A STUDY OF THE ENERGY AWARE ROUTING PROTOCOL (EARP)FOR Ad-HOC WIRELESS SENSOR NETWORKS

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Abstract

Wireless ad-hoc sensing devices set themselves apart from other wireless ad-hoc networks with their low power, light weight routing techniques, and adaptive transmission patterns. For ad hoc wireless sensing devices, this paper proposes an energy-aware routing protocol (EARP) and examines the energy consumption of the routing protocol and servicing phases. According to the energy consumption associated with reactive routing processing, EARP advises reducing route demands by offering route selection expiry durations. In a mobile ad hoc network, the devices are frequently battery-operated. The battery's power capacity determines how long a node can last. Each message sent and calculation run drains the battery. One strategy for managing power in wireless ad hoc networks is power awareness transportation. The energy supply of the network's devices are utilised more frequently on average and over time when pathways with lower reluctance levels are chosen. This suggests that the routing decisions made by the routing protocol must take the nodes' power states into account. The life of the node will be prolonged since nodes with low batteries will receive less packet forwarding preference than nodes with full batteries. A routing algorithm should seek to minimise control packets, such as recurrent patch messages, in order to prolong the lifespan of the endpoints and network. However, not all relay nodes and consciousness routing powering strategies are suitable for successfully implementing aware routing. This study suggests a novel method for calculating route expiration time that takes into account mobility, hop count, and time dependence. Unlike AODV, EARP maintains valid routes for longer periods of time, preventing recurring saturation of route discovery.

Keywords: Routing Protocol, ad-hoc wireless sensor networks, nodes, energy aware, data packets

1. Introduction

Ad hoc networks are wireless multi-hop networks that arise spontaneously with no equipment. They may be placed anywhere and do not require any fixed equipment, like as ground stations. The nodes self-configure into a connection and work together to preserve network access. If 2 nodes desiring to interact are not inside broadcasting distance of each other, an intermediary node is employed to forward packets. As a result, each node serves as both a router and a host. The nodes exchange topology data in the shape of control packets to find multi-hop paths to each other. These networks are generally used in situations when there is no or insufficient equipment, and quick network setup and self-configuration are necessary. Soldiers on the front, for instance, can use cellphones to communicate with one another, and in emergency scenarios like as disasters, where current technology has been damaged, an ad hoc network could be quickly built to aid in emergency preparedness. Sensor systems are a type of ad hoc network in which a number of sensors able to take a variety of measurements communicate with one another.

Forwarding in ad hoc networks has received a lot of attention in recent years [1–6]. Source started (responsive demand), table directed (constructive approach), and hybrid protocols are the three types of traditional routing systems. The paths are not calculated until they are required in source started protocols. [7] The packets will experience a route calculation delay as a result of this. Table-drivenprotocols are employed in circumstances where this delay is unacceptable. Routes to all locations are pre-computed and saved as routing tables in these technologies. Forwarding table upgrade packets are exchanged between the nodes on a regular basis to keep their forwarding table up to date.

[8]These early routing protocols are primarily concerned with preserving network access in a dynamic setting, and they primarily address concerns such as multipath routing and administration. MANET is a self-contained network of mobile nodes linked by wireless links. MANET was a wireless system that has no fixed structure or centralised control and consists of mobile nodes that are dynamically joined in any way. [9] Wireless networks are widely grouped into two types depending on network. The first category of infrastructure networks includes base stations. MANET, the second generation, allow people to interact without the usage of any infrastructure facilities, independent of their geographical area. [10]

Each node functions not only as a terminal, but also as a packet forwarding node. The units are able to move around and form a network on their own. [11] Emergency relief efforts and warfare are two of the most common uses for mobile Ad-Hoc networks. The goal of this research is to solve the problem of safe power awareness transportation in order to extend the network's lifetime. [12] The topology of a MANET can alter freely and often at unforeseen times because network nodes can relocate at random. The topology may be influenced by sending and receiving factors. As a result, finding and maintaining an ideal power aware path is quite tough.

By encoding control and data packets, encryption means that snoopers will not be able to understand the data passed across the network. [13] Authentication protects against fraud and validates the nodes' identities. Packet integrity ensures that packets are not tampered with or altered by an opponent. Wsns are discrete components with short battery life and no energy backup; they are intended to be used only once. As a result, a low-energy routing strategy would result in longer sensing lifespan and improved network efficiency. [14] The domain of navigation in ASNs is undergoing active investigation. Since the development of dynamical destination sequenced DSDV, a lot has changed in ad-hoc routing. ARPs like AODV and DSR are quite popular and well acknowledged. [15]

In the literature, various DSR and AODV approaches have been proposed; one such approach may be found in [6]. SARP, which adds the route caching capabilities of DSR to AODV to achieve improved efficiency, is also given as an upgrade to AODV. [16] An EARP dependent on AODV is presented in this study. This study examines the issue of frequent path expiry in detail, and proposes a criterion for statistically estimating route relevance time. As a result of this criteria, the number of route discovery is reduced, which increases fuel efficiency.

Because ad hoc networks are typically battery-powered, conservation of energy is a major concern. When a node functions as a router and transmits packets for other networks, its battery is depleted even if it has no messages of its own to send. [17] Unlike the microprocessor and communication hardware industries, where processing capabilities and line rate were steadily enhanced (every 18 months on average), battery tech has remained basically unaltered for many years. The battery's lifetime limits the number of hours an ad hoc network can operate. [18] In recent years, research into energy-saving strategies for mobile ad - hoc networks has exploded. Researchers are looking into saving energy at every layer of the standard protocol stack, starting with the radio layer and working their way up. At the protocol stack, data connection layer, and data link, massive energy reductions were achieved. At the broadcast layer, low-power devices, energy-efficient encoding, and a low transmit power level are some of the primary technologies used. To keep the link connected, the minimal transmitting power level is employed, which improves power conservation while reducing interference.

Power-saving data transmission methods at the data link layer are meant to coordinate the nodes' switching between resting and monitoring modes. It's also worth noting that the protocol levels in mobile power-saving techniques are tightly connected. The estimation of the minimal maximum transmission level, for instance, sometimes relies on GPS-enabled network applications to determine the nodes' geographic coordinates. The routing informationexchange structure at the protocol stack has an impact on the deployment of resting mode in the link layer. [19]

In response to the need for conserving energy at the network level, EAR protocols have been proposed. The energy used by the networks to transmit data packets is referred to as the energy used by the connectivity subsystem. The energy needed for data analysis and other supplementary processing is not taken into account because computing energy varies depending on each node's mission and is typically insignificant when contrasted to the energy needed by the transceiver module. One of the first goals of EAR was to find the optimum route such that the channel's total energy consumption was as low as possible. As a minimal energy issue, this issue has been handled.

2. Protocol for energy-aware networking

2.1. Routing metric for maximum lifetime of the system

Efficient power routing techniques are built at the network layer to find the optimum way so that overall energy consumption is minimised or system lifetime is maximised. The shortest path techniques are used, but rather of the simple hop count measure, more carefully constructed power-aware cost measurements are used. There have been suggested power-aware measures for defining routes with diverse aims. The following is a statistic that attempts to optimise the longevity of all network nodes:

$$c_j = \sum_{i=1}^{k-1} f_i(x_i),$$

wherecj represents the cost of transmitting packet j from network n1 to nodes nk via intermediary nodes n2ynk 1; xi is the total amount of energy spent by node I thus far; and fixi is node i's cost or mass: We chose fi because it symbolises a node's unwillingness to forward data.

$$f_i(x_i) = \frac{1}{E_i - x_i},$$

wherefixi represents the actual price of using network I xi represents the energy wasted by node I thus far (notice that xi is time-varying); and Ei represents the beginning energy of unit I when the network is established. As a result, fi is the inverse of node i's remaining energy: As a node's power declines, the cost of using that node rises.

2.2. EAR Performance

When there are several paths from an origin to a destination, EAR alternates between them and tries to distribute the load by optimising residual energy. As a result, the system lifespan will be longer than with traditional routing methods. We simulate its efficiency and contrast it to that of traditional ad hoc routing methods. The GloMoSim package, that is a modular simulation framework for wireless communication networks, is used to implement all of the simulations. The routing process was CBR, with each packet being 512 bytes. An extrapolation with a mean of one message per second is used to create the transmission rate between each sender and receiver (a session). Each simulationset has a different number of sensor nodes and events. When evaluating different protocols, however, we rendered each simulation's settings identical. We only include the energy required by communication components in our model, as practically all EAR systems do. Before the network was deployed, each node was given a set quantity of energy/battery reserve (20000 energy units). We believe that the expense of a node sending or receiving a packet may be characterised as the linear sum of the two portions below: a fixed cost connected with channel allocation cost and an additional cost proportionate to data packets.

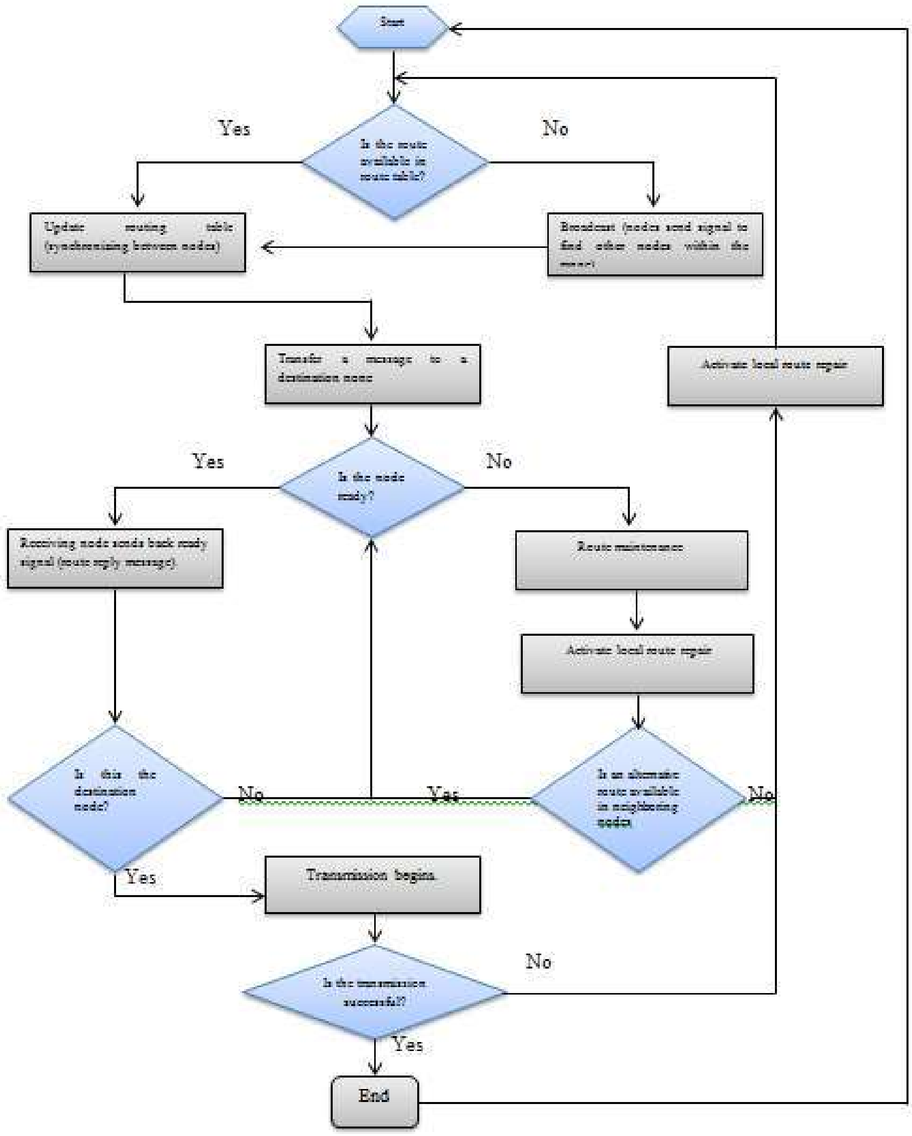

Figure 1 AODV routing protocol diagram

2.3. EARP:

Using energy-conscious parameters The connection and route costs are computed by energy-efficient routing methods. The min-max optimal routing method is used in energy - aware routing protocols. Conventional route discovery systems start the route discovery process by transmitting a request, which is supposed to be heard by nearby nodes, who then rebroadcast the packets. Everyone can now hear the retransmission packets. The request is ignored by a network that has previously rebroadcast it. Lastly, the destination node responds to the request that it has received. However, the most energy-efficient method is not determined until the end of the procedure. As a result, these protocols' path discovery mechanisms must be tailored to be fuel efficient.

2.4. Route maintenance that is energy conscious:

Route maintenance is often performed only when connections are disrupted due to the use of generic error packets. There is no way to communicate a change in link quality or energy cost needs as a result of node mobility. Modifications in the energy prices of the connections must be monitored on a regular basis to ensure that the amount of energy spent is kept as low as feasible. The transmission power must alter in response to the movement of terminals. When networks draw closer together, it must drop to save energy, and it must grow to maintain the relationship if it travels away. As a result, these variations in energy costs must be communicated to the source point.

2.5. Parameter of design:

The proposed method is created with the following factors in mind. For analyzing the two distinct configurations and verifying the result, the identical parameters are employed.

2.5.1. Packet Delivery Fraction (PDF):

It's the percentage of the actual data packets received correctly by gateway node to the number of data packets sent by destination node. The PDF measure is crucial because it indicates the rate of loss, or the maximum capacity that the system can tolerate. Packet conflicts at the 802.11 layer, system partitions, routing loops, and interface queuing drop are all reasons why packets may well not arrive at their destination. The PDF format is as follows:

$$PDF = \frac{\text{Number of packet Recived by the Destination}}{\text{Number of packets send by Source}}$$

A high PDF value implies that the majority of packets are transported to the higher levels, which is a good sign of protocol efficiency.

2.5.2 Energy Used for Efficient Data Delivery:

ECSDD is the organisation that represents it. It's the proportion of overall network energy usage to the number of info packets sent to the sink correctly. Except for MAC layer controls, the system energy usage comprises all power usage.

$$ECSDD = \frac{\sum_{k=1}^{N}(E_{ik} - E_{rk})}{\text{Total number of packet recived}}$$

Where Eik- represents the beginning energy of network k, Erk- represents the node k's remaining energy value at the end of the test, and N- represents the amount of nodes in a network. A lower ECSDD number indicates that the majority of the packets are sent with less energy, indicating that the protocol has improved its fuel efficiency.

2.5.3. VRBE:

It's a straightforward indicator of energy balance that can be utilised to extend the life of a network. The computed value shows whether the transport strategy has utilised an excessive number of sensor nodes. Because it is a metric of protocol impartiality, this is a critical performance measure. As a result, the desired value for this statistic is as near to zero as feasible. The smaller VRBE suggests that each network device is equally essential, and that no one node should be penalised more than others. It's written as,

$$V_{RBE} = \frac{\Sigma_{k-1}^{N}(E_{rk} - \mu)^2}{N}$$

$$\text{Where} \quad \mu = \frac{\Sigma_{k-1}^{N} E_{rk}}{N}$$

2.5.4. NL:

It's one of the most essential measures for assessing routing methods' energy efficiency in terms of network division. The loss of the initial cluster in a WAN, especially when the nodes are widely spread, seldom results in the network's entire failure. With an increase in the number of dead nodes, the network becomes partitioned. Even if the system is partitioned, end-to-end transmissions can still be achieved if at least one set of nearby nodes remains operational, as they can broadcast to one another and keep the system alive. As a result, NL can be characterized in a variety of ways.

1. It can be described as the amount of time it takes for K percent of a network's nodes to perish.
2. The network's lifespan under a particular flow can be defined as the time till the battery runs out.

2.6.Algorithm Proposed

1. Construct a simulator instance.
2. Make a nam and a trace file.
3. Configure node layout
4. Make a node

5. Assign all nodes to their initial placements.
6. Choose a source and a target node.
7. Using the formula below, calculate the entire time of flow.
Total time equals the difference between the start and stop times.
8. Calculate the energy needed to transmit all messages inside a flow based on the overall time of the movement. We use the energy model for this computation, which reveals that the energy used in conveying an information of size D bytes at a signal strength of pt may be stated as

$$E(D, p_t) = (k_1 \times p_t \times D) + k_2$$

In a two frame interchange 802.11 MAC context, the usual values for k1 and k2 are 4s/byte and 42Joules, etc, at maximum throttle (280mW) and 2 Mbps bit rate.

9. Determine the length between the source and the destination nodes and compare their energy levels.
10. The quadrant is generated by using the source address as the origin once the source and destination have been specified.
11. Determine the distance between the origin and destination nodes. Attach agents to the node, construct a forwarding table for each device in this flow, and start delivering data if the range becomes less than 200m and both have enough power to send all packets.
12. If the range between the origin and sink nodes is larger than 200 metres and both nodes have enough energy to send all packets, the next will happen.

3. SIMULATION AND RESULT

3.1. Simulation Environment

The ns-2 simulator is used to simulate the proposed method. Wireless scenarios are included in the setup. To run the program for the proposed method, changes were made to the files "mobilenode.cc" and "mobilenode.h" to obtain energy feedback, which was accomplished using the patched NOAH implemented in the ns-2 simulator.

The configuration comprises of a test bed with 50 nodes enclosed in a bounding box of 1800 x 840 Sq.m. Each node has a starting energy of 1000.0J. Because it is more realistic, we employ TwoRayGround. The duration of each experiment is determined by the requirements. The number of nodes is used to assess the scenario. CBR is used to create traffic. Each payload is 512 bytes in size. For every scenario, the system size and number of sites are maintained while the number of sources-destination pairings inside the network is varied. The model parameters are listed in Table 1.

Table 1: Parameter Simulation

Parameter	Value
Antenna design	Omni Antenna
Channel design	Wireless Channel
A Node's initial energy	1000.0 Joules
Type of interface queue	Drop Tail OR Pri Queue
Type of MAC	797.09
Maximum number of packets in queue	98
Type of network interface	Wireless Phy OR Phy
Number of nodes	30,23,40,34
Packet Size	1024 Bytes
Radio-propagation Model	TwoRayGround
Routing protocols:	EEPARP
Rx Power	1.00 W
Topographical Area	1700 × 800 Sq. m
Total simulation Time	according to the requirements
Traffic Model	FTP
Tx Power	1.00 W

The simulation makes it easier to analyse and verify procedures, especially in large-scale organizations.

4.2. Results Analysis

The initial scenario for the nodes network has been set up as shown below.

4.2.1 Setup-

In the first configuration, the number of sensor nodes is set to 25, the pause time is set to 25 milliseconds, the data packets in the queue was set to 100, and the size of every packet is 1060 bytes. Completing the simulation generates a graph for average latency, PDR, output, and residual energy. Figure 2 depicts a normal view of the nodes' locations for setup-1, which has 25 nodes.

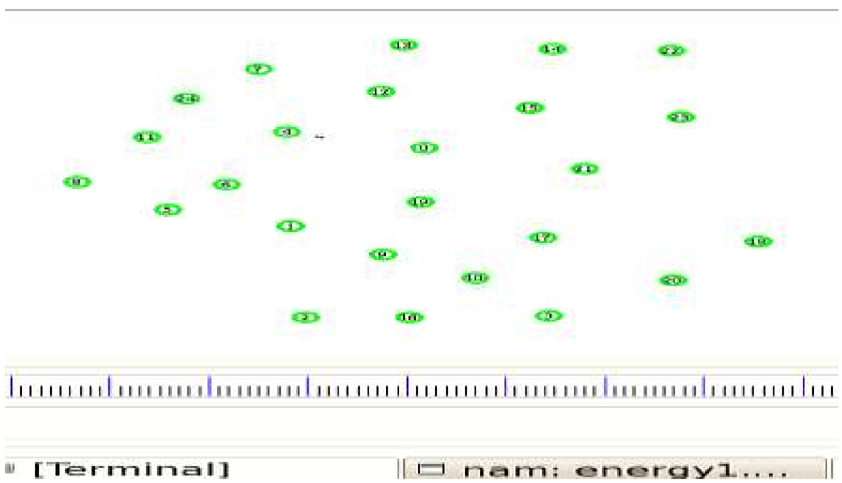

Figure 2 Snapshot of a 25-Node Simulation

3.2.1.1 Average E-E delay Vs Pause time

The chart for average latency vs. pause time is shown in Figure 3. From beginning to end, the average The average amount of time packets need to get from one end to the other is referred to as delay . Because the latency will be the identical for all additional flows, the graph is only for the first flow.

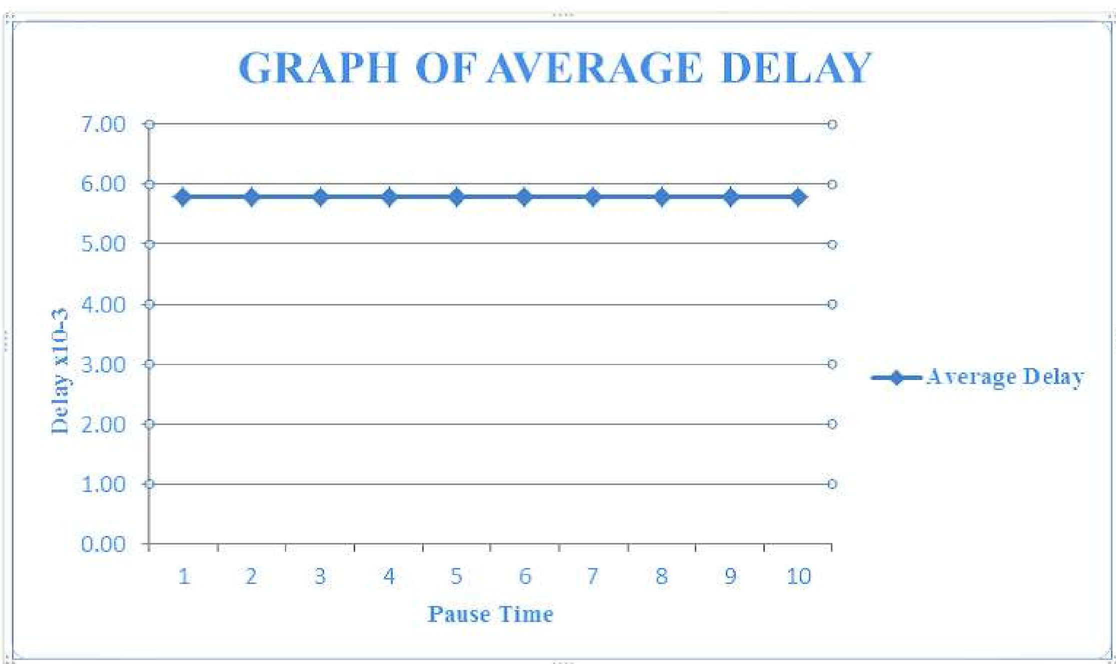

Figure 3 Average E-E Delay vs. Pause Time graph

The delay stays unchanged once the route is set, as shown in the graph above. The delay has remained unchanged.

3.2.1.2 PDRVs Pause time

Figure 4 depicts the PDR graph for a 25-node simulated scenario. The PDR for a 25-node system is found to be 89 percent. PDR is really high.

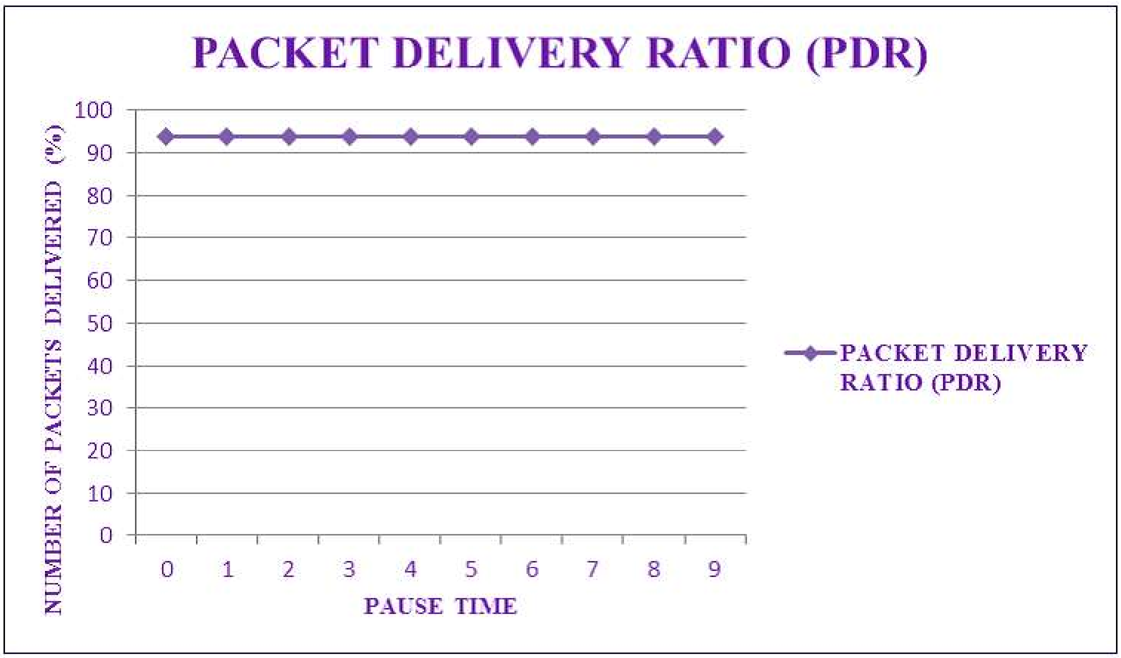

Figure 4 PDR Graph vs. Pause Time

3.2.1.3Graph of Remaining Energy

The leftover energy of nodes involved in the routing is depicted in Figure 5. The needed data power of all network participants is between 876.98J and 986.0702J after transmission. At the completion of the data packets, the residual energy supply of all nodes is adequate, as shown in the graph. This indicates that nodes are healthy at the conclusion of propagation, that is one of our paper's goals..

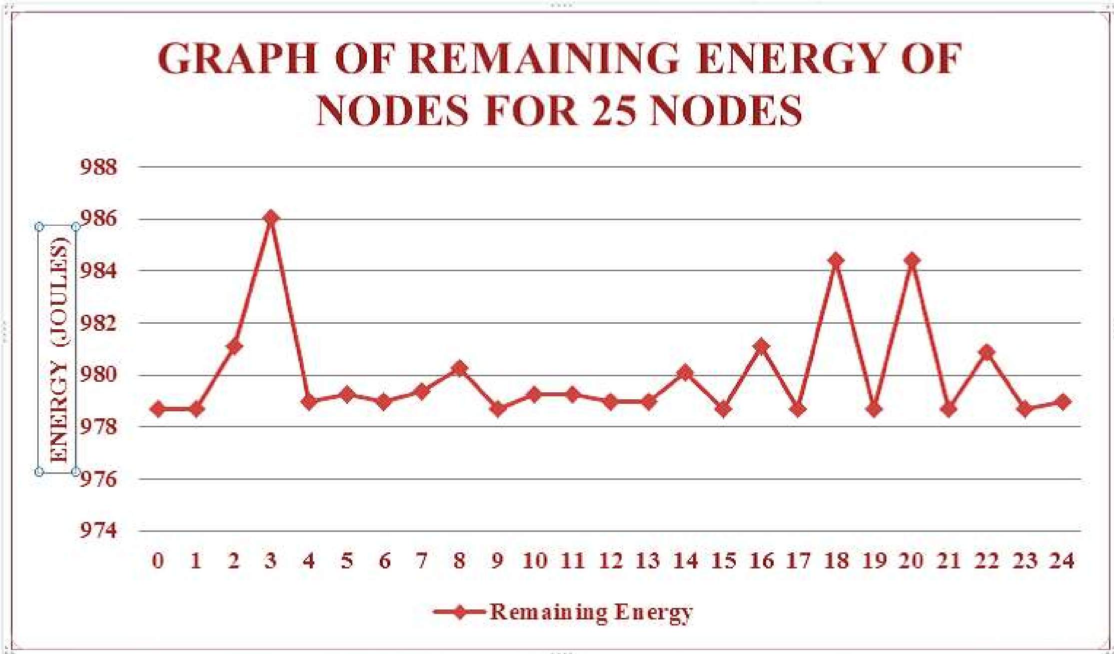

Figure 5 Graph of Node Leftover Energy

3.2.1.4 Time to Pause vs. Bandwidth

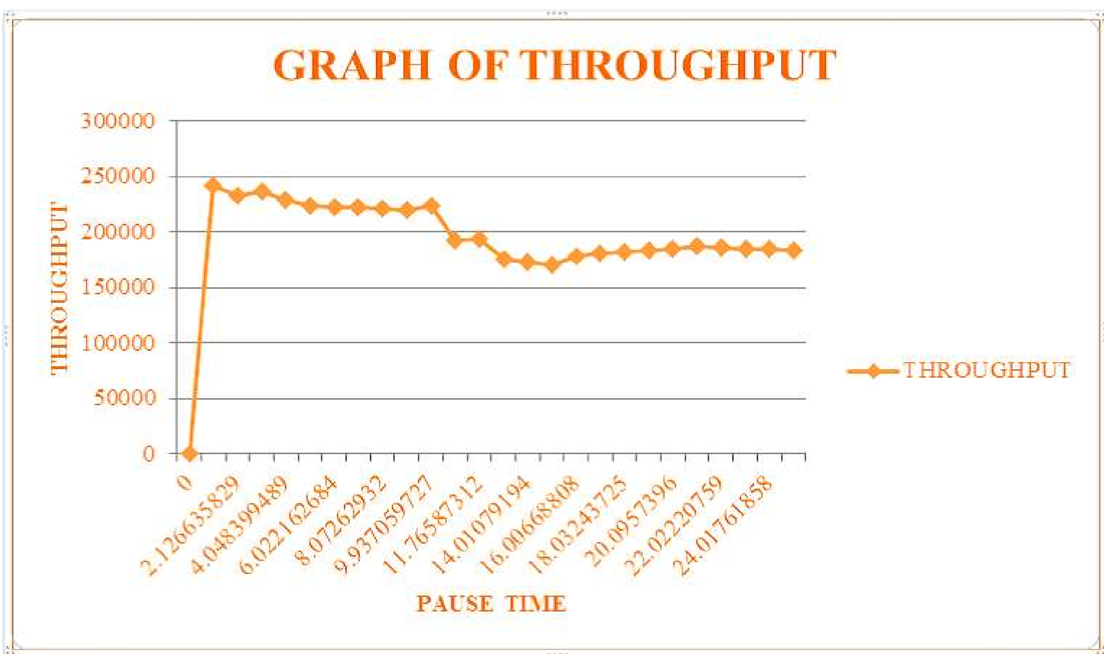

Figure 6 For a 25-node simulation process, a graph of performance vs. pause time is shown.

Throughput is a metric that compares the number of packets transmitted and received to determine the routing algorithm's effectiveness. The chart for throughput vs. pause time is shown in Figure 6. Because the consumption of available bandwidth is primarily for path setup at first, throughput improves with the time steps, but as the pause duration increases, it settles and uses the bandwidth utilization to its maximum capacity. The graph demonstrates that the approach may be used to larger density configurations..

4.Conclusion

MANETs have become more popular in recent years as a result of their unique form of network. MANETs, which are swiftly deployable and dynamic civilians and soldiers systems, have been employed for connectivity in recent times due to its convenience of installation, lack of infrastructure requirements, and a variety of other benefits. Due to the fast change in topology of the network in MANETs over time, routing methods in MANETs face new challenges, as classic routing techniques may not be suited for MANETs. One presumption is that a site can hear any broadcast signal delivered by other nodes in the similar subnet. Due to restricted bandwidth, it may not be true for endpoints in a cellular network. As a result, routing algorithms face significant hurdles as a result of this network paradigm. Furthermore, some protocols are unable of effectively handling network nodes. Before any network functions are standardised using simulations, academics are inventing new MANETs routing algorithms, evaluating and upgrading current MANETs routing algorithms. Apart from the problems listed above, another that is equally essential is network long life, which is totally dependent on the battery capacity and usage of the node in question.

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