

Power Optimal Location Based Routing protocol for IOT Based Ad Hoc Networks

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Abstract- People as well as other wired or wireless devices are multiplying at an exponential rate, and they must all be able to interact with one another wherever they are. In the age of future ad hoc base networks and the Web of Things, all self-configured & mobile devices require a dependable end-to-end communication path stated as "Internet of things". It is therefore envisaged that such a location-based routing algorithm would be efficient in selecting the best path while consuming less energy (battery power), thereby increasing the overall network life. Furthermore, each node's location is determined via the Global Positioning System. Due to the fact that all linked devices use batteries, we present in this study a cutting-edge routing mechanism called Power Optimum Location Based Routing Protocol for Internet Of Things and or Ad hoc Network (POLRP-IOT) which enables us to select the best route while consuming the minimal amount of energy. Furthermore, simulation findings demonstrate that the proposed method outperforms existing benchmark protocols including DSR, LEACH, or AODV.

Keywords: IOT; Ad hoc Networks; Location centric; Energy Efficient.

I. Introduction

Mobile devices may connect with one another and self-configure without the need of a centralized access point. This is what mobile device networks, or MANETs, which first appeared in 1970, are built of. An ad hoc network's nodes each keep track of a routing data to ensure connectivity. As a result, inside an ad hoc network, routing is a challenging task. Additionally, both wired and wireless devices now place a greater emphasis on integrating with the "IOT" environment due to the increasing growth in the world population in addition to other utilities. The acronym IOT stands for Internet of Things. Things include anything capable of having an internet connection. Common entities that objects can represent include users, gadgets, and sensors. Since each object may be configured to interact with a variety of other things, computing can be done from any location at any time. It stands for freedom

in both space and time. IOT thus demands universal computer connectivity [2]. Furthermore, integrating IOT with only an ad hoc system permits cross-device communication.

A. IOT and Ad hoc Network

IOT can only be used in conjunction with an ad hoc network because in today's communication environment, each node must be able to recognize, interact with, and work with other nodes in order to provide a better level of service. Because these nodes are energy-constrained, IOT and or Ad hoc networks' main objective is to utilize the energy at hand as effectively as feasible [3]. The fundamental goal of such an Internet - of - things ad hoc system is to reduce the total energy used by nodes when providing data by trying to identify the shortest and most efficient route for data transmission. Additionally, effective energy use is essential to maintaining network

connectivity (battery power). A perfect routing option must also be provided for such an IOT ad hoc network[4] in order to increase network lifespan by lowering overall power consumption.

B. Mobility and Location metric in Routing

Ad hoc networks' architecture is dynamically altered in both temporal and spatial configurations. As a result, it is challenging to pinpoint the location of the each moving node. Because Manet's efficiency routing is dynamic, location information is frequently paired with data on the node's velocity and direction of movement, which helps pinpoint the node's precise location [5]. Additionally, using distance as a routing parameter, which is the most fundamental method of location-based routing, is not practical because of mobility & radio wave properties. Other characteristics, like as link quality, that is significantly decreased when shielded by such a tree or a structure, are also helpful because distance impacts signal strength. As a result, in just this instance, signal strength rather than distance can indicate the quality of the route. Node speed also affects stability and quality. Being a node that moves quickly, link breakage is more likely to occur. As a result, information from of the Global Positioning Systems (GPS) may be used to base a method for figuring out the direction and speed of a node's movement [5].

Several academics have suggested location-based position aware routing strategies that, to name a few, effectively transmit data in ad-hoc networks. Location Aided Routing (LAR), Distant Route Effect Algorithms using Mobility (DREAM), Greedy Perimeter Stateless Routing (GPSR), and others are among them. This Position-Aided Routing (LAR) protocol utilizes node location data from such a GPS system or possibly another location device in order to determine the requested zone or expected zone prior to forwarding data packets [40]. Using geographic sources to direct traffic (GSR) [41] GPSR is ineffectual in urban environments because it depends on dispersed methodologies for graph planarization, according to recent study [42]. Geographic Stateless Route (GeoSVR): In just this study, stateless routing is linked to a vehicle's location and a digital map.

C. Energy (Battery power) metric in Routing

To store energy, every node uses batteries. Energy efficiency is just a crucial concern as a result. Numerous important variables, including the frequency of packet transmission and reception, have an impact on a node's energy usage. An energy-based route metric is always focused on two essential aspects. Start by lowering overall power usage. In order to improve communication, second, optimize network longevity [6]. Various researchers have also put forth numerous routing mechanism, with such a focus on plans that adapt a routing protocol, sleep behavior, effective coordination, data aggregation process, hop division, as well as cluster divisions, among other things, to take individual contributions out of each node toward the energy efficiency.

D. Objectives

- a) Providing an overview on IOT with ad hoc networks is the main objective of this study.
- b) To supply location-based routing for ad hoc IOT networks.
- c) To lessen the total power used by the Route.
- d) To propose the location-based routing mechanism for an IOT-ad hoc network with the maximum energy efficiency, which will help in selecting the ideal path with least amount of power consumption and lengthen the total network lifetime.
- e) To assess how the proposed protocol stacks up against earlier benchmark systems like DSR, LEACH, and PODRP.

E. Contributions

This research proposes a power-optimal location-based routing method for IOT Ad hoc networks to reduce total power consumption and prolonging network lifetime. This Radio Heat Dissipation method is also used to find the best and shortest route in terms of energy consumption (battery power) [7]. To optimize the chosen route, node locations are recorded, tracked, & compared to determine the closest node. The simulation results further demonstrate that POLR-IOT is appropriate in IOT-based Ad hoc networks and scored more effectively in terms of the selected performance metric.

F. Motivation

A network with mobility-capable nodes makes up IOT-Ad hoc, which is a self-contained system. A

decentralized, ad hoc network is used by the nodes to communicate with one another [3]. As a result of the fact that all nodes are battery-powered, it is also necessary to utilise a routing system that is effective and uses less power while preserving network longevity.

G. Organization of paper

The collaboration between the IOT & ad hoc networks was introduced in Section 1 of a article. After that, we talked about numerous routing issues related to location and energy use, problem formulation utilising research questions, and the goal, significance, and inspiration of research activity. A comparison table is used in Section 2 to assess the summaries of related publications. In Section 3, the suggested routing protocol is provided. In Section 4, the computational complexity, the packet arrival rate, the network lifetime, and the power consumption of the proposed routing protocol are theoretically analysed. In Section 5, you can review the simulation models, settings, and performance. Comparing the results to the current routing protocols is also helpful.

II. Literature Review

Routing for IOT-based ad hoc networking is among the most fascinating communication network research areas. There are several scholarly articles in this area. The shortest path between communication nodes is chosen as one of the network factors that can be utilised to optimise routing, as well as a number of other performance characteristics, which are provided in tabular form in Table 1.

Since the early 1980s, researchers have created a variety of routing techniques for wireless ad hoc networks. The researcher proposed a low power adaptable hierarchy for efficient choice of cluster heads and also to evenly distribute load among network nodes while using less energy (LEACH). Additionally, a schedule for data packet transmission must be followed by the nodes [8]. For IOT with wireless sensor networks, fully distributed multilayer routing and clustering with energy awareness[9]. PRRP, or position responsive routing protocol, was suggested. The main goal of this proposed effort was to reduce energy consumption by the integration of a global

position system (GPS) into nodes. Throughout the network, a grid of equal size is created with a fixed or variable amount of nodes. The IOT network's nodes can interact with one another via GPS and adjust their transmission power to find the best path to the desired location. Based on the data that the source node sent, the route is inferred. Although its intention was to increase data aggregation, the delay and energy use that resulted from it were higher [10].

The issue of quickly determining the optimum path to the destination is resolved by the proposal of a geographic multicast routing routing system based on a light weight distribution. To begin with, intermediary nodes were selected to make sure packets arrived at their intended locations. Then, looping pathways are found and eliminated. The optimum route is then created by combining multicast routes [11]. It is suggested to use a routing protocol based on game theory to choose the most effective hop for data transport. A cooperative game among two nodes decides which next hop is preferable and takes into consideration the distances between the sender & receiving nodes [12].

This protocol performs well in networks with high traffic and provides resilient path routing for IoT applications. Additionally, it is better suited for IOT applications for monitoring healthcare. This protocol primarily focuses on three variables: the signal to interference & noise ratio, the path's survivability from the next step to the destination, and the degree of congestion at the next hop node. Additionally, this protocol excels in regards to network throughput and reduces end-to-end delay[13].

In multisensor networks, this protocol incorporates unique scoring to enable energy-efficient routing. By allocating a score value to every node along the way as the result of a mix of evaluation metrics, it balances power consumption throughout all nodes thus lengthens WSN lifetime. Furthermore, our routing method accommodates cooperating non-cooperative nodes by establishing trust. Therefore, this protocol performs better in terms of extending the overall network lifetime. Protocol for global data decision routing to enhance data transmission efficiency. Estimating each route's delay and

locating a different route were the objectives of the protocol. The ignored path causes a greater delay than expected [14].

A routing protocol that is cognizant of spectrum energy has been developed to enhance communication between devices within IOT networks. As a result, the network's load became unbalanced, and its lifespan shrunk [15].

Using location data, the location-based energy routing protocol (LBPAP) was suggested to decrease the number of request regions needed to reach a destination node. The search effort and the number of calculations were reduced by LBPAP using the idea of line slope, resulting in longer battery and route lives. Because packet retransmission must be started, which uses up node energy, this lowers network throughput and shortens node life [16].

For opportunistic networks inside an IOT situation, it suggests a location forecast routing system that uses a Markov chain to anticipate the node's upcoming position or region and calculate the likelihood that a node will move in the desired direction. The total estimated delivery protocol, which only uses path weighting, creates its weighting system by taking into account important variables such path quality, residual energy, end-to-end delay, & inter-node distance [17].

A technique called PDORP is suggested for finding routes that use little energy. The DSR functions as the protocol in this system. Additionally, a genetic algorithm and a hybrid bacterial forage optimization are employed to efficiently gather node information. such that this protocol helps to acquire a quick and undamaged path with the least amount of end-to-end delay [18].

The thorough survey mentioned above does show that the majority of studies for energy-efficient routing strategies are recommended. The intellect of nodes is frequent in ad hoc & IOT, nevertheless. As a result, the issue of energy usage needs to be

$$ETX(K, D) = E_{elec}(K) + E_{amp}(kd^2)$$

Formula for receiver side energy consumption below Equation 2. (1)

$$ERX(K) = E_{elec} * K \tag{2}$$

E_{elec} = per bit energy consumption the transmitter circuitry and receiver circuitry.

E_{amp} = per bit energy consumption by the transmitter amplifier.

appropriately handled. By modifying a routing mechanism, several techniques, including sleep behavior, hopping division, clusters division, and many others, focus on the unique contribution made by each node to energy efficiency. By assessing the total route energy of all projected routes created by utilizing the standard routing protocol DSR, our proposed routing protocol POLR-IOT would choose the route with lowest energy and energy usage for ensuing communication. [19].

III. Proposed Model

An outline of the suggested protocol can be found in this section. The presence of surrounding nodes is crucial when considering multi-hop communication. More surrounding nodes also increase the number of routes that are available to go to the destination. In addition, each node travels arbitrarily whereas a global position system is used to track all of its neighbors' locations (GPS). As a result, once the relay node is located, the packet is sent and continues to be sent till it reaches the desired node. As a result, some of the surrounding nodes are positioned comparatively closer to one another than the other neighbors; these nodes are known as closed neighbors. The closest node is selected to serve as the relay node since GPS tracks each node's location. We choose the path that utilizes the least amount of energy, just like in our suggested model. Additionally, the radio energy dissipation model is used to calculate the total amount of energy used during route creation, with energy consumption directly proportional to a square of the distance between the transmitter and receiver for signal amplification to achieve a desirable signal-to-noise ratio at the receiver [7]. The resulting equation is as follows. According to Equation 1, the amount of energy in joules required for a node to transport a packet longer by k bits over a distance of d.

$$Total\ Energy\ Consumed = P_{ETX} + P_{ERX}$$

the total energy expended for sending and receiving data, as given in Equation [3] before.

Protocol	Guaranteed delivery	Mobility	Tools	Forwarding
LAR[20]	No	RWP	MaRS	Reactive
DREAMS[21]	Yes	RWP	NS-2	proactive
GPSR[22]	No	RWP	Ns-2	proactive
ALARM[23]	No	RWP	SimPY	Reactive
GLR[24]	Yes	RWP	NS-2	Reactive
MDORA[25]	YES	CFM	MATLAB	Reactive
AQRV[26]	NO	VECHICLE MOBILITY MODEL	NS-2	Reactive
EGSR[27]	NO	MANHATTAN MODEL, SUMO	OMNET++	Reactive
PGRP[28]	YES	SHADOWING, SUMO	NS-2	Reactive
ECRA[29]	Yes	SUMO	NS-2	Reactive
HOPRP[30]	No	-	Ns-2	-
CM-AODV[31]	No	-	realistic	Ns-2
EDRP[32]	No	RWM	Ns-2	Reactive
ZoMo[33]	No	Vehicular Mobility	Ns-2	-
CBLTR[34]	No	SUMO	MATLAB	Flooding

The DSR protocol serves as the foundation for our suggested routing protocol's route finding and management [19]. While deciding on a path from such a source node to a destination, each forwarding node constructs the route. Multiple paths from destination to source can be found when performing route discovery, too. We choose the path that consumes the smallest amount of energy as a result. Because energy optimization is the main issue with IOT-Ad hoc networks [6].

IV. Proposed Protocol (POLRP-IOT Networks)

The Location Centric Energy Optimal Routing System is a brand-new routing protocol that this research suggests to IOT ad hoc networks. This

Destination	Source route record				...
Dest[i]	Addr [1] distance	Addr [2] distance	...	Addr[n] distance	...

Fig 1. Modified routing table format

3. Sending RREQ packet, which contain a listing of each intermediary node it travels through as

protocol makes use of nodes that have GPS receivers. This technique uses the nodes' geographic position data to transmit data.

1. The aforementioned protocol uses the DSR upon demand routing algorithm to only discover & maintain routes when necessary, launching the route maintenance and discovery system. Every time a source node has to send a packet to the target network but is unaware of how to do so, the route discovery process starts. Every node in DSR maintains the routing information where it saves freshly found routes [19].

2. An added 2-byte range (d) value is kept in the route cache of every node. The routing & topology control message allows each node to submit its own distance field [14]. Figure

[1] shows a route cache as a result.

well as the source-id, location, Req-id, and the source-id, is how the source node starts a route [19]. A 1-byte entry for the distance choice has been added to the header. This field's presence suggests that each address should be supplemented by d values. To prevent any unnecessary bandwidth and energy use, the distance d is often maintained as zero in the RREQ [14]. In addition, a proposed protocol's improved RREQ communication networks is displayed in fig 2.

Option Type	Option Data Length	Identification	Distance op
Target address			
Address (1)		Distance (1)	
Address (2)		Distance (2)	
.....			
Address(n)		Distance(n)	

Fig 2. Modified RREQ format

4. When a route request reaches a node with a path to the destination stored in a route cache, or the destination itself, RREP is generated [19]. As a

result, Fig. 3 below illustrates the packet's structure.

Option Type	Option Data Length	Distance	Reserved
Target address			
Address (1)		Distance (1)	
Address (2)		Distance (2)	
.....			
Address(n)		Distance(n)	

Fig 3. Modified RREP format

Additionally, the total distance from of the source to the destination is determined after receiving a RREP packet. In order to choose the optimal path in terms of both location & power optimization following the numerous iterations of route searching by DSR, use the equation presented below in Equation 4.

$$E = K * \min (\sum d_1^2, \sum d_2^2, \dots, \sum d_n^2) \quad (4)$$

E is the total energy expended from source to target to send the information.

A. Proposed Mechanism

Figure 4 shows the flowchart for our algorithm's whole workflow. Our suggested mechanism is broken down into three sub-components: initial

configuration, relay node selection, and information sharing.

1. Initial configuration

Each node transmits control packets to learn about its surroundings after the network has been deployed. In the course of transmission, every node builds a routing table that contains paths to a destination via relay nodes. Since finding the quickest path to the destination is the primary goal, each node determines the distance from of the relay node after it. Then, portions of this value are distributed to the neighbors.

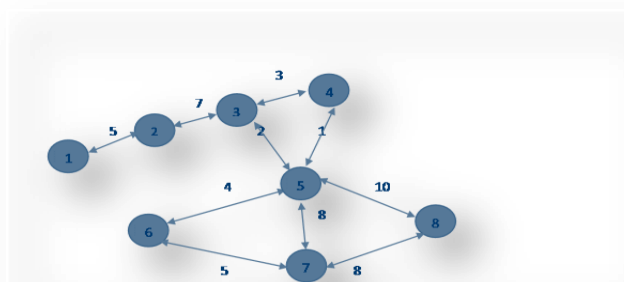


Fig 4. Random topology of Nodes

Presumption of making a route from Node 1 to node 8 for initial iteration is shown below in Table 2.

Routes	Distance of overall path ($\sum d$)	($\sum d^2$)	Energy consumption $E=Kd^2$
1-2-3-5-8	24	178	178000
1-2-3-4-5-8	26	188	188000
1-2-3-4-5-7-8	34	248	248000
1-2-3-5-6-7-8	32	193	193000
1-2-3-4-5-6-7-8	33	189	189000

Table 2: Different Route formation

From the view of above table, we choose the path which follow given below Equation [5]:

$$E=K*\min(\sum d_1^2, \sum d_2^2, \sum d_3^2, \sum d_4^2, \sum d_5^2) \quad (5)$$

$$E=K*\min(178,188,248,193,189) \quad (6)$$

For instance, shown below:

$E= k*178$ where assumed $k=1000$ means $E=1000*178=178000$ energy units.

2. Selection of Next Hop Node

The source node decides on a path and sends the RREQ to a higher hop address with the shortest distance. Repeating this action are all forwarding

nodes. The last mile node replies to the RREP delivered by the source node as it is the node closest to a destination along the route.

3. Information Exchange

The involved nodes compute their distance from of the nearest relay node using their current location each moment a data transfer takes place. The DSR protocol is used as the foundation protocol and allows each participating node to acquire a list of any and all relay nodes and their relevant distances. The nodes broadcast extra data in addition to the routing path which measures the separation between the current node and the following hop [19].

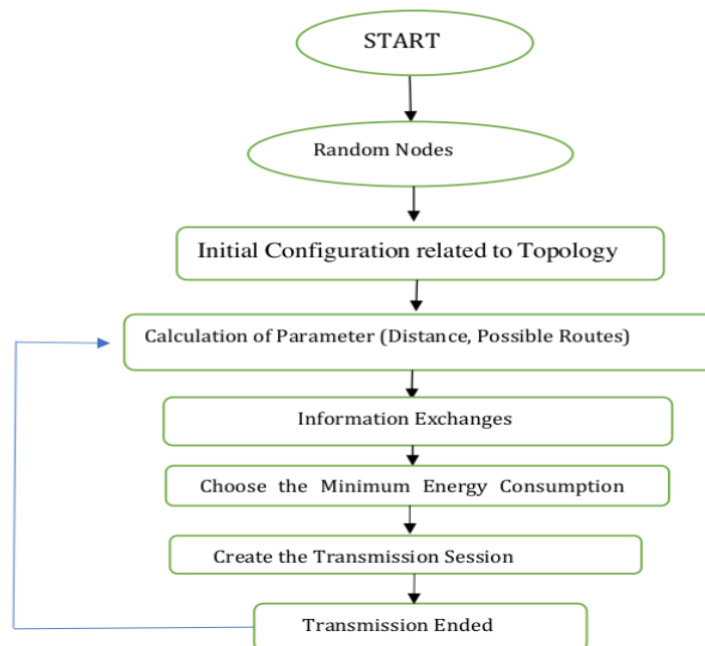


Fig 5. Flowchart for the Suggested Mechanism

V. Simulation & Results

The proposed application was modelled with the aid of the p5.js technology and JavaScript. Table 3 presents a list of the simulation parameters.

Parameters	Values
Number of nodes	20,30,40,50
Area	1500*1500
Propagation speed	4.2m/sec
Transmission range	350,400,450,500
Node distribution	Random waypoint model
Base protocol	DSR
Rx power	0.6 w
Tx power	0.6 w
Comparisons protocols	AODV
Software Used	JavaScript and its library p5.js
[pProcessor	Intel Core i5-7200 CPU @2.50GHz 2.70GHz
++RAM	8GB
System Type	64-bit Operating System, x-64 based processor

Table 3 Simulation Parameters

The simulation is shown with different transmission distances and placements for different node counts. Every node was in motion, hence the random waypoint model is employed to track their movements. Due to the unpredictable node motions, the GPS system (GPS) also precisely pinpoints each node's location. Based on where they had been, some nodes could be dispersed densely while others had few nearby nodes. Because of this, node location significantly affects network throughput, especially in terms of availability, networking life, and node proximity, which also lowers overall power consumption. Additionally, each of the chosen approaches have a reactive nature. As a result, a comparison is conducted between the protocol we recommend,

POLRP-IOT, and a protocol that determines the shortest path by utilizing a distance measure, such AODV. The entire power consumption of both protocols is compared when building different routes from source to destination while accounting for different transmission ranges [35]. Since the distance between the nodes determines how much energy is used overall in the shortest route-finding protocol route, equation 7.

$$E \propto d \tag{7}$$

However, as shown in the equation below, our proposed protocol POLRP-overall IOT's energy usage is based on the squared distance between nodes.

$$E \propto d^2 \tag{8}$$

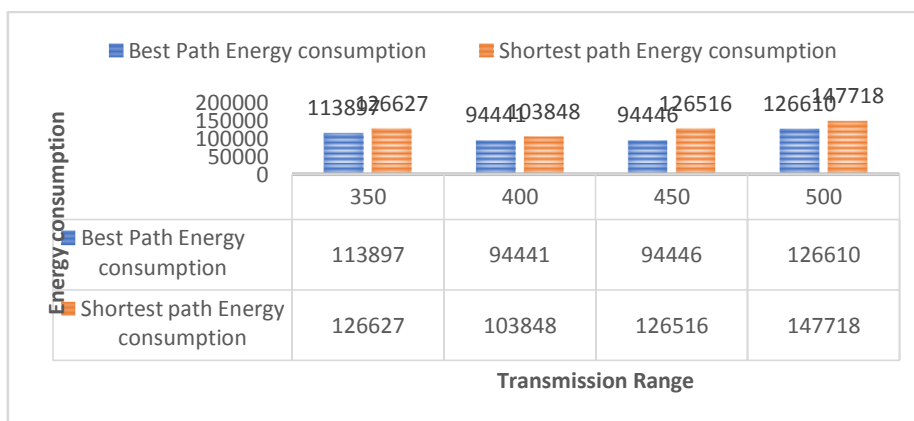


Fig 6. Energy consumption of 2 different protocol w.r.t Transmission Range

Since it shows lower energy consumption during route building in respect to various transmission ranges, the above figure illustrates how well our suggested protocol, POLRP IOT, performs in contrast to existing protocols.

Figure 7 illustrates how our suggested protocol works, showing how the overall network lifespan

gets better as the number of nodes rises. Additionally, longer network lifespans increase availability and throughput, which enhance network performance as a whole. Figure 7 below illustrates how POLRP-IOT and LEACH outperform other protocols such as DSR and PDORP.

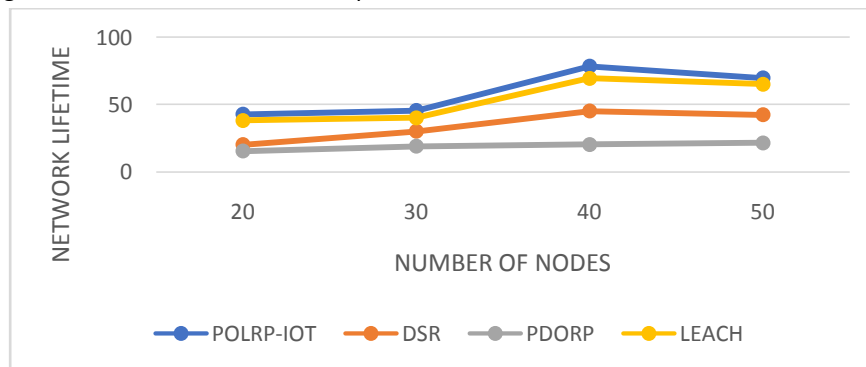


Fig 7. Network Lifetime of 4 different protocols w.r.t number of nodes

VI. Discussion

Finding the path with the lowest energy consumption (battery power) while still extending network lifetime is the goal of the POLRP-IOT protocol, which has been suggested. Additionally, the aforementioned results of the suggested protocol demonstrate improved performance in terms of energy usage when compared to a AODV protocol in terms of transmission range. The proposed protocol therefore outperformed in terms of reduced energy use relative to transmission range, with 10%, 9%, 25%, and 14% less consumption at transmission ranges of 300, 350, 400, and 450, respectively. These findings also demonstrate that it outperforms protocols like DSR, LEACH, and PDORP and lengthens network life as node count rises.

VII. Conclusion & Future Scope

The suggested methodology uses location to determine the best path with minimal or ideal power consumption. On top on DSR as a foundational protocol, we implemented POLRP-IOT. When compared to the smallest route-finding protocol (AODV) with regard to transmission range, the POLRP-IOT performed better in the trial in terms of overall route energy usage. In comparison to DSR, LEACH, and PDORP,

the suggested protocol also extends the total network lifetime. Game theory and the use of the cluster of groups inside the networks can be used to further this study. Additionally, the developed framework can be integrated with a system for managing trust to provide a route that is entirely reliable.

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