D distance between node i and j, and T is computing time difference between two nodes i and j. To calculate active time (Ai,j) between node i and j following equation (4) is used :

$$A_{i\,j} = (C - D_{i\,j}|V_{i\,j}|,\ V_{i\,,\,j} > 02 * D_{i\,j}|V_{i\,j}| + C - D_{i\,j}|V_{i\,j}|,\ V_{i\,j} < 0 \quad (4)$$

Where C is coverage mobile node range, Calculate cumulative pheromone value by using following equation (5)

$$\Delta Ph_{i\,j} = A_{i\,j} * E \quad (5)$$

Where E is the energy of the node. Ant node stores the minimum pheromone value between all visited nodes in the path because this value represents the lifetime of that path. When source node receives pheromone value, it calculate the intensity of pheromone in the path using following equation (6):

$$I = Ph_{min} * N * T \quad (6)$$

Where Ph_{min} is the minimum pheromone value of visited node, N is the number of nodes in between route and T is node travelling time from the source to destination node. Intensity of pheromone value of route will be consider when link failure occurs in network. So alternative route quickly available without broadcasting route initialization request.

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With this phenomenon route rediscovery will be faster and network performance is maintained such as through put and PDR is increases. ACO is stochastic in nature so results found in exploration and exploitation manner. Optimal results are based on pheromone value and evaporation rate. If evaporation rate is high then optimal solutions will required more iteration to solve the problem. Due to this overhead is increased when multimedia file transmitted.

4.0 ROUTE MAINTENANCE USING GWO

Optimal path is achieved by using ACO-AOMDV protocol but performance get affected when evaporation rate of pheromone value is decreases then path finding scheme reaches to local maxima. To minimize this possibility GWO use to maintain route with best score of alpha node. Proposed work is based on optimal results from ACO algorithm are consider to achieve the objective of quickly rebuild the route.

The GWO algorithm is based on the natural hierarchy and social interactions of grey wolves. In a pack of wolves, there are many categories of members depending on the amount of dominance, such as α, β, γ, δ. The most dominant wolf is α, and the dominance and leadership power of the wolves decreases from α to δ. The GWO ignore the omega nodes and so number of hops count is decreases from source to destination. To resolve routing problem in MANET GWO scheme is useful.

The GWO algorithm represents hierarchy of leadership and a gray wolf hunting mechanism. To simulate the leadership hierarchy in GWO alpha, beta, delta and omega wolves are used. Also there are three steps to optimize hunting such as search for prey, encircle prey and attacking prey. In MANET if hop count is minimize then overhead is maintained because traffic generation will be less as compare to other optimization techniques.

GWO-ACO based proposed system to provide route maintenance and fast route discovery while packet size and number of nodes are varies. Steps to maintain the route in MANET by using optimized route from ACO algorithm and of proposed system is mentioned below:

Step 1: Initialize the population of GWO such as X_i (i = 1, 2 . . . n) GWO coefficient parameters are A and C which are calculated as follows:

$$A = 2a*r_1 - a$$

$$C = 2r2$$

$$a = 2(1-I/T)$$

Where r1and r2 are random vectors with values [0,1], a= decreasing coefficient from 2 to 0, A is [-2,2], and C is [0,2]. Grey wolf changes the positions according to prey position so A and C used to represent this dynamic behavior of all wolf node.

Step 2: Optimal route values from ACO-AOMDV algorithm are consider to find available optimal value based on source nodes are moving towards destination nodes. Distance between source and destination node is D that define in equation (11) and future position of mobile node based on current perception is define in equation (2).

$$D = |C.X_p(I) - X_i(I)| \quad (7)$$

$$X_i(I - 1) = X_p(I) - A * D \quad (8)$$

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Where, I is number of iterations, X_p is a current position vector of destination node, X is current position vector of every node in network. step 2: Calculate the individual fitness value using hop count and higher sequence number of node in the population as X_α, X_β, X_γ .Equations (1.9) (1.10) (1.11) shows distance from α β and γ node.

$$D_\alpha = [C_1 * X_\alpha (I) – X (I)] \quad (9)$$

$$D_\beta = [C_1 * X_\beta (I) – X (I) \quad (10)$$

$$D_\gamma = [C_1 * X_\gamma (I) – X (I)] \quad (11)$$

Step3: Evaluate best solution from every node X αi , Xβj , $X\gamma_k$. Position vector for node α β and γ are shows in equation (4.12) (4.13) (4.14).

$$X_1 = [X_\alpha - A_1 * D_\alpha] \quad (12)$$

$$X_1 = [X_\beta - A_1 * D_\beta] \quad (13)$$

$$X1 = [X_\gamma - A_1 * D_\gamma] \quad (14)$$

Step 4: Calculate fitness score of route X (I−1) using equation (15).

$$X_{(I-1)} = (X_1 + X_2 + X_3)/3 \quad (15)$$

Step 5: Update fitness value of node X1, X2 in routing table. X3 value is not consider for establish a path. Which is only consider for path finding purpose.

Step 6: Evaluated value of Xα consider as optimal value. Performance of ACO-GWO based AOMDV protocol is relatively gives good performance for multimedia file transmission. Routing overhead is decreased while packet size is varies. Also throughput and end-to-end delay parameters are improved. Performance analysis shown in section 1.5.

5.0 RESULT ANALYSIS

Performance of AOMDV protocol with respect to packet size and number of node is varies network. Also throughput and end to end delay is affected in case of multimedia file transmission in MANET. In multimedia data transmission, data packet carries image, audio, video file, etc. These packets are divided into multiple packet and increase overhead in network.

Dolphin optimization algorithm apply on AOMDV to improve throughput and packet delivery ratio and also minimize end to end delay and routing load while video and audio file transmitted through network. As per result analysis, routing load is increased when multimedia file transmitted. ACOGWO algorithm provides global convergence of network. ACO algorithm also gives global maxima convergence in results but evaporation rate of pheromone values varies then performance down to local minima.

So, GWO algorithm combine together with ACO to maintain route and find optimal solutions. Quick route rediscovery done by GWO algorithm so performance of network is improved with concern of minimum end-to-end delay, maximized throughput and PDR. Table 2 presents a performance measurement of AOMDV, dolphin AOMDV, ACO-AOMDV and proposed system (ACO-GWO AOMDV).

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Table 2: QoS Parameter of AOMDV, ACO-AOMDV, Proposed System (ACO-GWO-AOMDV

Algorithm	file type	Packet De-livery Ratio	Throughput (kb/s)	End-to-end delay(ms)	Routing Load
AOMDV	Text	92.16	37.29	7.90	47
	Image file	91.75	37.37	8.28	44
	Audio file	78.86	28.53	7.9	68
	Video File	10.6	30.85	7.76	52
ACO-AOMDV	Text	95.25	48.99	5.88	42
	Image file	94.83	47.95	6.31	40
	Audio file	81.38	30.53	6.8	54
	Video File	39.29	30.31	5.1	41
Proposed System (ACO-GWO-AOMDV)	Text	98.32	54.45	4.67	20
	Image file	96.41	51.89	5.39	17
	Audio file	85.15	33.13	4.97	38
	Video File	50.00	34.56	5.1	35

Figure 8 shows comparative improvement in packet delivery ratio of ACO-AOMDV and proposed system (ACO-GWO-AOMDV) while transmitting text and multimedia files. PDR is steady in case of small packet transmission but in case of multimedia file it has been shows major variations. When number of nodes are increases ACO-GWO-AOMDV algorithm gives improvised results as compare to ACO-AOMDV because link failure and path maintenance is happened simultaneously.

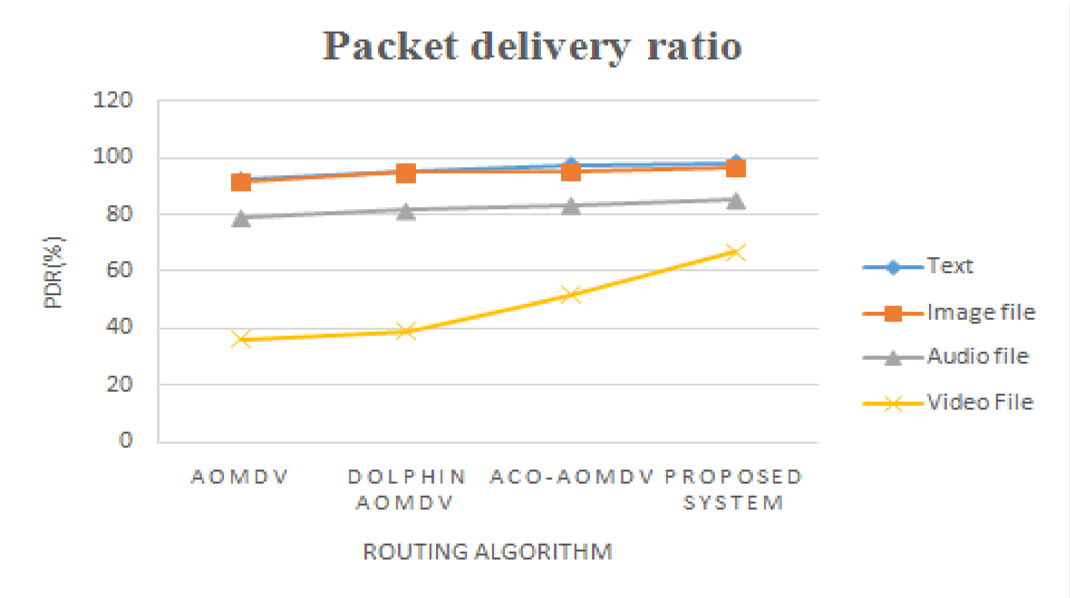

Figure 8: PDR of Optimized AOMDV Protocol

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Figure 9 illustrates the throughput performance of AOMDV, ACO-AOMDV and proposed system (ACO-GWO-AOMDV). For multimedia services and applications are required a minimum rate of throughput. When packet size is increases throughput is affected. With optimization techniques with AOMDV algorithm gives improved performance.

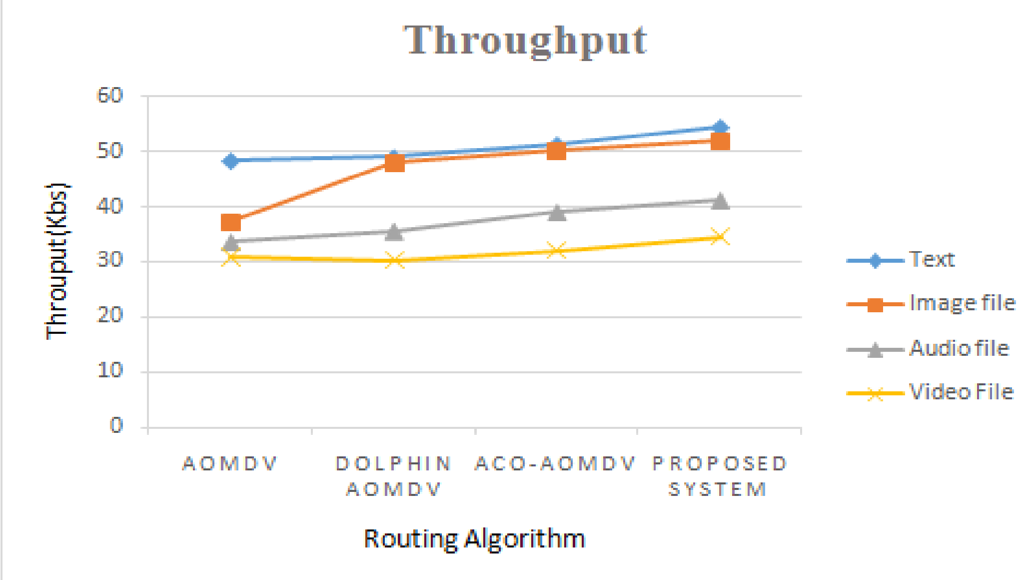

Figure 9: Throughput of Optimized AOMDV Protocol

Figure 10 presents end-to-end delay in case of AOMDV, ACO-AOMDV and proposed system (ACO-GWO-AOMDV).Conventional AOMDV protocol shows maximum delay while video files are transmitted and proposed system illustrates the minimum end-to-end delay. Also ACO-AOMDV has increased overhead while transmitting controlled packets so delay is also increases.

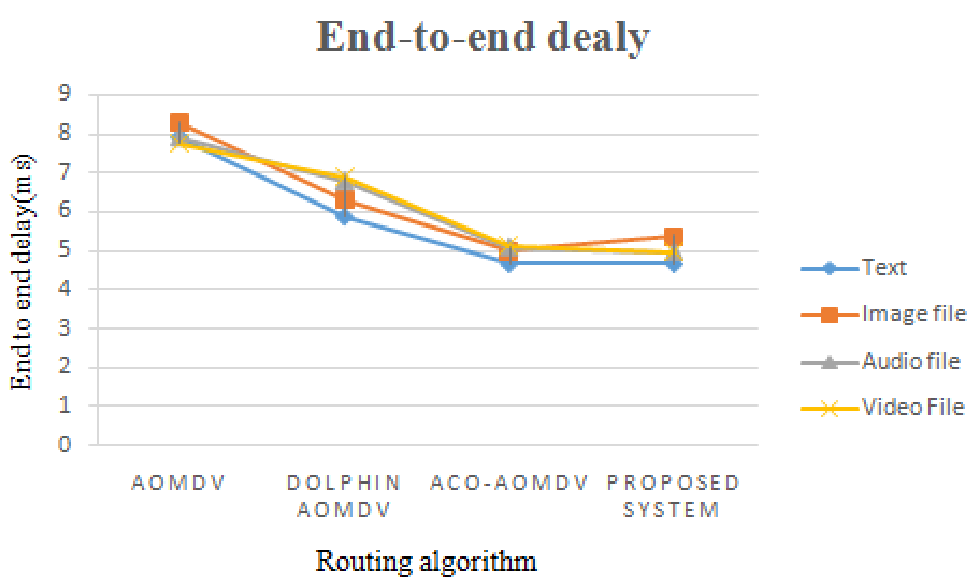

Figure 10: End-To-End Delay of Optimized AOMDV Protocol

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Figure 11 presents routing load performance of AOMDV, ACO-AOMDV and proposed system (ACO-GWO-AOM).ACO AOMDV provides relatively minimum routing load but when number of nodes and packet size are varies overhead is affect the network performance. This issue effectively handle by ACO-GWO algorithm and balance the routing load. Based on the above QoS parameter such as throughput, routing load, end-to -end delay and packet delivery ratio are improved as compare with conventional AOMDV protocol. Proposed system (ACO-GWO-AOMDV) provides improved performance with concerning of QoS parameter.

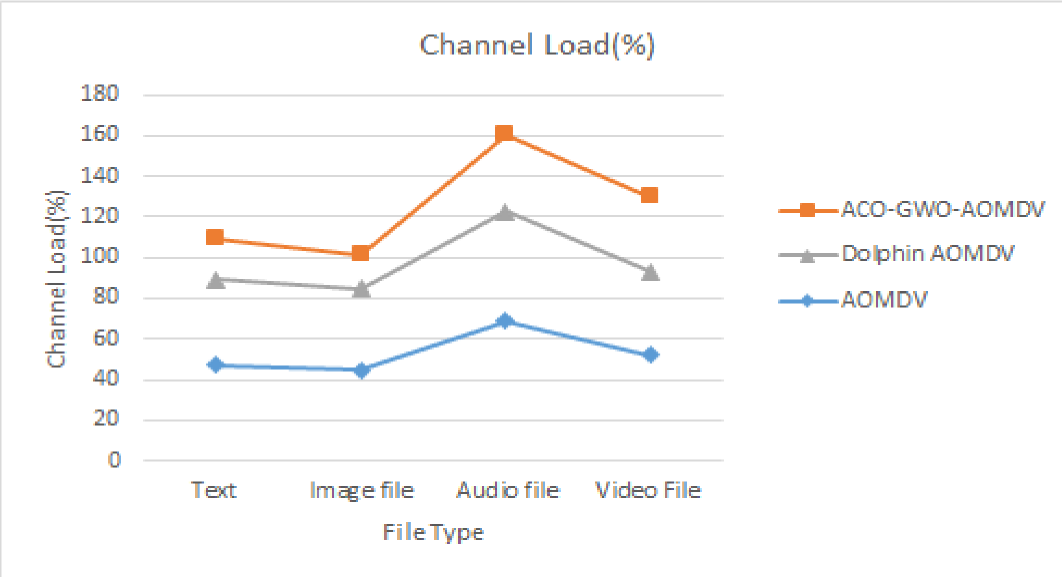

Figure 11: Routing Load of Optimized AOMDV Protocol

6.0 CONCLUSION

Secure QoS based multimedia data transmission protocol is design to analyses network performance in presence of malicious node. To provide global convergence in network swarm intelligence based GWO algorithm is used. During video files transmission Op-PKSEA algorithm shows increased through put up to 30%, packet delivery ratio up to 15% and minimize the channel load to 18% and end to end delay is minimize up to 20ms. Op-PKSEA algorithm concerning the parameters as mobility, number of nodes and packet size. The Op-PKSEA algorithm protocol maintain loop-free routing, mini mum control overhead, QoS provisioning for minimum latency, end-to-end delay, maximize packet delivery ratio and throughput.

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