IAES International Journal of Artificial Intelligence (IJ-AI)
Vol. 13, No. 4, December 2024, pp. 3892~3899
ISSN: 2252-8938, DOI: 10.11591/ijai.v13.i4.pp3892-3899

A systematic assertive wide-band routing using location and potential aware technique

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Article Info

Article history:

Received May 15, 2023
Revised Oct 18, 2023
Accepted Nov 11, 2023

Keywords:

Assertive routing algorithm
Distance-based routing
Potential based routing
Wide-band routing
Wireless sensor network

ABSTRACT

Delays occur when packets must be routed over several paths in a wireless sensor network with multiple origins and destinations. There are several causes, delays may occur everywhere, even in a multi-hop wireless network. Due to the broadcast nature of wireless networks, opportunistic routing was able to circumvent these delays. To avoid unnecessary delays, wide-band routing may be used to calculate the smaller path between two nodes. In this case, we address the shortcomings of the standard approach by taking into account the node's power. Path routing as well as the broadcast nature of wireless signals help mitigate the effects of shoddy wireless connections. The results show that the suggested approach outperformed the baseline in both end-to-end latency and packet delivery ratio.

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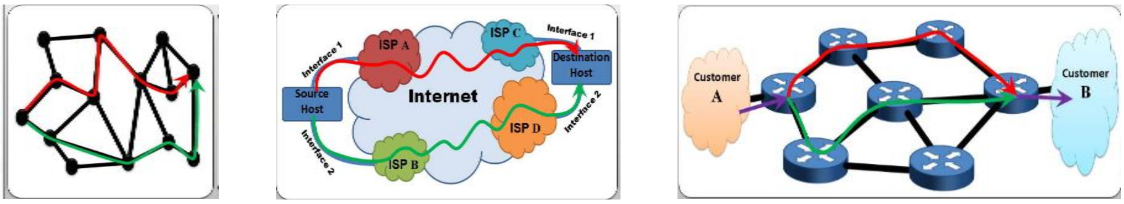
1. INTRODUCTION

Multipath routing is indeed a technique used to increase the network's bandwidth resilience [1]. Despite its inability to provide full or correct results, single-path routing remains the standard. The multipath may be flow-based dependent on the five-tuple of the packet's protocol, source IP, destination IP, source port, and destination port to choose which path to take. When using multipath routing, the traditional single-path network metrics will not be accurate. This includes the inability of traceroute to indicate nonexistent links when packets are sent through multiple pathways [2], [3]. With mobile adhoc networks, no infrastructure is set up in advance.

Lighter, less computationally powerful, static nodes are employed in sensor networks, which are deployed in isolated areas to keep an eye on whatever it is they are meant to keep an eye on. Both of these functions operate independently but in tandem. Due to the potential for data loss, their sizes are limited to very tiny radii. It is difficult to find and keep up with routes. Rather than using precise coordinates, most routing algorithms instead use the received signal intensity to determine the distance between nodes. GPS may also be utilized. This, however, calls for additional gear. As a result, it became clear that distance-based routing was inefficient. This zone based energy efficient routing protocol is a relatively new technology that uses zones to optimize network performance [4].

If just one possible route exists for a packet to take, its arrival order will mirror the order in which it was sent. Out-of-order delivery is a problem with multipath routing. This might be because the packets were reordered by the intermediary nodes or because the two packets took different routes. If two probing flows use the same way in a flow-based system, it functions similarly to a single path. Therefore, ensuring optimum path coverage to decrease the likelihood of relying on a single route, more packets should be sent as seen in

Figure 1. Figure 1(a) shows the graphical representation of multipath routing, Figure 1(b) shows the realization in the transport layer along with Figure 1(c) shows the realization in the network layer. If indeed the two packets arrive out of sequence, it could be because the intermediate router reordered them (a process known as packet reordering) or because they took different routes to their destinations.



(a) (b) (c)

Figure 1. Ilustration of multipath routing, (a) graph theoretical representation, (b) realization in the transport layer, and (c) realization the network layer

To reduce the negative effects of having an unstable wireless connection, a revolutionary routing strategy has been developed that takes advantage of both the spatial diversity and broadcast characteristics of wireless communication. OR stands for "opportunistic routing". In the network layer, there exists a predetermined list of nodes that will be used as "next hops" if a packet has to be forwarded. Based on its accessibility and availability, one of those nodes is chosen to serve as the actual relay. With more potential recipients, there is a greater chance that some of them will successfully get the packets. Because of this, it is more likely to be received the first time around, avoiding the need for costly retransmission.

The output and efficiency both go up because of this. The usage of OR is widespread, and most of the time it is used as a single-rate system. Methods of vetting potential candidates and ranking them have been used in a variety of works. Ni intends to transmit data to nd. Then set Ci of all nodes that fall within ni's range of transmission is probed. The range of transmission and the nodes closest to ni's neighbors both vary as the data rate increases or decreases. Take into account the group Fi: = ni1, ni2, nir. Candidates from this group will be sent to the next. This group of things is a small subset of the larger set Ci. These would be considered to include all the nodes that are participating in the forwarding depending on some selection process. Priority during packet relaying determines the ordering, and everything is sent in Fi.

2. RELATED WORK

Early on, devised an OR system for multihop networks that makes use of many radio frequency (RF) channels [5]. Multi-channel exceptionally opportunistic routing (MCExOR) is indeed a routing protocol that minimizes the number of hops required by wireless multi-hop networks. The total throughput grew as even the number of active RF channels rose. However, this required unique algorithms both route finding and packet forwarding, as well as an RF transceiver for each device. Tiny sensors only need a weak, non-rechargeable battery power to operate. There is a strong reliance on ambient conditions on the sensors. Therefore, making the most efficient use of energy is a primary priority in any routing approach.

They suggested just such a book. Multihop and OR theory was used, while optimization was carried out with the disparity in energy levels and the distance between nodes taken into account [6]. Minimal power consumption was shown using OR, which also boosted network performance by keeping nodes safe. If it were a node with a longer lifespan, this would be impossible. Unfortunately, this does not work while the nodes are in their sleep state. As part of OR, nodes that both overhear and take part in transmission are added to something like a forwarder list, which also includes nodes of varying priority. When a packet is sent from a higher-priority node to something like a lower-priority node, that packet would be dropped. Thus, setting priorities is difficult. They paid special attention to the process of narrowing down and ranking the options [7]–[9]. They presented a computationally cheap OR strategy that conserves energy. Active probing was utilized to decide on a network architecture for a dispersed set of hosts [10]. Approaches are used, both with and without the usage of routers. No mechanism can reliably generate an optimal route topology [11]. Help from the router was easy to use and practical in practice. Unfortunately, the prevalent tree-based topology was inapplicable here [12], [13].

The three modules large scale live update, multipath proactive source routing, as well as small scale re-transmission, were utilized [14]. Multiple pathways to the destination are discovered whenever the source initiates contact with that as well. It takes into account all of the potential routes, generates a matrix, and counts how many of those routes are completely separate from one another. The packets are routed to their final destination once all possible independent routes have been identified. When a packet is forwarded, it is done so because the forwarding node stands closer to the destination than that the source node and thus has more up-to-date routing information. If the nodes are moving swiftly and the network has a vast diameter, there is a danger that information will be lost, even by the time it reaches another distant node. In this instance, the forwarding node may update the portion of the forwarder list inside the packets based on its knowledge. If a data transmission fails between two forwarders, then data might be resent by any intermediate nodes that are not on the list. Researchers also demonstrated that multipath routing with mobile ad hoc networks (MANET) has better performance than other routing protocols in terms of packet delivery ratio, network latency (latency), and delay jitters [15].

They employed transmission interference and conflict to send the packet without any problems. For the signal-to-noise-ratio (SNR) just at the receiver to be met, the sum of the powers of each of the receivers as well as the noise power must be less than a specified value [2], [16]. When numerous nodes are broadcasting at once, concurrent transmitter sets are utilized for efficient, low-energy transmission. Effective forwarding across all links is achieved by the implementation of OR. Finding the expedited forwarding (EF) link rate for each emitter [17]. Both the forwarding candidate list as well as the transmission rate determine the EF rate. When there is just one forwarding candidate for every node, the OR technique is abandoned in favor of more conventional routing algorithms. They suggested location-based associativity routing to minimize the distance traveled throughout route discovery [18]. It is difficult to guarantee upkeep when linkages are broken. An associativity-based routing algorithm chooses the path between nodes based on their associativity states. With the whole network as just a potential destination, finding the optimal path takes a lot of time and uses a lot of bandwidth.

This location based opportunistic routing protocol (LOR) was proposed to ensure the timely and reliable delivery of packets in highly dynamic MANET [19]. It exploits the broadcasting property and the geographical routing of wireless media. When packets are sent out, the intermediate nodes act as forwarders even though the intended nodes do not forward them. Duplicate relaying due to packet rerouting may be reduced and the overheads associated with route recovery could be removed. To facilitate anonymous reactive routing within MANETs, they suggested a privacy-friendly routing in suspicious MANETs (PRISM) protocol [20]. It ensures the security of transmitted communications by authenticating nodes with the use of group signatures and blocking tracking of individual nodes. Under some traffic conditions, it performed better than link-specific state routing.

Scientists share the public’s worry about city traffic. Dijkstra's method, which locates the quickest route, is often used by driver assistance systems. Defrawy and Tsudik [21] shows object-oriented principles and has been tested utilizing microcontrollers to take into account the density of cars on the road and offer a speedy way. They used a data fusion method to further refine it [22]. The use of geographic routing helps to enhance the routing of vehicles in a city. However, signal loss might occur due to human error or natural disasters. They presented a geo-routing system that uses OR and takes into account the local road network [23]. After one packet arrives through a wireless broadcast, it is forwarded via OR. As just a result, there was less collision and a smaller channel loss. They created a low-cost, wireless, loop-less, and camera-less algorithm for regulating the traffic light using a wireless sensor network [24], [25]. The goal of this article was to develop an intelligent system that complements existing traffic management technology and shortens typical traffic-light wait times. Current technology determines the presence of multipath routing by tracking the reverse path of such a packet's journey. The final information would be a jumble of packets from several paths, in an unpredictable sequence. Metrics may also reveal whether routing was flow-based or packet-based. In the past, protocols have exclusively regarded wired connections. Wi-Fi, however, relies on a local area network (LAN) to function, and wireless usage has increased in recent years. Since the benefits of considering wireless communication are so great.

3. PROPOSED WORK

Delays can occur everywhere, even in multi-hop wireless networks, when there are multiple causes. Due to the broadcast nature of wireless networks, OR was able to circumvent these delays. Using location data for routing boosts a network's routing job throughput while reducing its power consumption and cost. Updating of node locations and routing tables are maintained by software agents. Unfortunately, packet loss and re-transmission will occur due to the subpar route quality. As packet forwarding is trustworthy, the path quality must be high. This network's survival period is determined by the total remaining energy of all mobile nodes. Therefore, it is not sufficient to only count hops when judging the efficacy of a network's routing. When evaluating transmission quality and improving its dependability, transmission delay and residual energy are indeed taken into account. Global optimum pathways are built from the source to the destination based on the computed residual energy of the cluster heads. Once data packets have been sent from their originating node, they are reported to the cluster leader. The ideal route for data transmission is determined by the cluster head, which selects the node with the shortest distance between it and the next hop. An exception is thrown in. Figure 2 shows flowchart of the proposed model whenever a new message is produced and the neighbor of the sending node must verify a single medium access control (MAC). Nonetheless, it is simple to insert and arbitrate messages along the route. Here, an attacker must assault not just one hop, but also two to succeed.

Figure 2 shows this is the suggested model's flowchart. Constructed, and then its size is assessed. Initially, the network formation is done then neighbor estimation is carried out and broadcasting of the 'Hello' message is done and energy details are received at the receiving location. After checking, the energy details and distance if it is 'Yes" the details are updated to the routing table and if it is 'No' then the energy details and distance are given back as feedback to the network estimation block for further verification. From the routing table the shortest path is selected and then checked if the check is failed the 'Yes' message is sent for which updating of the table, resending of route request (RREQ), and resting of Rtable is carried out and if the 'No' message is sent the packets are forwarded.

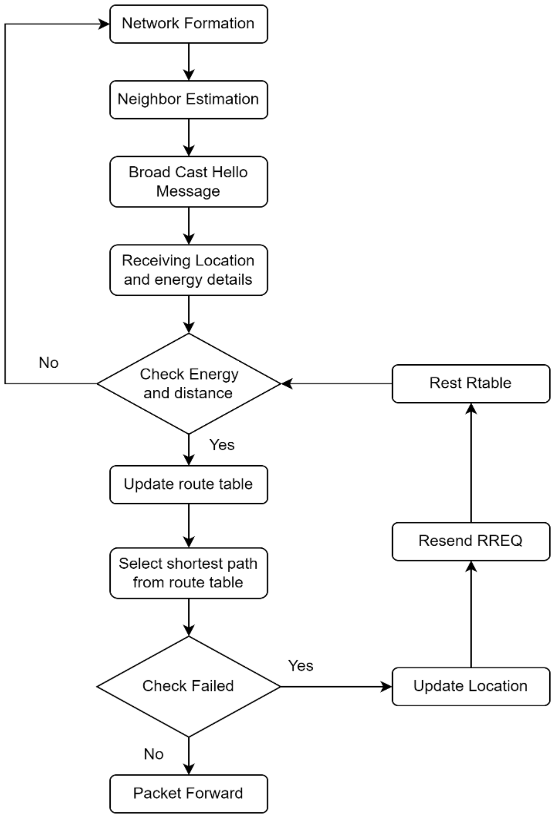


Figure 2. Suggested model's flowchart

Transmission has been made. Information on the energy and database specifics of reception are stored. The best way may be chosen by first calculating the energy and distance involved, and then updating the route. The required energy for data packets in the course of action of sending and collecting more than the distance d is described in (1) and (2):

$$Et\ (l,d)\ =\ l \times (E\ +\ \varepsilon d\alpha) \tag{1}$$

$$Er\ (l)\ =\ l \times Eelec \tag{2}$$

Where Et and Er are the required energy for sending and collecting energy progressively, $Eelec$ is the energy dissipation due to the cathodic loops, and l is the data packet size. ε is forms the energy consumption amplifier, α is the amplifying factor, α=2 is for the rarefaction model, when d ≤ d0 and wide-band fading model, α=4 when d > d0 as shown in the beneath equation. Where, and with forms the amplifier energy for unoccupied or rarefaction (*fs)* and wide-band design, here we consider the rarefaction model. Figure 3 shows the network of nodes.

$$x = \sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{mp}}} \quad (3)$$

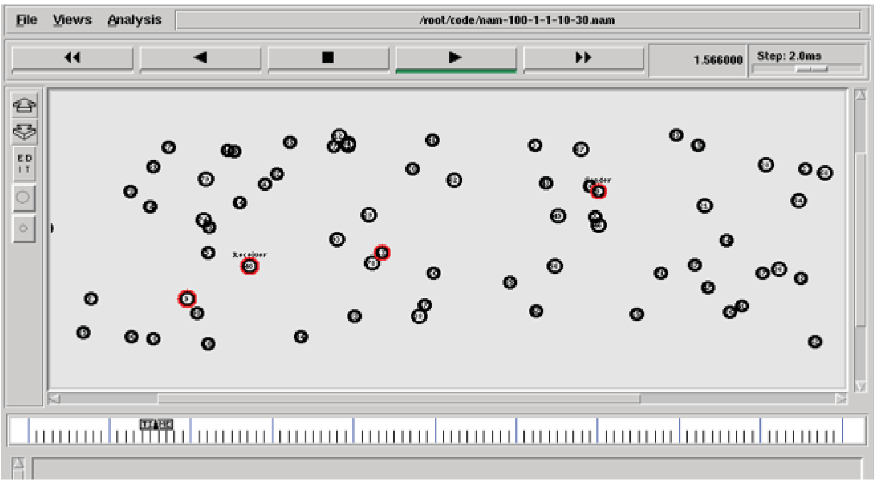


Figure 3. Network of nodes

4. RESULTS

Figure 3 shows a network with 100 nodes. The NS2 simulator was used to get these results. The image's red dots represent the senders as well as the recipients. There will be some lag time introduced by the multipath routing used in a wireless sensor network with multiple origins and destinations. In OR, opportunities are weighed. One way to achieve low-delay routing is to take into account the physical distance between nodes. In this case, we address the shortcomings of the standard approach by taking into account the node's power. Because of using the broadcast aspect of wireless signals, OR mitigates the effect of bad wireless connectivity on the routing strategy. There are two types of data delays: queuing delays and propagation delays. It is possible to use hop count instead of propagation delay when the queuing delay was disregarded. These results of time vs end-to-end delay are shown in Figure 4. The green line represents the improved method, while the red one displays the results of the current algorithm. As can be seen from the outcomes, optimal multilayer perceptron (OMLP) has a little smaller latency than the other schemes. The graph shows that the proposed system has a very low end-end delay compared to the existing method and the plot is between simulation time and end-end delay.

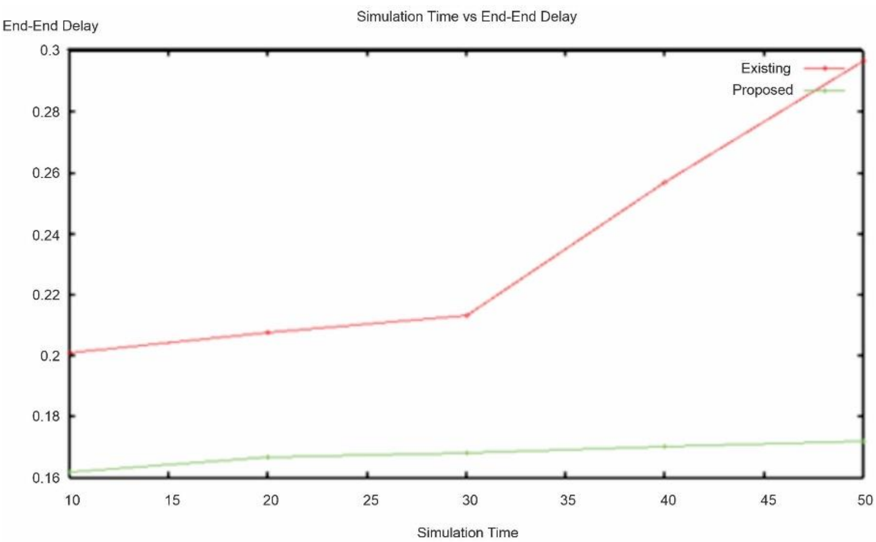


Figure 4. End-end delay

4.1. Packet delivery ratio

The number of packages received by the receiver as a percentage of total packets sent seems to be the packet delivery ratio. Figure 5 shows the packet delivery ratio. The much more effective approaches are those that ensure the message arrives at its intended recipient, neighbor, without any collisions. Figure 6 demonstrates that packet delivery ratio was concentrated greater in OMLP. The graph shows that the proposed system has a better packet delivery ratio compared to the existing method and the plot is between simulation time and packet delivery ratio.

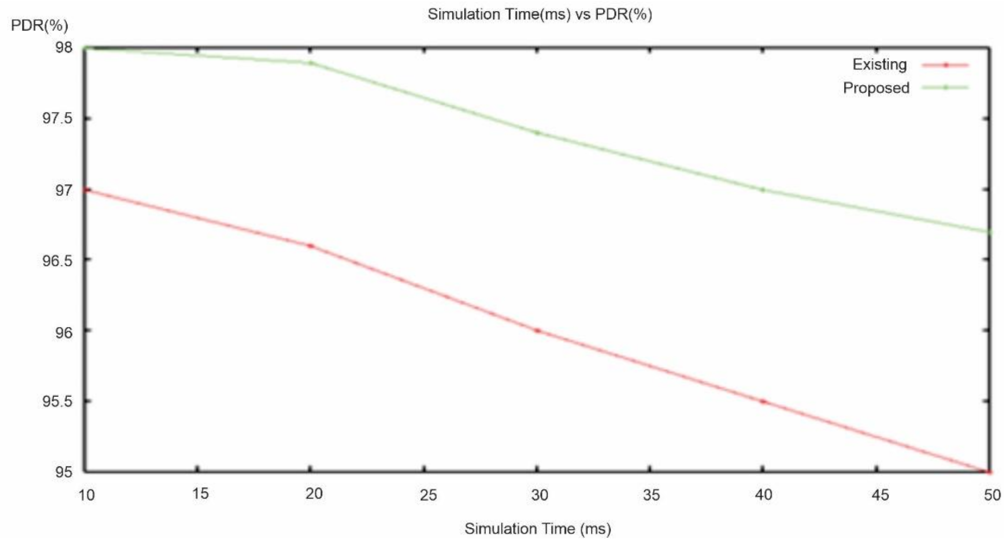


Figure 5. Packet delivery ratio

4.2. Packet loss

Packet loss occurs when data packets traveling across a network fail to reach their destination, resulting in incomplete or missing information. It can be caused by network congestion, faulty hardware, or interference. Packet loss can degrade the quality of communications and lead to issues like slower speeds, reduced performance, or interrupted services. Figure 6 shows that the proposed system has a lower packet loss rate compared to the existing method and the plot is between packet size and packet loss rate.

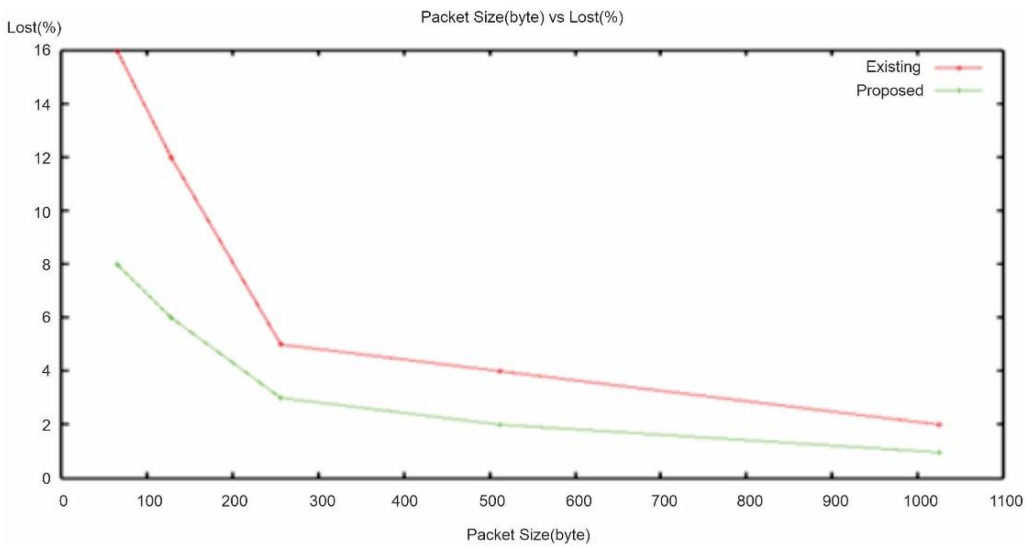


Figure 6. Shows that OMLP has a lower packet loss rate

4.3. Throughput

Throughput is the rate at which data is successfully transmitted over a network or communication channel within a given period. It is often measured in bits per second (bps), kilobits per second (kbps), or megabits per second (Mbps). High throughput indicates efficient data transfer and better network performance, whereas low throughput can lead to slow speeds and reduced service quality. Figure 7 displays the throughput data for just a simulation lasting 100, 200, 500 seconds with 100 nodes. There is no doubt that our OLMP system is more efficient.

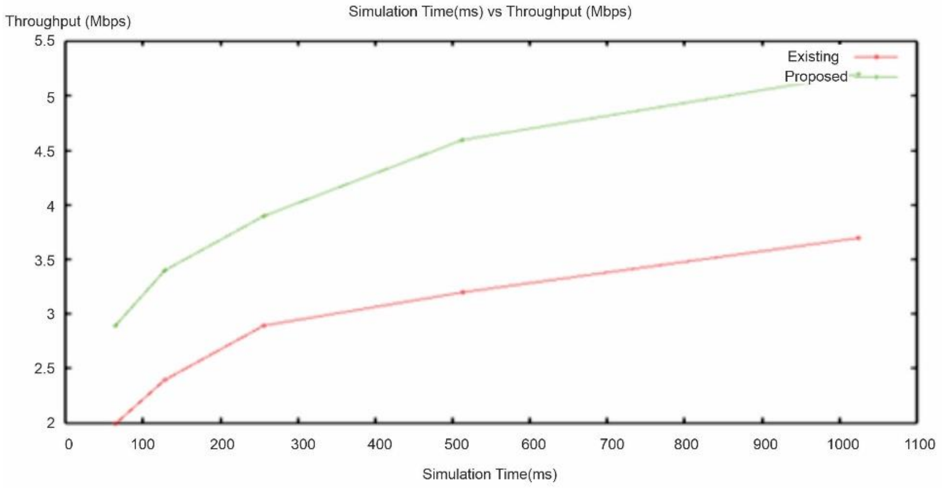


Figure 7. Throughput

5. CONCLUSION

The study offers a notion of multipath routing with a focus on its potential uses in wireless ad hoc and mesh networks. In this work, we highlight the primary advantages of multipath routing algorithms and describe its three basic components: i) discovery, ii) traffic distribution, and iii) path maintenance. Multiple multipath routing systems and ad hoc networks are also shown to illustrate the many approaches to implementing such networks, both wirelessly and through wired connections. These simulation results obtained using the network simulation tool (NS 2.34) demonstrate that the suggested protocol provides high throughput with low latency, as seen in the accompanying graph. Employing opportunistic multipath routing location and power as such a routing protocol may lead to a fast packet delivery rate, low latency, and high throughput. The difficulty of routing packets through a multi-hop network with various wireless connections from different origins while guaranteeing limited anticipated latency and traffic is taken into account. It is recommended that multi-hop wireless ad-hoc networks use OR to compensate for the shortcomings of traditional routing. Exploiting the broadcast aspect of wireless broadcasts and route diversity to mitigate the effect of poor-performing wireless connections here on the routing process.

REFERENCES

[1] S. Pan, Y. Tang, and G. Hu, "Identification of multipath routing based on end-to-end packet order," *2016 IEEE Global Communications Conference, GLOBECOM 2016*, 2016, pp. 1-7, doi: 10.1109/GLOCOM.2016.7841882.

[2] B. Augustin, T. Friedman, and R. Teixeira, "Measuring multipath routing in the internet," *IEEE/ACM Transactions on Networking*, vol. 19, no. 3, pp. 830–840, 2011, doi: 10.1109/TNET.2010.2096232.

[3] S. Pan, Z. Zhang, F. Yu, and G. Hu, "End-to-end measurements for network tomography under multipath routing," *IEEE Communications Letters*, vol. 18, no. 5, pp. 881–884, 2014, doi: 10.1109/LCOMM.2014.040214.132838.

[4] J. R. Srivastava and T. S. B. Sudarshan, "ZEEP: zone based energy efficient routing protocol for mobile sensor networks," *Proceedings of the 2013 International Conference on Advances in Computing, Communications and Informatics, ICACCI 2013*, pp. 990–996, 2013, doi: 10.1109/ICACCI.2013.6637311.

[5] A. Zubow, M. Kurth, and J. -P. Redlich, "Multi-channel opportunistic routing in multi-hop wireless networks," *Humboldt-Universität zu Berlin*, pp. 1-20, 2006, doi: 10.18452/2467.

[6] J. Luo, J. Hu, D. Wu, and R. Li, "Opportunistic routing algorithm for relay node selection in wireless sensor networks," *IEEE Transactions on Industrial Informatics*, vol. 11, no. 1, pp. 112–121, 2015, doi: 10.1109/TII.2014.2374071.

[7] X. Mao, S. Tang, X. Xu, X. Y. Li, and H. Ma, "Energy-efficient opportunistic routing in wireless sensor networks," *IEEE Transactions on Parallel and Distributed Systems*, vol. 22, no. 11, pp. 1934–1942, 2011, doi: 10.1109/TPDS.2011.70.

[8] X. Zhang and C. Phillips, "A survey on selective routing topology inference through active probing," *IEEE Communications Surveys*

and Tutorials, vol. 14, no. 4, pp. 1129–1141, 2012, doi: 10.1109/SURV.2011.081611.00040.
[9] P. Pujar, A. Kumar, and V. Kumar, “,” *IAES International Journal of Artificial Intelligence (IJ-AI)*, vol. 13, no. 1, pp. 1139-1148, 2024, doi: 10.11591/ijai.v13.i1.pp1139-1148.
[10] S. H. Sreedhara, V. Kumar, and S. Salma, “Efficient big data clustering using Adhoc fuzzy C means and auto-encoder CNN,” *Lecture Notes in Networks and Systems*, vol. 563, pp. 353–368, 2023, doi: 10.1007/978-981-19-7402-1_25.
[11] J. He and J. Rexford, “Toward internet-wide multipath routing,” *IEEE Network*, vol. 22, no. 2, pp. 16–21, 2008, doi: 10.1109/MNET.2008.4476066.
[12] M. G. Rabbat, M. J. Coates, and R. D. Nowak, “Multiple-source internet tomography,” *IEEE Journal on Selected Areas in Communications*, vol. 24, no. 12, pp. 2221–2233, 2006, doi: 10.1109/JSAC.2006.884020.
[13] D. Ghita, K. Argyraki, and P. Thiran, “Toward accurate and practical network tomography,” *ACM SIGOPS Operating Systems Review*, vol. 47, no. 1, pp. 22–26, 2013, doi: 10.1145/2433140.2433146.
[14] S. Prabhavat, H. Nishiyama, N. Ansari, and N. Kato, “On load distribution over multipath networks,” *IEEE Communications Surveys and Tutorials*, vol. 14, no. 3, pp. 662–680, 2012, doi: 10.1109/SURV.2011.082511.00013.
[15] G. D. Singh, M. Prateek, S. Kumar, M. Verma, D. Singh, and H. N. Lee, “Hybrid genetic firefly algorithm-based routing protocol for VANETs,” *IEEE Access*, vol. 10, pp. 9142–9151, 2022, doi: 10.1109/ACCESS.2022.3142811.
[16] N. G. Duffield, F. L. Presti, V. Paxson, and D. Towsley, “Inferring link loss using striped unicast probes,” *IEEE INFOCOM*, vol. 2, pp. 915–923, 2001, doi: 10.1109/infcom.2001.916283.
[17] A. Dhamdhere, R. Teixeira, C. Dovrolis, and C. Diot, “NetDiagnoser: troubleshooting network unreachabilities using end-to-end probes and routing data,” *Proceedings of 2007 ACM CoNEXT Conference - 3rd International Conference on Emerging Networking EXperiments and Technologies, CoNEXT*, 2007, pp. 1-12, doi: 10.1145/1364654.1364677.
[18] M. Rabbat, R. Nowak, and M. Coates, “Multiple source, multiple destination network tomography,” *Proceedings - IEEE INFOCOM*, vol. 3, pp. 1628–1639, 2004, doi: 10.1109/INFCOM.2004.1354575.
[19] V. N. Sastry and P. Supraja, “Location-based associativity routing for MANET,” *IEEE International Conference on Wireless and Mobile Computing, Networking and Communications, WiMob’2005*, vol. 3, pp. 49–56, 2005, doi: 10.1109/wimob.2005.1512884.
[20] X. Yang, J. Yin, and S. Yuan, “Location-aided opportunistic routing for mobile ad hoc networks,” *2009 5th International Conference on Wireless Communications, Networking and Mobile Computing*, 2009, pp. 1-5, doi: 10.1109/WICOM.2009.5301914.
[21] K. E. Defrawy and G. Tsudik, “Privacy-preserving location-based on-demand routing in MANETs,” *IEEE Journal on Selected Areas in Communications*, vol. 29, no. 10, pp. 1926–1934, 2011, doi: 10.1109/JSAC.2011.111203.
[22] N. Gayathri and K. R. M. V. Chandrakala, “A novel technique for optimal vehicle routing,” *2014 International Conference on Electronics and Communication Systems, ICECS*, 2014, pp. 1-5, doi: 10.1109/ECS.2014.6892655.
[23] N. Gayathri and K. R. M. V. Chandrakala, “Embedded driver assistance system for effective dynamic vehicle routing,” *International Conference on Embedded Systems, ICES 2014*, pp. 182–187, 2014, doi: 10.1109/EmbeddedSys.2014.6953153.
[24] K. C. Lee, U. Lee, and M. Gerla, “Geo-opportunistic routing for vehicular networks,” *IEEE Communications Magazine*, vol. 48, no. 5, pp. 164–170, 2010, doi: 10.1109/MCOM.2010.5458378.
[25] J. R. Srivastava and T. S. B. Sudarshan, “Intelligent traffic management with wireless sensor networks,” *2013 ACS International Conference on Computer Systems and Applications (AICCSA)*, 2013, pp. 1-4, doi: 10.1109/AICCSA.2013.6616429.

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