Performance Evaluation and Comparison of LANMAR and LAR1 Routing Protocols using QualNet

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Abstract. Routing protocols are pivotal in determining communication network efficiency and reliability, particularly in mobile-ad-hoc networks. LANMAR (Land-mark Routing)- and LAR1 (Location-Aided Routing) are two notable protocols in this domain, each offering distinct approaches to route discovery and maintenance. In this research, we conducted an in-depth comparative simulation study between LANMAR and LAR1 routing protocols using QualNet software. The primary aim was to assess and contrast their performance across essential metrics such as packet total packet enqueued, carried load Broadcast, Average Jitter Broadcast, and Originated Carried Load. Through extensive simulations performed under varied network scenarios and traffic conditions, we analyzed the behavior and efficacy of both protocols. The results obtained offer valuable intuition into the pros and cons of LANMAR and LAR1, aiding network designers and researchers in selecting the most appropriate routing protocol for specific MANET applications. This research provides to a thoughtful analysis of LANMAR & LAR1 routing protocols' performance in MANETs, enabling informed decision-making for network deployments and protocol enhancements. This research not only shows the relevance of routing protocols in contemporary networking but also highlights the critical role of QualNet in advancing the field of network simulation.

Keywords: LANMAR, LAR1, QualNet.

1 Introduction

In the realm of computer networking, selecting an appropriate routing protocol is crucial for ensuring efficient, reliable, and scalable communication within a network. The network layer, situated at the core of the OSI model, facilitates the exchange of data packets among interconnected users/clients. Routing protocols, tailored to optimize this process, exhibit varied approaches and algorithms, tailored to diverse network topologies, traffic patterns, and application requirements. This research aims at conducting a relative analysis between two prominent routing protocols namely Land-mark Routing & Location-Aided Routing 1, within the framework of the network layer. This study employs QualNet software, recognized for its ability to model and analyze complex network scenarios realistically [2]. LANMAR and LAR1 represent distinct paradigms in routing protocol design, both leveraging location information for routing decisions. LANMAR, based on the Land-mark Routing concept, employs location service providers known as "Land-marks" to aid in routing decisions. Conversely, LAR1 adopts a location-aided approach where users/clients utilize location information to proactively maintain routing tables. These protocols have attracted considerable attention from researchers and network practitioners due to their potential to enhance routing efficiency, particularly in MANETs & WSNs. Though theoretical studies have provided insights into their respective strengths and weaknesses, empirical evaluations through simulation offer a more practical understanding of their performance in real-world scenarios.

2 Literature Review

1. Introduction to LANMAR: LANMAR integrates Land-mark election to minimize routing update overhead in expansive networks and handles scalability by condensing remote node groups. Through performance assessments, the paper showcases LANMAR's efficacy and scalability, particularly in mobile ad hoc networks [1].

2. Introduction to LANMAR: Confining route discovery within a smaller "request zone," these protocols effectively decrease routing message overhead. The paper presents two algorithms aimed at efficiently determining this request zone, thereby improving routing efficiency in ad hoc networks [6,7].

3. QualNet's Role: QualNet, an advanced network simulation software, plays a crucial role in analyzing Wi-Fi inter-networking performance. Its ability to model intricate scenarios, traffic patterns, and Quality of Service (QoS) parameters offers researchers a robust platform for conducting thorough investigations [5,11].

3 Methodology

3.1 Simulation Environment and Tools

We thoroughly examined different routing protocols utilizing QualNet, a highly efficient network simulation software renowned for its ability to model and analyze computer networking environments. Qual-Net provides users with a flexible & adaptable option that mimics practical environments, facilitating a detailed examination of networking complexities. Through its simulation capabilities, we were able to explore a wide range of wireless routing protocols, enabling us to investigate various scenarios and standards relevant to routing protocols [5].

3.2 Technical Description

LANMAR

In the LANMAR technique, the network is segmented into subnets, each comprising users/clients with shared interests and potential for cohesive movement as a collective entity termed as a group. Each subnet vigorously elects a node as a land-mark. It is the allowance of FSR [Fish-eye State Routing Algorithm] and helps to increase scalability by reducing up-data traffic and routing table size [1,2].

In the LANMAR protocol, each node maintains two distinct routing tables: the resident table of routing and the Land-mark-table. The local table of routing comprises direct routes to nearby end points, while the Land-mark table stores different routes to all the remaining Land-marks from all the subnets. If an endpoint node is not found within a client's local routing table, the protocol checks the rational sub-net arena of the end point node. If the end point belongs to a different subnet, the packet is promoted in the direction of the Land-mark of that sub-net. The routing data contained in the table of land-mark is utilized for this purpose. Once the packet reaches the end point node's scope, the packet is directly routed to it bypassing the Land-mark [1]. To facilitate efficient routing, each user periodically transmits the topology data to its direct neighboring node. These updated packets include entries of the table of routing inside the node's wide-angle possibility and a piggybacked trajectory of all land-marks. Ordered numbers are employed to ensure packet transmission without a loop, with table tickets featuring smaller ordered numbers being substituted by those with greater tickets. Consequently, every single client/user obtains comprehensive topological data from the client within its wide-angle scope as well as acquires trajectory data related to the Land-marks, enhancing the overall routing efficiency of the network [2]. When a client wishes to establish a contact, the Algorithm is mentioned below:

- Information Structures along with Networking Model: Every user/client in the network has an exclusive identifier unit, communication range Rx, and a flag of land-mark. Users/Clients maintain neighbor lists, topology tables, next-hop tables, and distance tables. For each end point within the fisheye scope, entries in the topology table contain link state information and timestamps. Next-hop tables indicate the next hop for forwarding packets, while distance tables store the shortest path distances [1,6].
- Land-mark Ad-hoc Protocol of Routing: This Protocol introduces the idea of logical subnets where members share common characteristics. A land-mark client is selected in every subnetwork, improving accendibility by dropping the size of the routing table and updating traffic over-head. The protocol determines routing table accendibility issues by incorporating a Land-mark hierarchical routing approach. In

case of Land-mark failures, neighboring users/clients detect the silence, elect new Land-marks, and propagate this information across the network [6].
- Performance Evaluation: Simulation models are used to evaluate routing protocols within the GloMoSim library. The DCF WLAN IEEE 802.11 Standard is employed as the Media Access Layer-2 in tests. Traffic patterns & mobility models are varied to assess the protocol's performance under different conditions [6].

LAR1

LAR1 is an algorithm built upon the dynamic Source Routing [DSR] protocol. Its primary feature involves embedding position data in packets altogether, reducing traffic over-head of upcoming head path discoveries. LAR utilizes GPS to determine the position data of each user/client [3,15]. It is specifically designed for three types of packets to facilitate data transfer and maintain connections between users/clients: routing reply, routing request & routing error packets [4]. When a user/client wishes to connect, the below mentioned algorithm is used:

- Information Structures along with Networking Models: Every User/Client in the networks have specific characteristics like an exclusive identifier unit, communication range Rx, and position data. Users/Clients maintain routing tables, neighbor lists, and distance tables to facilitate efficient routing. The protocol utilizes location information to restrict the hunt for novel routes within the defined "region of request" in MANET [8,9].
- The process of discovering the Routes: This process involves the source node initiating a route request for an end client/user. The zone of request is expressed based on the expected zone of the end point client/user and the current location of the source client/user, adapting dynamically as the request propagates through the network. Intermediate users/clients may modify the request zone to ensure it includes their current location and the expected zone of the end point, enhancing route discovery efficiency [8,9].
- Performance Evaluation: Performance evaluation of the LAR-1 routing protocol involves simulations using network simulators like MaRS (Maryland Routing Simulator). The protocol's performance is compared with other routing schemes like flooding to assess metrics such as fraction of packet delivery, over-head of routing, delay in end-to-end client, and network lifetime. Techniques like TTL optimization and the use of directional antennas are explored to optimize routing efficiency and reduce overhead [8,9].

4 Simulation Setup

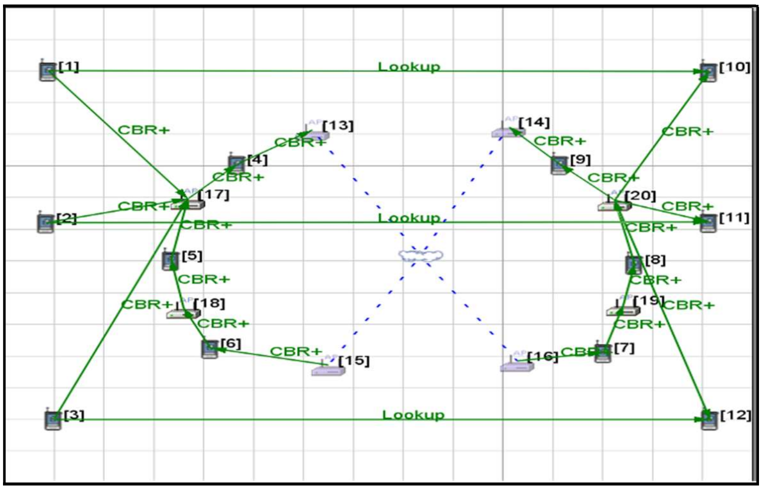


Fig. 1. Simulation Window

5 Results

5.1 Enqueue

For Wireless & Wired Network

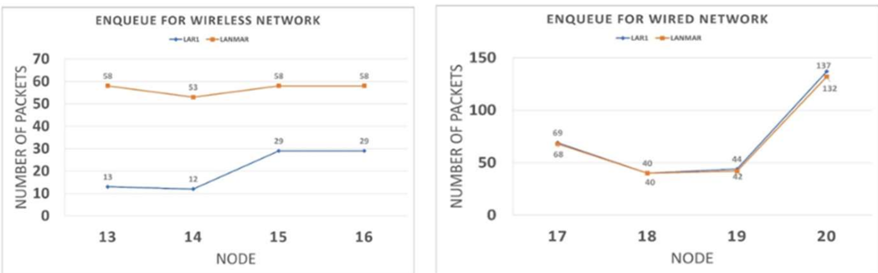
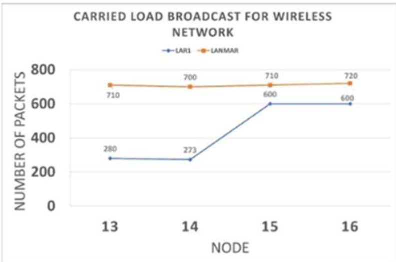


Fig. 2. Enqueue Comparison for different protocols between wireless and wired nodes.

The given graph indicates a noticeable difference in the volume of network packets appearing in the input queues across various clients within the computer network environment. This observation implies potential variations in the data traffic levels and potential load unevenness between LANMAR and LAR1 [11]. In case of wireless communication, as shown in Figure 2, LANMAR exhibits the highest packet enqueuing rate followed by LAR1. This suggests that LANMAR exhibits a higher rate of packet production or response when compared to other techniques whereas in the case of wired communication, there is a consistent flow of packets across the users/clients in both the protocols.

5.2 Carried Load Broadcast

For Wireless & Wired Network



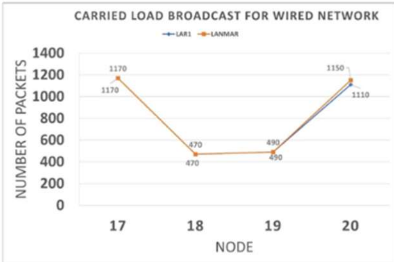


Fig. 3. Carried Load Broadcast Comparison for different protocols between wireless nodes.

Figure 3 displays a diverse spread of data transport load among various clients/users in the given computer networking environment, showcasing unique arrangements for the mentioned protocols. This highlights the distinct ways in which traffic is distributed and managed across the network, providing insightful awareness into the behavior of carried load in the performance of each routing protocol [10,12]. The Carried load Broadcast graphs studies a diverse distribution of data transportation load across different clients/users in the computer networking environment. In the case of wireless communication, as shown in Figure 3, LANMAR carries the highest load overall. It steadily operates the greatest number of packets at each client/user which suggests the efficacy in routing traffic efficiently within this computer networking situation whereas in the case of wired communication, there is consistent distribution of traffic load between each node in both the protocols.

5.3 Average Jitter Broadcast

For Wireless & Wired Network

Fig. 4. Average Jitter Broadcast Comparison for different protocols between wireless nodes.

The average jitter broadcast denotes the mean fluctuation in the time it takes for information packets to travel from one client/user to another within the computer networking environment. According to the research conducted by us based on the network scenario implemented using Qualnet, there was no difference between LAR1 and LANMAR observed in the case of Average Jitter Broadcast for Wired Network.

5.4 Originated Carried Load

For Wireless & Wired Network

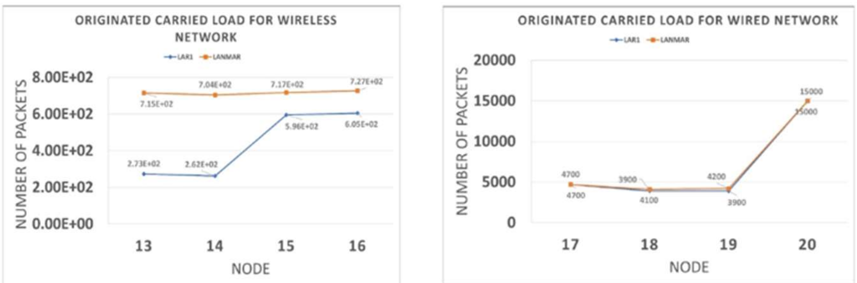


Fig. 5. Originated Carried Load Comparison for different protocols between wireless nodes.

Originated carried load pertains to the traffic load initiated by a node itself, stemming from its internal operations or the traffic it directly generates [13]. The Carried load Broadcast graphs highlight a varied distribution of traffic load generated due to its own node across different users/clients in the network. In the case of wireless communication, as shown in Figure 5, LANMAR carries the highest originated load which handles each node consistently as compared to LAR1 whereas in the case of wired communication, the traffic generated by each node in case of both the protocols are consistent.

6 Conclusion

In summary, the comparison between wired and wireless communication for LANMAR and LAR1 reveals a fundamental difference in the reliability of packet transmission through nodes. Wired communication consistently achieves a high rate of packet transmission, typically maintaining a range of 96% to 100%. This consistency ensures a stable and predictable transmission process. Whereas, wireless communication exhibits significant discrepancies, with packet transmission rates fluctuating between 22% and 50%. This fluctuation introduces unpredictability into the network, emphasizing the need to adapt strategies to accommodate the dynamic nature of packet transmission. Furthermore, when studying about the carried load, wired networks consistently manage 100% of the load, while wireless networks operate between 39% and 84.50%. Similarly, in terms of average jitter, wired networks maintain near-perfect performance, ranging between 94.10% and 100%, whereas wireless networks display more fluctuations. This significant difference underscores the importance of comprehending the unique characteristics and challenges posed by each communication medium in the design of efficient and dependable networks. While wired communication offers unmatched consistency, wireless communication requires adaptive strategies to address the fluctuations in packet transmission rates. As technology advances and networks evolve, recognizing and addressing these distinctions will be vital for optimizing communication systems across various environments and applications.

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References

1. Kaixin Xu, Xiaoyan Hong, Mario Gerla, "Landmark routing in ad hoc networks with mobile backbones, Journal of Parallel and Distributed Computing".
2. Dinesh Singh, Ashish K. Maurya, Anil K. Sarje;" Comparative Performance Analysis of LANMAR, LAR1, DYMO and ZRP Routing Protocols in MANET using Random Waypoint Mobility Model ".
3. Mohamed Adnene Zayene, Nabil Tabbane; " Performance Evaluation of Location-Aided Routing Protocols in Ad Hoc Network" IEEE 2009 Global Information Infrastructure Symposium (GIIS) - Hammemet, Tunisia (2009.06.23-2009.06.26).
4. Aakash Jaspera, Rajeev Paulusa, Shubhanshi Rathorea "Improvement of LAR1 Routing Protocol ".
5. Atharva Prafulla Joshi, Dr. Rupesh Chandrakant Jaiswal, Piyush More, Sakshi Naik, Reva Dalal "Performance Evaluation and Comparative Analysis of AODV, DYMO, IARP, and IERP Routing Protocols in Ad Hoc Networks " International Journal of Intelligent Systems and Applications in Engineering.
6. Guangyu Pei, Mario Gerla, and Xiaoyan Hong "LANMAR: LandmarkRouting for Large Scale Wireless Ad Hoc Networks with Group Mobility"
7. Maoyu Wang, Ying Ge, and Louise Lamont "Comparison of Two Hierarchical Routing Protocols for Heterogeneous MANET ".
8. Yottttg-BaeKo and Nitin H. Vaidya "Location-Aided Routing (LAR) in Mobile Ad Hoc Networks".
9. Hussein Al-Bahadili and Ali Maqousi " Performance Evaluation of the LAR-1P Route Discovery Algorithm".
10. Abhishek Kothari, Dr. R.C. Jaiswal, Satyam Munot, Anurag Deshpande, and Piyush More, "Hub-based LAN Simulation using QualNet,"3rd International Conference on Evolutionary Computing and Mobile Sustainable Networks (ICECMSN 2023).
11. Jaiswal R.C. and Lokhande S.D., "Measurement, Modeling and Analysis of HTTP Web Traffic", IMCIET-International Multi-Conference on Innovations in Engineering Technology-ICCC-International Conference on Communication and Computing -2014, PP-242-258, ISBN:9789351072690, VVIT, Bangalore.
12. Jaiswal R.C. and Lokhande S.D., "Performance Analysis for IPv4 and IPv6 Internet Traffic", ICTACT Journal on Communication Technology, September 2015, volume: 06, issue: 04, pp. 1208-1217. (Print: ISSN: 0976-0091, Online ISSN:2229-6948 (Impact Factor: 0.789 in 2015).
13. Jaiswal R.C. and Aishwarya Gaikwad, "Experimental Analysis of Bit torrent Traffic based on Heavy-Tailed Probability Distributions", International Journal of Computer Applications, ISSN No. (0975 – 8887),Impact Factor .3.1579(2016), Volume 155 – No 2, December 2016.
14. Azzedine Boukerche, Begumhan Turgut, Nevin Aydin, Mohammad Z. Ahmad, Ladislau Bölöni, Damla Turgut "Routing protocols in ad hoc networks: A survey".