ISSN: 2581-3404 (Online) IF: 5.86 (SJIF)
IJIRTM, Volume-10, Issue-1, February-2026

Quality of Services based Routing Protocol Techniques in Mobile Ad-hoc Network: A Comparative Review

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Abstract. *Mobile ad hoc networks (MANETs) are dynamic, self-organizing networks where data traverses multiple intermediary nodes, necessitating secure mechanisms to prevent access by hostile nodes. While new concepts have emerged to enhance routing reliability and information quality, challenges such as communication speed and service quality persist. This research work presents a comparative review on secure optimization routing algorithm for MANETs. The approach focuses on secure routing protocol and techniques incorporating intruder detection, facilitating trust-based, energy-efficient navigation, and quality of services parameters.*

Keywords: Mobile ad-hoc network, routing Algorithm, Optimization techniques, Quality of service.

Introduction

The MANET's mobility is a crucial parameter that affects the network performance very quickly. The decision about whether, where, and when to switch to another network is handled by mobility management. Coverage restrictions, bandwidth requirements, and other usages can influence forwarding decisions [5]. The two types of wireless networks cover a network that is not an infrastructure based and having an infrastructure. Fixed and wired gateways make up the fixed architecture of the infrastructure network. Another name for it is a cellular network. They have fixed base stations with cables connecting them to other base stations [6]. The infrastructure wireless LAN is the network of connects computers established on radio transmissions rather than wired connections. There is not the concept of movements of devices in wireless LAN. In ad-hoc networks, the devices can move from its fixed network and the topology makes it always dynamic rather than static. The performance of network varies when there is a change in the number of nodes (refers to scalability).

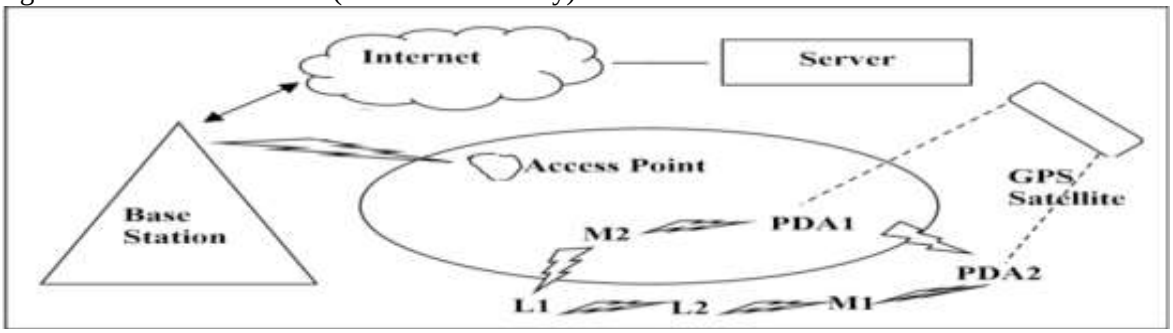

Fig. 1: MANET Architecture [1].

MANET Routing Protocols

Because the arrangements of nodes in an ad-hoc network are varying, so MANET nodes must find it on their own because they are unaware of it. When a new node enters in an ad-hoc network, it must first broadcasts its existence and arrival, along with listening capability from already existing mobile nodes. Routing protocols play a very crucial role in MANETs which has its own specific challenges as compare to the traditional networks. Nodes of MANET change frequently their relative positions, and then protocols are needed that can continuously monitor the condition and adapt or even optimize routes to keep alive efficient paths for data transmission. In addition, as there is no fixed infrastructure available the protocols themselves need to have built-in mechanisms for self-organization in order to ensure their connectivity and stability [7]. Many of the advances in protocol design are hybrids that adopt both proactive and reactive approaches to route discovery simultaneously enabling proactive route maintenance along with best-effort or redundant routing to optimize performance as network conditions wax, wane, and change according to application and user requirements [17].

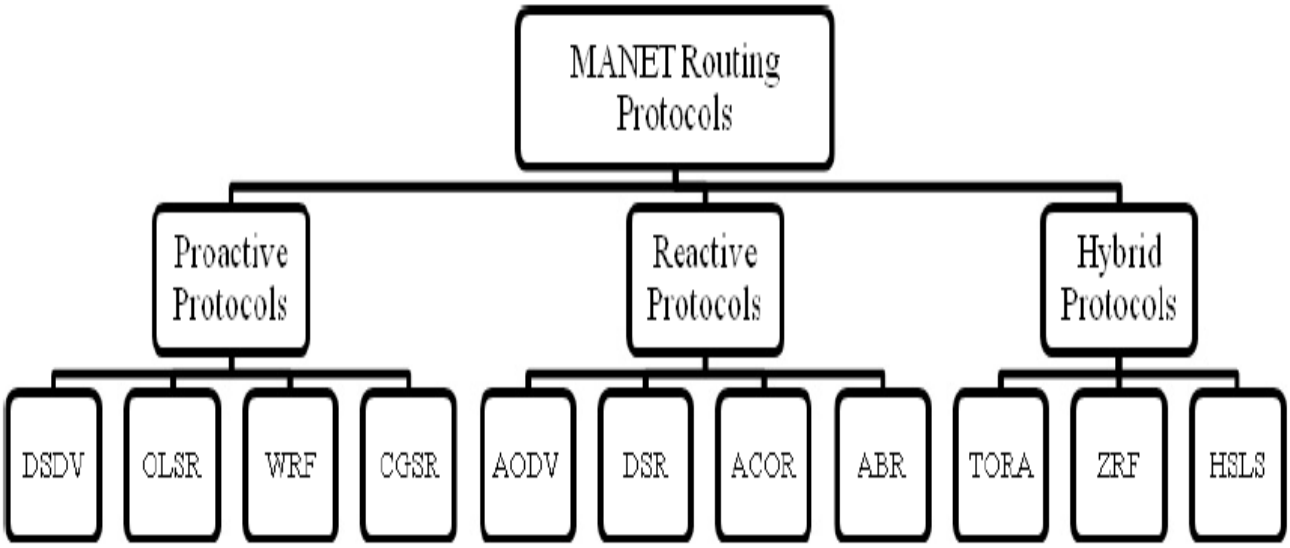

Fig. 2: Different Routing Protocols used in MANETs [19].

MANETs are rapidly deployable and self-configuring, making them well suited for use in areas where a network infrastructure does not exist or has been damaged during an emergency whereas traditional fixed-network infrastructures have problems such scalability, long deployment periods, difficult reconfiguration, and vulnerability to single point of failures [13]. Moreover, improvements in routing protocols like AODV (Ad hoc On-Demand Distance Vector) and DSR (Dynamic Source Routing), have brought a positive touch of accuracy to the data transmission involved within them. In addition, the application of artificial intelligence and machine learning algorithms that could provide more smarter MANET with self-organization to enhance network performance at any time.

Literature Review

Mobile ad hoc networks (MANETs) operate without fixed infrastructure and frequently change topology due to node mobility. This mobility imposes overhead in maintaining the topology, as each node shares its mobility information with others. To mitigate this issue, various cluster-based algorithms have been proposed to minimize routing table size. This section reviews literature that compares techniques, presents their experimental results based on comparative techniques, and discusses parameters relevant to these approaches, referencing work published in reputable journals.

Author details and Reference	Proposed Method / Approach/ used Routing Protocol	Quality of services Parameters/ Performance Metrics	Experimental Work/ Future Discussions
Satveer Kour et al. [1]	Scalability analysis of MANET using different node densities (25, 50, 75, 100) comparing routing protocols AODV and DSR.	Throughput, Goodput, Packet Received, Received Rate, Node Density	AODV shows 13.65% better throughput; DSR shows 12.66% better goodput, 65% improvement in packets received, and 10.3% higher received rate.
S. Hemalatha et al. [2]	Classification Algorithm Based Intruder and Black Hole Attack detection in AODV (CAIBHA-AODV).	Packet Delivery Ratio, End-to-End Delay, Attack Detection Time, Attack Rate	PDR between 90–92%; delay between 6–24 ms; attack detection time 10–25 ms; attack detection rate 95%.
Anoop Dev et al. [3]	Energy-efficient routing algorithms in MANET using swarm intelligence and fuzzy optimization techniques.	Energy Consumption, Packet Delivery Ratio, Route Stability, Control Overhead	Proposed algorithms reduce energy consumption and improve network lifetime especially in high mobility.
Noorulden Basil et al. [4]	Evaluation of MANET routing protocols using OPNET simulation comparing table-driven and on-demand routing protocols.	Routing Performance, Adaptability, Management Complexity	Simulation helps analyze routing protocol efficiency and adaptability in dynamic ad-hoc networking environments.
Satyanand Singh et al. [6]	Energy-aware routing algorithm prioritizing paths with higher residual energy in MANET.	Residual Energy, Communication Delay, Route Lifetime	Improves battery utilization and reduces communication delay by selecting energy-efficient paths.
Arvind Kumar et al. [7]	FPGA-based implementation of HMC-AODV routing protocol using Zedboard platform.	End-to-End Delay, Control Overhead, Packet Delivery Ratio, Hardware Utilization	Improves delay by 10.4–25.1% and control overhead by 8.9–35.4%; PDR = 1.0; reduces power consumption with 286 MHz support.
Aparna P. More et al. [9]	Hybrid Ant Lion Optimization (HALO) with AOMDV protocol for QoS-aware routing.	Throughput, Delay, Packet Delivery Ratio, Energy Efficiency,	HALO outperforms traditional ACO and LOA based routing approaches in QoS

		Routing Overhead	optimization.
M. V. Narayana et al. [11]	Energy-efficient transmission scheduling and collaborative sleeps scheduling in MANET.	Energy Consumption, Network Lifetime, Packet Delivery Ratio	Reduces energy consumption by 35% and improves network lifetime by about 40%.
Shyam Sundar Agrawal et al. [13]	Optimized Fuzzy Neural Network (OFNN) for fault-tolerant topology control with clustering.	Neighbor Node Distance, Path Stability, Link Expire Time	Improves path reliability and network performance through optimized clustering and routing.
Peter Maina Mwangi et al. [14]	Systematic literature review on secure routing protocols in Wireless Sensor Networks using PRISMA guidelines.	Security Attacks (Sybil, Wormhole, Blackhole), Secure Routing	Highlights importance of secure routing protocols to ensure data integrity, confidentiality, and reliable communication.
R. Khalvandi et al. [15]	Optimized routing metrics considering link length square, inverse channel gain, and link utilization.	Throughput, Energy Efficiency, Reliability, Load Balancing	Achieves several-fold improvement in throughput and up to 20 dB improvement in power efficiency.
S. Agnes Shifani et al. [17]	Security mechanisms in MANET including AES encryption, authentication protocols, and intrusion detection systems.	Encryption, Authentication, Intrusion Detection Accuracy	IDPS achieves detection accuracy of 96.4% ensuring secure and reliable MANET communication.

Table 1: This table show comparative literature review based on routing protocol and quality of services parameters.

Problem Statement

Mobile Ad Hoc Networks (MANETs) significantly advance wireless communications by enabling infrastructure-less, decentralized networks critical for applications like disaster recovery and military operations. However, they face challenges due to the energy limitations of battery-powered nodes, which complicate maintaining connectivity, latency, and throughput. Frequent changes in node topology disrupt communication paths and require constant routing updates. The route problem is central, necessitating reliable, efficient communication establishment without centralized oversight. Additionally, a tradeoff exists between energy efficiency and quality of service (QoS) parameters, such as packet delivery ratio and latency. Current energy-aware routing protocols often focus on isolated metrics, highlighting the necessity for integrated mechanisms that allow for dynamic adaptation and resource allocation in MANETs.

Conclusion

In mobile ad hoc networks (MANETs), mobile users are responsible for routing data due to the absence of infrastructure. Each mobile unit relays data to reach the destination when it is beyond radio range. MANETs face more security challenges than quality of service (QoS) issues, making intrusion detection essential for enhancing system security and preventing unauthorized access. The power loss of a mobile node can hinder its ability to forward packets, impacting the network's overall functionality. This research work discuss comprehensive review on routing protocol and optimization based techniques in MANETs,

in future work implementing efficient mobile ad-hoc network based system to enhance the quality of services parameters such as throughput, packet delivery ratio, end to end delay, and energy.

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