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Evaluation Of Power-Aware Routing Protocols In Mobile Ad Hoc Networks

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The nodes that make up an ad hoc wireless network, have a limited amount of power. Therefore, a big challenge in Ad hoc networks is power conservation. There are a number of suggested power conscious routing protocols that aim to reduce power consumption by mobile nodes. Performance of Energy-Aware Power Routing (EPAR) and Maximum Transmission Power Routing (MTPR) are examined in this study as they pertain to MANETs. Fifty nodes were randomly placed in a 1500x300 space and NS-2.29 was used to run the simulations. There was a constant rate of 20 m/s movement among the nodes, and their pause durations ranged from zero to sixty seconds. Included in the simulation settings were the following: CBR traffic type, 2 Mbps bandwidth, and 10,000 bytes maximum packet size. Metrics including residual battery power, power consumption, and network longevity were used to assess the routing protocols' energy efficiency. Compared to MTPR, EPAR had a larger residual battery power and a far lower power consumption rate, according to the data. A greater network lifespan was also shown by EPAR. When compared to MTPR in MANET settings, EPAR appears to offer superior energy efficiency and longer operational sustainability.

Keywords: Energy, Transmission, Residual battery, Network lifetime, Battery.

I. INTRODUCTION

A kind of wireless communication network called mobile ad hoc networks (MANETs) lets nodes—devices—talk to one another without depending on a fixed infrastructure or centralized control. With nodes moving freely inside the network, these highly dynamic networks present special difficulties in terms of routing, connection, and energy efficiency. Particularly given that many nodes in these networks are battery-powered, energy consumption control is one of the most important issues in the design and operation of MANETs. Power-aware routing techniques are absolutely necessary for guaranteeing network lifetime and effective data transfer as mobile devices have limited energy resources.

Power-aware routing methods aim to maximize the energy use of the network while preserving a consistent communication channel between nodes. Designed to reduce power use during route creation and data forwarding, these protocols serve to prolong the operational life of the nodes and hence the whole network. Energy efficiency is a key design consideration as mobile devices in MANETs are sometimes limited by low battery capacity. Unlike conventional wired or fixed infrastructure networks, MANETs are susceptible to energy depletion, which can cause network partitioning, communication delays, and even network failure if not handled.

Energy usage in MANETs is influenced by several important elements. The first is the transmission power needed for data transmitting and receiving. Particularly in settings where nodes must communicate over long distances, high transmission power can lead to considerable energy depletion. Power use is further influenced by the energy needed to keep the routing tables and carry out routing protocol activities like node discovery and route management. Moreover, since the network continuously adapts to changing topologies, the mobility of nodes and the frequency of route modifications might aggravate energy consumption. Improving the general performance of MANETs depends on building energy-efficient routing protocols flexible to these dynamic situations in this framework.

Power-aware routing systems use a number of techniques to maximize energy use. Choosing paths that reduce the transmission power needed for communication is one such method. Some protocols could select paths that balance transmission power and network stability in situations when long-range communication is required, therefore avoiding too high energy use on a single node. Dynamically changing the power levels depending on the nodes' remaining battery life is one more approach. For instance, a node with low energy could lower its transmission power or try to transfer packets via other nodes with greater energy reserves. Some power-aware protocols also include energy-aware load balancing and sleep scheduling to guarantee balanced distribution of node energy resources throughout the network.

Furthermore, power-aware routing protocols might consider node mobility as well. A protocol that is ignorant of the mobility pattern could choose a route that becomes ineffective or unavailable when nodes move out of range since nodes in MANETs might migrate unpredictably. Power-aware protocols might have systems for monitoring node mobility and changing routing pathways to reduce energy waste generated by node movement. This calls for the protocols to be very flexible, able to react fast to changes in the network architecture and offer efficient routes in real time.

II. REVIEW OF LITERATURE

Lonkar, Bhupesh & Karmore, Swapnili. (2022) Nodes, routers, and base stations that utilize less power are used in distributed wireless networks. Energy is lost by routing algorithms since transmission and reception are distance dependent. Wireless network low-power routing methods are developed by researchers. Every method has its own set of benefits, limitations, and potential avenues for investigation. There is a wide range of protocols when it comes to computing complexity, energy consumption, latency, throughput, and packet delivery ratio (PDR). Different performance metrics make it impossible for researchers to select optimal context-aware network models. In order to alleviate doubt, this article discusses the strengths of application-specific deployments. Researcher selection of context-specific routing models may be aided by this debate. The essay examines several performance measurements of power-aware routing models. Routing models for low-delay, high-throughput, high-PDR installations, etc., may be constructed using this comparison. An algorithm rank score (ARS) together with performance indicators is suggested in this research. To strike a balance in performance across several evaluations, network designers could use high-ARS routing models.

Onuora, Augustine et al., (2020) Over the past few decades, network routing has emerged as a hotspot for academic interest in computer networking. Both wired and wireless networks have been the subject of much study. New opportunities for studying network routing technology have emerged as a result of recent developments in the field. There has been a significant uptick in research on ad hoc networks, including WSNs, VANETs, WMSs, and MANETs. In light of the fact that many of the devices we use today are portable, the researchers set out to conduct a thorough evaluation of the many routing protocol technologies available for usage in MANET network routing schemes. Analyses of various kinds, categories, routing methods, coverage areas, metrics, repositories, and reconfiguration strategies for routes. The paper's focus was on comparing and contrasting the various routing methods. The protocols' strong points were displayed. This research also included network simulators that had these protocols pre-installed.

Elsadig, Muawia. (2018) MANETs have recently received a lot of attention because of the many significant roles they play in several fields, such as civil, military, and health. Locations that are inaccessible to humans, as those affected by natural disasters, may be reached by this kind of network. The routing procedure remains a significant obstacle in MANETs because of their highly mobile nodes and changeable topology, despite the fast advancement of MANET technology. An examination of many widely used MANET routing protocols is detailed in this work. Using throughput, end-to-end latency, and data packet delivery ratio as important performance metrics, this inquiry seeks to assess the performance of MANET routing protocols. These metrics are often used in these kinds of assessments. Based on our research, DSR and AODV are better than DSDV. The AODV is more effective in a low-density network than the DSR, while the reverse is true in a high-density network (one with many nodes). Thus, AODV is best suited for big networks, but DSR works well for smaller ones.

Arya, Vivek & Gandhi, C. (2015) Wireless networks that do not have a fixed infrastructure are known as mobile ad hoc networks. Included in it are mobile nodes that communicate wirelessly to keep the network online. Their decentralized nature makes them highly deployable in times of crisis or as needed. Nevertheless, MANET nodes rely on a finite amount of battery power. So, for an ad hoc network to operate as a whole, effective energy saving is crucial. In an effort to achieve energy efficiency via routing techniques, several energy conscious routing protocols have been created. To extend the life of nodes and, by extension, networks, many techniques have been devised. Energy conservation in mobile ad hoc networks is the focus of this research, which examines recently suggested protocols and techniques.

Mishra, S. & Pattanayak, Binod. (2013) Power Aware Routing takes into account factors such as energy consumption while routing traffic, total network node power consumption, overhead, etc., in an effort to maximize the network's lifespan through the use of specific Power Aware Routing Protocols. Since the amount of time that mobile nodes may be online is the most crucial constraint, designing MANETs with the purpose of providing power-efficient routes is more difficult than ensuring that routes are accurate and efficient. In this study, we take a look at MANET power-aware routing protocols and sort them into categories. In doing so, they reduce the amount of power needed for active communication (sending and receiving packets) or for passive communication (a mobile node sitting idle listening to the wireless medium for other nodes' probable communication requests), depending on the situation. By controlling transmission power, distributing loads, and managing power, active communication energy can be minimized. On the other hand, inactive communication energy can be minimized by switching to sleep or power-down mode and making use of power-aware metrics such as energy consumed per packet, time to network partition, variance in node power levels, cost per packet, throughput, end-to-end delay, packet delivery ratio, and so on. Every protocol has its own set of pros and cons, and some work better than others. This paper's goal is to make it easier for researchers to combine current methods in order to provide a routing mechanism that uses less power.

Mohsin, Ahlam et al., (2012) The high energy consumption of route discovery and collision avoidance, respectively, is a big concern with the present routing and MAC layer protocols for MANETs. Reducing the number of retransmissions and, by extension, bandwidth and power consumption, is a goal of several algorithms that make good use of location information and dynamically adjust the retransmission probabilities of intermediate nodes; however, this success came at the expense of network reachability. There were a lot of other writers that tried to attain better power saving. In order to help researchers in MANET energy conservation and provide a solid foundation for developing energy conservation algorithms, this paper reviewed some current literatures that proposed improvements to MANET energy conservation at the MAC and routing layers. It also highlighted the performance demands required of these protocols.

III. SIMULATION SETUP

The Mobile Ad Hoc Network simulations were activated with the help of NS-2.29. In the initial 1500x300 region, there are 50 nodes dispersed randomly in the simulated Mobile Ad Hoc Network. Using the setdest tool, we built mobility scenarios for the nodes. Each node in the network moved at a constant pace of 20 m/s throughout the simulation, and there were seven distinct pause durations, from zero to sixty seconds. When calculating the energy routing protocol's efficiency in MANET, many network performance indicators, including power consumption, network lifespan, and residual battery power, are input. Pictured in Figure 1 are the settings of the simulation parameters used to assess the routing protocols' performance. Along with the accompanying simulation settings, they were written using the tool command languages EPAR.tcl and MTPR.tcl.

Simulation Parameters	Values
Number of nodes	50
Area size	1500x300
Mobility model	Random way point
Traffic type	CBR
Packet size	Packet size
Queue size	50
Bandwidth	2Mbps
Routing protocol	EPAR, MTPR
Initial Energy	100J
Communication system	MAC/IEEE 802.11
Maximum packet size	10000

Figure 1: Simulation Parameters

In Fig. 2, we can see a snapshot of the MANET simulation setup for the EPAR power-aware routing protocol. It has fifty nodes in the NAM window. This is a mobile ad hoc network, thus all of the nodes are always going somewhere. The role of node 2 is that of receiver, whereas node 1 undertakes the role of transmitter. Network node 1 is transmitting data packets over the airwaves since these protocols are reactive routing protocols.

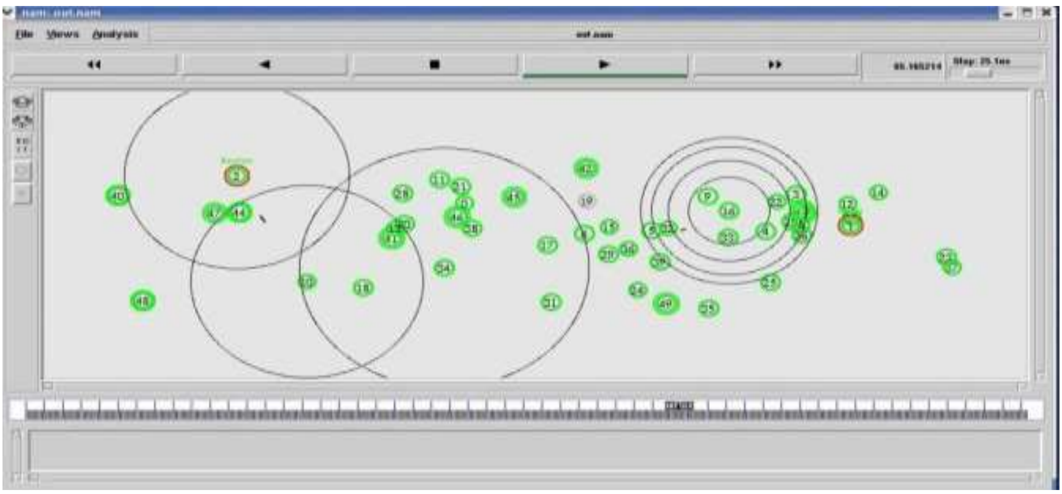

Figure 2: EPAR power aware routing protocol in MANET

IV. RESULTS AND DISCUSSION

Figure 3 illustrates the power consumption performance parameter of MANETs with EPAR and MTPR. Upon transmitting three thousand data packets, the MTPR utilizes 82% of the electricity, whilst the EPAR uses just 48%. EPAR has commendable performance efficiency.

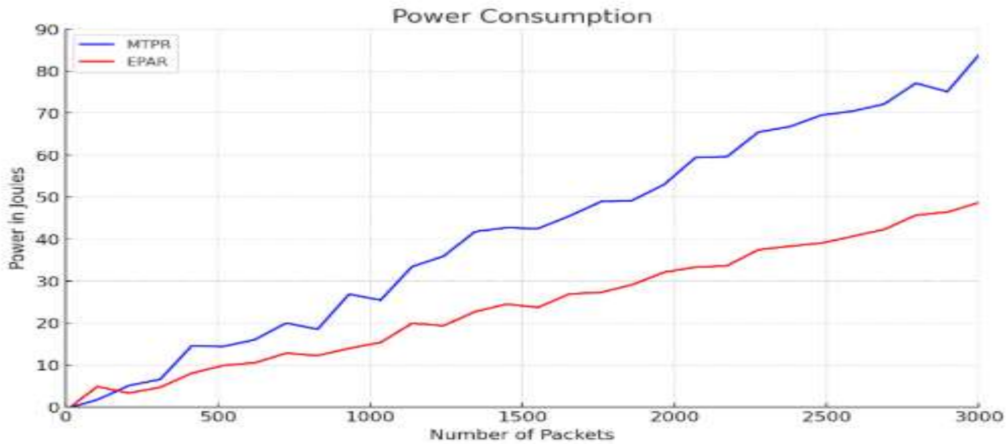

Figure 3: Consumed power performance metric of MANETs using EPAR and MTPR

Using EPAR and MTPR, MANETs' residual battery power performance parameter is shown in Fig. 4. Nodes start with 100 Joules of battery power. Once three thousand data packets have been sent in the MANET simulation, the remaining battery power drops dramatically. The power increases to 52% in EPAR terms, but only to 18% in MTPR terms. When comparing EPAR with MTPR, the difference in remaining battery power is clear. Indeed, EPAR is leading the pack with MTPR.

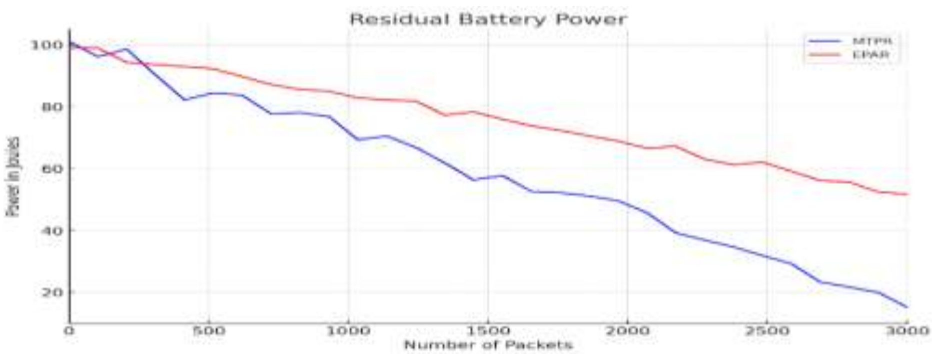

Figure 4: Residual battery power performance metric of MANETs using EPAR and MTPR

Using EPAR and MTPR, MANETs' network lifetime performance statistic is displayed in Fig. 5. The scenario concludes with EPAR's Power at 52% and MTPR's at 18%. A longer network lifespan is thus achievable with EPAR compared to MTPR.

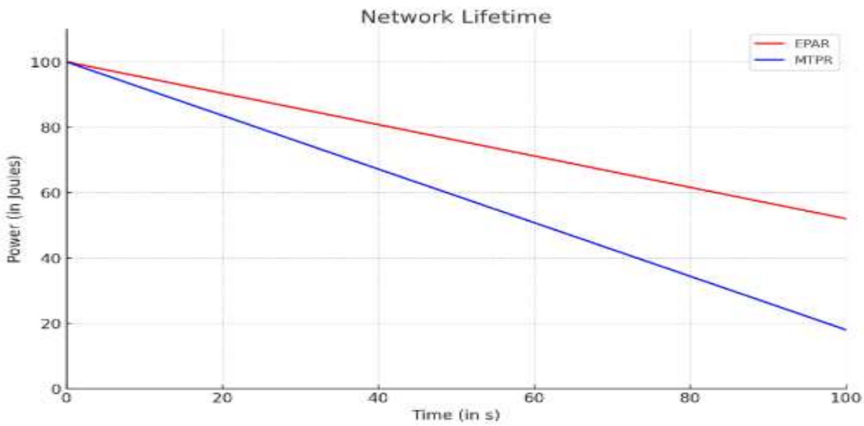

Figure 5: Network lifetime performance metric of MANETs using EPAR and MTPR

V. CONCLUSION

When comparing EPAR and MTPR as routing protocols for MANETs, the results show that EPAR provides more energy efficiency and longer network lifespans. Eppar clearly beats MTPR in simulations when it comes to important metrics like power consumption, residual battery power, and network longevity. These findings make EPAR a better choice for uses where energy efficiency is critical, as they demonstrate the significance of energy-aware routing in prolonging the operational lifetime of MANETs. In order to create communication systems that are more resilient and efficient in contexts that are constantly changing and have limited resources, this study emphasizes the possibility of EPAR optimizing energy consumption in mobile networks.

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