International Journal of Early Childhood Special Education (INT-JECSE)
DOI:10.9756/INTJECSE/V14I5.103 ISSN: 1308-5581 Vol 14, Issue 05 2022

A COMPREHENSIVE ANALYSIS ON MANET SECURITY ROUTING METHODS AND ITS CHALLENGES

R.Surya Prabha,

Research Scholar, Department of Computer Science, Sri Krishna Arts & Science College, Coimbatore – 641008

Dr.S.Saraswathi

Associate Professor, Department of Computer Applications, Sri Krishna Arts & Science College, Coimbatore – 641008

Abstract

Today, it is crucial to maintain a high degree of security to enable the secure and reliable exchange of information between businesses. However, safe data exchange via the Internet or any other network is always vulnerable to intrusions, assaults, and viruses. As mobile technology and mobile devices continue to evolve, mobile computing has become an integral part of our everyday lives. In this study, we examined many articles pertaining to routing, multi-path, load-balancing, and comparative analysis. The desire to be connected whenever, wherever, and however has led to the rise of wireless networks, creating a new area of study in determined and everywhere computing, which demands a highly secure and robust routing protocol to successfully handle peer-to-peer communication. For this reason, we employ a safe and stable routing protocol for ad-hoc routing in order to offer stable routing to the network and prevent unwanted intruders from disrupting the network.

Keywords: MANET, Routing, Security, Analysis, Energy Efficiency

INTRODUCTION

The MANET includes various characteristics such as self-creation, multi hop routing, self-organization, light weight terminals, distributed operations, autonomous terminal and self-administration [1]. In spite of these characteristics, the MANET needs to handle other issues while routing the information from source to destination because the presence of an unhealthy route leads to several problems such as node failure, link failure, packet failure, changes in topology, misleading nodes, selfish nodes, transmission error and congestion [3].

Route identification between source and destination node is one of the major challenges in Mobile Ad-hoc Networks. Hence, several methods have been developed in MANET for creating effective and optimized routes for overcoming the above difficulties. The proposed concept aims to investigate the various routing protocols and information broadcasting scheme for eliminating the intermediate attack and avoiding the maximum energy consumption also maintain the network life time and security [5-16].

- To eliminate the malicious node, present in the Adhoc network infrastructure and eliminate node failure, link failure and fake routes.
- To avoid energy consumption to increase the network lifetime
- To Eliminate the unauthorized access and to improve the network security.

The most important metrics in the world of MANETs and their typical applications are throughput, packet delivery ration the Memory-latency tradeoffs in all MANET protocols.

Proactive protocols, those that track the routing table and distribute it proactively across the network, require system nodes with enough memory to store the table. The table's distribution also adds to overall network overhead. Both of the previous issues become unfeasible as the mesh size grows, limiting scalability [23][27].

Reactive protocols don't use a routing table and instead find a route for each packet on the fly. They have higher latency than proactive protocols because packets take longer to find an on-demand route through the network to the destination node. The absence of a routing table solves the memory problem but introduces latency [56].

2. BACKGROUND STUDY

The Mobile Adhoc Network is a complex, self-organized, self-managed multihop wireless network. MANET is decentralized through a set of mobile nodes. The main challenge in MANET is the constantly evolving existence of the random node movement. Routing is the method of transferring information from source to destination through the network. Due to the versatility of nodes, energy and money, MANET routing is the largest difficulty in this network. This chapter discusses routing protocols and swarms intelligence algorithms to resolve these problems to find the complexities of shortest routing and enhance network efficiency.

2.1 MULTILAYER MULTIPATH ROUTING IN MANET

Mamata Rath et al. (2016) The Energy Efficient MANET Protocol Utilizing Cross-Layer Architecture has been suggested. A power-efficient network layer routing protocol in the network is built and simulated utilizing a modern cross-layer architecture technique to enhance stability and network existence. They concentrated on maximizing power and delay calculation connection expense to minimize the serious problem of restoring critical network services. They did not recognize overhead routing.

Vithya & Vinayagasundaram (2016) Have suggested the requisite engineering work to evaluate a path prediction based on node behaviour, which is applied by specifying the residual node capacity, the packet transmission rate of the node and the performance rate of the node for optimal path differentiation. The routing protocol's suggested job problems are the energy-efficient multipath, congestion identification, and load balancing high bandwidth demands.

2.2 MULTIPATH ROUTING IN MANET

Shilpa M. Chauhan et al. (2016) Updated OLSR has been proposed to save several shortest direct routes in the routing table. Whenever this relation breaks, it relates to the routing table without running the algorithm for path discovery. There is also less overhead and less capacity in the network.

Soundararajan & Bhuvaneswaran (2012) To achieve load balance and prevent MANET congestion, congestion regulated adaptive multipath routing protocol was suggested. This algorithm for finding multipath estimates multiple fail-safe paths which provide multiple routes to all intermediate nodes in the primary path. The several dangerous ways involve the nodes with the lowest charge and battery power and residual electricity. If the mean load of a node along the route goes above a threshold, it distributes traffic through disjointed multipath routes to minimize the load on a congested connection.

Natarajan, E & Devi, L (2014) The Cross-Layer Energy-Aware Routing and Congestion Management Algorithm in MANET was suggested. It minimizes data

transmissions and damages by accurately analyzing and responding to different low layer incidents. Which aims to preserve contact with the lowest risk of disruption and prolongs network existence due to the lowest potential energy usage for a given communication? Any of the current congestion management strategies cannot differentiate between packet loss due to failure of the connection and packet loss due to congestion.

2.3 LOAD BALANCING IN MANET

Sujata V et al.(2016) proposed an optimal routing strategy for congestion management called multipath load balancing technique (MLBCC). In MANET, the load is shared between many routes by reducing congestion. It is done with an arrival rate and a departure rate at a given period T during data transmission. The gateway node is chosen to spread the load effectively utilizing the connection and path cost.

Sushil Chandra Dimri et al. (2013) Have suggested a queuing delay-based traffic distribution scheme for each route and introduced a k- routing path that enables sending the data in a MANET of a given source Node. This traffic distribution approach will improve the network infrastructure's efficiency, balance loads and minimize system delays. The findings demonstrate that the traffic strategy division is more efficient than the shortest route in terms of load balancing, network efficiency and a reduced latency across the whole network.

Mahdi Abdulkader Salem et al. (2016) Proposed an optimized MANET load balancing protocol architecture that increases the load balancing solution's QoS efficiency and improves the network existence.

Mala C et al. (2012) The genetic algorithm software is used in this work to find out the most powerful multicast routing that satisfies service quality expectations such as total latency, total noise at the delay, packet failure and total metrics.

KiranRao, P & Vasundra, S (2012) proposed MANET's conscious channel routing with a safe hash algorithm application. Channel-conscious routing has been directed to increase the AODV protocol. The AODV protocol may be table-driven, and each routing table includes entries such as the target science address, sequences, hop variety, and expiry times for the entries. AODV needs to create a loop-free with several ties between a source and a destination. A stable hash algorithm software was used to ensure integrity.

Raghavendran et al. (2013) bestowed intelligent routing methods with swarm intelligence usage by mobile ad-hoc networks. Swarm Intelligence was a whole new plan focused on the direct experiences and attitudes the character discovered. Animals such as sharks, ants, and bees are hunting for socially intelligent foods. This nature galvanized various investigators, and the swarm intelligence structure was implemented into many wireless network routing algorithms. Routing was a means to find, pick and preserve ways from a supply node to a goal node. The intention was to find an optimal way by increasing efficiency and reducing the price.

Dilpreet Kaur & Mundra (2012) suggested that Ant Colony Optimization (ACO) solve the SP routing dilemma. Observations demonstrate that ants can find the shortest route between their nest and food sources. But the ideal solution is not always located.

2.2 ENERGY-EFFICIENT ROUTING IN MANET

In MANET, a protocol plays a key role in the routing process, including all nodes and synchronising any node. Due to specific factors such as complex topology, limited bandwidth, high usability and low strength, the mobile ad hoc network faces many challenges in routing and security. In certain situations, energy-efficient protocols, where there are no base stations and infrastructure, are necessary for routing. The routing protocol's role is to move the data to the destination and have a cost-effective path. Besides, the protocol must control node operation such that no disruption happens at any node stages.

Manish Bhardwaj (2015) Implemented a procedure to resolve the challenge of reducing energy supply for energy-efficient routing. The first approach was the wireless charging of the network and the provision of energy-friendly routing protocols to strengthen the networks. They often seek to minimize the overheads, efficiency and speed of convergence.

Muralidhar et al. (2013) Proposed Energy Effective Zone Protocol Disjoint Shortest Multipath Routing (EEZDSM). The shortest multipath between the nodes is set in an energy-efficient way. This energy efficiency form helps boost network existence, minimize congestion, communications reliability, and packet distribution ratio. This device often ensures protection by delivering a message successfully on several roads. The construction of energy effective areas tends to improve network life, congestion management and stability. It also aims to reduce packet loss by congestion reduction. Many routes for message transmission are used to secure message transmission. In comparison, the fastest multipath between nodes allows recovering data when nodes fail easily.

Reena Singh et al. (2014) Overview the significance and limitations of MANET's energy constraints when establishing the climate. The main purpose of this work is to include an improved energy-efficient AODV routing algorithm. The device gives an optimal path between the destinations as well. It also finds the ideal alternative route by considering the source nodes' lower power to lead data. The root nodes optimize the alternative node only.

Pandey & Mahapatra (2015) Proposed a handheld wireless sensor network energy-efficient routing protocol. In this work, the writers speak about the mobile and static network routing system and energy conservation. The paper offers an idea to recluse without utilizing more resources by approaching mobile network connection nodes. It improves network life by offering various time slots for nodes in different clusters. The redundancy of the sink and the cluster head is not diminished.

Zhang et al. (2013) Discuss the probabilistic solution in MANET to reduce overhead routing. It suggested a routing strategy focusing on retransmission delays to define the retransmission order and locate any adjacent nodes needing the connection between the accessible clusters. This system allows nodes for the coverage information of the other coverage ratio and connection element of the neighbour. The ratio of packet transmission highly demonstrates this device's efficiency and the latency between the nodes decreased due to less redundant transmitted.

Al-Maqbali et al. (2014) Proposed a MANET grid-based hybrid routing solution by creating routing node routes. The hybrid method uses reactive and constructive methods for finding the shortest path of trees between the source and goal nodes. And the reliability of road building is often ensured between the nodes to provide an alternative route.

Jamali et al. (2013) Projected MANET energy effective particle swarm optimization strategy. The weighted component is used in this work to track the path duration and the route energy level. This idea functions best by growing the lifespan of the throughput and node.

Sara & Rachida (2015) Provides an inter-domain energy-efficient routing protocol for wireless networks. In these works, MANET gateways establish routing structures focused on clustering technology and interdomain routing. The gates connecting to the numerous MANET groups must know about other gates to restore when the ties are broken. The overhead is lowered, and the usage of mobile migration principles improves routing power.

Gopinath & Nagarajan (2015) Searches MANET for an energy-based efficient packet forwarding multicast routing protocol. The suggested protocol is based on a threshold value to ensure efficient multicast routing to increase its reliability and connectivity. The network model is constructed by taking into consideration the distribution rate criterion. An efficient multicast backbone is designed to maximize the stability of multicast routes. Data packets are transmitted successfully through the secure route selected under the reliability criterion. The easiest option is to choose large residual energy.

Rajeshkanna, R et al. (2013) suggested a method demonstrating the value of routing protocol energy efficiency. The writers spoke about the AODV protocol and the framework for energy conservation in routing protocols. The protocol results in a controlled use of resources to maximize the life of nodes in AODV. In this proposed AODV extensions, the networking survival of the nodes has also improved. This study also demonstrates that combining two or more protocols provides greater efficiency than a single mechanism. It is suitable for the MANET setting. Choosing a protocol is often a crucial element that differs across networks and their properties. They also addressed the node's energy factor, which would not raise energy usage regardless of the nodes' strong mobility. Energy use is often viewed as one of the key issues for infrastructure-free networks of this nature.

2.4 BLACKHOLE MITIGATION ROUTING IN MANET

Siddiqua et al. (2015) Suggested a packet loss algorithm to detect and avoid by creating a discovery of information to classify black hole nodes. This work strengthens the current AODV routing protocol to protect the link between nodes while avoiding black hole attacks.

Pooja et al. (2015) The emergence of Blackhole Network Efficiency Attacks was detected. This paper introduces a modern technique named the Hint-based Probabilistic routing protocol. It is used to track black hole attacks by considering local utility functions. This paper analyzes network behaviour using a three-movement model and chooses the preferred simulation parameters.

EiKhin et al. (2014) Security risks against black hole attacks are studied, which drop all obtained data packets planned for transmission. A simulation-based performance review and an analysis of the black hole assault effect on AODV protocol were investigated.

Mahamuni et al. (2013) Proposed DSR-based routing with a black hole attack detection update. It is split into two phases: pre-path identification and protection of malicious nodes in data transmission. The proposed scheme's core advantage is its flexibility and reliability in complex situations for identifying malicious nodes. This maliciousness knowledge is processed in the nodes.

Mangesh Ghonge et al. (2012) The problems of black hole intrusion in ad hoc networks were studied. In a black hole attack, the malicious node attempts to say that it is the target node by submitting a bogus route response to the source node that initiated the inquiry. The malicious node will redirect packets and generate network traffic. Simulation findings demonstrate the consequences of the AODV protocol blackhole invasion.

2.5 SECURITY BASED PROTOCOLS IN MANETS

Chen et al. (2011) Proposed an appropriate key management protocol to synchronize admission control of MANET connection nodes. This approach provides a distributed authentication method with fast responses, reducing responsiveness and achieving high success. The MANET nodes' energy performance is considered, so the licensing service does not degrade the nodes' energy level. It also decreases unwanted user access and improves cluster protection.

Wang et al. (2011) Create a trusted MANET route by considering the coordination between reliability and the road duration. This paper gives an example of discovering the similarities of the attributes between friendly nodes and global nodes. The drop-down function is implemented by utilizing the similarity method of the attributes. In this way, the net willingly loses the unwanted packet. The black hole and evolving behavioural attacks are often quickly identified, and the transmitting range is expanded.

Salunkhe & Patil (2016) Presented MANET with an effective pause among the nodes anonymous, safe routing. This paper aims to ensure connectivity between nodes and boost packet delays by implementing a delay-efficient anonymous, safe routing.

Drira et al. (2010) Proposed the MANET Main Management System for an energy-efficient community. This methodology would not take into consideration the unified community key generation management method. But for each cluster, the cluster heads are created, and their topology is established. Malicious nodes are found by approved users using their community key in a multicast session.

Cho et al. (2012) Model a research approach for handling the trust protocol by optimising the trust chain in mobile ad-hoc networks. By connecting the confidence nodes, this model identifies the optimum duration between peers. Trade-off principles employed in this model minimize the nodes' energy level. The trust value estimation of the protocol is better than other works, but intrusion prevention and key management are not regarded.

The author (Jose Luis Padilla, et al. 2014) studies MANET output channel propagation characteristics. The optimum propagation restrictions were then overwhelmed by the inclusion of a certain multiterminal antenna arrangement that can be reconfigured using an optimisation technique. The optimum radiation architecture for each node of the network was selected using the optimization technique. Each node's required radiation

configuration increases MANET's transmitting/reception capability, depending on the channel characteristics' propagation.

(Mukesh Bathre and Alok Sahelay, 2013) Proposed for MANET an energy-optimized procedure. The energy-limited node was kept away from the packet transmission. This protocol uses a threshold value for each node, and on the chosen path, a fixed data transmission period has been processed. The threshold value is used here to assess if the node should be used to send the fixed packet duration.

(Ramanna Havinal et al. 2016) Proposed a routing system focused on the sophisticated energy-efficient MANET graph theory. This model addressed an actor, i.e. the field of data transfer availability. This structure clarifies the network model and contributes to an optimal energy efficiency routing strategy.

(Krittika Khator & Nitin Manjhi, 2015) The proposed MANET protocol for efficient and complex routing depended on energy and signal power. A predefined threshold for energy and signal intensity has been maintained. Centred on the threshold stage, nodes for packet forwarding have been selected.

(Shahram Jamali et al. 2013) Proposed an algorithm for rendering energy sensitivity in the current TORA protocol, namely Binary Particle Swarm Optimisation. The algorithm here finds the path duration and the route's energy level to be a concern for optimisation. The BPSO selects the route that maximizes the routing energy and route duration objective function.

2.3 SURVEY ON VARIOUS ROUTING TECHNIQUES FOR ENERGY OPTIMIZATION OF HIERARCHICAL MANET.

(Srinivas Kanakala et al. 2014) The goal is to reduce energy usage in routing protocols. To this impact, the author has incorporated the cluster-based routing protocol into the integrated network coding technologies and named the solution Energy-Efficient Cluster-based Routing Protocol (ECCRP). Network coding aims to improve the wireless network's efficiency and minimize the redundant transmission arising from broadcasting. Secondly, to utilize the cluster strategy, the total broadcast overhead is reduced. The ECCRP strategy initially divided the network nodes into clusters and picked a cluster node with maximum energy as a cluster head. The network coding was then used to minimize the overhead problem at the cluster heads. When adding the coding on the cluster heads, the protocol's simple queue configuration has been changed to minimize the transmission volume, thus reducing energy usage.

A clustering scheme focused on position knowledge (Anubhuti Roda Mohindra, Charu Kumar, 2013) was suggested to preserve finite energy sources and boost the scalability of clusters with the control of the signal location and power levels. A role management service has been introduced to provide reliable and swift routing and recovery during link failures. Depending on the proximity of the cluster head, nodes join the cluster that minimizes energy usage. This protocol preserves all inter and intracluster details and a path activation mechanism for consistency in the chart.

For MANET's energy optimization, the author (Abbas Karimi et al. 2014) suggested a Synthetic Ties Weight Clustering Algorithm (VLWBC). VLWBC finds the weight of two nodes on each virtual edge. The final weight tends to pick the cluster heads and the cluster heads for the corresponding heads. The system finds the final weight for each

node, according to the characteristics of the neighbouring node. (Dana et al. 2008) suggested a modern cluster-based routing protocol to achieve optimum network efficiency for cross-country architecture. This Protocol allows the networking, MAC and physical layer relationship to be smoother by changing the network state and the link variance for the cluster-based routing protocol. Physical layer details, such as signal strength, form stable clusters on the routing layer.

(Hamid Ali et al. 2012) Proposed a multi-target approach with a PSO algorithm that would shape optimized numbers and productive energy usage of MANET clusters. The cluster heads regulated traffic distribution between Inter and Intracluster. This algorithm considers the node level, battery power usage and mobile nodal transmitting power. The biggest advantage of this strategy is that it offers a solution in a reasonable time.

(J. John, R. Pushpalakshmi, 2014) Proposed an approach to optimization of the Ant colony for maximizing cluster heads collection. This algorithm optimizes numerous steps, such as node existence, connectivity overhead and mobility. The likelihood function has been predefined for clusters for an optimal cluster layout. The likelihood function was calculated by taking into account variables such as the rate of energy drain, remaining energy and mobility factor. The total contact burden has been measured annually. If its importance reaches a threshold, the head of the cluster is allocated.

(Naveen Chauhan et al. 2011) Proposed MANET weighted distributed clustering algorithm. This approach finds the weight for each node, by considering the propagation radius, node degree, and capacity to pick the cluster head. You pick the minimum number of cluster heads to optimize the usage of resources.

Table 2.1 Classification of AODV based Routing Protocols

S. No.	Name of Algorithm	Citation	Benefits	Shortcomings
1.	AODV	Perkins et al 2003	dynamic and multihop routing	Stale entries in the routing table
2.	AODV-ABR	Lai et al. 2007	Adaptive back-up routes	
3.	Low-overhead dynamic route-repairing protocol	Yu et al. 2007a	Deals with link failures	
4.	LBAQ	Yu et al. 2007b	Selects link with max QoS	
5	MP-AODV	Chang-Woo et al. 2010	one main path and one back-up path to destination are found during route	The protocol does not handle the routing decisions with
6	NDM-AODV	Shunli & Liping 2010	all the disjoint node paths are found and stored in routing	accumulates the nodes; reduces the

7	AOMDV	Yu Hua et al 2005	instead of disjoint node paths, these protocols find the link disjoint paths to the destination	data transfer starts only after all the paths are discovered
8	AODVM	Ye et al. 2003		
9.	AODVM-PES	Fubao & Baolin 2011		
10.	NDMP-AODV	Lal et al. 2012	source node starts transmission soon after the first node-disjoint route to the destination is found, thereby reducing the initial delay in transmission. Other routes are identified in	

NDMP-AODV (Lal et al. 2012) Another alternate AODV solution. Shortly after the first node-disjoint path to the destination is located, the source node begins transmission, reducing the initial transmission delay. Other roads are known and used as back-up routes, parallel to data transmission. A description of the AODV-based routing protocol comparison is given in Table 2.1.

Several other algorithms which operate on the probability theory and statistics are both operational and performing more successfully. Preventive routine algorithms (Goff et al. 2003) consider the risk that the routes will collapse and willingly lapse, which otherwise are likely to fail. This algorithm, therefore, operates at a protective threshold that must be discarded. The fixation of the preventive threshold is thus a big challenge influencing the preventive routing algorithm's efficiency.

3. DISCUSSION

The above analysis promotes MANET routing to face particular difficulties in routing protocols such as choosing a high energy-efficient route for data packets to be exchanged between nodes. The network is prone to be inclined to odd network times.

The conventional routing protocols do not address ad-hoc agility problems with no central server. The traditional ways of meeting various containment problems in a rather MANET setting are neither acceptable nor relaxed. The literature survey has shown that each routing protocol operates under various constraints and routes toward minimal network performance. None of the protocols is ready to meet all complex routing objectives. There is still a need to establish an alternative complex routing protocol that meets MANET's tightened needs.

4. CONCLUSION

Mobile Ad Hoc Network (MANET) is a kind of Ad hoc network comprised of wireless, mobile nodes. Due to its unique properties such as open network boundaries, changeable topology, and hop-by-hop communications, MANET faces a number of obstacles. Due to the fact that all nodes engage in communications and nodes are free to join and leave the network, security has become the most pressing issue in MANET. This study presents a

complete assessment of MANET security problems. Three significant security factors are proposed based on MANET features and security needs. In addition, each of the two distinct components of security is explored briefly. In addition, defeating strategies and various assaults in MANET are examined and analysed, and the future path of research in each field is outlined. Based on our analysis and discussions, the most successful MANET security strategies include routing information and encryption defeating techniques. Depending on the application, one of these methods may be used.

FUTURE DIRECTIONS

There are many research directions to be focused when it comes under the implementation of the MANET security approaches.

- The Architecture of the MANET should be designed with the key management and its distributions in their schemes.
- It should adopt for the changes in the new technologies of security solutions with their routing challenges.
- Need to analyze the intrusion detection system of methods to put forth for the research.
- Low cost of security mechanisms have to designed.

5. REFERENCES

[1] Anubhuti Roda Mohindra, Charu Kumar, 2013, "A Stable Energy- Efficient Location Based Clustering Scheme for Ad Hoc Networks", Quality, Reliability, Security and Robustness in Heterogeneous Networks, Springer, vol. 115, pp. 75-85

[2] Abbas Karimi, Abbas Afsharfarnia, Faraneh Zarafshan, and S. A. R. Al-Haddad, 2014, "A Novel Clustering Algorithm for Mobile Ad Hoc Networks Based on Determination of Virtual Links‟ Weight to Increase Network Stability", Scientific World Journal, Hindawi, vol 2014, Article ID 432952.

[3] Al-Maqbali, H, Day, K, Ould-Khaoua, M, Touzene, A & Alzeidi, N, 2014, "A New Hybrid Grid-based Routing Approach for Manets', Procedia Technology, vol. 17, pp.81-89.

[4] Balasubramanian Paramasivan, Maria Johan Viju Prakash & Madasamy Kaliappan. 2015, 'Development of a secure routing protocol using game theory model in MANETs', Journal of Communications and Networks, vol. 17, pp. 75-83.

[5] Chen, Q., Fadlullah, Z.M., Lin, X. and Kato, N., 2011. A clique-based secure admission control scheme for mobile ad hoc networks (MANETs). Journal of Network and Computer Applications, vol.34, no. 6, pp.1827-1835.

[6] Cho, JH, Swami, A & Chen, R 2012,'Modeling and analysis of trust management with trust chain optimization in mobile ad hoc networks', Journal of Network and Computer Applications, vol. 35, no. 3, pp.1001-1012.

[7] Chang-Woo Ahn, Sang-Hwa Chung, Tae-Hun Kim & Su-Young Kang 2010, 'A node-disjoint multipath routing protocol based on aodv in mobile ad hoc networks', Seventh International Conference on Information Technology: New Generations (ITNG), pp.828–833.

[8] Drira, K, Seba, H & Kheddouci, H 2010,'ECGK: An efficient clustering scheme for group key management in MANETs', Computer Communications, vol. 33, no. 9, pp.1094-1107.

[9] Dilpreet Kaur & Mundra, PS 2012, 'Ant colony optimization: A technique used for finding shortest path', International Journal of Engineering and Innovative Technology (IJEIT), vol.1, no.5, pp. 122-124.
[10] Dana, A. Yadegari, M. Hajhosseini and T. Mirfakhraie, 2008, „A Robust Cross-Layer Design of Clustering-Based Routing Protocol for MANET", International Conference on Advanced Communication Technology, Gangwon-Do, IEEE, vol. 2, pp. 1055 – 1059,
[11] EiKhin & ThandarPhyu 2014, 'Mitigating Scheme for Black Hole Attack in AODV Routing Protocol', Proceedings of the International Conference on Advances in Engineering and Technology, vol. 1, pp. 29-30.
[12] Fubao Yang & Baolin Sun, 2011, 'Ad hoc on-demand distance vector multipath routing protocol with path selection entropy', International Conference on Consumer Electronics, Communications and Networks (CECNet), pp.4715–4718.
[13] Gopinath, S & Nagarajan, N 2015,'Energy based reliable multicast routing protocol for packet forwarding in MANET', Journal of applied research and technology, vol. 13, no. 3, pp.374-381.
[14] Goff, T, Abu-Ghazaleh, NB, Phatak, DS & Kahvecioglu, R 2003, 'Preemptive routing in ad hoc networks', Journal of Parallel Distributed Computing, vol.63, no.2, pp.123–140.
[15] Hietalahti, M 2008,'A clustering-based group key agreement protocol for ad-hoc networks', Electronic Notes in Theoretical Computer Science, vol. 192, no. 2, pp.43-53.
[16] Hamid Ali, Waseem Shahzad, Farrukh Aslam Khan, 2012, "Energy- efficient clustering in Mobile Ad-Hoc Networks using multi-objective particle swarm optimization", Applied Soft Computing, vol. 12, pp. 1913–1928
[17] Haas, Z. J., & Pearlman, M. R. (2001). *The performance of query control schemes for the zone routing protocol. IEEE/ACM Transactions on Networking, 9(4), 427–438.* doi:10.1109/90.944341
[18] Jamali, S, Rezaei, L &Gudakahriz, SJ 2013,'An energy-efficient routing protocol for MANETs: a particle swarm optimization approach', Journal of applied research and technology, vol. 11, no. 6, pp.803-812.
[19] John.J, Pushpalakshmi.R, 2014, "A reliable optimized clustering in MANET using Ant Colony algorithm", International Conference on Communications and Signal Processing (ICCSP), IEEE, Melmaruvathur, pp. 51-55
[20] Jose Luis Padilla, Pablo Padilla, Juan F. Valenzuela-Valdes, 2014, "Electronically Reconfigurable Antenna Terminals for Energy Efficient Routing and Propagation Path Optimization Applied to Mobile Ad Hoc Networks (MANET)", Wireless Personal Communications, vol. 79, no.1, pp. 509-525.
[21] Krittika Khator & Nitin Manjhi, 2015, "Optimize Signal Strength and Energy Efficient Mechanism for Link Failure in MANET", International Journal of Computer Networking, Wireless and Mobile Communications (IJCNWMC), vol. 5, no. 1, pp. 1-12
[22] KiranRao, P &Vasundra, S 2012, 'Channel aware routing in MANET's with secure hash algorithm', International Journal of Scientific and Research Publications.
[23] Lal, Chhagan, Laxmi, V & Gaur, MS 2012, 'A Node-Disjoint Multipath Routing Method Based on AODV Protocol for MANETs', 26th International Conference on Advanced Information Networking and Applications (AINA), IEEE, pp. 399-405.

[24] Lai, Wei Kuang, Sheng-Yu Hsiao & Yuh-Chung Lin 2007, 'Adaptive backup routing for ad-hoc networks', Computer Communications, vol.30, no.2 pp.453-464.
[25] Liu Wei & Yu Ming 2014, 'AASR: authenticated anonymous secure routing for MANETs in adversarial environments', IEEE transactions on vehicular technology, vol. 63, no.9, pp. 4585-4593.
[26] Mala, C, Anurag, A, Mahesh, Aravind, R, Rajgopal, R, Narendran Rajagopalan & Nithya, B 2012 , 'Simulated study of QoS multicast routing using genetic algorithm', National Institute of Technology, Tiruchirappalli, World Applied Programming, vol.2, no.5, pp. 342-348.
[27] Mahamuni & Chandrasekar 2013, 'Mitigate Black Hole Attack in Dynamic Source Routing (DSR) Protocol by Trapping, International Journal of Computer Science Issues, vol. 10, no. 2, pp. 49-54.
[28] Mamata Rath, Binod Kumar Pattanayak & Bibudhendu Pati RATH 2016, 'Energy Efficient MANET Protocol Using Cross Layer Design for Military Applications', publications. drdo.gov.in, vol. 66, no. 2 Mar 22, 2016 - 2, pp.146-150, DOI: 10.14429/dsj.66.9705.
[29] Mahdi Abdulkader Salem & Raghav Yadav (2016) , 'Efficient Load Balancing Routing Technique for Mobile Ad Hoc Networks'International Journal of Advanced Computer Science and Applications, vol. 7, no. 5, pp 249-254.
[30] Mukesh Bathre and Alok Sahelay, 2013, „Energy Efficient Route Discovery Algorithm for MANET", International Journal of Engineering Research & Technology (IJERT), vol. 2, no. 7, pp. 1291-1295
[31] Muhammad Imran, Khan, F A, Jamal, T & Durad, M H 2015, 'Analysis of Detection Features for Wormhole Attacks in MANETs, Procedia Computer Science, vol. 56, pp. 384–390.
[32] Mangesh Ghonge & Nimbhorkar, S.U 2012, 'Simulation of AODV under Blackhole Attack in MANET', International Journal of Advanced Research in Computer Science and Software Engineering, vol. 2, no.2.
[33] Manish Bhardwaj 2015, 'Enhance Life Time of Mobile Ad-hoc Network Using WiTriCity and Backpressure Technique', Proceedings of the International conference on Recent Trends in Computing, vol. 57, no. 1, pp. 1342-1350.
[34] Muralidhar & Geethanjali 2013, 'Energy Efficient Zone Disjoint Shortest Multipath Routing Protocol', Problems & Application In Engineering Research, vol. 4, no. 1, pp. 195-201.
[35] Natarajan, E & Devi, L 2014, 'Cross Layer Based Energy Aware Routing and Congestion Control Algorithm in MANET', International Journal of Computer Science and Mobile Computing, vol. 3, no. 10, pp. 700-709.
[36] Naveen Chauhan, L. K. Awasthi, Narottam Chand, Ankit Chugh, 2011, "A Distributed Weighted Cluster Based Routing Protocol for MANETs", Second International Conference on Advances in Communication, Network, and Computing, Bangalore, vol. 142, pp. 147-151.
[37] Oliveira, CA, Pardalos, PM &Resende, MG 2006, „Optimization problems in multicast tree construction", In Handbook of optimization in telecommunications, pp. 701-731, Springer US, pp. 701-731.

[38] Preeti Raturi & Navin Garg 2014, 'Energy Efficient Routing in Mobile Ad-Hoc Network Based on AODV Protocol', International Journal of Engineering Research and Technology, vol. 3, no. 3 pp. 2224-2227.

[39] Prasanna J Shete, Awale, R N & Satish Y Ket 2017, 'Channel quality aware cross-layer design based rate adaptive MAC for improving the throughput capacity of multi-hop ad hoc networks', Ad Hoc Networks, vol. 63, pp. 45–61

[40] Perkins, C, Belding-Royer, E & Das, S 2003, 'Ad hoc on-demand distance vector (AODV) routing', IETF, RFC pp.3561.

[41] Pandey, S. & Mahapatra, R.P., 2015. A Centralized Comparison of Energy Efficient Routing Protocol for Mobile and Static Wireless Sensor Network. Procedia Computer Science, vol. 48, pp.467-471.

[42] Pooja & Chauhan, R.K 2015, 'An a ssessment based approach to detect black hole attack in MANET', Proceedings of the International Conference on Computing, Communication & Automation, vol. 1, pp. 552-557.

[43] Rajeshkanna, R, Poorana Senthilkumar, S & Kumuthini, C 2013 'Energy Efficient Routing Protocols in Mobile Ad hoc Network Based on Enhanced AODV Protocol', International Journal of Computer Science and Mobile Computing, vol. 2, no. 7, pp. 391-395.

[44] Ramanna Havinal, Girish V. Attimarad, M. N. Giri Prasad, 2016, "MECOR: Minimal Energy Consumption with Optimized Routing in MANET", Wireless Personal Communications, pp. 1-21

[45] Raghavendran, CHV, Naga Satish, G & Suresh Varma, P 2013, 'Intelligent routing techniques for mobile ad hoc networks using swarm intelligence', International Journal of Intelligent Systems and Applications.

[46] Reena Singh & Shilpa Gupta 2014, 'EE-AODV: Energy Efficient AODV Routing Protocol by Optimizing Route Selection Process', International Journal of Research in Computer and Communication Technology, vol. 3, no. 1, pp. 158-163.

[47] Sara, Z & Rachida, M 2015,'Energy-Efficient Inter-Domain Routing Protocol for MANETs', Procedia Computer Science, vol. 52, pp.1059-1064.

[48] Salunkhe, SP & Patil, HD 2016,'Delay Efficient Authenticated Anonymous Secure Routing for MANETs', International Journal of Computer Applications, vol. 148, no. 4.

[49] Shahram Jamali, Leila Rezaei, Sajjad Jahanbakhsh Gudakahriz, 2013, "An Energy-efficient Routing Protocol for MANETs: a Particle Swarm Optimization Approach", Journal of Applied Research and Technology, vol. 11, pp.803-812

[50] Srinivas Kanakala, Venugopal Reddy Ananthula, and Prashanthi Vempaty, 2014, "Energy-Efficient Cluster Based Routing Protocol in Mobile Ad Hoc Networks Using Network Coding", Journal of Computer Networks and Communications, Hindawi, vol. 2014, Article ID. 351020

[51] Soumyabrata Saha, Rituparna Chaki, 2011, "Cluster Based Mobility Considered Routing Protocol for Mobile Ad Hoc Network", Advances in Computer Science and Information Technology, Springer, vol. 131, pp 33-42.

[52] Shunli Ding & Liping Liu 2010, 'A node-disjoint multipath routing protocol based on AODV', Ninth International Symposium on Distributed Computing and Applications to Business Engineering and Science (DCABES), pp.312 –316.

[53] Siddiqua, A ,Sridevi, K & Mohammed 2015, 'Preventing Blackhole Attacks in MANETs using Secure Knowledge Algorithm', Proceedings of the International Conference on Signal Processing and Communication Engineering Systems, vol. 1,pp. 421-425.
[54] Shilpa M. Chauhan, Dr. Amit M. Lathigara (2016), "Energy Efficient Multipath OLSR in Mobile Adhoc Networks', International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 08.
[55] Soundararajan, S & Bhuvaneswaran, RS 2012, 'Adaptive Multipath Routing for Load Balancing in Mobile Ad Hoc Networks', Journal of Computer Science, vol. 8, no. 5, pp. 648-655.
[56] Sujata V. Mallapur , Siddarama R. Patil , Jayashree V & Agarkhed (2016), ' Multipath Load Balancing Technique for Congestion Control in Mobile Ad Hoc Networks', Advances in Computing and Communications.
[57] Sushil Chandra Dimri, Sushil Kumar Chamoli & Durgesh Pant 2013, 'Delay based Traffic Distribution of Heavy Traffic on K-Paths to achieve the Load Balancing and to minimize the Mean System Delay in MANET', International Journal of Computer Applications 63.22, pp. 25-30.
[58] Shekhar Tandan Prane & EtSaurabh 2011, 'A PDRR Based Detection Technique for Blackhole', International Journal of Computer Science and Information Technologies, vol. 2, no. 4. pp. 1513-1516.
[59] Sunil & Kumar 2016,'Implementation of delay variance attack using video streaming in MANET' , Optik-International Journal for Light and Electron Optics ,vol. 127, no. 6, pp. 3303–3307.
[60] Uttam Ghosh & Raja Datta 2015, 'A secure addressing scheme for large-scale managed manets', IEEE Transactions on Network and Service Management, vol. 12, no. 3, pp. 483–495.
[61] Vithya, G & Vinayagasundaram, B 2016, 'QoS in Wireless Multimedia Sensor Networks by Contextual Routing with Octree Data Gathering', Asian Journal of Information Technology, vol. 15, pp. 122-135.
[62] Wang, J, Liu, Y & Jiao, Y 2011,'Building a trusted route in a mobile ad hoc network considering communication reliability and path length', Journal of Network and Computer Applications, vol. 34, no.4, pp.1138-1149.
[63] Yang Xiang, Ke Li & Wanlei Zhou 2011,'Low-rate DDoS attacks detection and traceback by using new information metrics', IEEE Transactions on Information Forensics and Security, vol.6, no. 2, pp. 426-437.
[64] Yu Chang Wu, Tung-Kuang Wu & Rei Heng Cheng 2007a, 'A low overhead dynamic route repairing mechanism for mobile ad hoc networks', Computer Communications, vol.30, no.5, pp.1152-1163.
[65] Yu, M, Malvankar, A, Su, W & Foo, S 2007b, 'A link availability- based QoS aware routing protocol for mobile ad hoc sensor networks', Computer Communications, vol.30, no.18, pp.3823–3831.
[66] YuHua Yuan, HuiMin Chen & Min Ji 2005, 'An optimized ad-hoc on demand multipath distance vector(aomdv) routing protocol', Asia- Pacific Conference on Communications, pp.569–573.

[67] Ye, Z, Krishnamurthy, SV & Tripathi, SK 2003, 'A framework for reliable routing in mobile ad hoc networks'. In INFOCOM 2003. Twenty-Second Annual Joint Conference of the IEEE Computer and Communications, IEEE Societies, vol.1, pp.270–280.
[68] Zhang, XM, Wang, EB, Xia, JJ & Sung, DK 2013, "A neighbor coverage-based probabilistic rebroadcast for reducing routing overhead in mobile ad hoc networks", IEEE transactions on mobile computing, vol. 12, no. 3, pp.424-433.